Evaluation of Mitigation Success Criteria from Mine and Mitigation Bank Permits

Florida Department of Environmental Protection

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Floodplain Swamp, Econlockhatchee River, Orange County, FL

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Contents

Abstract

This is a comparative study of mitigation success criteria in phosphate mines, non-phosphate mines, and mitigation bank permits. The success criteria from 39 recent permits have been assembled, categorized, and compared for projects based on similar plant community types (specifically forested wetlands, herbaceous wetlands, and wet flatwoods) within permits for all three permitting groups. Examples of similar success criteria categories, such as vegetation, hydrology, and wildlife, are identified and evaluated. Categories that are unique to one or two permitting groups have also been compiled and reviewed. Reasons for similarities and differences are presented and discussed while successes and shortcomings are recognized.

Introduction

A team of highly experienced, Department of Environmental Protection employees has been tasked with categorizing and comparing the success criteria conditions within at least thirty Department permits to evaluate and define successes and shortcomings of existing permit success criteria. Permits from three permitting groups were reviewed: mitigation banking, phosphate mining and non-phosphate mining. This study is in support of the Department's policy of continuous improvement and providing exceptional customer service. This includes eliminating possible sources of waste and improving efficiency for the regulated community, Department staff, and the public.

The Applicant's Handbook (Section 10.1, effective 10/1/2013) states that the intent of the wetland regulatory provisions in the Environmental Resource Permitting program is, "…achieves a programmatic goal, and a project permitting goal, of no net loss in wetland or other surface water functions". Section 373.414(1), Florida Statutes (F.S.), requires the applicant to demonstrate that an activity will not be harmful to water resources or inconsistent with the overall objectives of the Department. The applicant must provide reasonable assurances that the activity in, on, or over surface waters or wetlands is not contrary to the public interest or will be clearly in the public interest using the seven criteria in the balancing test and the State water quality standards. Well-developed success criteria demonstrate to the public that the Department and the permittees are meeting this legislative requirement.

At their best, success criteria can provide objective measurable targets that provide permit holders a clear goal to achieve both regulatory success and a viable target ecosystem or community. At their worst, success criteria can force a permittee to base management activities on chasing a number that is not relevant to system development or target community characteristics. Equally bad would be where numeric success criteria are met without actual restoration of form and function of the target natural community. Success criteria can also be ambiguous, which may result in different interpretations of what success should look like. Success criteria should be clear, measurable, cost-effective, and correlate strongly with restoration of ecosystem functions and services.

The first wetland mitigation projects permitted were initiated following passage of the Warren S. Henderson Wetlands Protection Act of 1984, Sections 403.91 through 403.938, F.S. Subsequent to passage of that bill, the Florida Department of Environmental Regulation (DER) adopted Chapter 62-312, Florida Administrative Code (F.A.C.), (effective December 10, 1984). Rule 62-312.350, F.A.C. (effective date January 3, 1989), provided some early guidance on the development of mitigation success criteria. Although the rule was repealed in 2012, this section is still applicable for mining projects that are grandfathered from the environmental resource permit rules. This language reads as follows:

"62-312.350 Determination of Success for Mitigation Projects.

(1) Success criteria. Due to the wide range of types of projects which may be used to create or enhance existing waters, specific success criteria will be determined on a case-by-case basis. A determination that the mitigation area will be compared to a reference water will be specified by conditions in the permit when there is insufficient information available to judge the successful creation or enhancement of the type of wetland involved. In comparing the mitigation area to a reference water, it is not the intent of the Department to require that the mitigation area exactly duplicate or replicate the reference water. The reference water is to be used as a guide to the Department to assure that the mitigation area will be sufficiently similar to the reference water to meet the permitting criteria. Success must be measured in terms of whether the objectives of the mitigation can be realized. The success criteria to be included in the permit conditions must clearly address the minimum requirements necessary to attain a determination of success (e.g., percent cover by wetland vegetation, vegetation is reproducing naturally, target water quality standards are met, etc.). The mitigation will be judged to be successful if:

(a) All applicable water quality standards are met. However, where reference waters are used as a standard for dissolved oxygen, the daily and seasonal fluctuations of dissolved oxygen in the reference waters of the state shall be maintained;

(b) The mitigation project has a hydrologic regime sufficient to sustain it in a viable condition; and

(c) The specific success criteria contained in the permit are met.

(2) Climatic impacts. The Department shall take the occurrence of extreme or unusual climatic conditions into consideration when evaluating the success of the created or enhanced waters.

(3) Subsequent to determination of success by the Department, the waters of the state created or enhanced as mitigation can be used for purposes permittable pursuant to Chapters 62-6 and 62-25, F.A.C."

The above language is also referenced in the Mitigation Banking Rule (Chapter 62-342, F.A.C., effective February 2, 1994) in the definition of success:

"Rule 62-342.200(10), F.A.C., "Success" means when a Mitigation Bank meets the success criteria provided in Rule 62-312.350, F.A.C., and in the Mitigation Bank Permit."

Additionally, the Applicants Handbooks adopted as part of the Environmental Resource Permit rules, which has been in effect for most of the state since October 1994, provides the following success guidance:

*"**X.3.6 Mitigation Success:** Mitigation success will be measured in terms of whether the objectives of the mitigation can be realized. The success criteria to be included in permit conditions will specify the minimum requirements necessary to attain a determination of success. The mitigation shall be deemed successful … when all applicable water quality standards are met, the mitigation area has achieved viable and sustainable ecological and hydrological functions and the specific success criteria contained in the permit are met. "*

Mitigation Banking

The state of Florida authorized the establishment of mitigation banks and other offsite regional mitigation in 1993 with the passage of legislation that created Ch 373.4135 and .4136, FS. This legislation provided a shift in direction of mitigation in that it focused on an ecosystem approach, as stated in Ch 373.4135(1), FS: *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.*

As a result, the mitigation banks included more upland restoration, wetland restoration, and preservation as part of mitigation plans, compared to project-specific mitigation. In addition, there was a greater emphasis on restoring wetlands to their historic condition, rather than creation. These mitigation plans and associated success criteria proposed by the applicants, especially in the initial years of the program, led to the development of site-specific criteria for most mitigation banks.

Mining

Due to the nature of mining and the statutory reclamation requirements of chapter 378, F.S., most mining projects continue to rely on on-site creation for mitigation rather than using mitigation banks. The link between reclamation and mitigation for phosphate and heavy minerals mines is further strengthened by the provisions of Section 373.414(6)(b), F.S., which states that, "wetlands reclamation activities for phosphate and heavy minerals mining undertaken pursuant to chapter 378 [F.S.] shall be considered appropriate mitigation under this part if they maintain or improve the water quality and the function of the biological systems present at the site prior to commencement of mining activities"; the criteria for fullers earth mining (Section 373.414(6)(c), F,S.) is the same with the exception of the following caveat: " unless the site features make such reclamation impracticable, in which case the reclamation must offset the regulated activities' adverse impacts on surface waters and wetlands."

For limestone and sand mines, the mining operations result in a pit or lake with wetland mitigation typically done outside the footprint of mining operations. Most of the mitigation is done within or near the property of mine owner in the form of enhancement or restoration and occasional creation.

With on-site creation continuing as a common method of mitigation for many mining projects, the development of standard success criteria became important. After wetlands permitting was delegated to phosphate and non-phosphate staff in the mid 1990's, the success criteria evolved within each group to take into consideration the different mining methods and site conditions at the time wetland mitigation construction begins.

Non-phosphate

The Mandatory Non-phosphate Section developed the Specific Conditions Starter Kit. The purpose of the Starter Kit was to provide a suite of possible permit conditions, speed the permit writing process, and reduce errors. The Starter Kit's draft specific conditions were pre-reviewed for grammar and spelling. This included specific conditions for construction, water management, monitoring, wetland mitigation and release, on a case-by-case basis. The first version of the Starter Kit was based on previously used conditions from the short-lived Ghost Writer software developed for the Department. This version also included specific conditions from permits recently issued through the Bureau of Mine Reclamation (BOMR).

The use of the Starter Kit has resulted in permits with very similar success criteria. Over time, specific conditions were modified or added to the Starter Kit. The use of the Starter Kit did not prevent permit writers from modifying specific conditions or adding additional specific conditions to take into consideration unique site-specific and regional conditions. The Starter Kit did not provide success criteria targeting specific community types. Rather, each community type, the acreage of each wetland or community, species to be planted, and water levels were specified in the wetland construction conditions and plans. The success criteria were intended to be generic and applicable to all community types identified in the mitigation plans. These included (in summary):

- The mitigation site must be self sustaining for at least one growing season without intervention.
- Each mitigation site must have the minimum required wetland acreage and the type of targeted habitat based on the construction conditions.
- Hydroperiods must be within the range appropriate for the target community type. For long term projects, water elevations shown on plans are conceptual. Final contouring will be based on water levels at the time mitigation construction begins.
- Plant species and coverage must be what would be expected for the target habitat type.
- At least 80 percent cover of plants must be reproducing naturally, that are obligate or facultative wet species (other than in uplands), that commonly occur in the target community type, and are native to the county.
- Exotic and nuisance species are limited to five percent or less of the total cover.
- Forested wetlands must have at least 400 trees per acre growing above the herbaceous and shrub stratum. The canopy cover by appropriate trees exceeds 33 percent of the mitigation wetland area and in no area of an acre in size is the canopy tree cover less than 20 percent total cover.

Phosphate

For phosphate mining, most of the conditions in earlier permits were very similar to those of the non-phosphate starter kit since they were derived from earlier permits. They were typically vegetation based and included:

- Percent cover by native, non-nuisance wetland species shall be 80% or more in the groundcover;
- An average of 400 trees per acre shall be growing above the herbaceous stratum. No area more than 1-acre in size shall contain less than 200 trees per acre;
- The tree cover exceeds 33% of the vegetational cover and in no area of an acre or more in size is the tree cover less than 20%.
- Understory vegetation is reproducing naturally. Cattail, primrose willow and exotics are limited to 10% or less of their total cover. If these species exceed 10% of the total cover, their density must be declining over several years, which would be considered a positive indication that they are under control; and
- The restored wetland has a similarity of 0.6 (as determined using Morisita's Index) and 75% of the diversity of a mutually agreed upon control wetland (based on literature values, if possible).

An effort was made in the mid 1990's to improve on these criteria by evaluating what was in place in other areas around the country and to address shortcomings observed in some of the mitigation sites constructed at that time. Problems observed included: issues with hydrology, a lack of shrubs other than wax myrtle and willow, problems meeting the Morisita's Index requirement, inappropriate use of reference wetlands, and an inability to adequately assess reclaimed stream function, among others.

More recent permit conditions addressed these problems by having a heavier reliance on a range of reference wetlands for comparison of vegetation, replacing the similarity index with dominance and species richness requirements, more specific hydrologic requirements based also on reference wetland comparisons, and for forested systems, adding shrub density requirements and replacing the percent canopy cover requirement with minimal tree height. Additional criteria were developed for streams based on the macroinvertebrate community. Minor changes have been made over time to allow for continual improvement of the permit success criteria, to provide more flexibility and to correct missing attributes observed in some mitigation sites.

Approach

In order to evaluate the existing success criteria, our team assembled and reviewed permits from each of these permitting groups. A total of 39 permits were reviewed (Appendix A): 22 were mitigation bank permits, 8 were phosphate mine permits, and 9 were non-phosphate mine permits. All of the mitigation bank permits issued by the Department were considered,

rather than a more recent subset, in order to consider a wider range of target communities, forms of mitigation, and related success criteria.

The review included success criteria for preservation, creation, restoration and enhancement within phosphate permits, non-phosphate permits, and mitigation bank permits (Appendix C, D and E). Criteria associated with the purchase of mitigation bank credits were outside the scope of study.

Three broad types of mitigation communities were commonly found in the permits reviewed: forested wetlands, herbaceous wetlands, and wet flatwoods. Forested wetlands encompassed a large range of natural plant communities generally considered to be swamps and specifically include mixed hardwood swamps, gum swamps, bay galls, cypress domes and stringers, hydric hammock, floodplain swamps, etc. Similarly, herbaceous wetlands include wet prairies and a variety of marshes with different hydroperiods; these systems also included a shrubby or bog component at times. Wet flatwoods were all distinguished by plants with pyrogenic properties with generally sparse canopy of either pines (mostly longleaf, but also included slash or pond pines) or cypress or both.

Three other community types appeared to be more exclusive to particular permitting groups: streams, coastal communities, and uplands. Stream mitigation and associated criteria was mostly found in phosphate mine permits; coastal plant communities (tidal or estuarine) are limited to the mitigation bank permits; and upland mitigation was more frequently a component of mitigation bank permits than mines.

During review of the success criteria for each of these permits, a number of parameters were found to be frequently and commonly used for similar mitigation targets. Some of these parameters were applicable to many or all community types; others were specific to some community targets, but were found within all program permits. These common permit success criteria parameters served as the framework for Appendix B.

Certain types of permits were excluded from this review. This project did not review permits issued to mines located in the Miami-Dade Lake Belt Area. Permits for mines in this area must meet the unique requirements of Sections 373.4149 through 373.41495, F.S. To provide for the mitigation of wetland resources lost to mining, a mitigation fee is imposed on each ton of limerock and sand extracted. As provided in Section 373.41492(7), F.S., payment of the fee satisfies the mitigation requirements imposed under Sections 373.404 through 373.439, F.S., and any applicable county ordinance. The fee is provided to the South Florida Water Management District for use in constructing wetland mitigation for the permittees. An interagency committee determines how the funds are used. The permits for each mine do not include success criteria for wetland mitigation.

Chapter 62-348, F.A.C., provides for alternative wetland mitigation for the mining of high-quality peat. High-quality peat is mined from herbaceous freshwater wetlands, is classified as H1 to H4 (high fiber) on the von Post Humification Scale and has a pH less

than 7. High fiber peat is required by the horticultural industry. To date, no applicant has applied to use the alternative wetland mitigation provided by this chapter and thus there are no issued permits to review.

