Modeling trophic linkages with wading bird prey concentrations: turning ecosystem attributes into wading bird food

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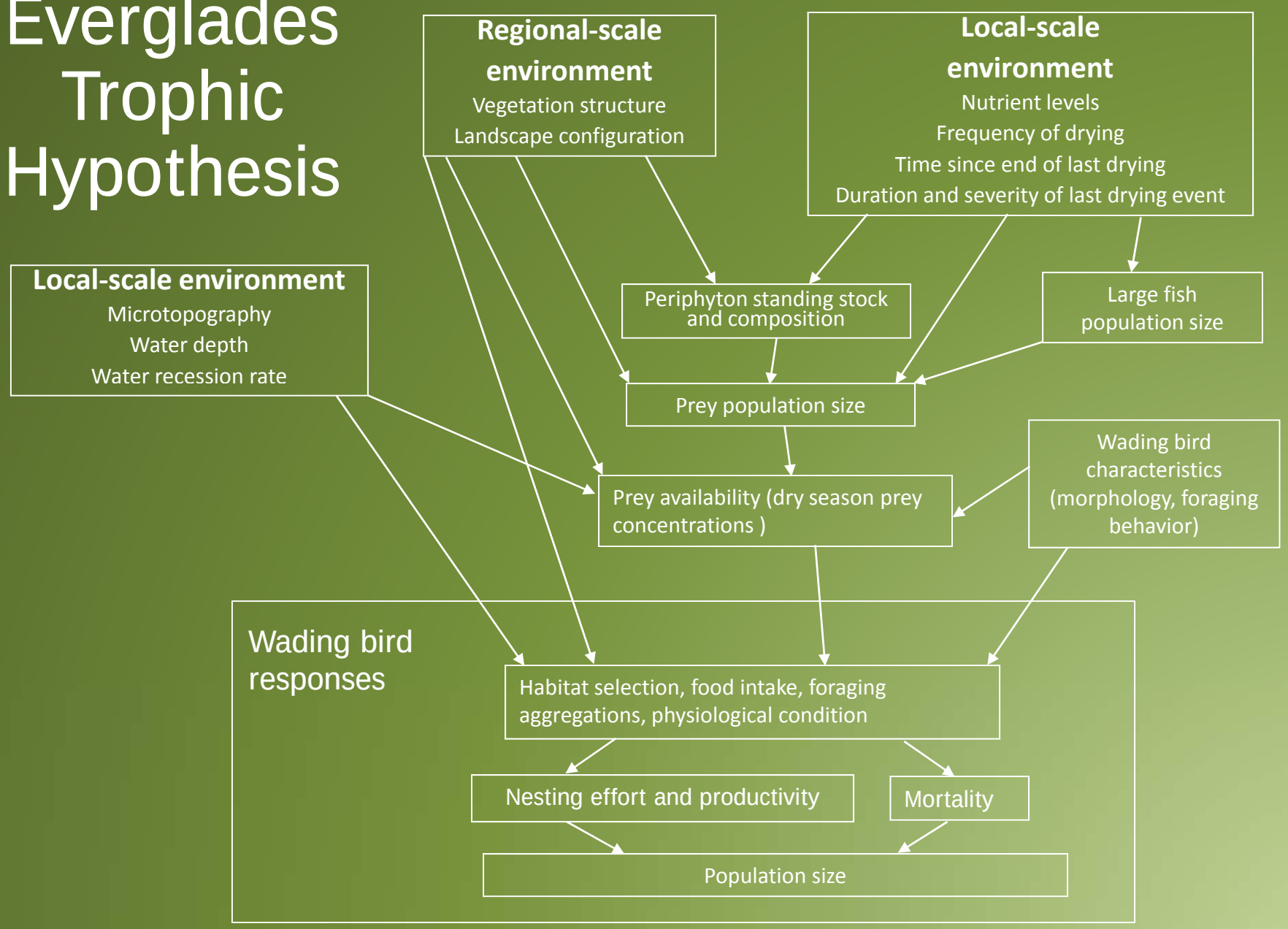
Everglades Trophic Hypothesis



