Targeted Ecological Restoration through Shallow Wetland Mitigation Banking with Wood Stork Benefits

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- Conservation of shallow wetland functions in mitigation banking is essential to stabilizing wood stork populations in Southwest Florida
- The Panther Island Expansion Bank on Corkscrew Swamp Sanctuary is designed to provide foraging opportunity during the early breeding season.

Wood storks





Corkscrew Swamp Sanctuary

Located in the Western Everglades

- Largest tract of old-growth bald cypress
- Historically most productive wood stork colony

Corkserew Śwame

Wood Storks (Mycteria americana)

- Indicators of wetland health
- Indicators of restoration success
- Decline in SWFL since 1970's



in US





Corkscrew Swamp's wood stork colony historically supported over 30% of the US nesting effort.



Figure 1. Nesting effort at the Southwest Florida Corkscrew colony compared to the rest of South Florida and the entire nesting population in the SE US. In the 1960's and 70's Corkscrew contributed 34% and 37% of the total nesting effort. In the 90's and 00's the Corkscrew colony contributed 9% and 8% respectively. The primary cause of the decline of the Corkscrew population is the loss of shallow wetlands across Southwest Florida.

*Other colonies in SoFL were active in the 1960's but the data is not available seperate from the SE US figures.

Cumulative losses of shallow wetlands (70%)



Losses of shallow wetlands from the predevelopment era to 2004 within the Corkscrew CFA in Southwest Florida

Hydric Flatwoods other shallow wetlands Wet Prairies other wetlands

Cypress

Tidal marsh Uplands Urban built-up

Agriculture / barren land Water; Canals





The CFA = 30km radius from a stork colony.

Wet prairie & hydric pine flatwood losses

Changes in shallow wetland coverage over time in the Corkscrew wood stork colony Core Foraging Area.

「東北		PDVM	2004 LC	
	Land Cover	Area (sq. mi.)	Area (sq. mi.)	% change
New Y	Hydric Flatwood	299.8	68.9	23.0%
	Wet Prairie	73.3	13.0	17.8%
0	Other ¹	13.7	33.5	243.9%
	Grand Total	386.8	115.4	29.8%

¹ The majority of the 2004 increases in the "other" category are attributed to the 6240 and 6191 FLUCCS classes, cypress-pine-cabbage palm and wet melaleuca respectively.

Shallow wetland losses in the Wood Stork CFA

Predevelopment Map

Gulf of Mexic

Losses of shallow wetlands from the predevelopment era to 2004 within the Corkscrew CFA in Southwest Florida

CFA shallow wetlands						
Core Foraging Area						
Corkscrew Swamp						
Hydric Flatwoods						
other shallow wetlands						
Wet Prairies						
other wetlands						
Cypress						

Marsh other deep wetlands Mangrove

2004 LC Map

Tidal marsh Uplands

Urban built-up

Audubon Agriculture / barren land Society Water; Canals

National

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Note: Corkscrew's Core Foraging Area (CFA) has lost 70% of it's historic shallow wetlands. This includes a loss of 82% of the wet prairie habitat. Wet prairies contribute significantly to woodstork foraging opportunity early in the nesting season. The CFA = 30km radius from a stork colony.

Wood Stork Life History

Breeding Season

- Length (weeks): 4 incubate, 9 brood/feed, 4 feed/fly
- Re-nesting option (possible when nest early, Dec/Jan)
- Foraging proximity (30km core) 10:30 calm:windy
- Foraging methods
 - Tactilelocation
 - Optimal water depths: 2-16"
 - Prey density: 16–40 fish/m²
 - Fish between 1 10"



Wood Stork habitat use study



within the Corkscrew Swamp



Note: The South Florida Water Management District 2004 Land Use Land Cover map for 2004 was used to create this map. Land Cover categories are based on FLUCCS.