Results

The vast majority of the permits reviewed contained success criteria parameters that were in common between permits, permit types, and community types. In this section, the common success criteria parameters are presented for both site-wide criteria and the three broad freshwater wetland community types found within both mining and mitigation bank permits: wet flatwoods, forested, and herbaceous. In addition, there were permit-specific criteria for the less common community types, including streams, uplands, and coastal communities.

Site-Wide Success Criteria

Most of the permits reviewed had a set of success criteria or standards that were applied across the entire mitigation area, or to each of the wetland components of the mitigation plan, and they were referred to as mine-wide or bank-wide standards. The most commonly used site-wide parameters and examples of the permit conditions are listed in Appendix B.

Period of non-intervention

Several permits required that the mitigation area be able to meet the overall success criteria without active management or corrective action for a specified period of time, as indication that the site is generally sustainable. The required period of non-intervention prior to release or success determination ranged from one to three years depending on the permit. This requirement does not negate other permit criteria that the site be maintained in perpetuity, however. At mitigation banks, these criteria, along with the other success criteria, must be met before the long-term maintenance period. At mines, the mitigation area is expected to maintain wetland functions after reclamation is complete and the land has been transferred to the next owner.

Plants are healthy and reproducing naturally

Permits required that conditions exist that will allow the plant community to be sufficiently healthy to spread via vegetative growth and reproduction into the future. Seedling establishment, growth and survival would also be expected when the conditions are appropriate for the expected plant community. Individual plant species are expected to be reproducing as expected for the species. Naturally reproducing plants would indicate that the mitigation area has soil, hydrologic and other conditions suitable for the target community. This is also an indicator that the mitigation will be sustainable in the long-term.

Target Communities

Most reviewed permits specified or described the overall goal of the mitigation or the target community type. In some cases, the permits used names and codes based on the Florida Land Use, Cover and Forms Classification System. In others, the permits used nomenclature based on the Florida Natural Areas Inventory (2010 edition or earlier).

Acres of Target Community

Permits identified the minimum number of acres that each target community type must achieve. This may be provided in the text of the success criteria, as a table, or in the construction conditions of the permit. Some mine permits identified the minimum acres for each mitigation site within the project, while others specified the minimum acreage of each community type within the project area.

Wetlands are Jurisdictional

Permits required that wetland communities at least meet the wetland delineation criteria. When defining the delineation criteria, this criterion either referenced Chapter 62-340, F.A.C., or Section 373.421, F.S. The use of delineation criteria was often used in conjunction with the required minimum acres for each wetland community type or wetland mitigation site.

Hydrology

Many permits include a narrative requirement or intent of the mitigation area, as a whole, to have "normal" or natural hydrologic conditions, generally based on observations over time (not necessarily water level recorders) of the hydrologic conditions. Indicators of hydrologic condition also included "no evidence of washouts, erosion or…unnatural channelized water flow" (Bear Creek MB) and hydric soil indicators (Sweetwater Mitigation Bank). Some banks also included site-specific criteria for particular wetland areas, based on the regional reference conditions and mitigation activities. Hydroperiods and depths of inundation, based on field measurements, are standard conditions for non-phosphate mine permits, and phosphate mine permits typically require that water level data resemble reference wetlands or the range of values predicted by modeling (such as in Mosiac South Fort Meade Hardee mine permit).

Soil Criteria

Six mitigation bank permits where hydrologic changes are proposed at the site (Bayfield, Bear Creek, Heather Island, Little Pine Island, St. Marks, and Sweetwater) included soil-based success criteria. Most of these require that the wetlands demonstrate or indicate appropriate hydric soils.

Most recently issued phosphate permits include criteria requiring the development of hydric soil characteristics and appropriate soil moisture. Phosphate permits have also included other soil characteristics of compaction and litter accumulation (Ona Fort Green) in addition to hydric indicators (South Pasture Extension) as part of the success criteria.

Nuisance and Exotic Plant Species

Limits on the coverage by invasive exotic and nuisance species were in all permits. However, the format and performance standard of these success criteria was substantially different between the reviewed permits. Some permits just used the term "exotic species." Sometimes examples were provided such as melaleuca, cogon grass, Brazilian pepper, and Australian pine. Other permits specifically referred to the Florida Exotic Plant Council's List of Invasive Species. Some permit conditions specified the publication year of the list, while others were open ended referring to "the most recent" list. Some permits specifically stated that the Category I and Category II lists were to be used.

Many permits just used the term "nuisance species." Often examples were provided such as *Typha* spp., *Mikania scandens, Trema micranthum, Rubus,* and viney species such as *Vitis* and *Smilax*. The non-phosphate mine permits referenced the definition of nuisance species in surface waters quality standards (Rule 62-302.200(20), F.A.C., "Nuisance species" shall mean species of flora or fauna whose noxious characteristics or presence in sufficient number, biomass, or areal extent may reasonably be expected to prevent, or unreasonably interfere with, a designated use of those waters.).

Some permits had separate criteria for invasive exotic species and nuisance species; other permits combined them into one maximum cover criteria. The coverage limits also varied considerably with the permit. Examples are:

- Nuisance and exotic vegetation shall not exceed 1% of the aerial extent. (Everglades Mitigation Bank, Phase1)
- Invasive exotic species cover is less than 1% cover in any one acre and nuisance native species are less than 5% cover in any one acre (Sandhill Lakes Mitigation Bank).
- Less than 2% coverage with invasive exotics vegetation and less than 5% coverage of nuisance vegetation. (Everglades Mitigation Bank, Phase1)
- Exotic and nuisance species are limited to five percent or less of the total cover (Non-phosphate)
- Coverage by category I and II invasive exotic plant species (pursuant to the most current list established by the Florida Exotic Pest Council at www.fleppc.org) shall not exceed 1% total coverage per acre; and
- Nuisance species including, but not limited to *Typha, Rubus,* and viney species such *Vitis* and *Smilax,* are <5% cover per acre (10% in uplands) (Bayfield Mitigation Bank).

- Invasive exotic vegetation shall not exceed a total of 2% cover per acre, and shall consist of only seedlings sprouted since the previous treatment.
- Invasive exotic species cover is less than 1% cover in any one acre and not more than a cumulative 2 acres throughout the site.
- Invasive exotic vegetation (based on the 2009 list of Invasive Species by the FL Exotic Pest Plant Council (EPPC), Category I) shall not exceed a total of 1% cover, and nuisance vegetation (EPPC, Category II) shall not exceed a total of 3% cover per acre bank-wide.
- Cover by nuisance vegetation species, including cattail (*Typha* spp.), climbing hemp vine (*Mikania* spp.), saltbush (*Baccharis* spp.), and willow (*Salix* spp.), shall be limited to less than 10% relative cover. However, any member of the species listed above shall not be considered a nuisance species in cases where it individually contributes less than 3% to the relative vegetation cover and does not dominate any patches greater than ¼-acre in size (South Pasture Extension, PCS Loncala)
- Cover by nuisance vegetation species, including, but not limited to *Typha* spp. (cattail), *Ludwigia peruviana* (primrose willow), and *Mikania* spp. (climbing hemp vine) shall be limited to less than 10% of the total wetland area. (Mosaic Ona-Fort Green)
- Invasive exotic vegetation including, but not limited to Cogon grass (*Imperata cylindrica*), melaleuca (*Melaleuca quinquenervia*), Climbing fern (*Lygodium* spp.), Chinese tallow (*Sapium sebiferum*), primrose willow (*Ludwigia peruviana*), and Brazilian pepper (*Schinus terebinthifolius*) shall not be considered an acceptable component of the vegetative community. Invasive exotic species shall mean those species listed on the Florida Exotic Pest Plant Council's 2011 list of invasive exotic plant species. (PCS Loncala).

Success Criteria for Wet Flatwoods

Flatwoods communities are included in both mining and mitigation bank permits, but variously referred to as "wet flatwoods", " hydric pine flatwoods", FLUCCS 411 (upland pine flatwoods), and FLUCCS 625 (hydric pine flatwoods). For the purpose of this report, success criteria review and discussion is focused on wet flatwoods. The permit bank/mine-wide success criteria generally further define this community based on FLUCCS list of dominant species, permit-specific reference wetlands, or the Florida Natural Area Inventory's Guide to the Natural Communities of Florida.

Wet flatwoods ground cover

All of the permits included a success criteria parameter that required a minimal cover by native herbaceous species. The amount of cover required varied from 55% cover by fire-adapted, native, wet flatwoods/wet prairie species (Sandhill Lakes MB) to 80% cover by non-nuisance, non-exotic FAC, FACW, or OBL species (CF South Pasture Extension mine). In general, those permit conditions with greater percent cover requirement had less restriction

on the species that could be considered with the cover measurement. It appears that the intent in those cases was the establishment of sufficient ground cover to prevent erosion and to preclude establishment of nuisance/ruderal/weedy or exotic/ invasive species.

The maximum amount of remaining non-vegetated area (bare ground, leaf litter, open water) in this community type was generally in the range of 10 – 20%.

Wet flatwoods ground cover composition

Similarly, all of the permits included one or more success criteria parameters that addressed the composition of the groundcover strata.

The template language for non-phosphate mining permits generically referred to species "that commonly occur in the target habitat type and are native to XX county" when measuring cover, and "species …similar to what would be expected for the target habitat type".

A reference wetland is sometimes used for community composition comparison, as in "species richness and dominance regimes shall be within the range of values documented within the referenced hydric pine flatwoods"(CF South Pasture Extension mine) and "at least 75% of the quadrat's species shall also be found in the reference wetland sampling" (Pensacola Bay MB).

In some permits, the community composition is addressed by cover by certain species or groups of species, as in "average cover of graminoids is 60% of the herbaceous groundcover" (Sandhill Lakes MB) or "at least 10% of the relative cover shall be derived from wiregrass (*Aristida stricta* var. *beyrichiana*)" (CF South Pasture Extension mine).

Other permits specify the expected or minimum species diversity, such as "an average of at least 40 species typical of wet flatwoods" (Nokuse Plantation MB), "$\geq$ 45 appropriate species per transect" (Bayfield MB) and "the cumulative total of appropriate species from qualitative and quantitative transects >60" (St Marks MB).

The most common species-specific or group- criteria for flatwoods groundcover composition involved fine fuel grasses, especially in contrast to ruderal or non-native pasture grasses. This has been expressed as "wiregrass plus Curtis's dropseed shall rank among the top 5 herbaceous species in dominance" (Bayfield MB), "cumulative total cover by range grasses, such as Bahia grass (*Paspalum notatum*) and Bermuda grass (*Cynodon dactylon*), shall be less than 10%" (CF South Pasture Extension mine), and "the collective cover of pioneer *Andropogon spp*. does not exceed 25% cover" (Sandhill Lakes MB).

Wet flatwoods Shrub cover, height, composition

The shrub strata component of wet flatwoods was expressed in two very different types of success criteria.

The mitigation bank permits, and some of the mine permits, had criteria that were based on frequent fire management of the flatwoods, with expected outcome of limiting shrub height and cover contribution to the community. Examples include "less than 30% relative cover with woody shrubs" and "At least 80% shrubs reduced to coppice <2m in height" (Breakfast Point MB), "Gallberry, yaupon, wax myrtle, fetterbush, titi and other woody shrubs shall be no taller than the coppice sprouts that could have arisen from root crowns following the most recent successful fire" (Nokuse Plantation MB) and "For wet prairies and flatwoods with fire management: Gallberry, yaupon, wax myrtle, titi, and other woody shrubs shall be no taller than the coppice sprouts that could have arisen from root crowns following the most recent fire" (Non-phosphate).

On the other hand, some phosphate mine permits had minimum cover and composition requirements for the shrub strata, with no fire management indication: "The shrub layer shall contain at least 5 of the species listed for the target community type on Appendix 7 - Table RP-2 and shall have an average of at least 300 shrubs per acre" (CF South Pasture Extension) and "Hydric pine flatwoods areas shall have an average density of 350/shrubs acres to be composed primarily of saw palmetto (*Serenoa repens*), gallberry *(Ilex glabra*), fetterbush (*Lyonia lucida*), and other species typical of hydric pine flatwoods" (Mosaic Ona-Fort Green).

Wet flatwoods Canopy cover and composition

Because a hydric flatwoods is a forested community, nearly all permits contained success criteria for canopy cover, canopy density, and/or canopy composition. The tree density requirements varied greatly and appear to reflect, in part, the pre-mitigation condition.

Some mitigation bank sites are silviculture sites that were planted intensively with slash pine; in these cases, the intent is to *reduce* the slash pine density: ""The combined canopy (>4" d.b.h.) of slash pine and loblolly pine shall not exceed 15 live trees/acre on average, and in no monitoring quadrat should the tree density be greater than 20 trees/acre." (Pensacola Bay Mitigation Bank)

In addition, those mitigation banks that were previously silviculture sites had criteria on the shift of canopy species from a dominance by slash pine to one of longleaf pine: "Total slash pine saplings and trees are <75 trees per acre, with an average of 50 longleaf pine/ ac. taller than grass stage and increasing in height" (St Marks Mitigation Bank).
For mining sites where there is no existing plant cover, the intent is to *create* a minimum density of trees, dominated by pines, to establish the community: "Pine flatwoods areas shall have an average of 50 trees per acre." (Mosaic Ona-Fort Green), "shall have an average of at least 150 live trees per acre that are at least 12 feet tall. No area greater than an acre in size shall have less than 50 trees per acre" (CF South Pasture Extension), and "The canopy layer shall be dominated by (meaning that > 50% of all trees are) slash pine (*Pinus elliottii*)" and

"At least 5 of the tree species on Appendix 7 - Table RP-2 shall be present" (CF South Pasture Extension).

Wet flatwoods fire management

As noted in the shrub strata criteria, hydric pine flat woods in Florida had a historic fire frequency of 1- 3 years, although there may be periodic fire frequencies of 5 – 10 years in certain landscape settings and conditions.