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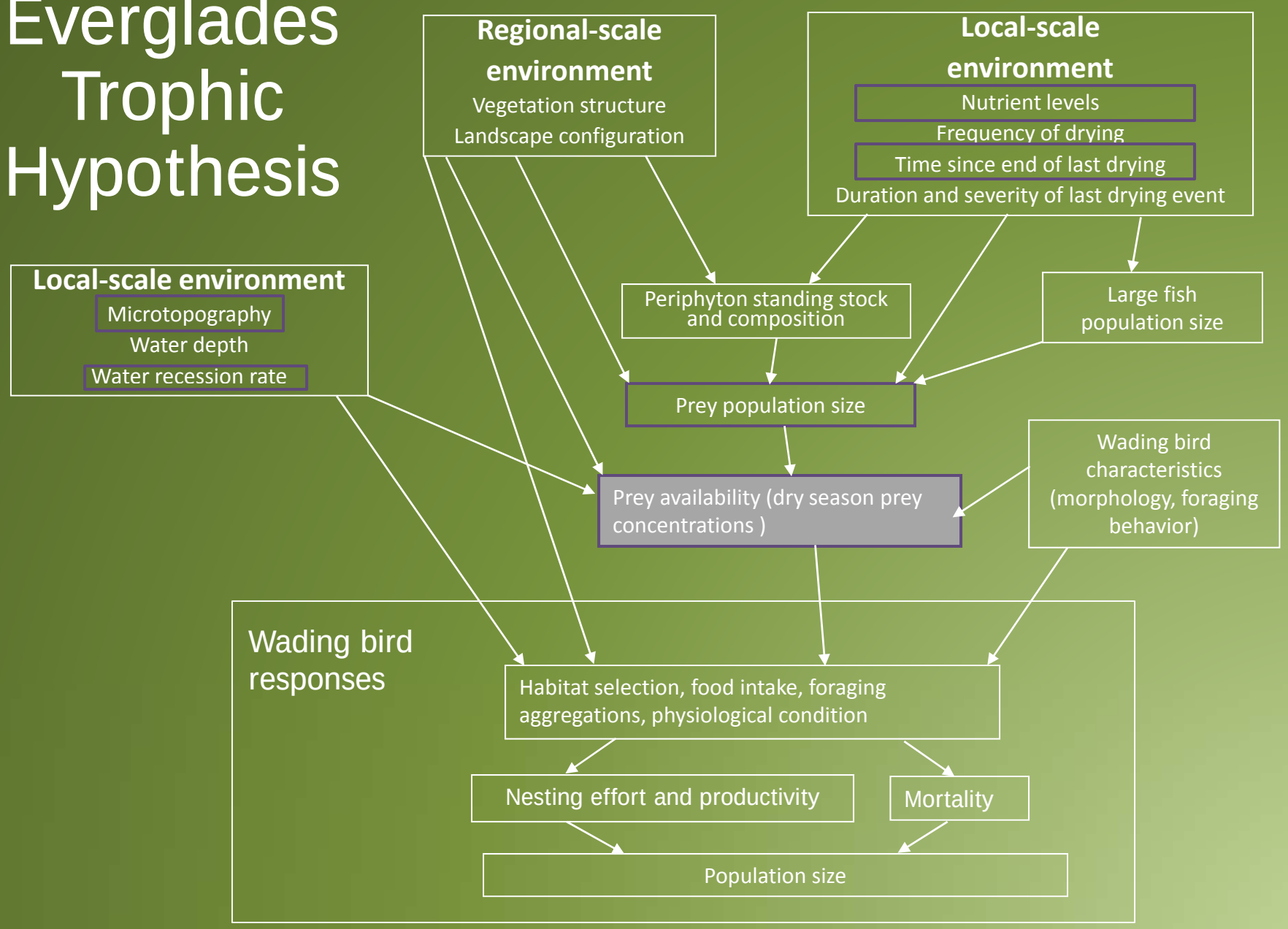
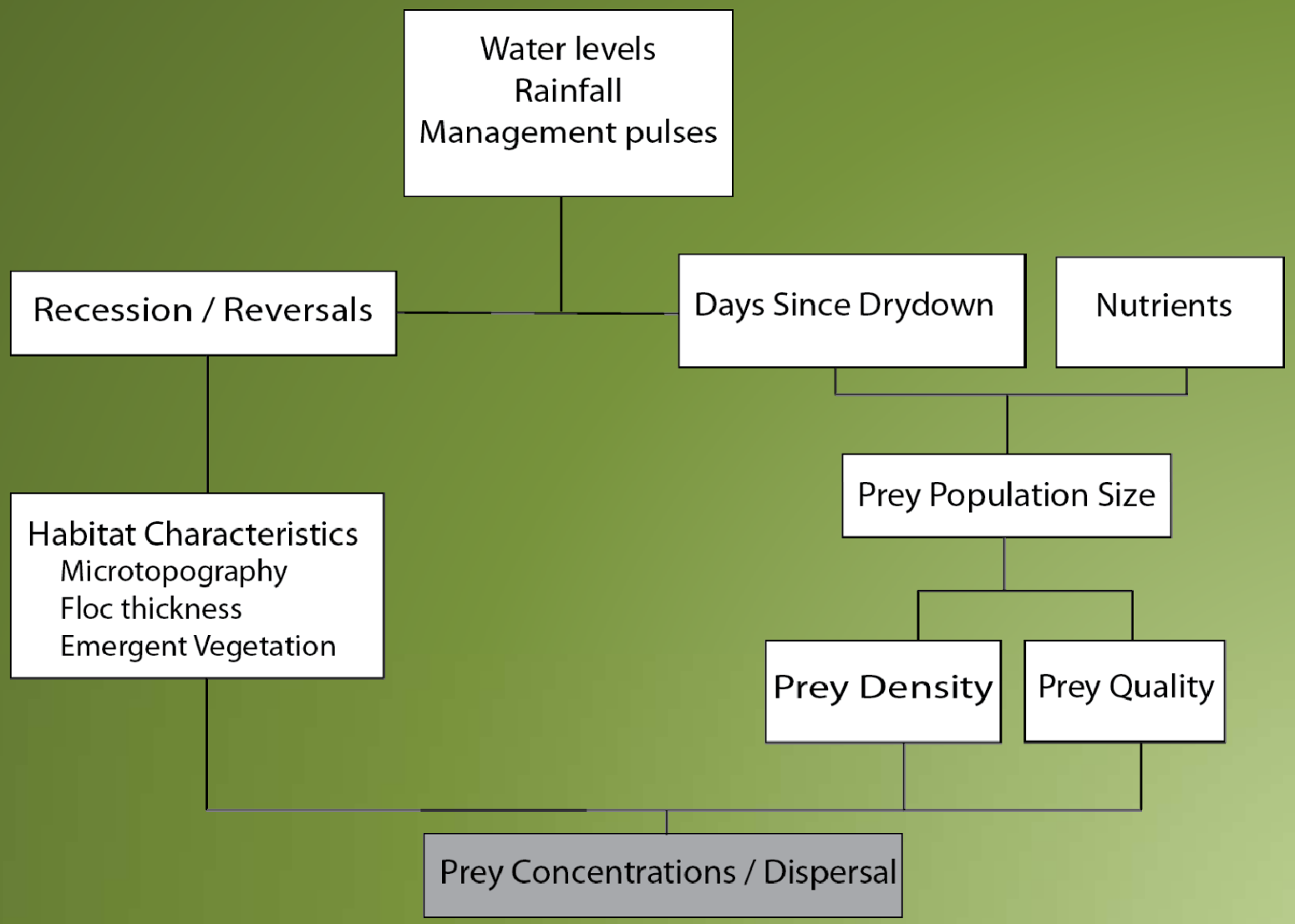


Factors affecting prey concentrations



Trophic Hypothesis

- More water ⇨ More fish ⇨ More birds

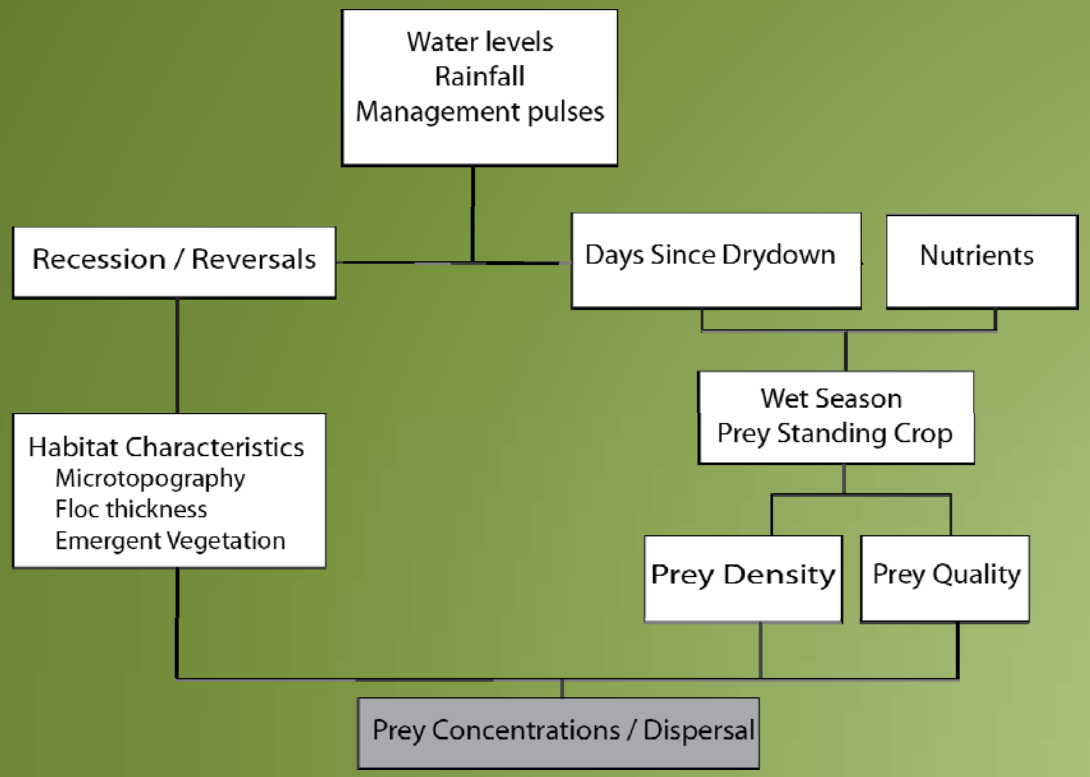
- A quantitative link not yet been established

Trophic Hypothesis

- Wading bird populations often highest after droughts
- Prey availability ⇨ Prey density + Prey vulnerability

Objectives

1. Identify the spatial and temporal patterns of prey concentrations throughout the Everglades landscape
2. Use model selection in an information-theoretic approach to quantify the relationship between prey concentrations and microhabitat variables.



