Performance Measure Name and Number

NPB PIR Part 1 Project PM #9- Hydrologic/Spatial Connectivity

Justification

Agricultural practices and urban development activities such as drainage systems, roadways, utility corridors and housing have disrupted and impacted wetland communities by fragmenting the natural hydrologic landscape. Specifically, the continuity of pre-development surface water flow through wetland systems has been compromised, and the loss of continuity between and among greenway connections has resulted in the loss of wildlife habitat and functionality. Hydrologic connectivity is essential to the ecological integrity of the landscape, and reduction or alteration by anthropological processes can have major negative environmental effects (Pringle, 2003). The Wetland System Assessment Study conducted within the Cypress Creek/Pal-Mar and Groves Basins reported a fifty percent loss in spatial coverage of wet prairies and sloughs and a similar gain in pine flatwoods between 1940 and 2000 (C&N Environmental Consultants, 2002). In addition, some areas in J. W. Corbett Wildlife Management Area have experienced flooding in historically dry pine flatwood habitats that limits fire management practices needed for management of plant communities (USACE and SFWMD, 2014). Extension of hydrological and spatial connectivity between watersheds is essential to restore more natural hydropatterns, provide benefits for wetland communities, wildlife and land management, and preserve critical wildlife habitat throughout the ecosystem.

Establishment of new hydrologic connections in the landscape and restoration of connectivity in highly modified human-dominated landscapes can have species- to ecosystem-level effects (Pringle, 2003). Increasing the spatial extent of natural areas within the project study area, one of the 3 major goals of the CERP (USACE and SFWMD 1999), will help to maintain and promote biodiversity by increasing available resources and habitat. Similarly, population and system dynamics would benefit from the hydrologic/spatial connectivity between protected lands by alleviating obstacles in the spread of native flora and wildlife movement between natural areas. Flora and faunal species would experience a spatial increase in suitable habitat and movement corridors and potentially, a larger reproductive gene pool due to the expansion of protected natural areas. Some of the large expanses of conservation areas and publicly-owned wetlands within the North Palm Beach County project area are currently fragmented due to historical development. Small properties separating these natural areas have been utilized for agricultural practices and other usage; subsequently, these parcels of land have been drained and the landscape of these properties has shifted from historic wetlands and uplands to improved pasture or uplands dominated by invasive and exotic species. Opportunities exist to implement management measures to restore hydrological connectivity and/ provide a more contiguous greenbelt of expanded native habitat. See Figure 1 for map of Loxahatchee River Watershed and major canals, roads that have divided many natural areas from each other.

CERP Evaluation Target

Highest % increase in connectivity compared to the total maximum score achievable of 100% based on Hydrologic/Spatial Connectivity Matrix and Scoring Rubric.

Evaluation Protocol

Potential for hydrologic and spatial connectivity will be evaluated using the "Connectivity Matrix" (Table 1)developed by the interagency team. The Connectivity Matrix and rubric were developed as a method of evaluating potential connectivity to meet ecosystem restoration objectives and uses several ecologic, hydrologic and management criteria to evaluate sites: Downstream Hydrologic Linkage; Greenway Corridor; Water Quality; and Fish and Wildlife. Each alternative is evaluated to determine how well it meets each criterion by using a scoring rubric (Table 2): Not at all = 0, Partially =12.5, Yes, completely =25. There are four criteria resulting in a total possible score for any alternative of 100. The existing conditions baseline alternative is scored as a 0 from the standpoint of natural areas being disconnected with respect to hydrology and flow to the river, and natural areas allowing natural movement of physical and biological resources. All alternatives are then compared to Future Without Project score to estimate increased connectivity from actions to plug canals and ditches, flowways to improve hydrologic connections, removal of levees/berms that are barriers to flow, and providing movement of water below roads and between natural areas. See example scoring of project alternative in Table 3 using Flowway 1 from 2010 Draft Alternative Formulation Briefing Report for North Palm Beach County Part 1 (SFWMD, 2010).

