75

Fish Community Colonization Patterns in the Rocky Glades Wetlands of Southern Florida

William F. Loftus[1], Robert M. Kobza[1,2], Delissa Padilla[1], and Joel C. Trexler[2]

[1] USGS, FISC-CWRS, Everglades Field Station, Homestead, FL, [2] JCWS-USGS, [3]Florida International University, Miami, FL

USGS science for a changing world

INTRODUCTION

Karst wetlands are poorly studied aquatic habitats. Their ecology depends on interactions of geology, hydrology, and biological processes. The Rocky Glades, the drainage divide between Shark and Taylor sloughs, is an example of a karst wetland characterized by:

- Water diversion, agriculture, and urban development which have irrevocably altered over half the area (Fig. 1);
- Short Inundation, from 3 to 7 months, significantly reduced from historical conditions (Fig. 2a, b);
- Thousands of solution holes of varying depths (Fig. 3) ;
- Deeper holes connect directly to groundwater to provide drought refuge for aquatic organisms.

Figure 1 -Array Locations

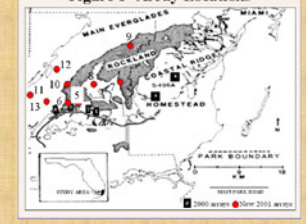
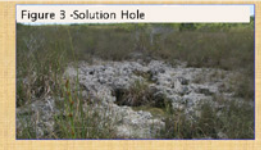


Fig. 2a

Fig. 2b

Figure 2a. Rocky Glades in January 1897 (Willoughby 1898); 2b. Rocky Glades in November 2001. **Hard to float a boat today!**

Figure 3 -Solution Hole



Study Background

- Region ignored for aquatic study – terrestrial-like for much of year.
- Loftus et al. (1992) first sampled aquatic animals in Rocky Glades. They reported:
  - Mass fish movements in early wet season
  - Rapid reproduction during short wet period
  - Use of solution holes as dry-season refuges
  - Altered hydrology.
- Drainage has degraded aquatic habitat function of this region; Can CERP Restoration restore those functions and increase its value to the ecosystem?
- **We need better data on habitat use and movement patterns, and estimates of historical hydrology!**

ABSTRACT

The Rocky Glades is a south Florida landscape degraded by drainage and land conversion. It remains structurally intact only in Everglades National Park. This important short-hydroperiod wetland maintains a persistent fish community because of refuges in the highly eroded karst and connections to permanent water bodies. Fishes can survive beneath the surface for months, but the degree that local refuges (solution holes) versus distant refuges (sloughs and canals) provide recruits for recolonization is unclear.

In 2000, we performed a pilot study to test use drift fence/funnel traps to study fish dispersal, composition, and succession. The study was expanded spatially in 2001, and we also used traps to sample solution holes. Fishes colonized surface habitats almost immediately after flooding, indicating use of local refuges. Most of the 24 fish species collected appeared during the first week of reflooding. Larger-bodied species and non-native fishes appeared to immigrate later. We describe how the data will be used in restoration of this region and the future research questions and requirements to achieve that goal.

OBJECTIVES

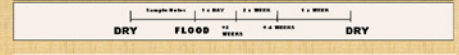
- Study seasonal use of surface/subsurface habitats by fishes.
- Quantify effects of hydrology on fish movements and catch.
- Determine if Rocky Glades is a source or sink for fishes.
- Estimate responses by fishes to restoration plans.

METHODS

Array Traps

In 2000, 4 drift-fence arrays (#1-4)(Array 2: Figs 4a-c) erected to measure dispersal and relative abundance of fishes with the arrival of the wet season (Fig. 1). The road shoulder is the southern border to each array. Minnow traps at center sampled for 24h. In 2001, additional 9 arrays (#s 5-13) erected away from roads for wider spatial coverage (Fig. 1). Arrays 7-13 sampled less frequently because of logistical constraints.

Sampling Design (2000):	Sampling Design (2001-Present):
· 4 Arrays · 3 Minnow Traps (3mm mesh) · 3 Compass Directions (E,N,W) · Collect, Measure, Weigh and Sex All Fishes	· 13 Arrays · 3-4 Minnow Traps (3mm mesh) · 3-4 Directions (E,N,S,W) · Collect, Measure, Weigh and Sex All Fishes



Solution-Hole Traps

When wetlands dry, minnow traps sample fishes using holes near arrays for refuge. Holes sampled twice weekly, then weekly. Fishes measured, identified, and returned to holes alive.

Physical Measurements

- Staff gauges at arrays and holes for relative water depths;
- Rain gauges for daily rainfall;
- YSI recorders for seasonal measures of pH, Dissolved Oxygen, Water Temperature, and Specific Conductance;

Flow using timed floating bottle and Sontek© ADVM.