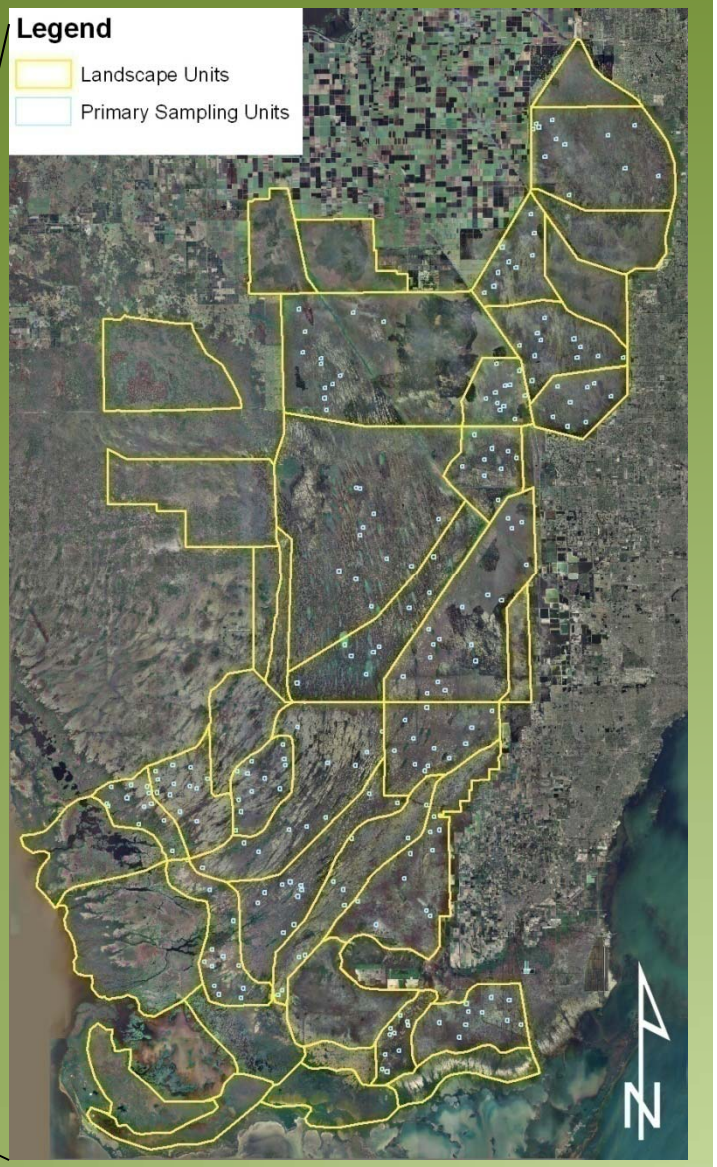
Methods

Multistage Sampling Design
(Cochran 1977)

- Landscape units (LSU)
- Primary sampling units
- Sites
- Throw-trap subsamples (1 m^2)