Summary table of foraging habitats used for foraging significantly more than expected: *Early dry season*

Table IV-16. EARLY Foraging Events - Nesting Sept-Dec 2008 - CFA

		Proportiona	Number	Expected ^b number of	Proportion observed	Confidence intervals on proportion of occurrence
Habitat type	Total area	of total area	of storks	storks	in each	(<i>pi</i>)° (95% family
(Land cover FLUCCS code)	(sq. miles)	(pio)	observed	observed	area (<i>p</i> i)	confidence coefficient)
Ditches 5120_X	61.32	0.122	58	12.5	0.56	$0.421 \leq p_i \leq 0.706$
Wet Prairies 6430	11.90	0.024	13	2.4	0.13	$0.031 \leq p_i \leq 0.222$
Reservoirs 5000	18.99	0.038	7	0.9	0.07	$-0.004 \leq p_i \leq 0.140$
Freshwater Marshes 6410	61.98	0.123	11	12.7	0.11	$0.018 \leq p_i \leq 0.195$
Cypress Domes Heads 6215	11.59	0.023	1	2.4	0.01	$-0.018 \leq p_i \leq 0.038$
OTHER	36.66	0.073	4	7.5	0.04	$-0.017 \leq p_i \leq 0.094$
Mixed Shrubs 6172	47.10	0.093	4	9.6	0.04	$-0.017 \leq p_i \leq 0.094$
Mangrove Swamp 6120	15.41	0.031	0	3.1	0.00	$0.000 \leq p_i \leq 0.000$
Cypress Pine Cabbage Palm 6240	16.91	0.034	0	3.5	0.00	$0.000 \leq p_i \leq 0.000$
Mixed Wetland Hardwoods 6170	23.46	0.047	0	4.8	0.00	$0.000 \leq p_i \leq 0.000$
Wet Pinel ands Hydric Pine 6250	66.28	0.131	4	13.5	0.04	$-0.017 \leq p_i \leq 0.094$
Row Crops 2140	49.65	0.098	0	10.1	0.00	$0.000 \leq p_i \leq 0.000$
Cypress 6210	82.97	0.165	1	16.9	0.01	$-0.018 \leq p_i \leq 0.038$
totals	504.23		103			-

^a Proportions of total acreage represent expected Wood Stork observation values as if storks foraged in each habitat type in exact proportion to availability.

^b Calculated by multiplying proportion $p_{i0} \ge n$; i.e. 0.16456 $\ge 103 = 16.9$.

^c p_i represents theoretical proportion of occurrence and is compared to corresponding p_{i0} to determine if hypothesis of proportional use is accepted or rejected, i.e. p_i = p_{i0}.

 Early in the dry season, Wood Storks use of <u>wet prairies</u> and <u>shallow</u> <u>ditches</u> for foraging was significantly above expected values based on availability.

Start of Nest Initiaiton at Corkscrew 1958-2010



Storks are nesting later



Later nesting translates to lower productivity

Wood Stork Radar Historic CFA Corkscrew Swamp: October/December

- Core Foraging Area
- Corkscrew colony
- Hydric Flatwood
- Hydric Hammock
- Wet Prairie
- Scrub Cypress Marsh
- Cypress
- Swamp Forest
- Mangrove
- Tidal Marsh
- Uplands
- Beach
- Water



Note: This map shows the primary wood stork foraging habitat available historically in the early breeding season. Wet prairie 73.3sq.mi, Mangrove 21.0 sq.mi, Tidal marsh 1.67 sq.mi, Scrub cypress 1.2 sq.mi. Wet prairie and scrub (or dwarf) cypress have hydroperiods of between 2-6 months, with maximum depths of between 6-12 in. The South Florida Water Management District pre-development map was used to create this map.





Wood Stork Radar Historic CFA Corkscrew Swamp:

January/April

- Core Foraging Area
- Corkscrew colony
- Hydric Flatwood
- Hydric Hammock
- Wet Prairie
- Scrub Cypress
- Marsh
- Cypress
- Swamp Forest
- Mangrove
- Tidal Marsh
- Uplands
- Beach
- Water



Note: This map shows the primary wood stork foraging habitat available historically in the mid-breeding season. Cypress 107.6 sq.mi, Marsh 49.5 sq.mi, Mangrove 21.0 sq.mi, Tidal marsh 1.67 sq.mi. Cypress hydroperiods vary between 6-8 months with maximum depths between 12-18 in. Marsh hydroperiods vary from 6-10 months with max, depths from 12-24 in. The South Florida Water Management District pre-development map was used to create this map.





