Ecological Monitoring to Track Succession and Evaluate Performance of a Western Everglades Wetland Mitigation Bank

Mica Rumbach and Shawn E. Clem

Western Everglades Research Center
Corkscrew Swamp Sanctuary
Naples, FL

INTRODUCTION

Wetland conservation and restoration are crucial to maintain the essential functions wetlands serve in our watersheds. Mitigation banking by for-profit companies can be a valuable conservation tool, providing funds for relatively costly restoration projects. As development of wetland habitat continues and mitigation banking becomes more prevalent in South Florida, it is imperative to ensure wetland banks provide the ecological functions they are intended to provide and that these functions persist in the years and decades after restoration is deemed complete.

Audubon Florida's partnership with Panther Island Mitigation Bank (PIMB), a ~4,500-acre wetland mitigation bank constructed by The Wetlandsbank Group and directly adjacent to Audubon's Corkscrew Swamp Sanctuary (CSS), provides an excellent opportunity for pre- and post-restoration monitoring (Fig. 1). We began a long-term monitoring program on PIMB in 2014 with a primary focus on ecological function provided for wading birds. Hydrology, aquatic fauna and wading birds are monitored to assess prey density and availability for wading birds throughout the nesting season and the value of restored wetlands for foraging. We are also monitoring herpetofauna, birds, and mammals in order to quantify habitat use by other wildlife.

PIMB was previously row crops and the former fields have been restored in phases, providing an ideal opportunity to examine post-restoration succession (Fig. 2). Our monitoring program includes post-restoration monitoring on Phase 2 (completed 2000), Phase 3 (completed 2001), and Phase 4 (completed 2002) and pre- and post-restoration monitoring on Phase 8 (completed 2016), Phase 9 (restoration in progress) and Phase 10 (pre-restoration). We also conduct monitoring within Corkscrew Swamp Sanctuary's wet prairie which provides a relatively pristine reference site. Summary data presented here represent a preliminary look at what can be gained from this long-term monitoring program.

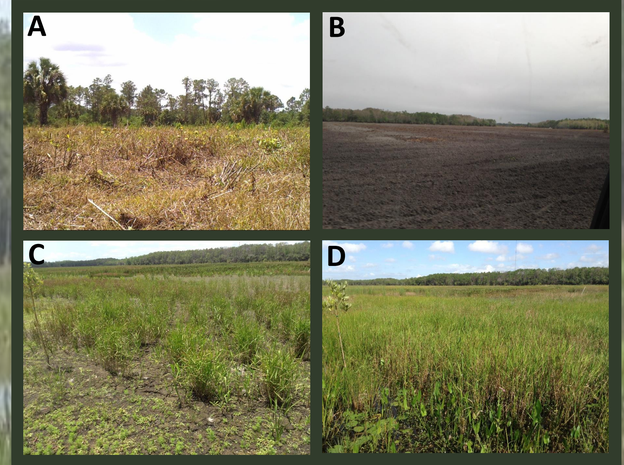

Fig 2. Photo documentation of the restoration process (Phase 8): fallow farm field (A), land cleared and topsoil removed (B), land contoured and planted (C), and restored marsh one year -restoration (D).

HYDROLOGY

Goal: to monitor changes in surface and groundwater hydrology

Methodology: Hydrologic monitoring of the expansion phases is primarily conducted by The Wetlandsbank Group and consists of a network of groundwater wells throughout the existing (already restored) and expansion (in progress) sections of the bank. We collect daily rainfall data on site and a groundwater well (NW) adjacent to a restored section of PIMB.

Results: Analyses of hydrologic data are ongoing. We present a hydrograph of daily water levels adjacent to a restored phase of PIMB for WY2015-present (Fig. 3).

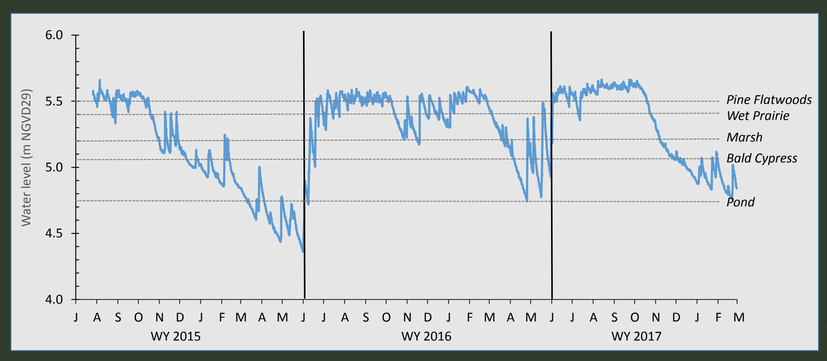

Fig 3. Daily water level (m NGVD29) from groundwater well 'NW' adjacent to a restored phase of PIMB WY2015 to present. Estimated elevations of wetland habitats are indicated to demonstrate approximate hydroperiods.