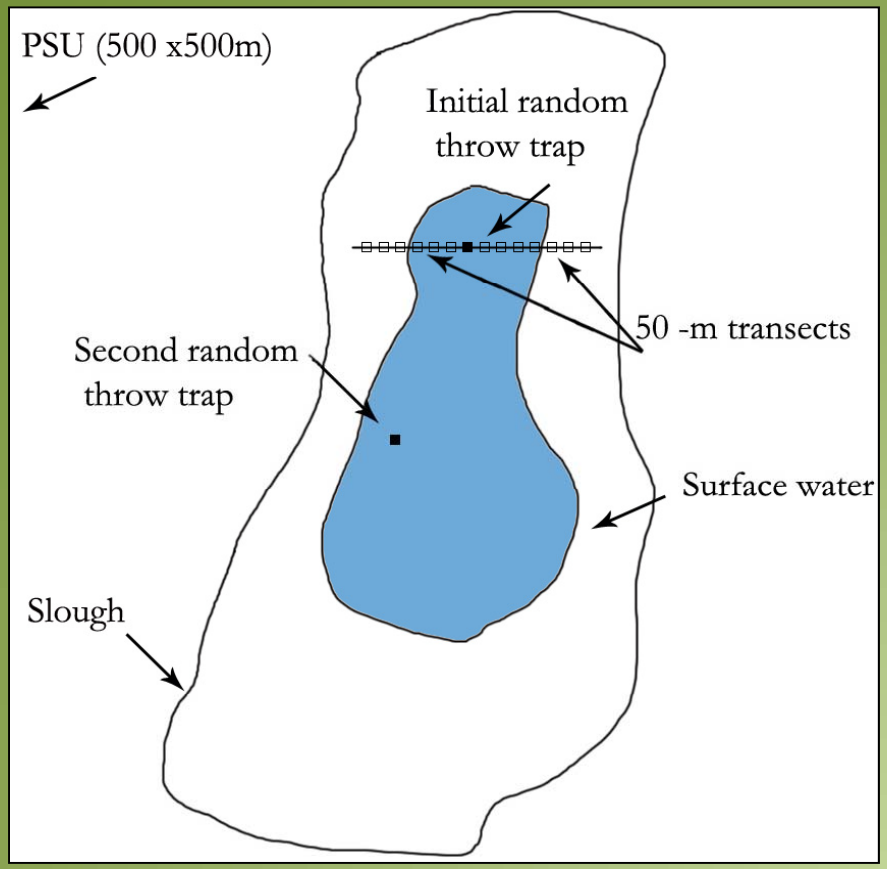
Study Area

- Extant Everglades (7919 km^2)
- Dry seasons (Dec.-May) of 2005-2009

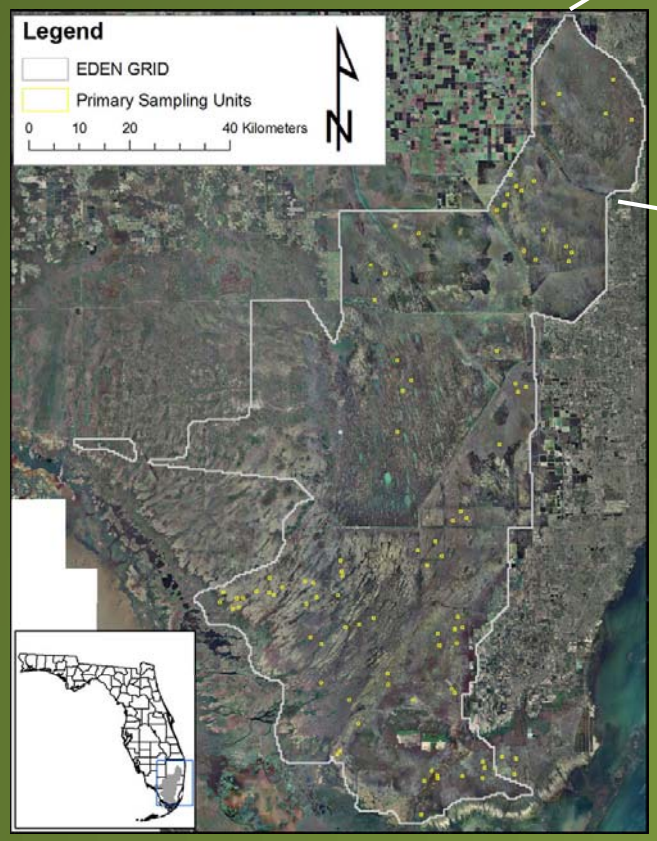


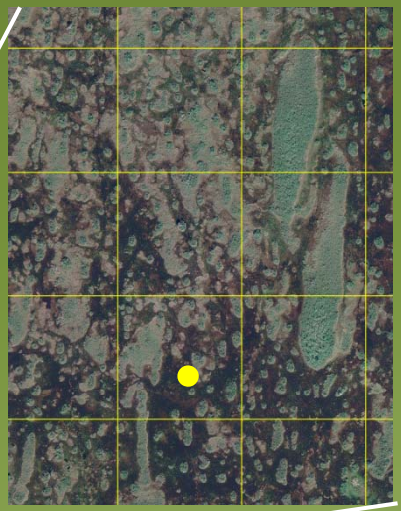
Field Methods

Throwtrap sampling site



Variables

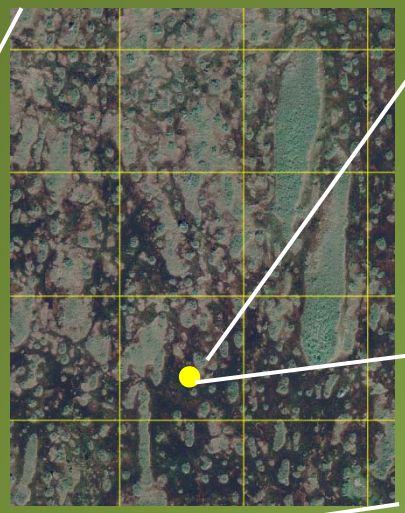


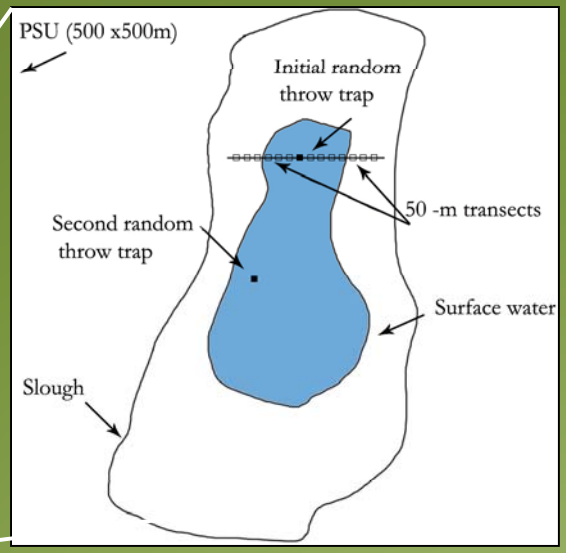


- Hydrological variables will be calculated for each EDEN grid cell where prey were sampled

- Data on wet season biomass from Joel Trexler's MAP Aquatic Fauna Project

Variables

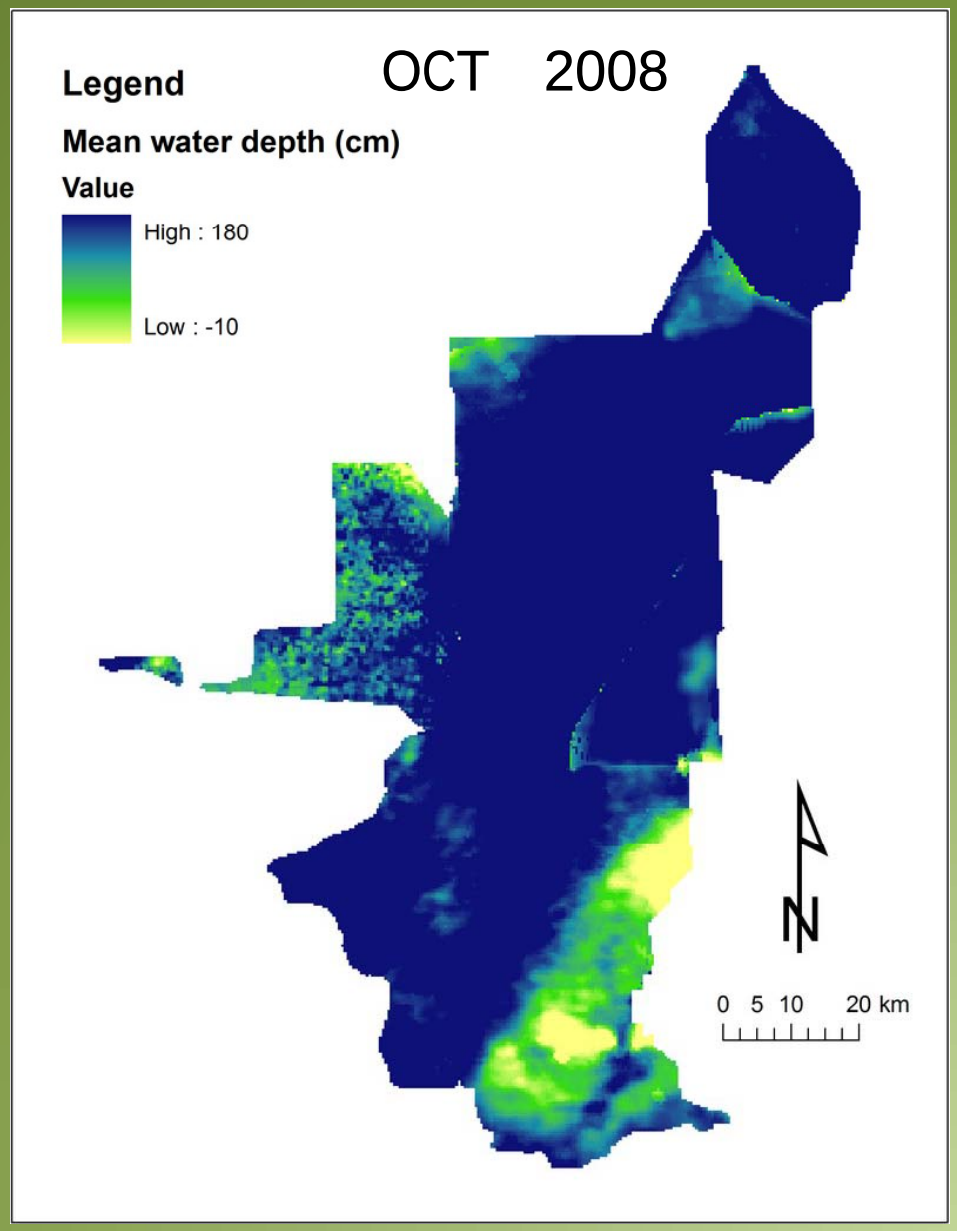




- Habitat variables collected at site
- Emergent vegetation, floc thickness, microtopography index

Methods

- Recession of water levels during the dry season is an important mechanism for concentrating aquatic wading bird prey



