FEEDING ON THE EDGE

FORAGING WHITE IBIS (*EUDOCIMUS ALBUS*) TARGET INTER-HABITAT PREY MOVEMENTS

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INTRODUCTION

The Everglades supports large colonies of nesting wading birds in the dry season (December-April) as the wetlands dry and prey concentrate (Ogden 1994, Frederick and Ogden 2001). The Everglades landscape consists of subtle elevation changes, with higher elevation ridges and lower elevation sloughs (~15 - 20 cm difference). Although the specific role of ridges is poorly understood, small topographic gradients generally facilitate prey concentration in drying sloughs as prey move down-gradient. The prey concentration in shallow pools is thought to sustain breeding by wading birds like White Ibis (*Eudocimus albus*) (Hoch et al. 2015, Botson et al. 2016).

Most studies of White Ibis (herein ibis) foraging suggest that they commonly feed in sloughs between 9-19 cm deep (threshold of 24 cm) (Gawlik 2002, Heath et al. 2009). White Ibis feed heavily on slough crayfish (*Procambarus fallax*) in the dry season (Boyle et al. 2012), and observations indicate that crayfish densities in sloughs peak with > 20 cm water depths (i.e.,when ridges dry and crayfish move from ridge to slough; Kushlan 1979, Cook et al. 2014). Whether ibis can access crayfish in this deep water has not been studied. To address this, we made continuous observations in replicate drying wetlands to examine the predator-prey interaction between ibis and crayfish and determine the depths at which ibis feed.

STUDY SITE

The observational study took place in wetland sloughs bordered by higher elevation ridge habitat ("shallow slough" in Fig. 1), in three replicated wetland macrocosms at the Loxahatchee Impoundment Landscape Assessment (LILA), Boynton Beach, FL, USA, over the 2017 dry season (February-April). The impounded macrocosms lie adjacent to each other with flora, fauna and elevation features characteristic of the Everglades ecosystem.

Figure 1. Aerial image of a wetland macrocosm in LILA. Each wetland includes tree islands, higher elevation ridges, and lower elevation deep and shallow sloughs. The camera viewing area is also noted.

HYPOTHESES

Depth Limitation Hypothesis
The majority of Ibis foraging will occur when slough depths are 9-19 cm deep (Gawlik 2002, Heath et al. 2009).

Crayfish Density Hypothesis
Ibis will mainly forage in sloughs when the adjacent higher elevation ridge habitats are almost dry and crayfish are migrating down-gradient (slough depths > 20 cm) (Cook et al. 2014).

Foraging Distribution Hypothesis
Ibis will selectively forage near the ridges as crayfish move between habitats (Cook et al. 2014).

METHODS

Ibis foraging responses were quantified over 0.13-0.14 ha of the slough (Fig.1) with game cameras (Reconyx PC800 Hyperfire) using time-lapse imagery. Cameras took photos every 3 minutes from 6:00 am to 2:00 pm (Feb. 27-April 28), as the water receded at a controlled rate of ~ 0.6 cm per day. Counts from the images determined the daily average ibis density and the distribution of ibis relative to the slough-ridge edge (~1.65 m of slough along the boundary).

Left: Image of White Ibis, Glossy Ibis, and Little Blue Herons foraging in deep water along a slough edge at LILA

Right: Throw trapping in one of the sloughs at LILA

Continuous depths were measured using automated recording devices. We sampled crayfish at 7 random points in each slough at three water stages, using a 1m^2 throw trap. Sample dates were Feb. 8-10: when slough depths were 44-52 cm, March 13-17: when crayfish concentration was expected and water was 7-11 cm on the ridges (≥ 29 cm slough depths), and April 3-7: when ridges were dry and slough depths were 10-22 cm.

IBIS FORAGING DEPTHS

Table 1. The weighted average foraging slough depth for White Ibis in each wetland macrocosm (M1, M2, M3) from all 61 days of observation (28 February–28 April, 2017). The weighted standard deviation is reported for each weighted depth.

Wetland	Weighted Mean Slough Depth (cm)	Weighted STDEV
M1	28.6	6.1
M2	26.4	6.1
M3	32.5	5.6

IBIS + CRAYFISH ACTIVITY

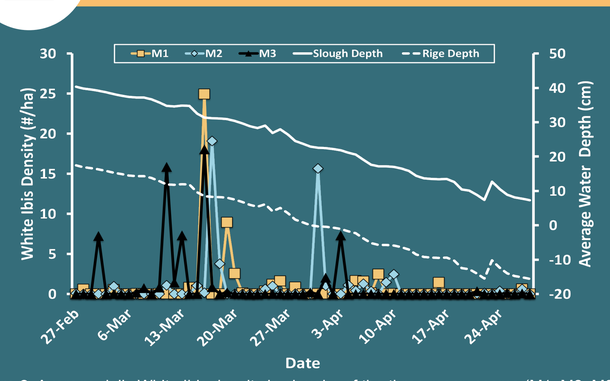

Figure 2. Average daily White Ibis density in sloughs of the three macrocosms (M1, M2, M3) at LILA over the 61-day period of observation. Mean water depths in sloughs and ridges is plotted on the secondary y-axis. The ridges were completely dry by March 27- April 4, with M3's drying first.