Figure 1 – Map of Loxahatchee Watershed and Disconnected Natural Areas in Existing Conditions

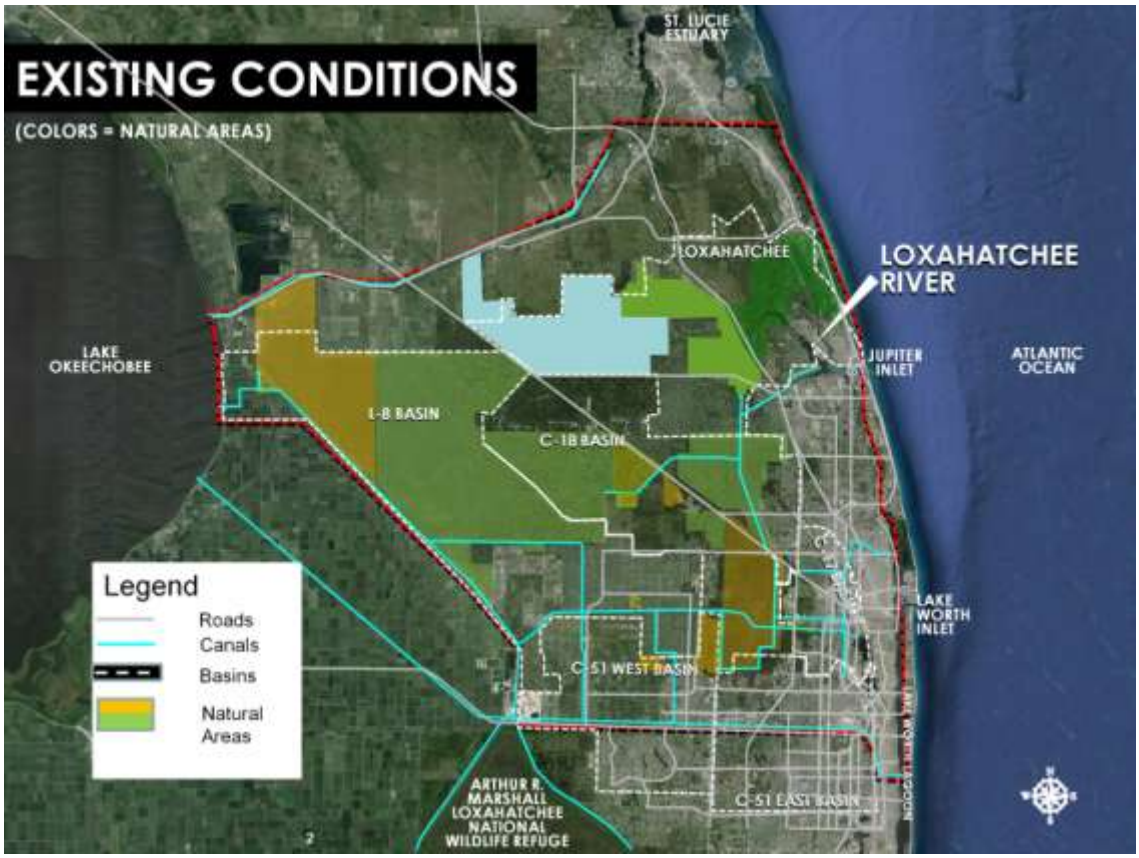


Table 1. Hydrologic/Spatial Connectivity Matrix

Hydrologic/Spatial Connectivity Matrix	Criterion Value based on Subteam Assessment	Maximum Score Possible
Connection provides historic hydrologic linkage which contributes to the restoration of downstream areas and improved quantity, timing and distribution of water. Connections that are closer to the river based on GIS analysis will be scored higher than those further away. See Figure 2 example.		**25**
Connection is part of a proposed greenbelt. See Figure 3 example of greenbelts.		**25**
Connectivity promotes water quality improvements and protects water quality.		**25**
Connectivity contributes to expanded native habitats and the support of wildlife populations by improving the foraging range, territory, or migration path of listed or rare endemic species (See Figure 4 for an example of Wildlife Layers). Wildlife utilization scores are used from the Wetland Rapid Assessment Procedure scoring sheets to identify the value of reconnecting various segments of natural areas.		**25**
TOTAL SCORE		**100**

CRITERION SCORING: **0**: No/Does not occur; 1**2.5:** Partially occurs; 2**5**: Yes/Definitely occurs