Wood Stork Radar Historic CFA Corkscrew Swamp:

March/May

- Core Foraging Area
- Corkscrew colony
- Hydric Flatwood
- Hydric Hammock
- Wet Prairie
- Scrub Cypress
- Marsh
- Cypress
- Swamp Forest
- Mangrove
- Tidal Marsh
- Uplands
- Beach
- Water



Note: This map shows the primary wood stork foraging habitat available historically in the late breeding season. Swamp forest 88.0 sq.mi, Marsh 49.5 sq.mi, Mangrove 21.0 sq.mi, Tidal marsh 1.67 sq.mi, Swamp forest hydroperiods vary from 8-10 months, with maximum depths between 18-24 in. Marsh hydroperiods vary from 6-10 months with max, depths from 12-24 in. The South Florida Water Management District pre-development map was used to create this map.





Wood Stork Radar 2004 CFA Corkscrew Swamp: October/December

- Core Foraging Area
- Corkscrew colony
- Hydric flatwoods
- Forested shallow
- Wet prairie
- Marsh
- Cypress
- Forested deep
- Mangrove
- Tidal
- Water
- Uplands
- Agriculture
- Urban and disturbed



Note: This map shows the primary wood stork foraging ha bitat available in the early breeding season circa 2004. Wet prairie 13.1sq.mi. Mangrow 15.8 sq.mi. Tidal marsh 3.14 sq.mi. Wet prairie shave hydroperiods from 2-6 months and maximum depths from 6-12 in. The South Florida Water Management District pre-development map was used to create this map.

> National Audubon Society



Wood Stork Radar 2004 CFA Corkscrew Swamp:

January/May

- Core Foraging Area
- Corkscrew colony
- Hydric flatwoods
- Forested shallow
- Wet prairie
- Marsh
- Cypress
- Forested deep
- Mangrove
- Tidal
- Water
- Uplands
- Agriculture
- Urban and disturbed



Note: This map shows the primary wood stork foraging habitat available in the early breeding season circa 2004. Marsh 66.9 sq.mi. Cypress 105.9 sq.mi. Forested deep wetlands 59.1 sq.mi. Mangrove 15.8 sq.mi. Tidal marsh 3.14 sq.mi. These wetlands have hydroperiods in excess of 6 months. Maximum water depths range from 12 to more than 24 inches.

The South Florida Water Management District pre-development map was used to create this map.





Mitigation of wetland impacts will determine fate of SWFL wood stork nesting



Shallow wetlands are disproportionately impacted resulting in significant losses.



Panther Island Mitigation Bank expansion site

Little Corkscrew Island

Corkscrew's stork colony is less than 1 mile from the mitigation bank. Restoration will restore shallow wetland functions to former wetlands.

Corkscrew Swamp





LEE Gollier

Existing Panther Island Mitigation Bank (PIMB) and Proposed Panther Island Mitigation Bank Expansion (PimbE)

Key Factors in Wetland Creation Design

- Hydrology over time
- Soil chemistry
- Weather patterns
- Interaction with adjacent/near vegetative communities
- Clear goal for target communities





Proposed Panther Island Mitigation Bank Expansion (PimbE) Existing Conditions Groundwater and surface water wells installed Data collected for 3+ years Results used to build groundwater potentiometric "contour lines" for key time periods

Proposed Panther Island Mitigation Bank Expansion (PimbE) Groundwater Contours <u>Design Targets</u>

Short hydroperiod marshes/prairies

Optimum forage opportunities Oct-December

Large area contributing to forage zones

Proposed Panther Island Mitigation Bank Expansion (PimbE) Wetland Creation/Restoration Plan

Proposed Panther Island Mitigation Bank Expansion (PimbE) Early November Forage Area Availability

In Conclusion

Research has provided further insights into important parameters for wood stork needs.

Historic as well as current patterns of habitat loss must be considered in species conservation efforts

Existing Panther Island Mitigation Bank has successfully added January through April wood stork forage opportunities.

Proposed expansion of bank provides an opportunity to act on knowledge gained by current research on wood stork foraging needs.

Restoring and creating wetlands based on research findings and with a clear goal of the key functions the wetlands will provide, represents an excellent synergy of land management, research, and conservation efforts and goals.

Thank you

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