Success criteria in mitigation bank permits generally refer to cover by fire or number of successful fires, such as "Prescribed fire routinely carries over a minimum of 70% of the community type after each burn." (Nokuse Plantation MB) and "At least 3 successful prescribed fires have been conducted in this community" (St Marks Mitigation Bank). In these permits, the required frequency is addressed in other permit conditions specific to the prescribed fires, such as this condition from St Marks Mitigation Bank permit: *12. Fire Management Plan. Following the completion of plantation pine thinning described in Specific Condition 11 above, prescribed fire shall be implemented in accordance with this condition and the Fire Management Plan, provided as Attachment C, to attain the proposed enhancement, and as a long-term management tool to sustain the communities and function..… An initial fuel- reduction prescribed burn shall be conducted within 1 year following harvest in any management unit. Subsequent burns are scheduled on a target of a 3 year rotation or as frequently as fuel and weather conditions would result in a complete restoration burn.*

At least one of mining permits' condition is similar in that is refers to other resources for fire frequency: "Prior to release request, all mitigation sites which involve the creation of fire-dependent communities, including freshwater marshes and hydric pine flatwoods, shall have in place a long-term management plan that includes prescribed burning at ecologically appropriate intervals. For the purposes of this condition, ecologically appropriate fire return interval shall be determined through consultation of the Florida Natural Areas Inventory's Guide to the Natural Communities of Florida (2010 Edition), the Soil Conservation Service's 26 Ecological Communities of Florida (February, 1981), or other published literature documenting natural fire return intervals in the appropriate community type" (PCS Loncala and CF South Pasture Extension).

The non-phosphate template language provides a definition of successful burn and reliance on a separate plan, analogous to the mining permit language, but with a larger acceptable range of fire frequency: "b. The fire management plan to be used is detailed in Attachment *[XX]* to this permit. The permittee shall obtain appropriate state and local approvals prior to starting the burns. Within *[XX]* months after permit issuance, or as soon thereafter that the appropriate climatic conditions exist, the initial burn shall be conducted in a manner to optimize fuel management, enhancement of appropriate vegetation and eradication of nuisance or inappropriate woody shrubs. Thereafter, prescribed burns shall be conducted in accordance with the fire management plan during early summer growing season every 1 to 7

years (depending on fuel and climatic conditions) to promote the reproduction and establishment of appropriate species. c. A prescribed fire will be defined as "successful" if at least 80 percent of the appropriate areas within a burn unit are burned. (Non-phosphate)

Wet flatwoods Hydrology

In general, permits with flatwoods that did require hydrologic data for success applied those criteria site wide, for all of the wetland communities, and relied on comparison to reference wetlands or target expectation: "Each site shall have hydroperiods and depths of inundation based on field measurements that are within the range of conditions for the target community type" (Non-phosphate), "Each created wetland shall have hydroperiods and depths of inundation sufficient to support wetland vegetation and that are within the range of conditions occurring in the reference wetlands of the applicable community type for the same time period as determined based on the monitoring data." (CF SPE), and "Wetland hydrology shall indicate the presence, morphology and distribution of seasonal high saturation and seasonal high inundation, and/or hydric soil indicators sufficient to confirm that the appropriate saturation or inundation depths are achieved for the target ecosystem" (Sweetwater Mitigation Bank)

Where specific hydrologic activity is part of a flatwoods mitigation plan, there were specific hydrologic criteria for the flatwoods at that particular site that reflected regional climate patterns and expected regional water levels, such as "Minimum of 90 days of soil saturation (water levels within 6 in of surface) or inundation during June-Oct. of a typical rainfall year" (Corkscrew Regional Mitigation Bank) and "All low water crossings and ditch fill areas have been installed to the satisfaction of the Department, are stabilized and showing no signs of erosion, and have operated as designed, without the need of repairs for a period of at least three years." (Pensacola Bay Mitigation Bank)

Success Criteria for Forested Wetlands

This section presents success criteria for a wide range of forested wetland communities. For example, the permit for the Maxville North Mine included mitigation for the following communities: bay swamps (FLUCCS 611), Gum swamp (FLUCCS 613), Cypress (FLUCCS 621), Pond Pine (FLUCCS 622), Wetland Forested Mixed (FLUCCS 630), Wetland Shrub (FLUCCS 631), and Other Wetland Forested Mixed (FLUCCS 6301). This group of wetlands is expected to have a tree canopy closure of ten percent or more, as recommended by the Florida Land Use, Cover and Forms Classification System for general mapping purposes. The expected or normal tree canopy closure varies across forested community types. Examples of the success criteria for forested wetlands can be categorized into the following groups. The success criteria are provided in Appendix B.

Ground Cover/Herbaceous – Percent Cover

The success criteria require a minimum cover with native, non-nuisance wetland (obligate and facultative wet) species. This minimum cover ranged from 60 (Little Pine Island Mitigation Bank) to 90 percent (Florida Mitigation Bank) of the total wetland area, with 80 percent being the most common in the reviewed permits. A couple of permits accepted facultative species within this minimum cover (CF South Pasture Extension and Corkscrew Regional Mitigation Bank), but only one of these required that the obligate and facultative wet species predominate.

The Sandhill Lakes Mitigation Bank permit recognized that the percent groundcover may be lower where there is canopy shading. The Bayfield Mitigation Bank required a combined ground, shrub and tree cover of facultative wet and obligate species of at least 80 percent.

Ground Cover/Herbaceous – Species Diversity

Permits used two different success criteria as indicators of species diversity. Some permits identified a specific number of species that needed to be present, such as "10 or more" (Breakfast Point Mitigation Bank) or "minimum of 15 (Little Pine Island Mitigation Bank)." Some permits required comparison of the dominance of species in the mitigation area to reference wetlands (e.g., Mosaic South Fort Meade Hardee). Others permits compared the mitigation area to literature on the target community type (Non-phosphate Starter Kit).

Bare Ground, Leaf Litter, Open Water

Reviewed permits set specific limits on the maximum amount of bare ground and unvegetated open water within the forested wetland mitigation area. This limit was either 10 or 20 percent of the area. The CF South Pasture Extension permit limited the combined open water and/or bare ground to less than 10 percent. The Breakfast Point Mitigation Bank required less than 20 percent combined bare ground, leaf litter and water.

Shrub Cover

Some permits set a limit on cover by shrubs ranging from a maximum of 25 percent (Pensacola Bay Mitigation Bank) to 50 percent (Bear Creek Mitigation Bank) of the area. The Sweetwater Mitigation Bank required that at least 70 percent of the shrubs in the ecotone be reduced to coppice.

In other permits, the minimum number of shrub species and the number of shrubs per acre were specified. This ranged from 3 (PCS Loncala) to 7 (Mosaic Mining Unit T) species present and 50 (PCS Loncala) to 100 (e.g., Mosaic South Fort Meade Hardee) shrubs per acre. The Mosaic South Fort Meade Hardee permit excluded early successional species such as Carolina willow, saltbush, was myrtle and elderberry from the count. The Mosaic Mining Unit T permit specified the minimum number of species per five-acre area. This included at

least 7 species from a primary list and 12 species from a secondary list, and at least 80 primary shrubs per acre and at least 20 secondary shrubs per acre.

The non-phosphate mine permits included the generic requirement that species and coverage be expected for the target habitat type.

Canopy – Tree Density, Cover

The success criteria for tree density or cover varied widely between the reviewed permits. All mining permits and a few mitigation bank permits specified a minimum number of trees per acre. This ranged from an average of 10 (Breakfast Point Mitigation Bank) to 400 (Corkscrew Regional mitigation bank) for mitigation banks and was consistently at least 400 trees per acre for the mining permits. Some phosphate permits gave additional flexibility in allowing the densities to fall within the range documented in the reference wetlands.

Most mitigation banks specified a minimum canopy cover for desirable trees species instead of a minimum tree density. This ranged from 30 (Garcon Peninsula Mitigation Bank) to at least 80 (Bayfield Mitigation Bank) percent. Some permits specified the minimum combined coverage by groundcover, shrubs and trees of 80 percent. For mining permits, the non-phosphate starter kit requires at least 33 percent canopy cover while most phosphate permits did not include a canopy cover requirement.

Some permits specified a minimum size for the trees. This ranged from 6 (Corkscrew Regional Mitigation Bank) to 12 (Mosaic Ona-Fort Green) feet when a specific height was identified, or trees above the herbaceous and shrub strata. Several permits for phosphate mines specified that the height requirement does not apply to cabbage palms that had a leaf at least 3 feet long. Some permits required a minimum 4-inch diameter breast height for DBH measurements and tree counts.

The Wekiva River Mitigation Bank permit included a linear restoration requiring 20 trees per 600 linear feet, at least 6 feet tall, and each having a canopy cover diameter of 3 foot or greater.

Canopy – Composition, Diversity

Similar to tree density or cover, the success criteria for composition and density varied widely between the reviewed permits.

Some permits provide a list of species that should be present. For example, the Bayfield Mitigation Banks requires at least 10 percent relative combined cover from a list of wetland wildlife mast producing species. The Mosaic Mining Unit T permit required a number of trees from a primary list and a secondary list. Similarly some permits specify that at least 50 (Loxahatchee Mitigation Bank) to 90 (Florida Mitigation Bank) percent of the trees will be from the list of obligate and facultative plants in Rule 62-340, FAC.

The Loxahatchee Mitigation Bank permit required that each sampling station should be dominated by one of the species from a provided list. On the other hand, some permits limit the dominance such that no one species is greater than 50 percent coverage.

Some permits were less specific requiring plant species, coverage, or relative cover to be similar to the target community type base on community descriptions (Non-phosphate Starter Kit) or reference wetlands. Species richness values and dominance were also used.

Hydrology

Two kinds of success criteria for hydrologic conditions were identified. One required that hydroperiods and depths of inundation to be based on field measurements that are within the range of conditions for the target community type descriptions (Non-phosphate Starter Kit) or based on reference wetlands (CF South Pasture Extension). The other, more commonly found in mitigation bank permits, set specific numeric standards for depths and days of saturation or inundation. Numeric standards were based on the target community type, regional conditions, and site-specific conditions.

Success Criteria for Herbaceous Wetlands

This group of wetlands included many community types ranging from wet prairies to deepwater marshes. For example, the Black Gold – Gator Mine permit alone included freshwater marsh (FLUCCS 641), wet prairie (FLUCCS 643), and emergent aquatic wetlands (FLUCCS 644) in this category.

In addition to the site-wide criteria, the success criteria can be categorized into the following parameters. Examples of the success criteria for herbaceous wetlands are provided in Appendix B.

Ground Cover, Percent Cover

The success criteria require a minimum cover with native, non-nuisance wetland (obligate and facultative wet) species. This minimum cover ranged from 60 (Little Pine Island Mitigation Bank) to 90 (Florida Mitigation Bank) percent of the total wetland area, with 80 percent being the most common in the reviewed permits. Some permits included facultative species within this minimum cover. The Corkscrew Regional Mitigation Bank permit required that the obligate and facultative wet species still predominate. One permit excluded transient facilitative species such as dogfennel, sesbania, wax myrtle, shyleaf, or similar species to demonstrate achievement of vegetation performance standards.

Ground Cover, Species Diversity

Permits used several different success criteria as indicators of species diversity.

- Some permits identified a specific number of species that needed to be present, such as “5 or more” (Breakfast Point Mitigation Bank) or “minimum of 15” (Little Pine Island Mitigation Bank).
- Permits required that at least 70 percent of the groundcover consist of species from a provided list of 26 species (Loxahatchee Mitigation Bank) and that listed ruderal species comprise no more than 30% of the groundcover.
- Some permits required comparison of the dominance of species in the mitigation area to reference wetlands (e.g., Mosaic South Fort Meade Hardee). Others compared the mitigation area to what would be expected for the target community type (Non-phosphate Starter Kit).
- The Everglades National Park, Hole in Donut based success on comparing Whittaker curves with naturally occurring communities in the area.

Some permits required that freshwater marsh mitigation areas show appropriate zones or rings of progressively more hydrophytic plants from the boundary to the center (St Marks Mitigation Bank, Heather Island Mitigation Bank, Mosaic South Fort Meade Hardee).

Bare Ground, Open Water

Reviewed permits set specific limits on the maximum amount of bare ground and unvegetated open water within the forested wetland mitigation area. This limit was either 10 or 25 percent of the area. The CF South Pasture Extension permit limited the combined open water and/or bare ground to less than 10 percent. The PCS Loncala permit required less than 25 percent combined bare ground and open water.

Shrub Cover

In this category, the success criteria are expected to limit the presence of trees and woody shrubs. Some permits set specific criteria for shrubs alone while others set criteria for the total cover by both shrubs and trees. Shrub species may be limited to 10 percent of the cover or the combined shrub and trees may be limited to 10 percent of the cover.
Permits provided numeric standards for shrubs targeting the outer transition zone within 50 feet of the marsh (e.g. PCS Loncala). The CF South Pasture Extension required at least 5 shrubs per acre while the other required at least 10 shrubs per acre.

Some reviewed permit set limits on shrub height. The permit for the Garcon Peninsula Mitigation Bank limited the height is no taller than the coppice sprouts after the most recent fire. The Breakfast Point Mitigation Bank set the coppice limit to less than 2 meters.
The permit for the Mosaic Lambe Tract had success criteria for a shrub marsh. This permit compared the mitigation area to a referenced shrub wetland and limited the cover by Carolina willow and wax myrtle.

Tree Cover

Some permits set specific criteria for trees alone while others set criteria for the total cover by both shrubs and trees. Permits limited woody species to between less than 10% (Heather Island Mitigation Bank) to 25% (Florida Mitigation Bank) of the cover in all strata combined. The Breakfast Point Mitigation Bank permit set a limit of 30 trees per acre in the wet prairies rather than a cover limit. Cypress, tupelo and pop ash were not included in the exclusion.