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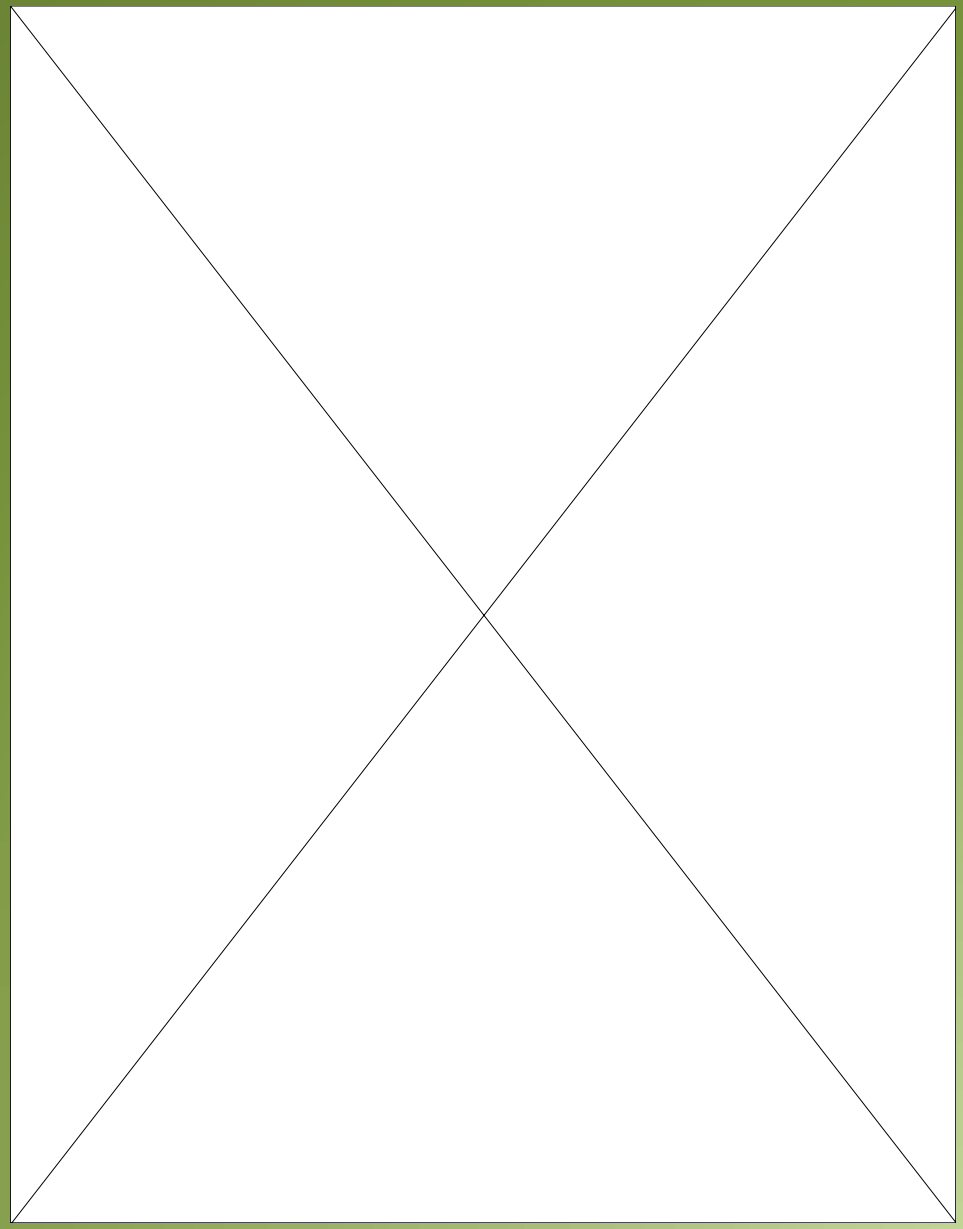

Methods

- Drying front moves across the landscape trapping fish and macroinvertebrates in isolated pools

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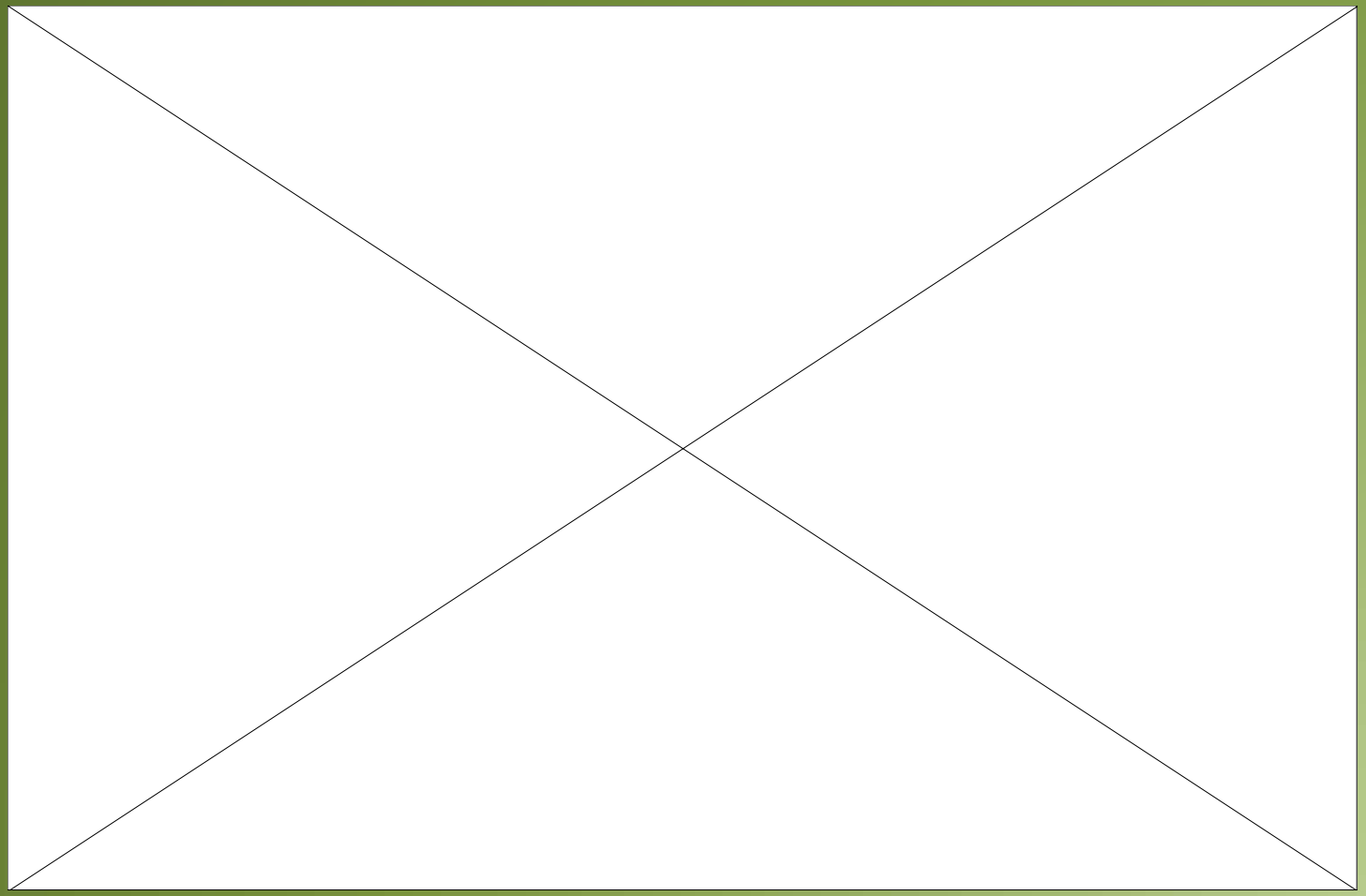