Table 2: Scoring Criterion Rubric

Criterion	No/Does not Occur = 0	Partially Occurs = 12.5	Yes/Definitely Occurs = 25
1.0 - Hydrologic Linkage to River	Restoration actions do not allow any additional water to flow to the Loxahatchee River;	Restoration actions improve wetland storage near Loxahatchee River that allows for groundwater recharge that is greater than 10 miles away from the river; or promotes additional flows of water to the river.	Restoration actions improve wetland storage near Loxahatchee River that allows for groundwater recharge, and promotes additional flows of water to the river and are closer than 10 miles to the river.
2.0 - Greenway Corridor	Restoration actions do not support hydrological restoration or additional connections existing or proposed greenway corridors.	Restoration actions support hydrological restoration in a portion of existing or proposed greenway corridors.	Restoration actions support hydrological restoration along a majority of an existing or proposed greenway corridor.
3.0 - Water Quality Improvements	Connectivity and restoration actions do not provide additional water quality improvements.	Connectivity and restoration actions improves water quality by partially allowing for sheetflow across natural lands, natural flow ways providing some treatment, but also utilizing the canal system.	Connectivity and restoration actions improves water quality by allowing for only sheetflow across natural lands and natural flow ways.
4.0 - Flora and Fauna	Restoration actions do not lead to wildlife connectivity.	Restoration actions address 1 of 3 questions regarding flora and fauna benefits from connectivity	Restoration actions address 2-3 of the 3 questions regarding flora and fauna benefits from connectivity.

Figure 2 – Example Distance from and Visualization of Flow Connections to Loxahatchee River Map

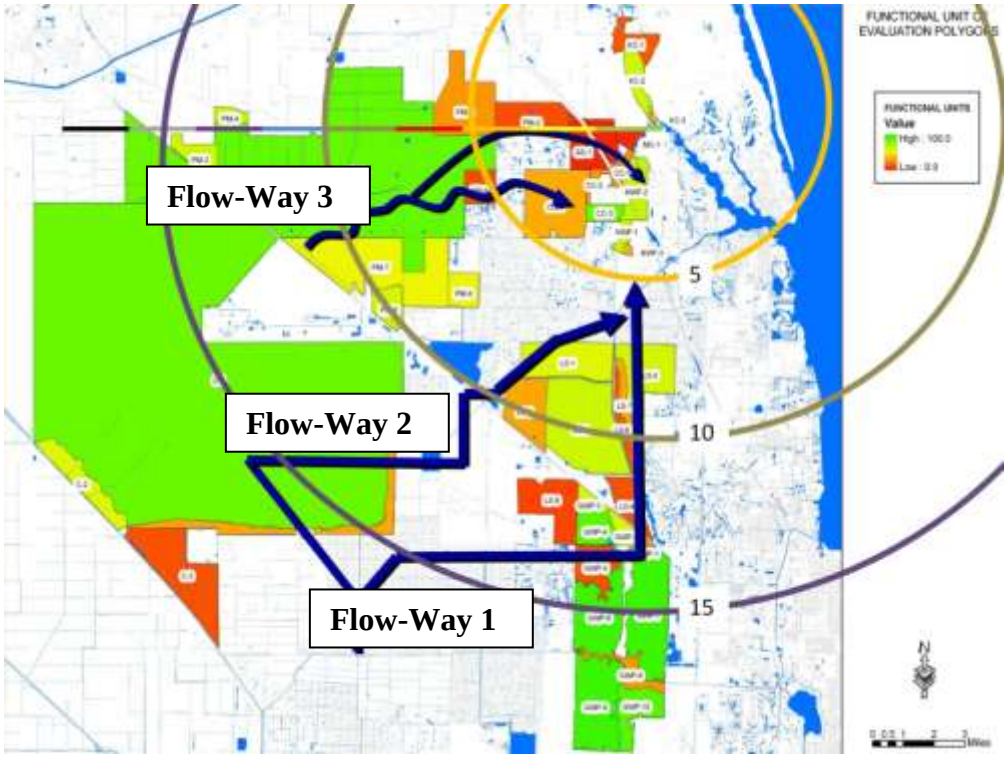
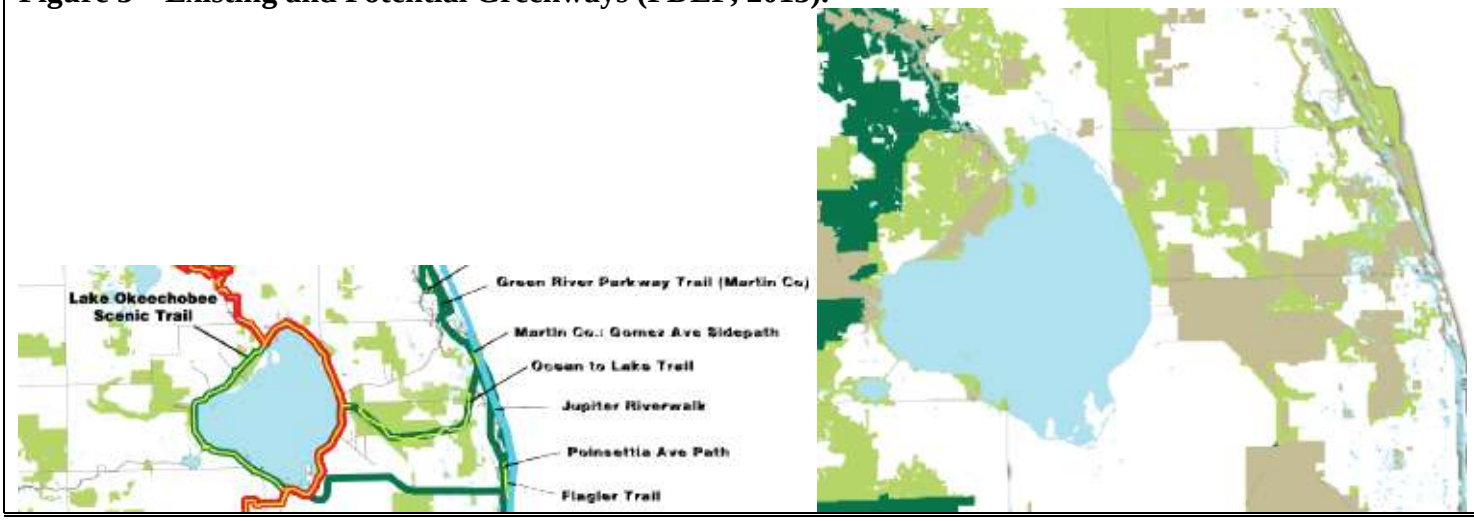