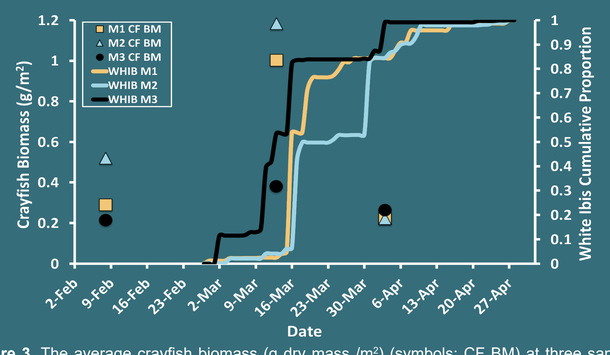

Figure 3. The average crayfish biomass (g dry mass /m^2) (symbols: CF BM) at three sample times, and the continuous proportional accumulation of White Ibis (lines: WHIB) foraging activity over the 61-day observation period. In M3, White Ibis foraged earlier in the month and may have lowered crayfish biomass prior to the second sampling.

IBIS DISTRIBUTION

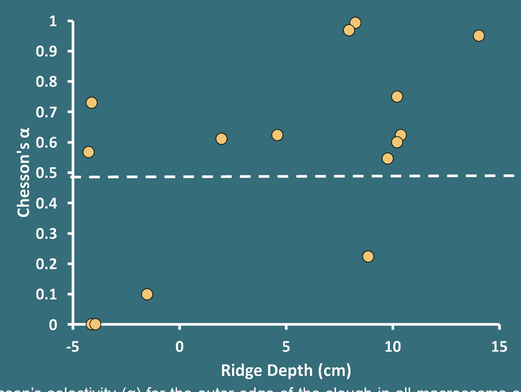

Figure 4. Chesson's selectivity (α) for the outer edge of the slough in all macrocosms compared against ridge depth for the 5 highest days of ibis activity in each macrocosm (80-89% of ibis activity/wetland). An α value of 1 indicates complete selection for the slough edge, a value of 0.5 indicates non-selective habitat use, and a value of 0 indicates complete selection for the inner slough.

RESULTS

Daily mean ibis densities varied from 0-25/ha over the macrocosms during the 61 days. 50-83% of White Ibis foraging occurred when the sloughs were ≥ 29 cm deep (Fig. 2).

The average ibis fed in slough water depths of 26 – 32 cm, higher than literature-suggested limits (24cm) (Table 1).

Mean crayfish biomass varied through time ($X^2 = 9.6$, $p = 0.008$), peaking in all three sloughs during second sampling session in mid-March. The final sampling period had low crayfish biomass (10-22 cm slough depths). The greatest increases in ibis activity occurred in mid-March with highest crayfish densities (Fig. 3).

The spatial distribution of ibis for the 5 highest foraging days in each wetland favored the edges (10-12% of a slough area), with 73–100% of ibis per slough area in the edges. Ibis preferred slough edges when the ridges were still inundated (α = 0.55–0.99) in 9 out of 10 days (Fig. 4).

CONCLUSION

Ibis foraging patterns support our crayfish density and foraging distribution hypotheses. Ibis responded to crayfish movement rather than previously identified depths (9 -19 cm), demonstrating they can effectively forage in 25 - 32 cm depths (Fig. 5).

The pattern suggests that the depth-mediated costs of foraging for crayfish may be different than when foraging for fish (Gawlik 2002, Heath et al. 2009).

This is a new mechanism by which ibis find food in the Everglades. Maintaining ridge elevation and ridge-slough patterning may be important in order to sustain nesting ibis populations.

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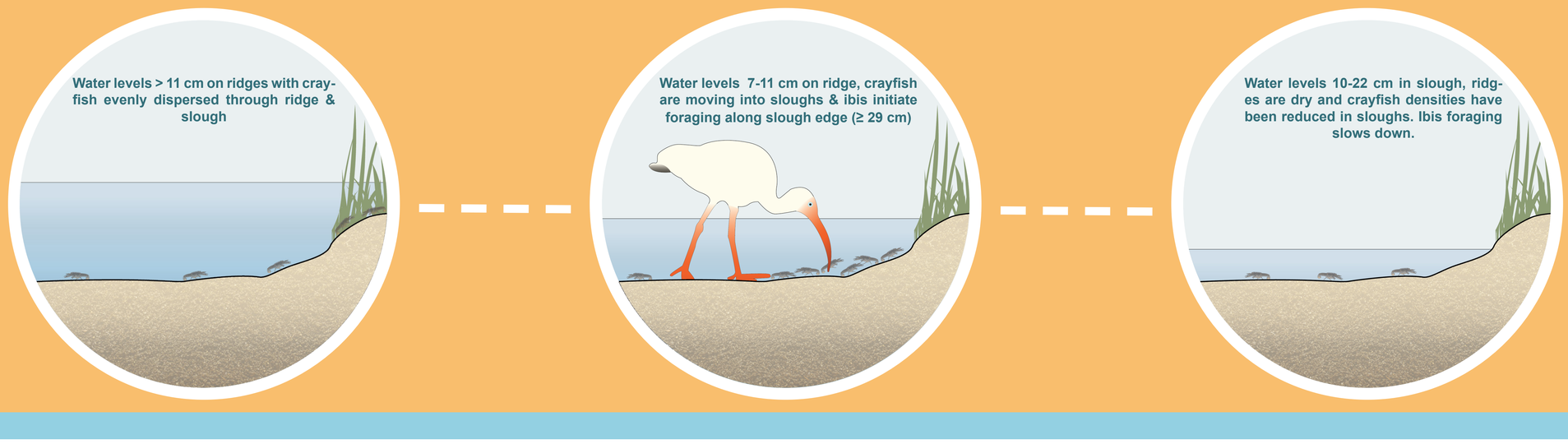

Figure 5