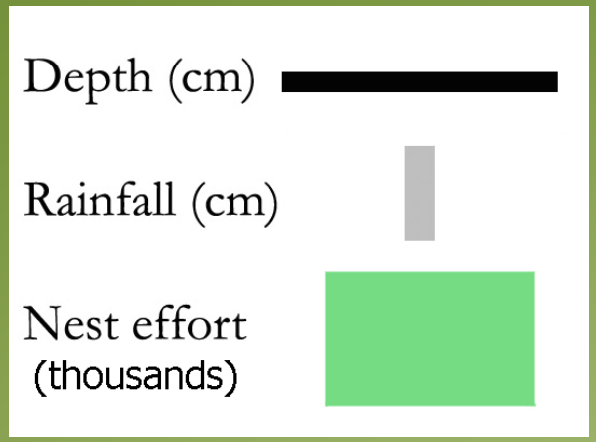
Statistical Methods

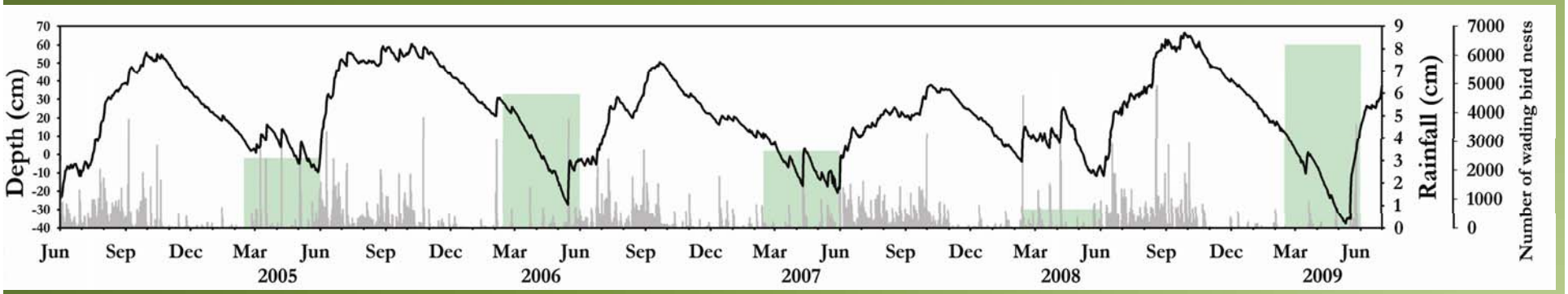
- Quantified relationships between wading bird prey concentrations and variables:
  - Wet season prey biomass
  - Recession rate
  - Days since last drydown
  - Microtopography index
  - Throw trap emergent vegetation
  - Floc thickness
  - Recession* wet season prey biomass
- Used information theoretic approach to investigate 47 competing models
- Employed Akaike's Information Criterion for small sample sizes (AICc) to determine most parsimonious model

Results

Hydrologic Conditions

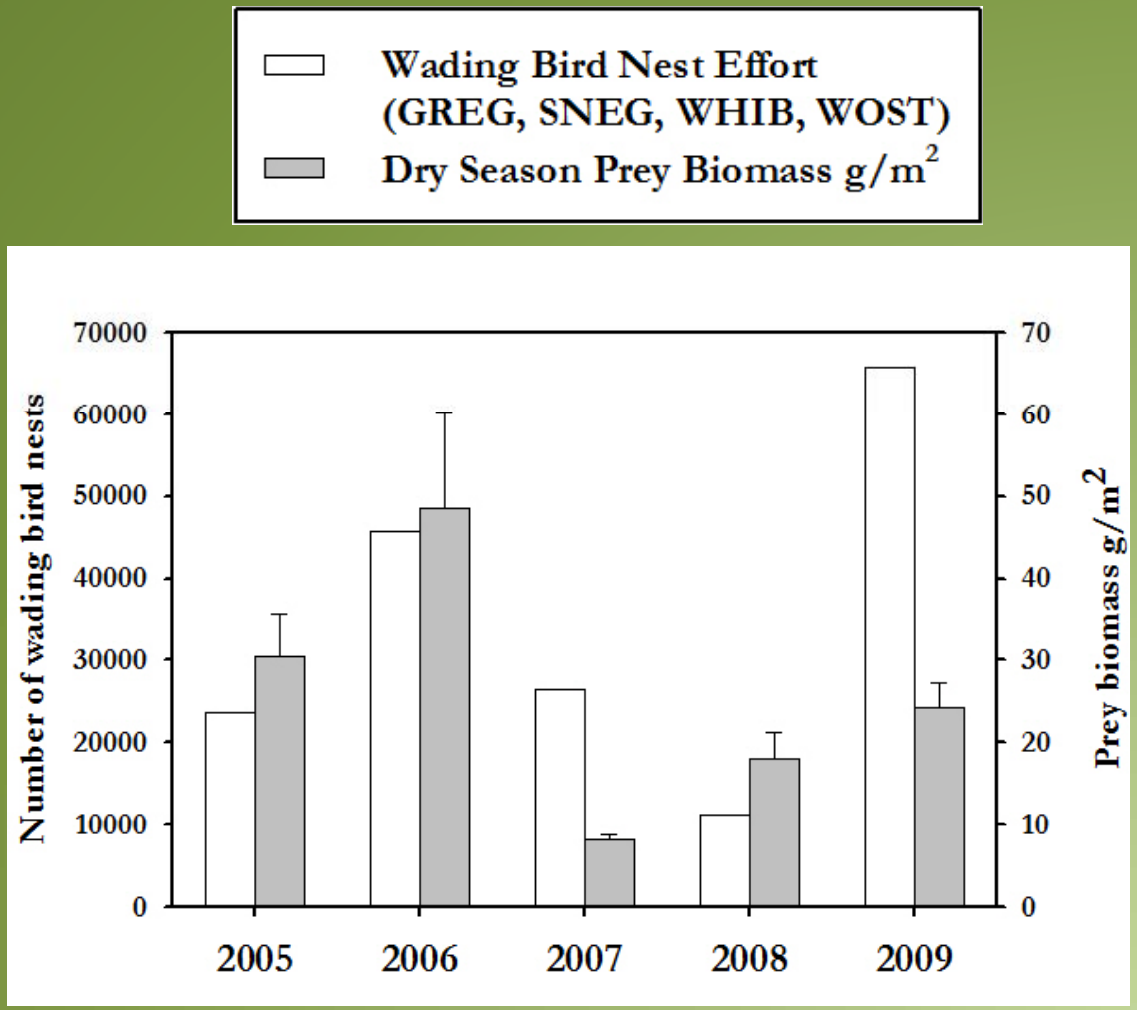
- Depth
  - Mean of 42415 EDEN grid cells
- Rainfall
  - mean of 13 gages