Figure 3 – Existing and Potential Greenways (FDEP, 2013).



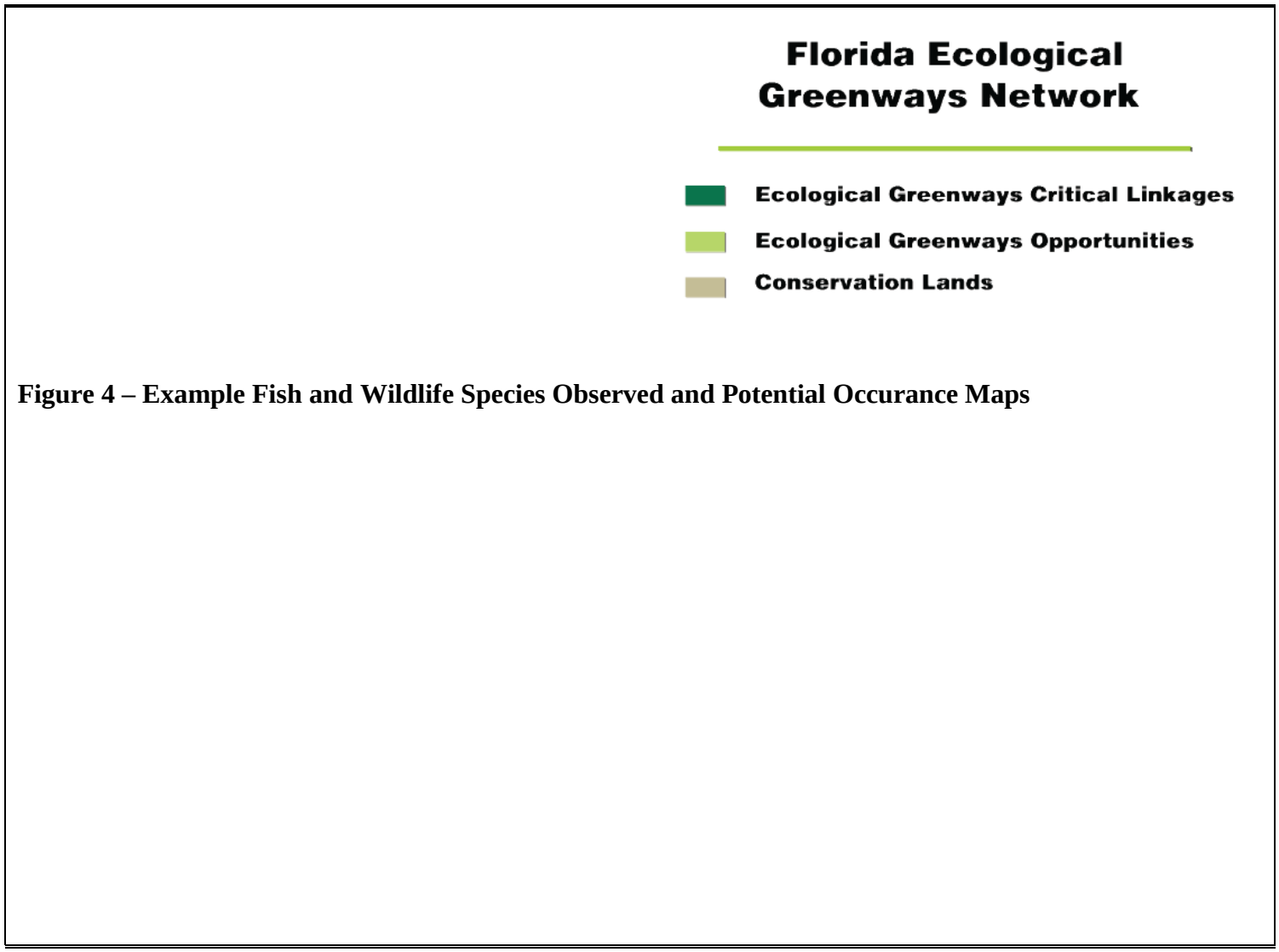
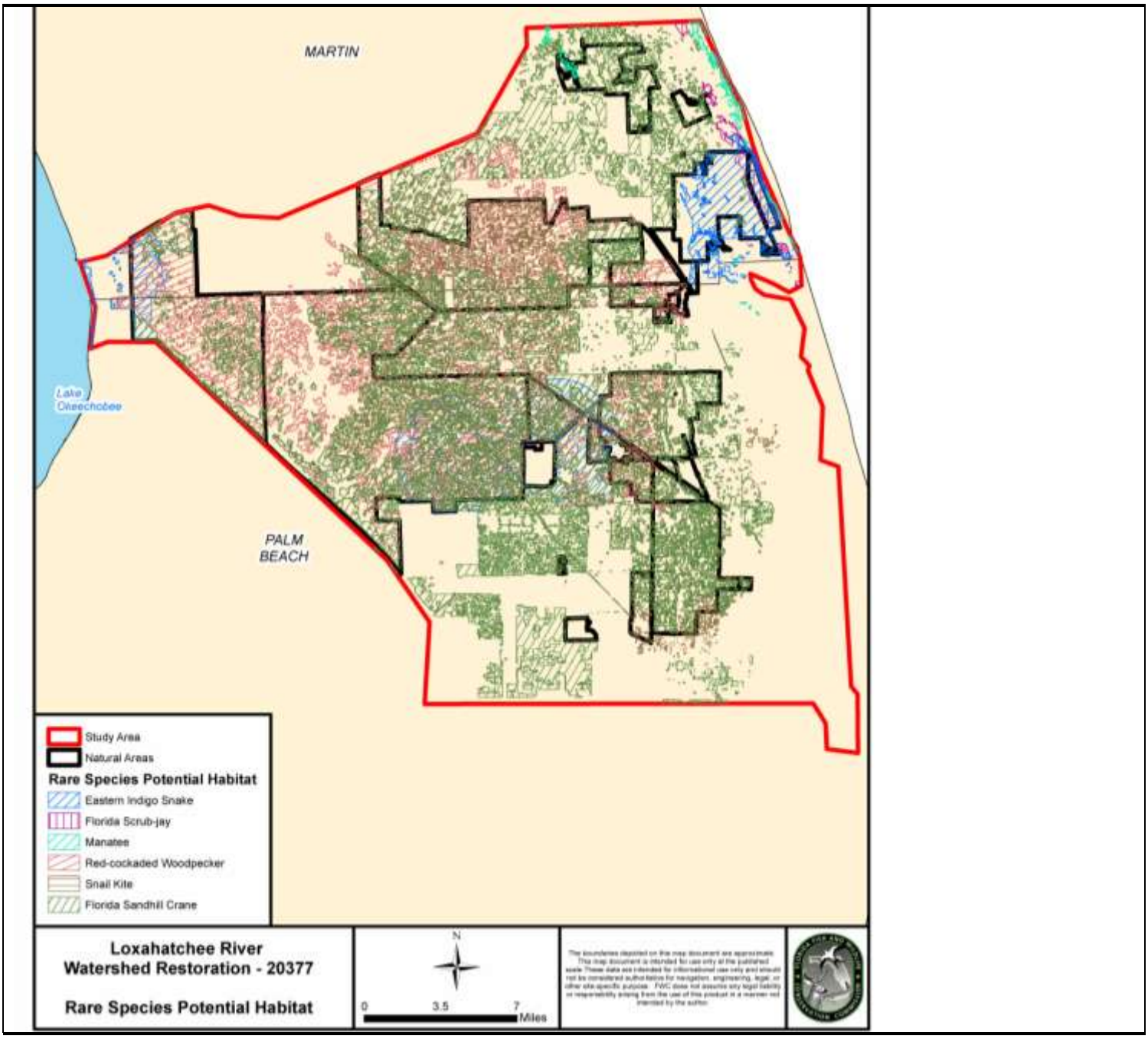