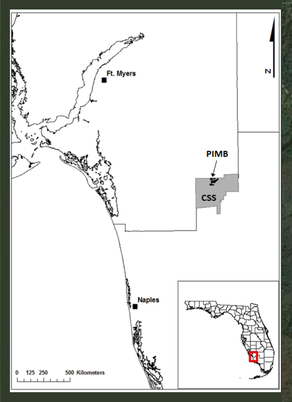

Fig 1. Location of Corkscrew Swamp Sanctuary and Panther Island Mitigation Bank (PIMB) in southwest Florida. Phases restored 2000-2002 (Phases 2-4) are outlined in blue and Phases currently undergoing restoration (Phases 8-10) are outlined in red.

AQUATIC FAUNA

Goal: to characterize aquatic fauna community structure and prey standing stock (including intra- and inter-annual site variation) and quantify changes through post-restoration succession

Methodology: Sites were established opportunistically on pre-restoration sites (primarily ditches and ponds) and adjacent to intended prey concentration areas on post-restoration sites. Sites are sampled annually in October, December, and February using 1-m^2 throw traps (3 to 5 throws per site) and Gee's wire mesh minnow traps (3 3-mm mesh and 3 6-mm mesh traps per site, 24-h soak) (Fig. 4).

Results: To date we have collected 21 fish and 3 crustacean species. Incomplete sampling due to ongoing restoration and unusual hydrology in WY2016 prevented a meaningful look at aquatic prey standing stock; we provide an example of community composition at a site that is 16 years post-restoration (Fig. 5).

Fig 4. 1-m2 throw trap (Right) and wire mesh minnow traps (Left) used for aquatic fauna monitoring.

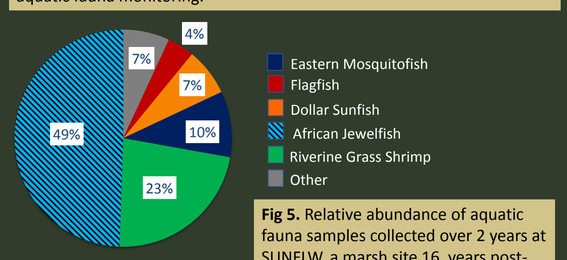

Fig 5. Relative abundance of aquatic fauna samples collected over 2 years at SUNFLW, a marsh site 16 years post-restoration.

WADING BIRDS

Goal: to quantify use of restored wetlands by wading and marsh birds

Methodology: Survey methods were adapted from the Standardized North American Marsh Bird Monitoring Protocol (Conway 2011) focusing on wading and marsh birds. Two-observer surveys are comprised of a 5-minute visual survey and a 4-minute call-back survey (targeting Least Bitterns, King Rails, American Bitterns and Pied-billed Grebes). Wading bird surveys are currently conducted on the PIMB expansion (Phases 8-10) and CSS only.

Results: Initial analyses focus on Phase 8 where restoration was completed in 2016. We conducted 3 pre-restoration surveys (Jan.-Mar. 2014) and recorded no wading or marsh birds. We've conducted 12 surveys post-restoration (Jan. 2016-Feb. 2017) and have recorded 16 target species (Table 2).

Table 2. Wading and marsh bird observed on Phase 8 following restoration (completed 2016).

Species
Pied-billed Grebe (*Podilymbus podiceps*)
Anhinga (*Anhinga anhinga*)
Great Blue Heron (*Ardea herodias*)
Great Egret (*Ardea alba*)
Snowy Egret (*Egretta thula*)
Little Blue Heron (*Egretta caerulea*)
Tricolored Heron (*Egretta tricolor*)
Glossy Ibis (*Plegadis falcinellus*)
White Ibis (*Eudocimus albus*)
Wood Stork (*Mycteria americana*)
Black-bellied Whistling-Duck (*Dendrocygna autumnalis*)
Blue-winged Teal (*Anas discors*)
Clapper Rail (*Rallus crepitans*)
Common Gallinule (*Gallinula galeata*)
American Coot (*Fulica americana*)
Sandhill Crane (*Antigone canadensis*)

HERPETOFAUNA

Goal: to quantify amphibian and reptile populations in in-tact (CSS) and restored (PIMB) wetlands

Methodology: Surveys are conducted in partnership with the University of Florida's Croc Docs as part of the Everglades Invasive Reptile, Amphibian, and Mammal Monitoring Program (EIRAMP). Monthly nighttime driving surveys are conducted along a 25.2-km route spanning CSS and PIMB. The route contains 4 checkpoints where 5-minute visual and vocal observations are recorded. This methodology also serves as a method of early detection of non-native reptiles.