Prescribed Fire Frequency

Success criteria identified the number of required burns (usually a minimum of 1 to 3) and the extent of the burned area (70 or 80 percent). The PCS Loncala and CF South Pasture Extension permits required a long-term management plan that includes burning at appropriate intervals.

Hydrology

As with the forested wetlands, two kinds of success criteria for hydrologic conditions were identified. Most mining permits and some mitigation banking permits required that hydroperiods and depths of inundation be based on field measurements that are within the range of conditions for the target community type (Non-phosphate Starter Kit) or a set of reference wetlands (Mosaic Ona Fort Green Extension). More mitigation bank permits and a few phosphate permits set specific numeric standards for depths, and days of saturation or inundation. For example, the Corkscrew Regional Mitigation Bank permit requires a minimum of 150 days of soil saturation or inundation during a typical wet season rainfall year and the Mosaic South Fort Meade Hardee permit states "wet prairies shall remain inundated for no more than eight (8) months of the year during a typical after year, defined as being within the 20^{th} and 80^{th} percentile of historical record in terms of total rainfall and major event occurrences".

Other

The Loxahatchee Mitigation Bank permit included success criteria for wetland dependent fish, amphibians, reptiles, birds and mammal species.

Success Criteria for Streams

Success criteria for streams were mainly included in permits associated with phosphate mining. Disturbance of streams associated with non-phosphate mining projects are minimal and no mitigation bank permit include stream credits that involve channel creation, restoration or enhancement. However, wetland credits for enhancement or restoration of stream swamp, bayou and slough areas are included in some mitigation bank permits and the criteria are vegetation based (Bayfield, Garcon Peninsula, and St. Marks Mitigation Banks). The Devil's Swamp mitigation bank includes a seepage stream and success criteria include

"No evidence of unnatural erosion, drainage or inundation in streambed or vegetation" and "no decline in existing vegetation".

Six of the eight phosphate permits included stream criteria for stream restoration or creation. The criteria included requirements for some or all of the following parameters: hydrology, channel stability, geomorphology, in-stream habitat, vegetation and biota.

Hydrology

Hydrologic criteria ranged from the more general: "Tributary wetlands shall have seasonal flow patterns similar to the reference wetlands of that community type for the same time period" (Ona Fort Green Extension), to more specific, requiring meeting specified bankfull depths, frequencies and discharges based on monitoring data and verification of bankfull depths through field indicators. The criteria are linked to designs for specific streams (CF South Pasture Extension) and/ or to verify modeling results for selected streams (Mosaic South Fort Meade Hardee). Some also included velocity requirements verified through the amount of aquatic vegetation in the channel (CF South Pasture Extension).

Channel Stability and Morphology

Criteria for stream channel integrity and morphology ranged from basic verification of bank stability and no significant erosion or bank undercutting/caving in the two stream restoration permits (Mosaic Altman Tract and Lambe Tract), to more detailed requirements for surveys of cross section, profile and planform characteristics that verify that the approved Rosgen stream class has been created and that each stream is similar to the designs shown in the permit. (Mosaic Ona Fort Green and South Fort Meade Hardee).

Habitat

Criteria for instream habitat ranged from more general "Tree roots, log jams, snags and other in-stream structure are present at desirable intervals along the stream" (Mosaic Ona-Fort Green Extension), to more specific with spacing requirements in stream designs included in the permit (CF South Pasture Extension).

Vegetation

Vegetation criteria for the stream channel itself were not included in most permits. The CF South Pasture Extension permit included a limit of no more than 50% vegetation cover on the channel bottom and includes minimal riparian buffer zone widths for different stream types. Riparian buffer zone requirements for the other permits are typically included in the wetland vegetation criteria. The two permits requiring stream restoration included criteria similar to those for the wetland vegetation such as: limits on nuisance and exotic species cover and species richness and dominance similar to reference sites (Mosaic Altman Tract and Lambe

Tract). The Altman Tract permit also requires planting of trees along the banks of the restored channel and the filled in ditch has to have 200 trees per acre.

Biota

Criteria for the biota include those for fish and/or macroinvertebrates. Macroinvertebrate criteria include demonstration that the site passes the Department's Stream Condition Index (SCI) or that species diversity and richness are similar to values found in the literature or reference streams and that all functional feeding guilds of reference streams are present (Mosaic Ona Fort Green and Mining Unit T). In newer permits, the SCI was not included because the SCI was modified and no longer applies to non-perennial streams. The CF South Pasture Extension permit has an added requirement for documentation of a sustained presence of lotic and lentic species in proportions based on literature values or those of reference non-perennial streams in the region.

Fish criteria were included in two permits. The stream restoration project in the Mosaic Altman Tract permit requires that 80% of the species present in a reference stream are found in the restored stream. The CF South Pasture Extension permit requires species richness of the native fish community to fall within the range of values documented in non-perennial reference streams of each stream type.

Success Criteria for Uplands

Among all permits surveyed from all permitting groups, success criteria were identified for the following upland community types: mesic pine flatwoods (13 permits), sandhills (four permits), upland longleaf pine (one permit), and xeric oak (one permit) palmetto prairie (three permits), mixed rangeland (one permit), cropland and pastureland (one permit), upland oak hammock/live oak hammock (four permits). The success criteria for each target community were grouped and compared to identify similarities and differences in how mitigation "success" is measured. When possible, central tendencies among the criteria are described and notable variation around the central tendency is highlighted.

FDEP Mandatory Phosphate Success Criteria for Other Surface Waters

Several of the phosphate mining permits contained criteria for restoration of non-wetland floodplain ("other surface waters"). These criteria generally were similar to the standard criteria for wetlands with the exception that the vegetation was not required to be dominated by wetland indicator species. The success criteria specific to other surface waters include 1)**"**Native upland species shall be considered desirable vegetation when evaluating non-wetland, non-stream other surface waters (FLUCFCS 211o, 321o, 330o, 411o, 427o, 434o, and 438o)." and 2) "For the purposes of evaluating other surface waters revegetated to cropland and pastureland (FLUCFCS 210o), pasture grasses such as Bahia (*Paspalum notatum*) and Bermuda grass (*Cynodon dactylon*) shall also be considered desirable

vegetation species." In general, where phosphate mining permits included upland success criteria, the criteria were for this type of mitigation.

Mesic Pine Flatwoods

The most common upland community type with mitigation success criteria was mesic pine flatwoods, and eleven mitigation bank permits and two phosphate permits included success criteria specific to mesic pine flatwoods communities. Mitigation bank permits that include success criteria specific to mesic pine flatwoods communities include Bayfield, Bear Creek, Breakfast Point, Corkscrew Regional, Devil's Swamp, Heather Island, Nokuse, St. Marks, Sweetwater, Sandhill Lakes, and Wekiva River. The recent phosphate permits with mitigation success criteria were South Pasture Extension and South Fort Meade Hardee. It is worth noting that the Bayfield Mitigation Bank, in addition to "mesic pine flatwoods", also has a community type described as "upland longleaf pine." The success criteria for these upland longleaf pine areas were combined into the "mesic pine flatwoods" category for the purpose of this analysis.

In addition to the typical criteria (e.g., 70-80% total vegetative cover, limit on nuisance/invasive species) these permits also include success criteria that apply specifically to mesic pine flatwoods mitigation areas. These conditions are mostly vegetation-based, and focus mainly on restoration of a sparse canopy of longleaf pine (*Pinus palustris*), restoration of a diversity of pyrogenic groundcover, and elimination of crop pines (as slash pine (*Pinus elliottii*) and/or loblolly pine (*Pinus taeda*)). The mesic pine flatwoods criteria were similar among permits, and were grouped here into the eight common parameters discussed below.

Density of pines

Six mitigation bank permits and one phosphate mine permit with mesic pine flatwoods mitigation areas require specific densities of longleaf pine (LLP). The target LLP density for "success" varied from a potential minimum of three LLP/acre (Sweetwater) to a potential maximum of 200 LLP/acre (Sandhill Lakes). The success criteria involving density of LLP are summarized in Table U-1. Four mitigation bank permits also limit the density of crop pines (i.e., loblolly and/or slash pine).

Table U-1: Mesic Flatwoods Criteria - Densities of Pines

Permit	**Year Issued**	**Longleaf (LLP) or Slash Pines**	**Crop Pines**
Devil's Swamp	2004	avg. 10-70 pines/acre	
Sandhill Lakes	2005	Avg. 100-200 LLP/acre	
Nokuse	2008	(≥50 subcanopy or canopy LLP/ac., but ≤ 150 planted LLP/ac.	<100/ac
Breakfast Point	2011	10-70 pines/acre	
Bayfield	2011	75-125 LLP/acre	<30/acre
St. Marks	2011	≥ 50 LLP/ac. taller than the grass stage and increasing in height	< 150/acre

Sweetwater	2011	30-70 pine trees/acre with minimum 10% as LLP	
South Pasture Extension	2012	≥ 150 trees/acre with minimum 50% as LLP or slash pine.	
Bear Creek	2012	30% of pines must be LLP	< 70/acre
Heather Island	2013	(pine saplings and trees are 30-70/acre w/ at least 50 LLP/acre taller than the grass stage and LLP comprise ≥ 80% of all tree species > 1" dbh	

Prescribed burn

Seven mitigation bank permits with mesic pine flatwoods mitigation areas require successful application of prescribed fire. The minimum number of prescribed fires required for success ranged from one to three. Some permits (e.g., Heather Island) also require a "positive response" following the fire. The success criteria involving application of prescribed fire are summarized in Table U-2.

Table U-2: Mesic Flatwoods Criteria – Prescribed Fire Requirements

Permit	**Year Issued**	**Minimum Prescribed Fire Requirements**
Devil's Swamp	2004	3
Corkscrew	2006	1
Wekiva River	2008	1
St. Marks	2011	3
Bayfield	2011	3
Breakfast Point	2011	3
Heather Island	2013	3 (also requires "positive response following the fire"

Groundcover species diversity

Eight mitigation bank permits with mesic pine flatwoods mitigation areas require a minimum number of non-canopy or groundcover species per transect. The target diversity per transect for "success" varied from a minimum of 25 species for all transects (St. Marks) to a maximum of 40 species/transect (Bear Creek, Devil's Swamp, Heather Island, and Sweetwater). One permit (Heather Island) allowed canopy species to count towards the total while the other permits allowed only shrubs and groundcover species. The success criteria involving ground cover diversity are summarized in the Table U-4.

Table U-4: Mesic Flatwoods Criteria – Minimum Groundcover Diversity

Permit	**Year Issued**	**Minimum # of species/transect**	**Minimum # of species (all transects)**
Devil's Swamp	2004	40	NA
Corkscrew	2006	30	NA
Breakfast Point	2011	30	NA
Bayfield	2011	35	NA
Sweetwater	2011	40	NA

St. Marks	2011	NA	25
Bear Creek	2012	40	NA
Heather Island	2013	25	40

Total cover requirement/limit on bare ground

Several of the permits with mesic pine flatwoods mitigation areas require at least 80% cover with vegetation (< 20% bare ground/leaf litter). These permits include Devil's Swamp, Breakfast Point, Bayfield, Bear Creek, Heather Island, South Fort Meade-Hardee, and South Pasture Extension. The Sweetwater permit was somewhat more stringent in that it limits bare ground to 10%.

Shrubs reduced to coppice

Six of the mitigation bank permits with mesic pine flatwoods mitigation areas require that shrubs present be "reduced to coppice." Presumably, this means that fire is applied with sufficient frequency and intensity to maintain the shrub layer at a height appropriate for the target ecosystem. Four of these permits (Bear Creek, Breakfast Point, Devil's Swamp, and Sweetwater) require that at least 80% of shrubs be reduced to coppice while the other two (Heather Island and St. Marks) require that 70% of shrubs be reduced to coppice. The St. Marks permit did not consider *Serenoa repens* to be a shrub for the purposes of this condition.

Proportions of shrubs/herbaceous plants in the ground cover

Nine of the mitigation bank permits with mesic pine flatwoods mitigation areas include success criteria requiring expression of the herbaceous component and limiting the expression of the shrub component. In most of the permits, these criteria were paired, with one criterion requiring that the herbaceous layer contribute some minimum amount of relative cover (usually 60-70%) and a second criterion limiting relative cover from shrubs (ranged from 20% to 40%). The relative cover requirements for shrubs vs. herbaceous species in mesic pine flatwoods mitigation sites are described in Table U-5.

Two of the mitigation bank permits contained interesting variants of this condition. The St. Marks permit varied in that it considers saw palmetto (*Serenoa repens*) to be an herbaceous species for the purposes of the condition. Also, the Nokuse permit does not specify a numerical target for herbaceous species cover, and instead requires demonstration that the groundcover is sufficiently established to carry a fire over 70% of the upland communities. This criterion is function-based rather than form based.

Table U-5: Mesic Flatwoods Criteria – Relative Cover by herbaceous/shrub components

Permit	**Year Issued**	**Maximum relative % cover by shrubs**	**Minimum relative % cover by herbaceous species**
Devil's Swamp	2004	40%	≥60%
Sandhill Lakes	2005	20%	≥70% (all spp. must be "fire-adapted")
Nokuse	2008	35%	NA
Breakfast Point	2011	40%	≥60%
Bayfield	2011	30%	≥60%
Sweetwater	2011	30%	≥70%
St. Marks	2011	NA	≥70% (including saw palmetto)
Bear Creek	2012	NA	≥70%
Heather Island	2013	NA	≥70%

Key groundcover species success criteria

Four mitigation bank permits (Bayfield, Bear Creek, Heather Island, and St. Marks) and one phosphate permit (South Pasture Extension) included mesic pine flatwoods success criteria that require some minimum amount of a specific groundcover target species. Most often this non-canopy target species was wiregrass (*Aristida stricta* var. *beyrichiana*). The Bayfield permit requires that "wiregrass plus Curtis' dropseed (*Sporobolus curtissii*) rank in top five in importance." The St. Marks, Bear Creek, and Heather Island permits require that, "Wiregrass is among the top 5 dominant species by importance value." The CF South Pasture Extension phosphate mine permit requires that at least 10% of the relative ground cover be derived from wiregrass.