Figure 4 – Example Fish and Wildlife Species Observed and Potential Occurance Maps


MARTIN
Lake Okeechobee
PALM BEACH
Study Area
Natural Areas
Rare Species Potential Habitat
Eastern Indigo Snake
Florida Scrub-jay
Manatee
Red-cockaded Woodpecker
Snail Kite
Florida Sandhill Crane
Loxahatchee River Watershed Restoration - 20377
Rare Species Potential Habitat
N
0
3.5
7
Miles

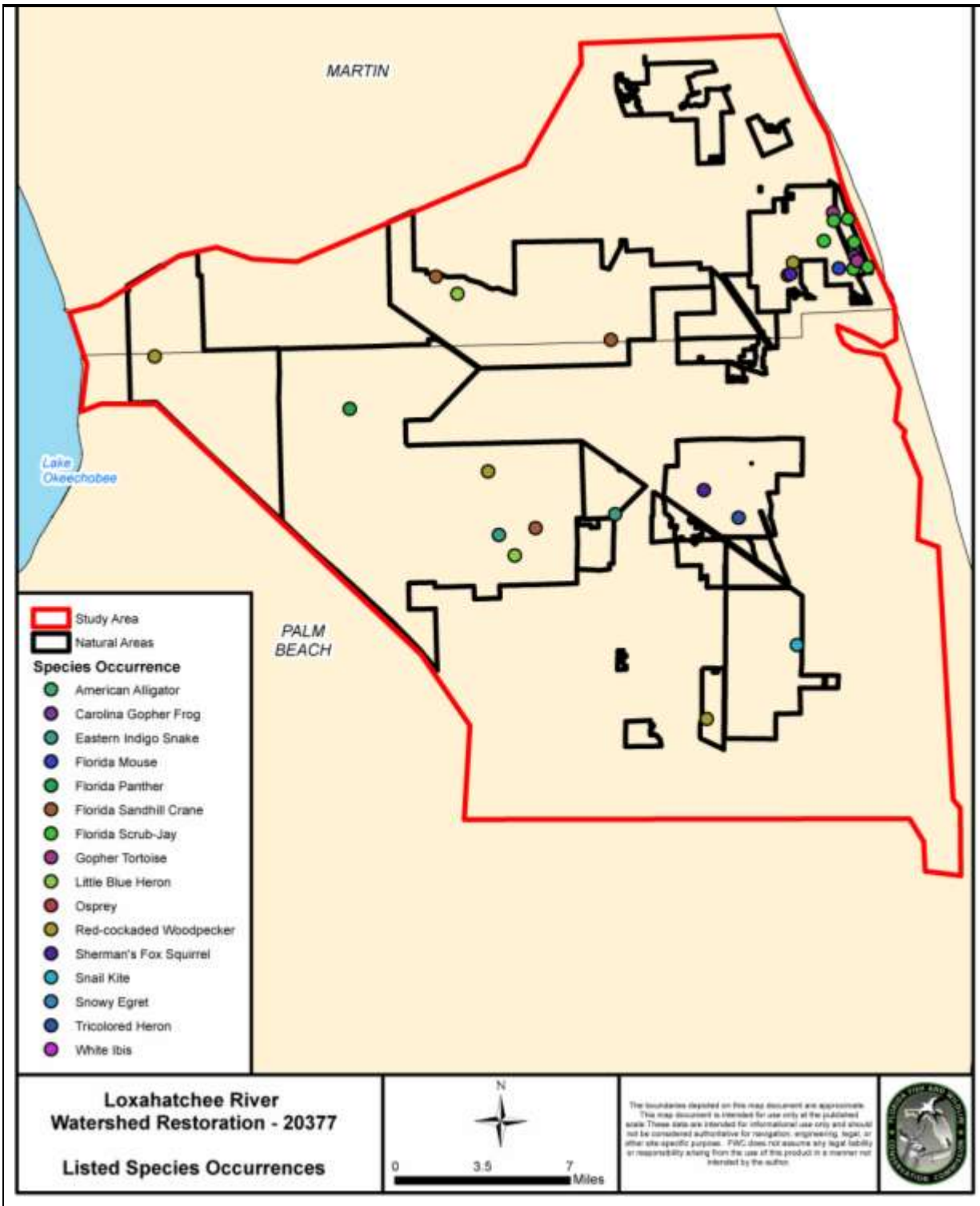

MARTIN
Lake Okeechobee
PALM BEACH
Study Area
Natural Areas
Species Occurrence
American Alligator
Carolina Gopher Frog
Eastern Indigo Snake
Florida Mouse
Florida Panther
Florida Sandhill Crane
Florida Scrub-Jay
Gopher Tortoise
Little Blue Heron
Osprey
Red-cockaded Woodpecker
Sherman's Fox Squirrel
Snail Kite
Snowy Egret
Tricolored Heron
White Ibis
Loxahatchee River
Watershed Restoration - 20377
Listed Species Occurrences
N
0
3.5
7
Miles

Table 3 – Example Connectivity Score for Restoration Project Alternative (Flow-way 1 – L-8/GWP/Loxahatchee Slough/Northwest Fork [SFWMD, 2010])

Hydrologic/Spatial Connectivity Matrix	Criterion Value based on Site Inspection
Connection provides historic hydrologic linkage which contributes to the restoration of downstream areas and improved quantity, timing and distribution of water. Connections that are closer to the river based on GIS analysis will be scored higher than those further away. See Figure 2 example.	**12.5**
Connection is part of a proposed greenbelt. See Figure 3 example of greenbelts.	**25**