Results: Twelve surveys were conducted October 2015 to March 2017 and 12 reptile and 11 amphibian species have been observed to date (Table 1).

Table 1. Reptile and amphibian species detected through EIRAMP surveys at PIMB and CSS.

Reptile Species
American Alligator (*Alligator mississippiensis*)
Striped Mud Turtle (*Kinosternon baurii*)
Florida Redbelly Turtle (*Pseudemys nelsoni*)
Brown Anole (*Anolis sagrei*)
Green Anole (*Anolis carolinensis*)
Southeastern Five-lined Skink (*Plestiodon inexpectatus*)
Florida Water Snake (*Nerodia fasciata*)
Southern Ringneck (*Diadophis punctatus*)
Everglades Racer (*Coluber constrictor*)
Eastern Ratsnake (*Pantherophis alleghaniensis*)
Florida Scarlet Snake (*Cemophora coccinea*)
Corn Snake (*Pantherophis guttatus*)
Amphibian Species
Two Toed Amphiuma (*Amphiuma means*)
Southern Toad (*Anaxyrus terrestris*)
Southern Narrowmouth Toad (*Gastrophryne carolinensis*)
Greenhouse Frog (*Eleutherodactylus planirostris*)
Cricket Frog (*Acris gryllus*)
Oak Toad (*Anaxyrus quercicus*)
Squirrel Treefrog (*Hyla squirella*)
Green Treefrog (*Hyla cinerea*)
Cuban Treefrog (*Osteopilus septentrionalis*)
Leopard Frog (*Lithobates sphenocephalus*)
Pig Frog (*Lithobates grilio*)

MAMMALS

Goal: to quantify occupancy of restored wetlands by medium- and large-sized mammals; secondarily, to document mammal populations prior to invasion by large non-native reptiles

Methodology: A network of trail cameras were installed on PIMB and CSS beginning in 2013. Cameras are moved quarterly to better span the survey area and decrease theft/vandalism.

Results: Fourteen mammal species were documented in the first year of sampling (Nov. 2013 to Dec. 2014) (Table 3). Number of cameras and effective camera trap days varied by restoration phase, but totaled 38 camera locations and 3,560 effective camera trap days in the first study year (Table 4). Processing of camera images and occupancy estimation is ongoing.

Table 3. Mammal species detected on trail cameras on PIMB Nov. 2013 to Dec. 2014.

Species
White-tailed Deer (*Odocoileus virginianus*)
Coyote (*Canis latrans*)
Bobcat (*Lynx rufus*)
Florida Panther (*Puma concolor coryi*)
Eastern Spotted Skunk (*Spilogale putorius*)
North American River Otter (*Lontra canadensis*)
Raccoon (*Procyon lotor*)
American Black Bear (*Ursus americanus*)
Nine-banded Armadillo (*Dasypus novemcinctus*)
Virginia Opossum (*Didelphis virginiana*)
Domestic Cat (*Felis catus*)
Domestic Dog (*Canis lupus familiarus*)
Wild hog (*Sus scrofa*)
Human (*Homo sapien*)

Table 4. Number of cameras locations and effective camera trap days on each restoration phase (Nov. 2013 to Dec. 2014).

Phase	No. of camera locations	No. of camera trap days
2	2	395.39
8	12	1,070.11
9	17	1,435.81
10	7	658.95
Total	38	3,560.25

ACKNOWLEDGEMENTS

We are grateful for assistance and support from our research partners, including The Wetlandsbank Group, Stantec (esp. Tom Trettis), and UF's Croc Docs. Funding was provided by The Batchelor Foundation, the Robinson Foundation, South Florida Water Management District (EIRAMP) and several other generous Audubon Florida donors. Additional support and assistance were received from Audubon Florida staff and volunteers (esp. Ralph Arwood).