2005 2006 2007 2008 2009

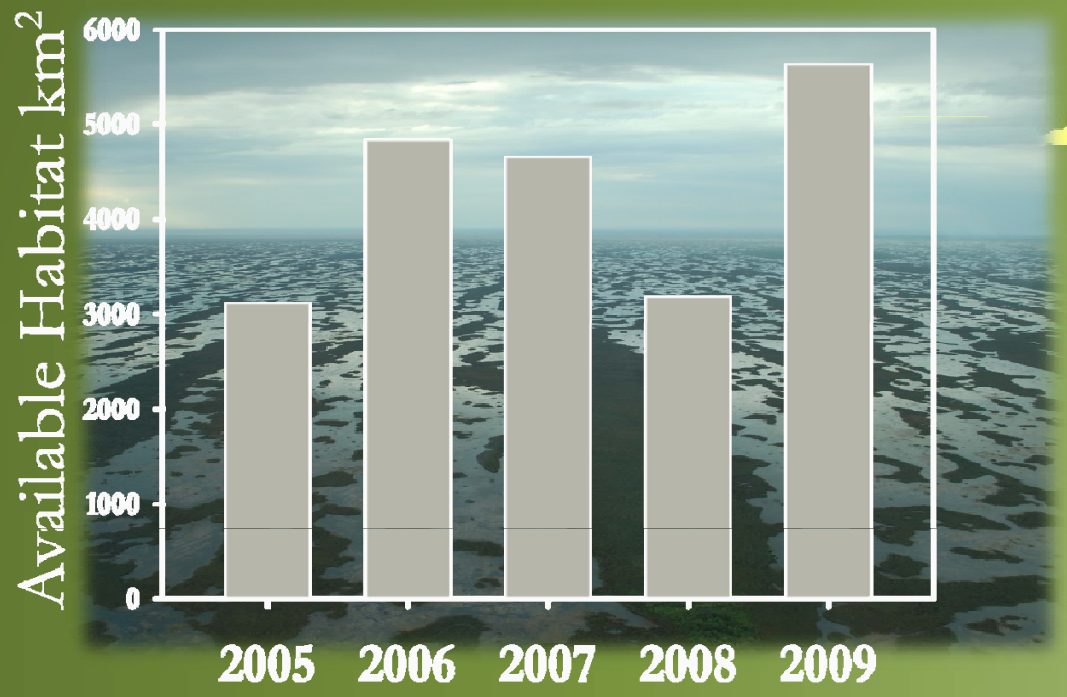
Dry season prey concentrations and wading bird nesting effort

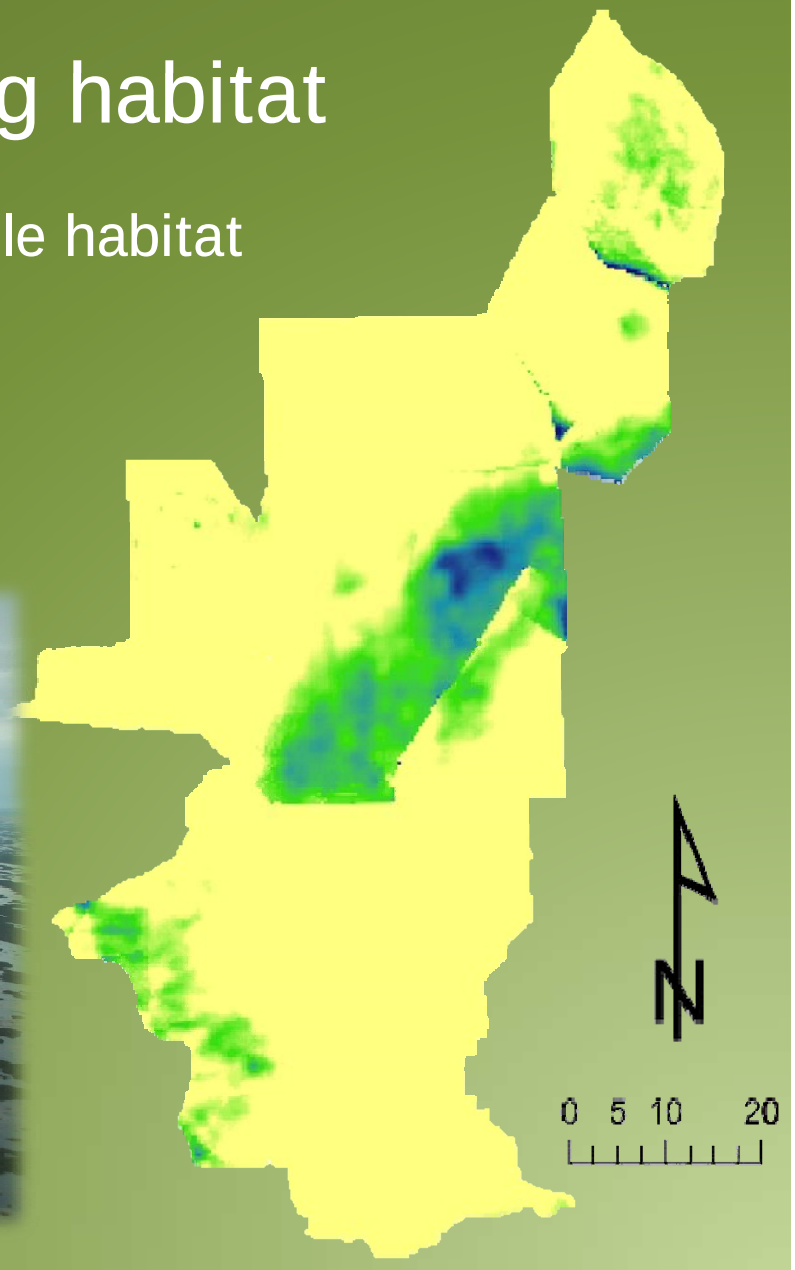


Results

Availability of suitable foraging habitat

- 2009 had the highest amount of suitable habitat of the five years
  - 5633 km^2 (83% of landscape)





Results

Year	Hydrology	Prey	Nest Effort
2005	Poor Good wet season water levels, dry season marked by reversals	Low	Low
2006	Optimal Long and high wet season water levels, steady recession	High	High
2007	Poor Low wet season water levels, drought	Very low	Low
2008	Poor Low wet season water levels, several reversals	Low	Very low
2009	Good High wet season water levels, prolonged drydown creating large area of available habitat	Moderate	Very High

Model selection with AIC of factors affecting prey concentrations

Hypothesis	K	AICc	Δ_i	w_i
-REC +MCRIND +REC*WETBIO	6	1931.085	0	0.4553
-WETBIO –REC +MCRIND +REC*WETBIO	7	1932.256	1.1709	0.2535
-WETBIO –REC +MCRIND + TRAPEMVEG +REC*WETBIO	8	1933.845	2.7601	0.1145
-DSD -REC -MCRIND + REC*DSD	7	1936.904	5.8194	0.0241
-WETBIO –TRAPEMVEG +REC*WETBIO	6	1936.943	5.85860	0.0243

- Best model included the terms recession, microtopography index and the interaction recession*wet season biomass
- Second best model included same terms, with the addition of the main effect wet season biomass