Connectivity promotes water quality improvements and protects water quality.	**0**
Connectivity contributes to the spread of native habitats and the support of wildlife populations by improving the foraging range, territory, or migration path of listed or rare endemic species (See Figure 4 for an example of Wildlife Layers). Wildlife utilization scores are used from the Wetland Rapid Assessment Procedure scoring sheets to identify the value of reconnecting various segments of natural areas.	**12.5**
TOTAL SCORE	**50**

Source and History of Evaluation Protocol

C & N Environmental Consultants, Inc. 2002. Cypress Creek/Pal-Mar and the Groves Basins Study: 2.1.1. Wetland System Assessment.

Florida Department of Environmental Protection, 2013. Florida Greenways and Trails System Plan 2013-2017. http://www.dep.state.fl.us/gwt/FGTS_Plan/PDF/FGTS_Plan_2013-17_publication.pdf

Pringle, C. 2003. What is hydrologic connectivity and why is it ecologically important? Hydrological Processes 17: 2685-2689.

SFWMD, 2002. Northern Palm Beach County Comprehensive Water Management Plan

USACE and SFWMD. 1999. Central and Southern Florida Flood Control Project Comprehensive Review Study Final Integrated Feasibility Report and Programmatic Environmental Impact Statement (Restudy).

SFWMD. 2010. Draft Alternative Formulation Briefing Report for North Palm Beach County Part 1.

USACE and SFWMD, 2014. Draft Report Synopsis for Loxahatchee River Watershed Restoration Project.

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