Limit on cover by range grasses

One recent phosphate mining permit (South Pasture Extension) includes a 10% limit on cover by range grasses in mesic pine flatwoods mitigation areas. This limit is due to the nature of the mine reclamation process, as pasture grasses are often used to stabilize soil during the initial stages of reclamation. These grasses can be difficult to eradicate from mitigation sites, particularly when the target community has a shallow or short-duration hydropattern.

Sandhills

The second most common upland community type with mitigation success criteria was sandhills, and four mitigation bank permits (Devil's Swamp, Nokuse, Sandhill Lakes, and Wekiva River) include criteria for preserved or restored sandhill communities. In addition, the Bayfield Mitigation Bank includes criteria for "Xeric Oak." For the purposes of this report, these xeric oak criteria have been grouped with the sandhills.

In general, the success criteria for sandhills are similar to the success criteria for mesic pine flatwoods. These conditions are vegetation-based, and focus on restoration of ground cover,

managing the site to obtain an appropriate number of trees, and an appropriate frequency of fire.

Species diversity/abundance

The Bayfield permit included success criteria to address the need for a certain amount of oaks to restore the xeric oak community. This criterion reads, "Oak species (i.e. *Quercus incana*, *Q. geminata*, and *Q. laevis*) in the Xeric Oak Community are present and controlled by fire to attain the abundance appropriate to the **Attachment C** condition."

Proportions of shrubs/herbaceous plants in the ground cover

Three of the four mitigation bank permits with sandhill restoration sites include numeric success criteria for herbaceous layer and one had narrative criteria; all included a maximum numeric criteria for shrub cover. This criterion is nearly identical to the criterion balancing relative cover contributed by herbaceous species vs. shrubs that was included in the mesic pine flatwoods communities, though the proportions may differ to account for the differences in target community. The relative cover requirements for shrubs vs. herbaceous species in sandhill mitigation sites are described in Table U-6.

Table U-6: Sandhills Criteria – Relative Cover by herbaceous/shrub components

Permit	**Year Issued**	**Maximum relative % cover by shrubs**	**Minimum relative % cover by herbaceous species**
Devil's Swamp	2004	50%	≥50%
Sandhill Lakes	2005	20%	≥70% (all spp. must be "fire-adapted")
Nokuse	2008	35%	"adequate density to carry prescribed fire"
Bayfield	2011	40%	≥50%

Shrubs reduced to coppice

All of the mitigation bank permits require that shrubs in sandhill communities be "reduced to coppice".

Density of pine

All four of the mitigation bank permits with sandhill mitigation areas mandated some relatively low densities of pine, ranging from 10 pines (slash or longleaf)/acre to a maximum of 150 longleaf pines/acre and some degree of crop pine reduction where the site was previously in silviculture.

Table U-7: Sandhill Criteria – Pines

Permit	**Year Issued**	**Maximum density of crop pines**	**Required number of longleaf pines/acre**
Devil's Swamp	2004	NA	30 – 70 *pines*/acre
Sandhill Lakes	2005	NA	100-200/acre
Nokuse	2008	100/acre	50 - 150 LLP/acre
Bayfield	2011	≤ 30/acre	75 – 125 LLP/acre

Prescribed burn

All mitigation bank permits reviewed that included sandhill communities required prescribed fires prior to success. The number of fires ranged from a minimum of one (Wekiva River) to a minimum of three (Devil's Swamp, Breakfast Point, and Bayfield). In addition to the application of fire, the Wekiva River permit also requires a "positive response" following the burn. The Nokuse permit did not set a specific number of required fires, but referred to the prescribed fire schedule that was attached to the permit.

Minimum # of groundcover/shrubs spp. /transect

Three of the four mitigation bank permits with sandhill mitigation areas require a minimum number of non-canopy or groundcover species per transect. These mitigation banks include Bayfield (minimum 20 species/transect), Devil's Swamp (minimum 30 species/transect), and Wekiva River (minimum 25 herbaceous species per transect from the sandhill plant list in the permit).

Key groundcover species success criteria

The Bayfield Mitigation Bank permit requires that "wiregrass plus Curtis' dropseed rank in top five in importance" and the Wekiva River Mitigation Bank permit requires a minimum 25 herbaceous species per transect from the sandhill plant list included in the permit. The Wekiva River permit also requires that at least 30% of the total ground cover be derived from graminoid species. The Wekiva River permit also limits the amount of cover provided by ruderal/pioneer species, stating that, "the collective cover of pioneer *Andropogon* spp. ≤ 50% of the graminoids found in each transect."

Total cover requirement/limit on bare ground

Three of the four mitigation bank permits with sandhill communities include a success criterion limiting the aerial extent of bare ground and/or leaf liter. Bayfield, Devil's Swamp, and Wekiva River each limit bare ground/leaf litter to 40%, 60%, and 20%, respectively.

Palmetto Prairie:

One mitigation bank permit (Florida Mitigation Bank) and two phosphate permits (South Pasture Extension and South Fort Meade Hardee) include palmetto prairie mitigation areas.

The Florida Mitigation Bank permit did not include success criteria specific to palmetto prairie communities, likely because of the minor extent of that community type at the bank. The two phosphate permits requiring palmetto prairie mitigation areas (South Pasture Extension and South Fort Meade Hardee) included success criteria for restoration of palmetto prairie "other surface waters".

In addition to the typical common success criteria applicable to most permits (e.g., 80% aerial vegetative cover, limitations on nuisance/exotic/invasive species, etc…) these phosphate mining permits also include success criteria that apply specifically to the restored palmetto prairie communities. These conditions are vegetation-based, and mainly focus on restoration of palmetto in the shrub layer. The success criteria from both of these permits that are specific to the palmetto-prairie areas are listed below:

Example U.1: South Fort Meade Hardee (2008):

- Palmetto Prairies (FLUCFCS 321o) shall have an average of at least 400 shrubs per acre and greater than 50 percent of the shrubs shall be palmetto (*Serenoa repens*). At least 80 percent of the total cover of ground cover species shall be those species typical of palmetto prairie or wet prairie vegetation.

Example U.2: South Pasture Extension (2012):

- Native upland species shall be considered desirable vegetation when evaluating non-wetland, non-stream other surface waters (FLUCFCS 211o, 321o, 330o, 411o, 427o, 434o, and 438o).
- Palmetto prairie other surface waters (FLUCFCS 321o) shall have an average of at least 25 trees per acre and 400 shrubs per acre. Greater than 50 percent of the shrubs shall be saw palmetto (*Serenoa repens*). At least 80 percent of the relative cover in the ground layer shall be native species typical of palmetto prairie or wet prairie communities. Cumulative total cover by range grasses, such as Bahia grass (*Paspalum notatum*) and Bermuda grass (*Cynodon dactylon*), shall be less than 10%.

Upland Oak Hammock/Live Oak Hammock:

The Florida Mitigation Bank permit includes criteria for preserved live oak hammock communities. In addition to the typical common success criteria applicable to most permits (e.g., 80% total cover, limit on nuisance/invasive species, etc…) the permit also includes success criteria that require that the preserved live oak hammocks not show signs of disturbance from baseline:

Example U.5: Florida Mitigation Bank (1997):

- Preservation-only (Live Oak Hammock: Meets the criteria overall in Specific Condition 17.a. and 17.b., approximates ideal conditions of community descriptions in Attachment C and show no signs of disturbance or degradation from baseline.

Two recent phosphate permits (South Pasture Extension and South Fort Meade Hardee) included criteria specific for live oak hammock mitigation areas reclaimed as "other surface waters." In addition to the typical "for all mitigation areas" criteria (e.g., 80% total cover, limit on nuisance/invasive species, etc…), these permits also include success criteria that apply specifically to the restored live oak hammock communities. These conditions are vegetation-based, and mainly focus on restoration of appropriate trees, shrubs, and limitations on pasture grasses in the ground cover.

One noteworthy aspect of these criteria for the phosphate permits is that the stem density of 400/acre appears to be cumulative for trees and shrubs. The live oak hammock criteria from each of these permits are listed below:

Example U.6: South Pasture Extension (2012):

- In addition to the standard OSW conditions for this permit, Forested other surface waters areas other than pine flatwoods (FLUCFCS 427o, 434o, and 438o) shall have an average combined total of at least 400 live trees and shrubs per acre and shall consist of species typical of the specific FLUCFCS designation (427o, 434o, 438o) being created. Trees shall average at least 12 feet tall (the height requirement does not apply to Cabbage palm (*Sabal palmetto*), which shall have at least one leaf that is three (3) feet long including the stalk). At least 80 percent of the relative cover in the ground layer shall be native species typical of the native forested community type being created. Cumulative total cover by range grasses, such as Bahia grass (*Paspalum notatum*) and Bermuda grass (*Cynodon dactylon*), shall be less than 10%.
- SPE: Native upland species shall be considered desirable vegetation when evaluating non-wetland, non-stream other surface waters (FLUCFCS 211o, 321o, 330o, 411o, 427o, 434o, and 438o).

Example U.7: South Fort Meade Hardee (2009):

- "Forested [other surface waters] areas shall have an average combined total of at least 400 live trees and shrubs per acre and shall consist of species typical of the specific FLUCCS code (410o, 425o, 427o, 434o) created. Trees shall average at least 12 feet tall (the height requirement does not apply to Cabbage Palm (*Sabal palmetto*), which shall have at least one leaf that is three (3) feet long including the stalk).

Success Criteria for Coastal Communities

Five of the mitigation bank permits (Bear Point, Breakfast Point, Everglades – Phase 1, Everglades – Phase 2, and Little Pine Island) include mitigation success criteria for sites that that are either on or in very close proximity to the coast. These communities may be influenced by tidal changes or have salinity concentrations higher than in freshwater. In contrast, none of the recent mining permits included coastal mitigation. Due to the limited extent of coastal communities, this category could be considered by some to be a technical side-note of limited importance. However, a comprehensive review of the recent permits would be incomplete if these criteria were omitted. More importantly, these criteria have

been included due to the emerging importance of coastal mitigation projects and the need to further develop effective performance standards for coastal communities.

The community types, as described in the permit success criteria for these coastal mitigation projects are summarized in Table CO-1.

Table CO-1: Community Types in Permits with Coastal Characteristics

Permit	Year Issued/Modified	Permitted Community Types
Everglades – Phase 1	1996	Herbaceous Freshwater with Tree Islands; Saltwater Marsh with Tree Islands
Little Pine Island	1996/2012	Forested Freshwater Coastal Fringe; Forested Saltwater Coastal Fringe; Herbaceous Saltwater Coastal Fringe; Herbaceous Freshwater/Brackish Coastal Fringe
Bear Point	2003	Estuarine Mangroves; High Marsh; Mudflats
Everglades – Phase 2	2003/2013	Freshwater Herbaceous Flats; Brackish Herbaceous Flats; Mangrove/*Distichlis* Flats; Freshwater Tree Islands and Forested Riverine Areas; Saltwater Tree Islands
Breakfast Point	2004/2011	Coastal Flatwoods; Coastal Basin Marsh

In general, the success criteria for the coastal mitigation projects were similar to the success criteria for herbaceous and forested wetlands. For example, common success criteria for these coastal systems included parameters such as cover requirements for appropriate wetland groundcover, limits on the extent of nuisance and/or exotic vegetation, similarity to reference wetlands, species richness requirements, demonstration of success via functional assessment, and requirements to conduct prescribed burning. These common parameters included in the coastal systems varied in similar fashion to the ranges observed for the freshwater herbaceous and forested wetlands. For example, appropriate groundcover ranged from narrative criteria requiring similarity to reference wetlands (Little Pine Island) to a minimum of 80% cover by appropriate species (Everglades – Phase 1). Similarly, criteria limiting coverage by nuisance and/or exotic vegetation took on several forms and ranges of allowable cover.

Several success criteria from these permits appear to be intended to account for coastal characteristics of the projects. These uniquely coastal criteria are summarized in the bullet points below:

- The Bear Point Mitigation Bank requires evidence of no loss of seagrasses in the Indian River associated with the project. This is based on infrared aerial photographic surveys and quadrats.
- The Everglades Mitigation Bank – Phase II requires documentation of seagrasses and macroalgae establishment on submerged bottom of fish enhancement areas.
- Little Pine Island Mitigation Bank provides success criteria for soils including targets for redox potential, pH, and interstitial salinity.
- The Everglades Mitigation Bank includes criteria for the average thickness of hydrated periphyton (0.75 to 1.25 inches) in herbaceous communities.
- The Everglades Mitigation Bank requires crocodile habitat enhancements, and documentation of crocodile use and nesting.
- Faunal-based criteria are included in Little Pine Island and Everglades – Phase 2. These typically included richness or abundance requirements for macroinvertebrates (2), fish (4), amphibians (4), reptiles (3), birds (4), and mammals (3).
- Everglades Mitigation Bank – Phase II, requires the development of periphyton layers of minimum thicknesses in herbaceous and brackish marshes, and requires establishment of appropriate mangrove and buttonwood cover in mangrove/saltgrass flats communities.
- The Everglades Mitigation Bank – Phase II permit requires documentation of a shift in the community boundary at the freshwater/brackish water herbaceous marsh zones resulting from a levee removal.

Unique or Site-Specific Criteria

Among all permits surveyed, the mitigation success criteria were based mostly on measures of vegetation and hydrology. Occasionally soil-based success criteria were also included. The majority of the plant criteria were quantitative measures. Hydrology criteria were most often narrative in nature, and soil criteria usually are limited to development of hydric soil indicators (though some older permits included soil criteria for compaction and/or documenting an increase in organic matter).

In addition to these “standard” types of success criteria, some permits included one or more unique, site-specific, or project-specific success criteria. These novel success criteria are categorized into a few distinct groups. In addition, a list of miscellaneous criteria that were too variable is provided in the final section. For the complete text of these criteria as well as their context, the reader is referred to Appendices C, D, and E.