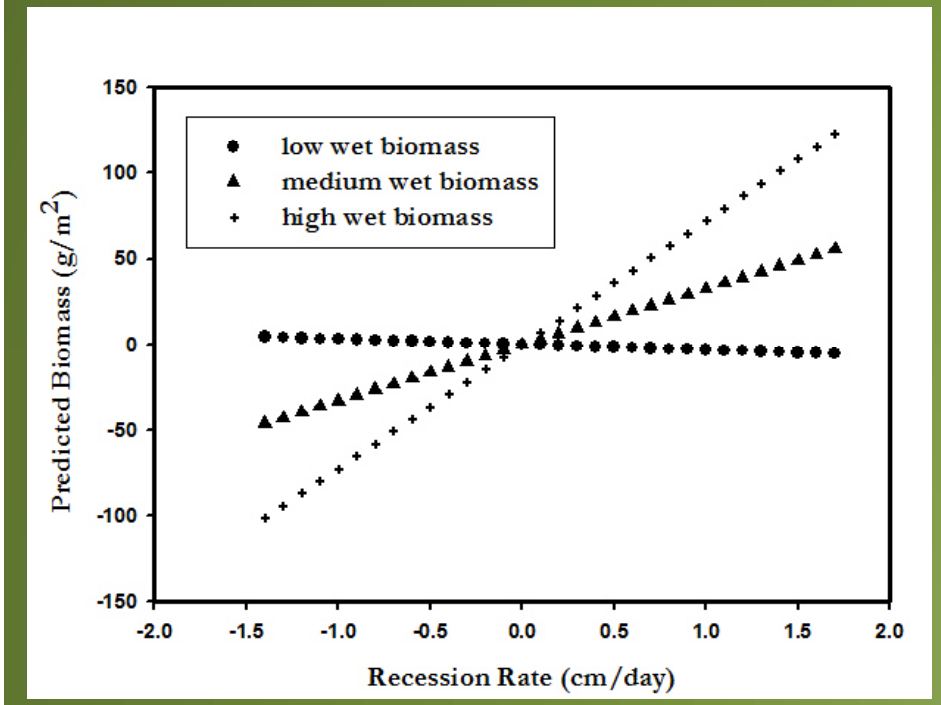
Parameters of importance

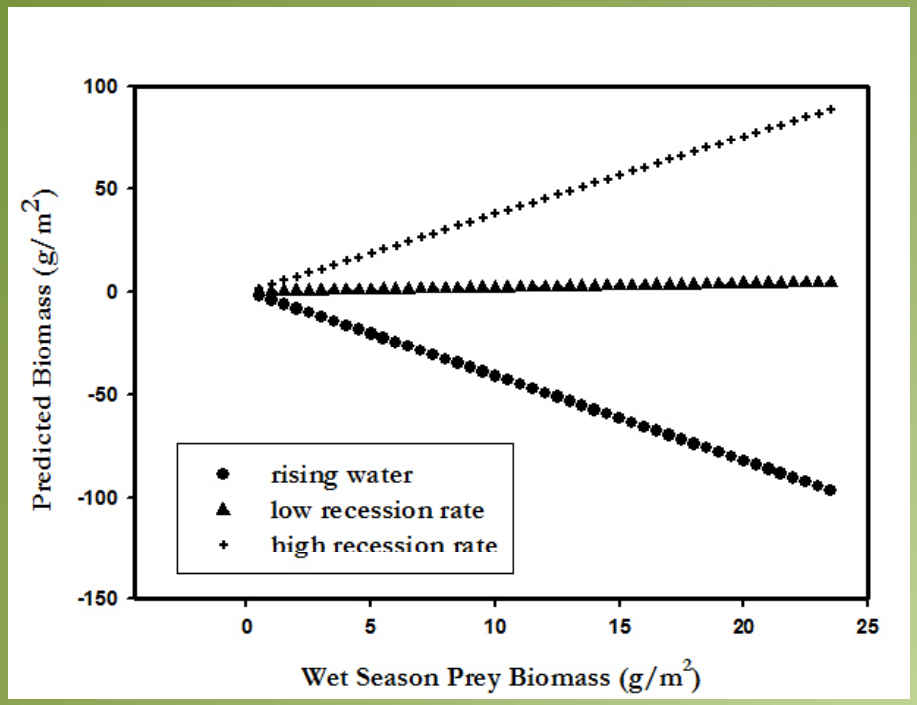
Parameter	β	SE	Σw_i
Recession	-6.7158	15.8703	0.94002
Microtopography Index	0.9632	0.3411	0.94513
Wet Season Biomass	-0.5232	1.1101	0.44945
Wet Season Biomass * Recession	3.5868	1.6920	0.8776

- High positive effect of microtopography index
- Effects of wet season biomass and recession rate are dependent on one another

Interaction of recession and wet season biomass

Wet season biomass + Recession Rate = Prey Concentrations

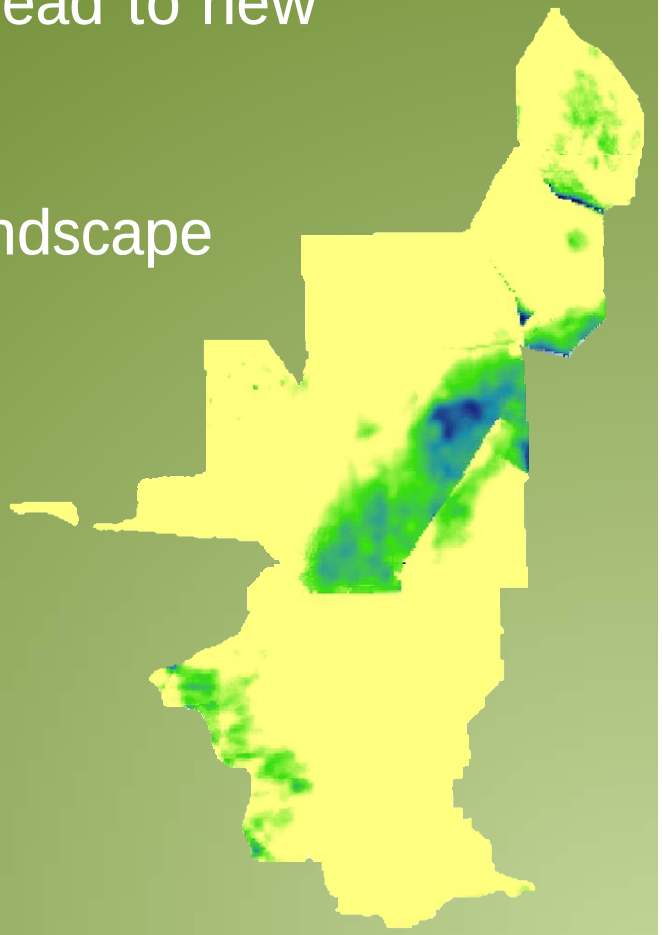




Discussion

Landscape Availability Hypothesis

- Contradictions between the abundance patterns in wading birds and their prey in 2009 lead to new hypothesis
- Responded to large portion of the landscape becoming available



Discussion

Factors Affecting Prey Concentrations

- Further evidence that microtopography and recession are critical to promoting the concentration of prey
- First quantitative link between dry season prey concentrations and prey production during the wet season.

Conclusion

- First quantitative evidence in support of the trophic hypothesis

restored hydrology ⇨ higher prey availability ⇨ higher wading bird nesting effort

Acknowledgements

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Questions?