DATA

HYDROPERIOD

- Figure 5a shows relative depth and hydroperiod for the 4 arrays in 2000; Figure 5b for 2001. **Hydropattern varies spatially and annually.**
- Western arrays 3&4, lower in elevation, flooded earlier than the eastern arrays 1 & 2, and had longer hydroperiods.

Figure 5a

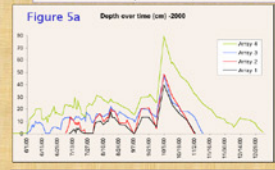
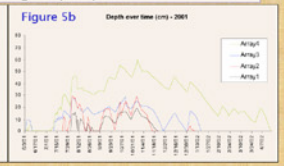
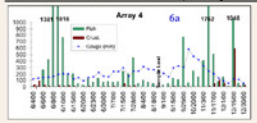


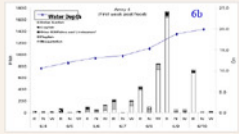
Figure 5b

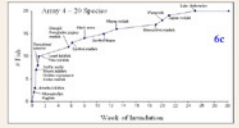


DRIFT-FENCE ARRAYS (Array 4 as example of data being collected)



- Array flooded early June; dried by end of December 2000.
- Large numbers of fish caught as waters fell in winter (Fig. 6a).
- Fish appeared in traps immediately after the wetlands flooded, possibly indicating local subterranean refuges (Fig. 6b).
- Flow was generally east to west towards Shark River Slough





- Larger species appeared later in the sample, perhaps because of dispersal from distant refuges (Fig. 6c).
- Cumulative annual directional dispersal by fish differed in 2000 and 2001.

Array 4	E	N	W
2000	9498	1155	2009
2001	2006	747	2167

Species	No. of fish	% of fish
Gambusia holbrooki	14673	60.1%
Jordanella floridae	3377	13.8%
Lepomis marginatus	2222	9.1%
Poecilia latipinna	1626	6.7%
Fundulus confluentus	863	3.5%
Heterandria formosa	406	1.7%
Belonesox belizanus	233	1.0%
Ciclasoma urophthalmus	198	0.8%
Ciclasoma bimaculatum	123	0.5%
*Other species**	272	1.1%

*E. sucetta, E. everglades, L. microlophus, L. macrochirus, L. punctatus, T. meriae, N. maculatus, N. gyrinus, C. variegatus, C. managuense, E. gloriosus, C. guiosus, A. natalis, and F. chrysotus

G. holbrooki

Array	# Fish caught per trap day	# of different species caught	Flood Time
1	87	18	109 days
2	159	20	111 days
3	142	19	158 days
4	301	20	214 days

Array	1	2	3	4
1	x	17	15	17
2	17	x	16	19
3	15	16	x	16
4	17	19	16	x

- 24 total species in 2000, including 5 exotic species.
- Species richness relatively high for short-hydroperiod wetlands.
- Between 15-19 species shared by arrays.

Restoration Hypotheses

Rocky Glades historically had longer flooding periods, deeper water, higher groundwater levels, and dried later in autumn than under today's conditions (Fig. 7).

This promoted freer movements by fishes, longer feeding and reproduction periods, shorter times in confined refuges, and availability to wading birds early in the dry season.

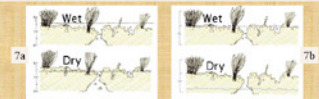


Figure 7A. Cartoon of wet/dry season hydrology in historical Rocky Glades; B. Present-day conditions.

Present-day conditions result in shorter flooding periods, discontinuous flooding patterns, and fish remain longer in refuges where mortality is high. **CERP must try to restore historical conditions.**

Questions/Plans

We will use present-day data on fish/habitat relationships in combination with modeled historical conditions to set targets for restoration. We continue to study the role of the Rocky Glades in south Florida:

- Do fish recolonize from local solution holes (double arrow) or from distant sloughs/estuaries (single arrows)?

Attempt to use stable isotope and otolith markers to identify sources of Rocky Glades fishes.

- Can fish survive below ground for months? Can they move long distances rapidly?
  Perform lab tests of swimming speed, endurance, and physiology under simulated habitat conditions.
- What role does flow play in fish dispersal?
  Need better spatio-temporal flow data for this region.
- What were historical water levels in wet and dry seasons?
  Reconstruct historical hydrology through models.

ACKNOWLEDGEMENTS

Special thanks to Victoria Foster, Andrew Martin, Phil George, Diane Riggs, Hardin Waddle, and Angela Griffith for array construction, field, and lab processing. This study is supported by DOI's Critical Ecosystem Studies Initiative (CESI) in cooperation with the US National Park Service, and by the USGS Florida Integrated Science Center.