Documented Transfer of Water

Several of the unique success criteria involve documenting the transfer of water to, from, or within mitigation sites as a result of the mitigation activities. Of the permits reviewed, five contain success criteria used to document expected effectiveness of culverts, low water crossing or other flow-ways installed as part of the mitigation plan. In addition, the mandatory non-phosphate “starter kit” contains a criterion that was included in this category.

These six conditions are shown on Table UN-1. For the complete success criteria, the reader is referred to Appendices C, D, and E.

Table UN-1: Site-Specific Criteria Requiring Transfer of Water

Permit	Year Issued	Intent	Condition Language
Bear Point	2003	Allow water transfer of water through a mosquito impoundment to coastal marsh/ mudflats.	Pumps and culverts operational. During the "pumped-impoundment condition", the volumetric transfer of water shall be at least 80% of modeled "Natural" conditions. During the "open culvert condition", the volumetric transfer of water shall be at least 90% of modeled "Natural" conditions.
Everglades Phase II	2013	Allow transfer of water across a levee/canal system to freshwater sawgrass marsh and coastal brackish marsh	"To establish that the L-31-E levee culverts are functioning to simulate natural sheet flow, the permittee shall document the transfer of an average of 7,000 acre-feet of water per year, for 5 years, with no one year having less than 6,000 acre-feet (except in case of "drought" as defined by SFWMD), and that all culverts have been operating as designed with only routine maintenance for at least 3 years. The hydrograph of the water transfer shall mimic natural annual patterns."
Mandatory Non-Phosphate Starter Kit	2013	Require reclaimed headwater wetlands to store and release water appropriately	The headwater wetlands should be storing and releasing water to the downstream wetlands and to the tributary in a manner approximating that of the reference wetlands of that community type.
Bayfield	2011	Allow flows between areas dissected by an impoundment	Staff gauges show an equalized water elevation balance for at least two years…;
Heather Island	2013	Allow flows between areas dissected by an impoundment	Water levels on either side of the road removal area and along Horseshoe Road (WLR pairs 6 and 7, 10 and 11, 14 and 15) will demonstrate nearly equivalent water levels when there is surface water, and very similar ground water levels as well;
Wekiva River	2008	Ensure grading has been completed sufficiently to distribute water evenly	Hydrology: All of the roadway removal and associated earthwork areas in the bank are stabilized at grade, with no ridges or swales the block or conduct flow, and no erosion is apparent. The low water crossing areas are effective in recreating sheetflow drainage characteristics within the site, culverts are providing increased hydrologic

		across the site	connectivity with no signs of erosion or piping, and these structures have required no repairs beyond minor maintenance specified in Specific Condition 26 for at least three (3) years.

Specific Water Quality Criteria

Some site-specific success criteria involve documentation that the mitigation activities have resulted in a measurable improvement in water quality. This type of criteria was included in two of the mitigation bank permits (Florida Mitigation Bank and Everglades Mitigation Bank – Phase II). At the Florida Mitigation Bank, a 15% improvement in chlorophyll a, total phosphorus, total nitrogen, and turbidity between the inflow and the outflow of the forested wetlands mitigation area is required for success (see Appendix E). At the Everglades Mitigation Bank – Phase II, documentation of a decreasing trend in salinity downstream of several culverts installed to restore freshwater flows to a coastal marsh is required (see Appendix E).

Hydrologic Targets for Water Stage and Duration

Most, if not all, permits require that hydropatterns be appropriate to support the target community. However, a few permits specified numerical target water elevations and/or hydroperiods as measures of mitigation success. These criteria have been applied to forested, herbaceous, and coastal mitigation wetland projects. In general, these hydrologic criteria involve documenting a minimum degree of inundation or saturation for a certain period of time, such that appropriate hydrology for the target community can be demonstrated.

For example, the Bear Point and Loxahatchee permits each include site-specific hydropattern criteria that must be met in order to document success. The Loxahatchee Mitigation Bank requires water levels to hit normal pool water targets, peak water targets, and low water (i.e. drawdown) targets. See Example UN-1 below. For the full success criteria, please refer to Appendix E.

Example UN.1: Loxahatchee Mitigation Bank (2011):

- During any year, the following criteria shall be met at each of the water level recording devices to demonstrate appropriate and fluctuating water levels:
  - inundation or saturation at or above 14.2 NGVD for at least 150 consecutive days
  - a minimum inundation at or above 14.75 NGVD for a 30-day period , and
  - water levels shall fall below 14.2 NGVD for at least one 30-day period.

Other variants of the hydrologic targets include Bear Point and Heather Island. The Bear Point permit involves regular pumping of water to achieve and maintain mitigation goals, and the success criteria are designed to ensure that this pumping is successfully being carried out at the appropriate intervals (see Appendix E). The Heather Island permit requires comparing the pre-mitigation and post-mitigation hydrograph curves to document a "flattening" of the descending limb of hydrographs compared to pre-construction data (see

Appendix E) as one indicator that the water levels are adequate to support the target communities.

Documented Use by Fauna

Several of the mitigation bank permits required documentation that the restored areas are being utilized by fauna. The degree of specificity with regard to the type of fauna that could demonstrate achievement of the performance standard varied among permits. The permits with fauna-based success criteria include Bear Point, Corkscrew, Florida, Little Pine Island, Loxahatchee, and Nokuse. Types of fauna included in these criteria include fish, amphibians, reptiles, birds, mammals.

For example, the Corkscrew Regional mitigation bank permit requiring documented use by several classes of wetland-dependent fauna including mammals, birds, and amphibians/reptiles. The Nokuse permit requires an average 1 gopher tortoise burrow/acre in suitable tortoise habitat.

Monitoring to ensure no degradation of offsite/adjacent/downstream resources

One coastal mitigation bank (Bear Point) permit and one phosphate mining permit included success criteria aimed at documenting that adjacent or downstream resources were not degraded as a result of the activities. The Loncala Tract permit requires that flows in a downstream creek channel are similar to pre-project flows upon completion of construction of the mitigation. This condition reads, “Following watershed restoration and reconnection of all mitigation wetlands the bankfull discharge stage, volumes, and frequency of occurrence shall be comparable to the values observed prior to the initiation of mining operations.”

Miscellaneous Site-Specific Criteria

Additional site-specific criteria of note include the following:

- Two mitigation bank permits (Bayfield and St. Marks) require at least 10% relative combined cover of the following wetland wildlife mast producing species: *Ilex cassine, I. amelanchier, I. coriacea, I. myrtifolia, Vaccinium corymbosum, Cephalanthus occidentalis.*
- Little Pine Island Mitigation Bank: Provides a list Multiple Parameters and requires that a subset of the parameters be met to document success (see Appendix E).
- Little Pine Island Mitigation Bank: Requires documentation that a viable seed bank of non-nuisance native wetland species has been established, as demonstrated by germination experiments that have been approved by the Department prior to their initiation (see Appendix E).
- Everglades Mitigation Bank – Phase II**:** Requires documentation of a shift in community boundaries following implementation of the mitigation activities (see Appendix E).

- Everglades Mitigation Bank – Phase II**:** Requires that, in mangrove restoration sites, mangroves in test plots have 20% greater increase in the number of leaves than those from similar test plots in an area unaffected by hydrologic enhancements.
- Everglades Mitigation Bank – Phase II) requires construction of habitat amendments intended to benefit American crocodiles (*Crocodylus acutus*) and restore essential fish habitat (see Appendix E).
- Bear Point Mitigation Bank: Requires that, in Estuarine Mangroves/High Marsh/Mudflats communities, all water quality sampling locations shall maintain a non-reducing environment, as indicated by monthly water quality samples within specific limits for the two years prior to the success determination (see Appendix E).
- Most recent phosphate mining permits (South Pasture Extension, Ona Fort Green, and South Fort Meade Hardee): Include success criteria requiring that certain types of short-hydroperiod wetlands (generally wet prairies) dry for a specific period of time each year.
- Graham Swamp Mitigation Bank: Includes criteria that mirror the hydrologic backstop language in the wetland delineation rule (62-340, Florida Administrative Code (F.A.C.) (see Appendix E).
- Community Boundaries must be within 10% of Permitted Values: Two mitigation bank permits (Bear Creek and Little Pine Island) required remapping of the community boundaries following the completion of mitigation activities. These are obviously intended to deal with uncertainty in how the community types would fall out post-restoration and the need to reallocate credits accordingly in the case that the community boundaries shifted in excess/short of some (10%) threshold.

Discussion

We were tasked with compiling mitigation success criteria and evaluating those criteria to identify successes and shortcomings. To accomplish this, we looked at success criteria from recent permits that were issued by three wetland permitting groups with generally large and complex wetland mitigation projects: mitigation banking, phosphate mining, and non-phosphate mining. The success criteria were compiled from the range of mitigation project types including creation, restoration, preservation and enhancement of both wetland and upland communities. The purchase of mitigation bank credits was outside the scope of study. Additionally, it is worth noting that the mitigation bank permits contain “interim” success criteria. These criteria are designed to indicate progress toward mitigation success rather than success itself and served as the basis for mitigation bank credit releases. Therefore, we avoided use of these interim criteria in this review whenever possible.

The permits in this study included success criteria from a broad range of community types. Broadly speaking, three common categories of freshwater mitigation wetlands (forested wetlands, herbaceous wetlands, and wet flatwoods) were identified. These broad categories each contain several specific community types. For example, forested wetlands alone included a diversity of community types such as baygall or bay swamps, cypress/tupelo basin swamps, cypress/tupelo dome swamps, floodplain swamp, and alluvial swamps (FNAI, 2010)

which can also be described as several different vegetation classifications according to FLUCCS.

In addition to the three major types of mitigation wetlands (forested, herbaceous, and wet flatwoods), several less common wetland types were identified during our review. These include (1) coastal, which is a diverse but small group unique to the mitigation banks, (2) streams, which were unique mostly to the phosphate mining permits, and (3) upland mitigation sites, mostly mesic flatwoods and sandhills and mostly in mitigation bank permits.

Similarity among Permitting Groups

In general, the mitigation success parameters were similar among the permits we surveyed. The majority of these success criteria focus mainly on documenting establishment of development of specific vegetation community characteristics and appropriate hydrology. An illustration of this point is the striking similarity between the common "site-wide" criteria, which are nearly identical (in intent, at least) between the majority of the mitigation banking, phosphate mining, and non-phosphate mining permits surveyed. For instance, all of the permits contained success criteria limiting the presence or extent of invasive exotic plants, although the actual language and numeric standards varied. Similarly criteria requiring the successful establishment of the required wetland acreage (as determined by Rule 62-340, F.A.C.) were nearly ubiquitous among the permits we surveyed.

One key reason for the general similarity is that all of the permits, regardless of the permitting group, issued since 1993 were under the same statutory guidance of Chapter 373, Part IV, F.S. Another possible reason for the similarity between these permitting groups is the fact that the original policies concerning success criteria were first developed when a single office within DER oversaw all wetlands permitting of large scale projects. This meant that most of the permits were written by a handful of people. After wetlands permitting was delegated to phosphate and non-phosphate staff in the mid 1990's, the success criteria evolved to take into consideration the different mining methods and site conditions at the time wetland mitigation construction begins.

Yet another reason for similar permit conditions was staff training. Since the mid 1990's, the Department-wide training workshops included reviewers of the mining applications. The workshops presented a range of topics addressing the review of applications, permit conditions, compliance and enforcement. These workshops helped to develop consistency between the various offices that reviewed applications.

Common Differences between Permitting Program Groups

There were some notable differences in the success criteria between the permits issued by the three different permitting groups.

The majority of the dissimilarities likely are a consequence of each of these groups focusing on mitigation projects that differ substantially in the mitigation starting point. For example, for the phosphate and heavy minerals mining mitigation projects the starting point typically was wetland creation on a mine reclamation substrate consisting of newly deposited tailings and overburden. These success criteria were focused on the establishment of a plant community and required relatively high values for cover by groundcover and shrub species and relatively high density of trees. In contrast, peat mines typically provide restoration within the footprint of mining operations in addition to creation, restoration and enhancement nearby. Thus, on-site, post- mining mitigation is in stark contrast to the mitigation projects conducted by mitigation banks and other types of mines (e.g. limestone and sand), which tend to focus more on restoration and enhancement of degraded communities.

Common Wetland Criteria

In general, the success criteria were similar between the three permitting groups and the success criteria were structured similarly across the range of target community types. For the most part, the conditions were vegetation-based measures of community development with narrative hydrologic criteria. The "common" criteria we identified were a requirement that the community is self-sustaining, that the mitigation site reflects the characteristics of the target community, that the required acreage of wetlands is actually constructed and functional as wetlands, that hydrology is appropriate for the target community type, and that nuisance and exotic species are held below the threshold specified in the permit. Most permits included "site-wide" success criteria that were applicable to the whole mitigation project or mitigation site, in addition to success criteria that are applicable only to specific mitigation community types.

Vegetation

The vegetation criteria were usually the most quantitative in nature and included measures from the canopy, subcanopy, and ground cover strata, as appropriate for the target community type. It is worth noting that the terms canopy, subcanopy, and ground cover were not used consistently among all permits, likely to account for type of target community. Of the vegetation criteria, the shrub and ground cover composition seemed to be emphasized in most permits.

Criteria associated with the canopy layer for forested communities and flatwoods typically consisted of measures of tree density or canopy cover and diversity. For forested wetlands, mitigation bank permits included canopy cover more often than tree density requirements, phosphate permits primarily included tree density and non-phosphate permits typically included both. The lower end for canopy cover was similar for all permit types and was higher for some mitigation banks likely due to more mature starting points. The target tree density varied across community types in accordance with the target community. However, for the wetland creation projects associated with mining permits, the tree density

requirements were often higher (typically 400 trees per acre for forested wetlands and 200 trees per acre in flatwoods) than would be expected for canopy trees in a mature reference site of the target community. This wide difference in tree density likely results from a need to determine success while these created sites are still in a relatively early stage of succession.

Vegetation criteria for the subcanopy and ground cover layers were focused on growth of appropriate species for the target community type and implementation of appropriate management activities. Site stabilization and limitation on the extent of bare soil was also a major focus. The shrub and ground cover criteria include limits on inappropriate species, cover by herbaceous and woody species, and species composition and diversity. One major point of divergence between the mitigation banking and mining permits was identified in the shrub conditions, in which mining permits that predominantly required wetland creation tended to focus on re-introduction of shrub density and diversity into the created landscapes while the mitigation bank permits, which predominantly required restoration and enhancement, focused more on ensuring that the mitigation sites do not become overgrown with shrubs. Again, this major difference appears mainly attributable to differences in the mitigation starting point. For example, many of the mitigation bank sites were fire-suppressed and mitigation goals included restoration of more open flatwoods or wet prairies. In contrast, most phosphate permits required minimum shrub densities for forested sites to ensure the shrub component is being returned to the landscape, as the created mitigation areas following mining typically start with bare soils and no seed bank. In the case of flatwoods communities, the goal is to ensure adequate cover by palmetto, gallberry and ericaceous shrubs. Similarly, many created forested wetlands will lack shrubs other than pioneer species, like wax myrtle and willow, if other species are not planted.

Several phosphate permits also required creation of shrub swamps as mitigation and therefore have minimum density requirements. A few phosphate permits also included a minimum density requirement of shrubs around marshes. It may be appropriate to evaluate these last two examples and decide if use of these criteria should continue in the future since they may not result in replacement of natural Florida wetlands communities even though they may have offset adverse impacts.

Non-phosphate permits had conditions similar to mitigation bank permits for shrubs in flatwoods and wet prairie systems. However, there were no specific shrub density or cover requirements for other forested wetlands. This may be an oversight, at least for created systems, since as with phosphate projects, later successional shrub species may not readily colonize on their own.

Whether or not facultative species should or should not be included in the minimum cover of desirable species may need further evaluation. Most permits specified that “wetland” species or FACW or OBL species were to be included in the percent cover measurements, but several did not, and a few allowed inclusion of facultative species. This may vary by wetland type with flatwoods and wet prairies potentially having a greater percentage of facultative species.

The site-wide criteria showed that there is currently a wide range of standards for the limits on exotic and nuisance species. The maximum allowable coverage by exotic and nuisance species ranged from 1 to ten percent of the wetland area. Many permits provided example exotic and/or nuisance species by name. Only the non-phosphate mine permits referenced the definition of nuisance species in the surface waters quality standards rule (provided in rule 62 302.200(20), F.A.C.) The Garcon Peninsula Mitigation Bank was unique in that it set specific limits for *Sapium sebiferum* (Chinese tallow) and *Paspalum notatum* (bahiagrass), due to the conditions at the site. These limits were separate from, and in addition to, the limits applicable to the any other invasive exotic species. Two phosphate permits (South Pasture Extension and Loncala Tract) established a threshold for native "nuisance" species, such as cattail (*Typha* spp.), where these native nuisance species would not be considered as a nuisance unless such species individually surpassed a threshold of 3% cover or domination of any area > ¼-acre in size.

Each permit identified the desired species required in the mitigation area. Often the desired species were listed in the construction or success conditions of the permit. These identified the number of species to be present or the coverage area required by these species. Some permits required the mitigation area to be compared to a reference wetland, or a range of reference wetlands. Others compared the mitigation area to what would be expected for the target community type. This recognized that a given community type will have a range of species depending on its site-specific physical factors. Others specified minimum richness requirements for the site as whole or for each transect, or in the case of the Mosaic Mining Unit T permit, for every 5-acres. It is not clear which, if any, of these approaches is best, in terms of what is reasonably achievable and what is ecologically the most sound.

Zonation in depressional marshes was included in the criteria for two mitigation bank and several phosphate permits. However, not all marshes have or should have zonation (many basin marshes do not), so this needs to be recognized as criteria are written.

Most permits identified a minimum coverage for desired species. This minimum cover ranged from 60 to 90 percent of the total wetland area with 80 percent being the most common in the reviewed permits. This standard would be sufficient to show that the mitigation area is following a trajectory toward a more mature system. In some cases the coverage may recognize that deepwater wetlands will normally have open water areas.

Hydrology

Hydrologic criteria were universal amongst the permits and, for the most part, were narrative criteria requiring that hydroperiods and depths of inundation be within the range of conditions expected for the target community type. This type of condition recognizes that a given community type may occur within a range of hydroperiods and depths. Several of the

phosphate permits included criteria requiring that hydroperiods consistent with values observed in reference wetlands during the same time period. Comparison with reference sites within the same period of record requires data to be collected from reference wetlands during multiple years, but has the advantage of providing reliable data for comparison even during drought or very wet years, if the reference sites are located nearby and are hydrologically-similar to the target community. A few permits did include unique hydrologic criteria with specific numerical targets for stage, stage duration, and sometimes drydown time. One phosphate mining permit and one non-phosphate mining permit included criteria requiring the mitigation site contribute appropriate flows to downstream resources. It will be interesting to evaluate the advantages and challenges associated with each of these types of hydrologic criteria as the mitigation sites from these projects develop.

Soils

Most phosphate permits and a few mitigation bank permits included hydric soil characteristics as success criteria. These success criteria may be useful where the starting point for mitigation construction is backfilled tailings and overburden or a hydrologically-impacted wetland. Most of the reviewed permits did not include this condition. Likely this was because if the water levels are correct, hydric soil indicators will be present.

Other than requiring hydric soil indicators, most of the permits made reference to soils only with regard to hydrology (saturation) or stating that soils had to be stabilized. It is known that some older phosphate permits (e.g. South Pasture) included specific limits on soil compaction. However, this has not proven to be an effective indicator in the field for phosphate mine reclamation sites. In wetlands, organic matter content is a reliable indicator of wetland hydrology. Soil organic matter (SOM) content was used as a success criterion during the early days of phosphate-related wetland mitigation in Florida, but no longer is widely used as it is known that the SOM does recover, so long as appropriate wetland hydrology and vegetation are established (Nair et al., 2001). One mitigation bank permit included a unique soil criterion requiring measurement of oxidation-reduction potential and interstitial salinity.

Fauna

Six of the mitigation bank permits included some faunal criteria such as richness or abundance requirements for macroinvertebrates, fish, amphibians, reptiles, birds, and/or mammals. Otherwise, faunal-based success criteria were generally not used.

Functional Assessment

The mitigation bank permits commonly make use of functional assessments following the completion of mitigation activities to determine if the mitigation has resulted in the degree of increase in ecological function that was contemplated before implementation of the

mitigation plan. If the functional assessment determines that the site has not resulted in the degree of functional improvement contemplated, then a certain amount of the mitigation credits will not be released. In contrast, the mining permits did not typically include functional assessments following implementation of the mitigation plan.

Reference Wetlands

Some mitigation bank and most phosphate permits required the use of reference wetlands for vegetation based success criteria. The structure of the reference wetland criteria varied considerably. For example, reference wetlands were not included in any of the non-phosphate success criteria which referred to the target community type as described in literature. Of the phosphate and mitigation bank permits that did include reference wetland criteria some used one reference wetland while others relied on a range of sites. Where reference wetlands were not used, the conditions were based on comparisons to a target community type (either a general FLUCCS description, a FNAI description, to site specific description included in the permit. Other permits specify a minimum species richness per site or transect. Some permits included additional requirements for either dominance of certain species, such as wiregrass in flatwoods, or limits to certain species, such as pasture grasses in flatwoods or wet prairies.

It is not clear which approach, if any, is best for use of reference wetlands. The effectiveness of basing criteria on reference wetlands depends on how the reference wetlands are chosen and when. They should be approved before the projects are initiated so a clear goal is defined, otherwise it is possible to choose sites that match what was created or restored and not necessarily what was impacted. Reliance on a single reference site versus a range of sites also needs consideration. Use of a single site may be overly restrictive. But if a range of sites is used, what level of specificity is required? For example, freshwater marshes include a diversity of vegetation types determined primarily by topography and hydroperiod. So if a permit requires creation of several freshwater marshes and the reference marshes identified include deeper flag marshes, shallower maidencane marshes and even more shallow graminoid dominated marshes and all the marshes created/restored are deeper flag marshes, are the permit criteria met? It may be that use of reference sites needs to be more narrowly defined in order to ensure functional replacement.

Other Communities Discussion

Uplands

In the permits we surveyed, the mitigation success criteria for uplands were nearly exclusive to mitigation banks; though some of the recent phosphate permits had limited amounts of upland mitigation and/or sites restored as “other surface waters” due to a requirement in the phosphate mine reclamation rule (Rule 62C-16, F.A.C.) to restore non-wetland floodplain. Typical mine permits do not provide wetland mitigation credit for reclamation of uplands, and there were no success criteria for “true” uplands in either the phosphate or non-phosphate success criteria. Therefore, the majority of the upland mitigation success criteria reviewed

here are from mitigation banking permits. A small amount of upland enhancement was incorporated into the mitigation plan in at least one permit (S. Pasture Extension).

Among all permits surveyed from all permitting groups, success criteria were identified for the following native upland community types: palmetto prairie, upland oak hammock/live oak hammock, mesic pine flatwoods, sandhills, upland longleaf pine, and xeric oak. Some of the "other surface waters" upland mitigation from one recent phosphate permit included community types such as "cropland and pastureland" and "mixed rangeland". These are not native community types and therefore do not represent appropriate mitigation activities. The main upland community types that were observed were mesic pine flatwoods and sandhills.

The success criteria for mesic pine flatwoods and sandhills were generally similar to one another but contained slight variations to account for the difference in target community type. The success criteria generally were vegetation-based and included parameters such as tree density (especially the minimum density of longleaf pine or xeric oaks and the maximum density of crop pines), implementation of an appropriate prescribed fire regime, and restoration of appropriate pyrogenic ground cover. In addition to requirements for prescribed fire, these permits usually contained criteria designed to document a successful implementation of the fire regime. These criteria include a requirement for shrubs to be reduced to coppice, limitations on shrub cover, and minimum coverage requirements for herbaceous species. Additional success criteria included total cover requirements/limits on the aerial extent of bare ground and limitations on the extent of cover allowed to be contributed by range grasses. These additional criteria, which were more common to created mitigation wetlands for mining projects, appear to be intended to ensure the sites have been adequately stabilized while also ensuring that pasture grasses that may have been used to stabilize the substrate are not inhibiting the development of native ground cover. Two somewhat unique criteria common to permits with upland mitigation sites were restoration of key groundcover species (usually wiregrass) and/or limitation on the acceptable amounts of weedy (ruderal) groundcover species. One permit also required documented use by certain fauna (gopher tortoises).

It is well-known that restoration of groundcover is as important, if not more important than restoration of the canopy pyrogenic community types of Florida. However, the phosphate permits tended to place more emphasis on the canopy of forested upland communities. It is likely the focus on restoration of appropriate canopy species is an artifact of compliance with mine reclamation standards and the fact that, in the majority of mine reclamation mitigation sites, the establishment of a canopy is needed to combat the "weediness" of the reclaimed sites resulting from an abundance of light. Unfortunately, this may have been a shortcoming in certain upland mine reclamation community types, as mesic flatwoods, sandhills, and palmetto prairie are generally not light-limited, even in their "mature" (i.e. subclimax) condition, given an appropriate fire regime. In contrast, the upland success criteria from the mitigation bank permits focused heavily on restoration of appropriate ground cover species.

Streams

The stream criteria were almost exclusive to the phosphate mining permits. Some flowing water systems were present in the mitigation bank permits, though truly stream-specific criteria were not identified.

The criteria were usually limited to the stream channel itself since the adjacent riparian zone is covered in the vegetation criteria. The criteria have become more detailed over time with most recent permits including hydrologic requirements based on monitoring linked to bankfull designs for each stream and/ or to verify modeling results for selected streams. Hydrology criteria overlap the channel integrity and morphology criteria, which are based on the results of as-built surveys, in assuring that appropriate bankfull dimensions are created based on each stream's Rosgen class and drainage basin size. The designs are derived from a range of on-site reference streams or a broader range of minimally impacted regional streams.

Criteria for creation of in-stream structure have also become more specific in more recent permits with specific spacing requirements included. Verifying that these habitats are being utilized is verified through the criteria for macroinvertebrate and/or fish community structure. These biological criteria may in some ways be the most difficult to develop because of the lack of available data on non-perennial streams. The Department's stream condition index (SCI) is currently designed for use on perennial streams. Most of the streams permitted for mining do not flow frequently enough to pass the SCI. This method could still be used if alternative thresholds were developed for non-perennial streams. Similarly, there is very little fish data available on smaller, mostly headwater streams in Florida, limiting the use of fish community structure as a criteria. However, since macroinvertebrates and fish are the primary faunal species using streams and are recognized worldwide as the primary indicators of stream health, some sort of faunal criteria needs to be included in stream mitigation permits. Without adequate data to develop the criteria, the Department has gone back to the approach taken in earlier permits, relying on reference streams to evaluate these projects.

Very few of the streams permitted with these criteria have been constructed yet, so it is too early to determine if these conditions are adequate to ensure that functional streams are being created.

Coastal

Some mitigation banks are in areas with coastal communities. These communities may be influenced by tidal changes or have salinity concentrations higher than in freshwater. Because these areas are not generally attractive to modern mining operations, none of the reviewed permits for mines included success criteria for coastal communities. Success criteria for coastal communities were similar to the criteria for other communities in the areas of having appropriate vegetation and hydrology. Having appropriate salinity was an additional criterion.

Unique/Site Specific

The majority of the truly quantitative measures are centered on counts of vegetation. Hydrology-based criteria, while common, were usually narrative in nature, and the soil-based criteria usually are limited to development of hydric soil indicators. In addition to these "standard" types of success criteria, some permits included one or more unique success criteria. This was particularly true among the mitigation bank permits. Usually, these criteria were designed to document a response demonstrating the efficacy of the mitigation activities.

These novel success criteria were categorized into a few distinct groups: transfer of water, specific water quality criteria, and site-specific hydrologic targets. Documenting the transfer of water was used to demonstrate the effectiveness of culverts or flow-ways installed as part of the mitigation plan. Unique water quality criteria were used to document a measurable improvement in various water quality parameters which included salinity, chlorophyll a, total phosphorus, total nitrogen, and turbidity. The site-specific hydrologic targets took the common narrative hydrologic success criteria a step further and specify numerical target water elevations and/or hydroperiods as measures of mitigation success. Other themes identified in the unique criteria include requirements to document that mitigation sites are being utilized by certain fauna or no longer are impacted by a particular problem species. In addition to these basic groupings, several unique criteria were identified that were too variable to be grouped. Examples of these include monitoring to ensure no degradation is occurring to downstream or adjacent resources, creation of habitat for specific fauna (e.g. American crocodiles), an observed shift in community boundaries, development of a periphyton layer, and dry down requirements for short hydroperiod wetlands.

Variability in Target Community Descriptions

One potential explanation for some of the variance in permit success criteria is that descriptions of the target community types have changed as time has progressed. The description of the mitigation target should have a dominant influence on the criteria used to determine mitigation success. Many of the reviewed permits were more general with respect to defining the target community types and referred to the land cover descriptions and numerical identifiers from the Florida Land Use, Cover, and Forms Classification (FLUCCS) manual. Such classification systems, while useful, are not sufficient to describe the range of variability of wetland systems in Florida. For example, FLUCCS code 621 (Cypress) could be used to describe several different ecological communities such as cypress domes, cypress strands, cypress-dominated floodplain forests, and cypress flats.

Broad categories, such as "forested wetlands" and "herbaceous wetlands", potentially include a wide range of community types from periodically saturated wetlands to deepwater wetlands.

In general, each of the three permitting groups has moved towards use of natural community descriptions in addition to the FLUCCS manual. Because the joint permit application forms required use of FLUCCS to Level 3 (or National Wetland Inventory for Southwest Florida

Water Management District), the FLUCCS or NWI were the classification used in vast majority of permit applications and supporting materials. Prior to the implementation of the Statewide Environmental Resource Permitting (SWERP) forms adopted in Chapter 62-330, F.A.C., (effective October 1, 2013), it was common for FLUCCS descriptions to be modified on a project-specific basis to allow them to better represent natural communities. SWERP Rule requires maps indicating the plant community mapping based on the 2010 Florida Natural Areas Inventory (FNAI) Guide to the Natural Communities of Florida (FNAI, 2010), in addition to the maps using the FLUCCS.

Biogeographic Variation in Natural Community Characteristics

The State of Florida is ecologically diverse and ecosystems in different regions of the state take on different characteristics. There are several physiographic provinces in Florida. The climate differences between north and south Florida are expressed not only in temperature ranges, but also the seasonality of rainfall. As a result, the characteristics of many natural communities vary across the state. For example, Carr et al., (2010) describe sixteen distinct types of fire-dependent pinelands in Florida. Regional differences also exist with respect to threats posed from invasive exotic species. While invasive exotics are a concern statewide, different species of invasive exotics are problematic in different areas of the state, as evidenced by some species-specific success criteria, such as limitations for Chinese Tallow trees in permits for northern Florida and limitations for tropical soda apple (*Solanum viarum*) in permits covering the southern portion of the state.

Some differences in criteria were noted to account for biogeographic variation. In general, mitigation bank permits from south Florida with pine flatwoods had criteria for South Florida slash pine (*Pinus elliottii* var. *densa*) rather than longleaf pine (*Pinus palustrus*), because longleaf pine is not found in South Florida; mitigation bank and mining permits from areas further north did require longleaf pine. Among phosphate permits, accounting for biogeographic variation was not a major concern for most projects since the majority of mining occurs in the Bone valley region of central Florida. However one phosphate mine does operate in north Florida and the forested wetlands there differ from their counterparts substantially in terms of the extent of ground cover. To account for this variation in ground cover, one recent north Florida phosphate permit (PCS-Loncala) included success criteria specifying use of relative cover for the ground layer (instead of total cover) to account for the fact that dense ground vegetation is not expected.

Variability in Pre-Mitigation Site Conditions

Success criteria may differ from one another due to differences in the condition of the land upon which the mitigation activities are to be conducted at the time the mitigation work begins. At many mine sites, the mitigation projects involve wetland creation from bare mineral soil on the mined land. For many non-phosphate mine permits and most mitigation bank permits, the mitigation may involve enhancement and/or restoration activities. The

restoration and enhancement sites may include a variety of conditions present upon implementation of the mitigation activities. For example, the initial conditions at mitigation bank sites range from intensive silviculture or other forms of agriculture, to artificially drained or impounded wetlands, to natural communities degraded by invasive exotic species and/or fire suppression, to relatively intact natural upland and wetland communities. The success criteria for each of these activities should (and do) vary to take these factors into consideration. Because of these different starting points, it should be expected that there will be substantial differences between these types of mitigation sites within the first five to ten years (likely more) following implementation of the mitigation plan. As such, the criteria for these situations would not be the same.

Wetland creation sites on reclaimed mined lands occur on a variety of reclamation substrates. For example, reclaimed phosphate mines contain four main substrate types: sand tailings, overburden, sand/clay-mix, and phosphatic clay. Differences in reclamation substrate likely result in different sets of requirements for and challenges to achievement of mitigation success. For example, within reclaimed phosphate mines sand tailings are much easier to contour than sand/clay-mix, which could have an effect on topography of the mitigation site and the operator's ability to construct the land surface in relation to expected water levels. In addition, the suite of species that will readily colonize fine-textured materials such as sand/clay-mix likely differs from the suite of species that will readily colonize sand tailings (though adequate replacement of topsoil potentially could compensate for these differences). Non-phosphate mines that do mitigate within the mine reclamation footprint have entirely different substrates, each with their own considerations. Our review of these permits, however, did not identify differences in success criteria to account for variation in the substrate on which the mitigation is built. It is worth noting that many of the current mining permits maximize certain types of mitigation on specific substrate types to take advantage of their perceived superior properties for conducting mitigation.

Because ecological restoration projects, particularly reclamation and creation, can take decades to fully mature (particularly for created forested wetlands) it may not be practical to set mitigation success criteria that require replication of conditions in a mature system, as the performance standards should be achievable in a reasonable time frame. For example, success criteria for wetland creation are designed to determine success despite the site still being in a relatively early stage of succession. In contrast, restoration and enhancement projects may begin with an area that has some qualities of the native community, albeit degraded due to agriculture/silviculture, hydrologic changes, fire suppression and/or extensive invasion by exotic vegetation.

Progression of Wetland Science and Changes in Expectations

Ecological restoration science has progressed during the evolution of each of the three permitting groups and that progression has affected ecological expectations and influenced the evolution of the success criteria. Further, incorporation of knowledge derived from research and experience has resulted in changes in expectations. For example, there is now

greater ability, through herbicides and land management, to control and potentially eradicate, or prevent, certain invasive exotic plants than there was 10 or more years ago. Similarly, there is a greater body of knowledge on the mitigation and management tools needed to reduce the establishment and presence of ruderal or weedy "nuisance" species, in addition to pasture grass eradication. Success criteria have changed, and should continue to change, as new science and practice is incorporated into permit conditions.

Changes in expectations have resulted in more specification of mitigation activities with regard to community type. As research and experience have accumulated, it was realized that mitigation of specific community types was needed to appropriately offset impacts and loss of those community functions. For example, the mitigation associated with many older phosphate and non-phosphate mining permits generally only distinguished between forested and herbaceous wetland communities In contrast, newer mining permits often specify a variety of community types, and contain relevant success criteria specific to those communities

Successes

Though the permits we reviewed here were mostly recent, each of the permitting groups has a long history of wetland permitting experience using the precursors of the criteria here reviewed (in many cases, identical to the criteria here reviewed) and can point to examples of wetland mitigation projects that have been effective in restoring wetland functions. Some specific successes of the criteria developed to date include the following:

- Our groups have developed mitigation success criteria for a wide array of community types, including criteria designed for specific types of uplands and forested and herbaceous wetlands.
- We have incorporated past experience and a restoration ecology knowledge base as time has progressed, and success criteria from each of the groups have evolved accordingly. Numerous iterations of these criteria have been utilized over time and each of our groups has retained those criteria that appear to be effective indicators of success and discontinued use of less-effective criteria. The similarity between the criteria used by the different groups is a testament to that.
- Review of our collective pool of recent permits demonstrates that we have criteria for several community types, and some of the permits account for biogeographic variation across the state. Using our pool of collective criteria, a regulatory agency could identify criteria designed to measure mitigation success for nearly any type of wetland community in the state, and account for some degree of biogeographic variation within the state.
- One of our permitting groups (non-phosphate) made use of a permit "starter kit" that serves as a repository of potential success criteria. Criteria can be chosen from this starter kit based on the circumstances specific to the mitigation project being permitted. The starter kit was intended to be refined over time based on experience and new research. Having this "success criteria tool kit" will help to further evaluate

success criteria in the future, both for use in individual projects and for evaluating the effectiveness of the criteria themselves.

- Our groups have made more consistent use of natural community descriptions as part of the mitigation goal. As time has progressed, permit community descriptions have transitioned from plant cover descriptions such as FLUCCS to more ecologically-based natural community descriptions. The Statewide ERP rule adopted October 1, 2013, requires FNAI classification on mitigation map submittals. Therefore, the trend towards use of natural community descriptions should continue.

Shortcomings

The review and comparison of our collective pool of success criteria from recent permits has allowed us to identify areas that could be improved. These areas include:

- The criteria need to be refined further to better account for biogeographic variation, where applicable. In our pool of permits, we identified examples of success criteria that accounted for biogeographic variation within the state. However, these examples were from a subset of our community types (generally flatwoods) and such criteria appear to be an exception rather than the rule. Success criteria should be evaluated to assess the need for additional refinement to better account for biogeographic variation.
- The criteria could be better refined to account for the mitigation starting point. Effectively measuring success of a wetland creation project likely requires different metrics than the metrics for measuring success in more mature ecosystems associated with a wetland restoration or enhancement project. For example, in the phosphate mining creation projects, several conditions are focused on getting a certain degree of tree and shrub diversity and abundance into the ecosystem, as the start point was bare substrate, while in the mitigation banking permits (usually enhancement for flatwoods) the conditions focus more on returning the tree and shrub composition to a more natural community structure.
- We need to continue to refine the criteria to consider the stage of succession expected at the time success will be determined. Not all mitigation sites will be mature climax or subclimax communities within the life of the permit reviewer. Therefore, the success criteria for a forested wetland creation site should not mandate characteristics that are only possible in a mature system. Some conditions may be more effective "early indicators" of success than others. For example, while the density of trees likely will change significantly after the initial planting and as wetlands develop, the species composition and diversity may be effective measures of eventual success. We need additional research and follow-up to get a better idea of what indicators were reliable "early indicators" so that we can have assurance that projects are truly on a trajectory towards success without requiring exceptionally long periods of monitoring.

- A wider range of indicators of wetland function should be explored. The success criteria were predominantly vegetation-based, though there consistently were hydrology-based criteria and sometimes hydric soils criteria.
- We limited our review to DEP-issued permits. We should expand reviews to include mitigation banks and other large scale mitigation project permits that were issued by the water management districts.
- There have been some inconsistencies in the numeric criteria of the success criteria. In particular, there are inconsistencies in use of metrics, particularly of relative versus total cover, particularly with regard to appropriate ground cover. Some permits simply say coverage while others specify total or relative cover. Based on our review, it is clear that both total and relative cover are needed together, in most cases. Total cover deals with abundance while relative cover deals with relative proportions of the abundance. They are complementary. One without the other is an incomplete picture.
- More biotic criteria need to be developed for non-perennial streams, analogous to the SCI.
- The use of reference wetlands is unbalanced. If we determine that reference wetlands are critical to determining success, we need to ensure that they are used consistently. A library of reference wetland data to be kept on file could maximize effectiveness and efficiency.
- More qualitative measures of success should be explored.

Future Needs

Future success criteria will have to be consistent with the new statewide environmental resource permit rules which became effective on October 1, 2013. Section 10.3.6 of the Applicant's Handbook I provides that, "Mitigation success will be measured in terms of whether the objectives of the mitigation are expected to be realized. The success criteria to be included in permit conditions will specify the minimum requirements necessary to attain a determination of success. The mitigation shall be deemed successful by the Agency when all applicable water quality standards are met, the mitigation area has achieved viable and sustainable ecological and hydrological functions and the specific success criteria contained in the permit are met. If success is not achieved within the time frame specified within the permit, remedial measures shall be required. Monitoring requirements shall remain in effect until success is achieved as specified in the permit. Maintenance requirements shall remain in effect as specified in the permit."

The regulatory permitting groups and the permittees would benefit from permits that:

- Consistently and clearly express the objectives of the mitigation. In order to accomplish that, there needs to be greater understanding of the natural communities and ecosystem attributes,

- Include expectation of the mitigation over time, so that the success criteria accurately reflect both the starting condition and release conditions, and
- Specify efficient and effective monitoring that clearly support the success criteria.

In order to provide this service consistently and throughout the program, staff development should address:

- Mechanisms of natural systems as succession progresses following disturbance or during primary succession,
- Hydrologic monitoring conditions that may be used to verify whether a mitigation area has achieved the ecological and hydrologic goal,
- The scientific study and practical application of ecosystem restoration,
- Community descriptions used by the Florida Natural Areas Inventory. This would include the range of characteristics that can be exhibited by a community, physical factors that influence these characteristics, and ecotones, and
- Monitoring for success.

Literature Cited

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