Effects of seasonal hydrology & the 2010 cold snap on the distribution & abundance of snook, (*Centropomus undecimalis*) in the upper Shark River, Everglades National Park

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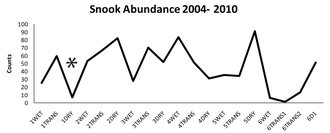
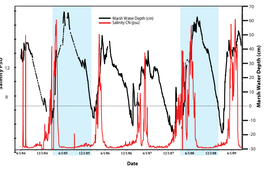
Introduction

Snook (*Centropomis undecimalis*) are an estuarine-dependent fish, present throughout the Caribbean Sea, ranging as far north as central Florida (Adams et al. 2010). Despite their limited range in U.S. waters, they are the fifth most targeted species on the entire East Coast. In 2004, 1.5 million fishing trips were directed towards catching snook on the gulf coast of Florida alone. Unfortunately, heavy coastal urbanization has altered the magnitude and dynamics of freshwater flow into estuaries essential for snook, depleting stocks (Roberts et al. 1999). Additionally, during January 2010, an extreme cold snap caused unusually cold water temperatures, resulting in a large fish kill that may have further depressed snook abundances.



The Everglades ecosystem is widely regarded as having one of the best snook fisheries in the state (Muller and Taylor 2005), however there is a relative dearth of information on how snook populations respond to abiotic drivers (Osborne et al. 2006).



Thus, a mechanistic understanding of how snook populations respond to pulsed hydrological drivers is critical for effective management this important fishery resource.

This study examined the effects of spatial and temporal variability on the abundance and distributional patterns of snook, one of Florida's most sought after gamefishes.

Field Survey

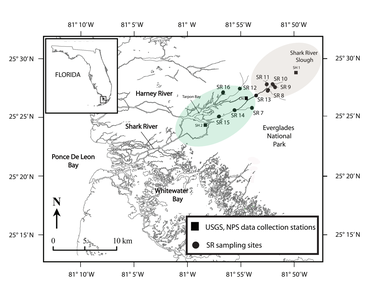
- We sampled 10 creeks in the marsh-mangrove interface in the western region of Everglades National Park (ENP).

- All sampling was conducted via electrofishing in 3 replicate 5-min bouts per creek.

- We sampled in the wet (Nov), early dry (Feb) and late dry (April-May) seasons for 6 years (n =484 samples).

Statistical Analyses

- We examined variation in CPUE (Catch per unit effort) of snook, testing spatial and temporal variation & key abiotic covariates using mixed model inference (Burnham & Anderson 2002, 2008).



Multiple Hypotheses

We used an information theoretic approach to test possible drivers of snook abundance as a function of:

1. Temporal effects 2. Tidal effects 3. Marsh conditions
4. Prey availablility 5. Temporal and spatial effects only
6. Combination of factors

Hypothesis	Model	AIC	Delta AIC	WEIGHT (Wi)	R2
Temporal, Spatial & Prey	**Year*Season*Creek + Tide + Depth + Freshwater prey**	**997.7**	**0.00**	**0.501**	**0.65**
Temporal, Spatial & Prey	Year*Season*Creek + Depth + DO + Tide + Freshwater prey CPUE	999.2	1.50	0.237	
Marsh	Marsh Depth	1208.9	211.20	0.000	
Marsh	DSLD + 15 day ave + Marsh Depth	1212.3	214.60	0.000	
Prey	Ln prey + MARSH DEPTH +SALINITY	1195.1	197.40	0.000	
Prey	ln FW prey	1212.3	214.60	0.000	
Spatial (creek)	Creek + Depth + DO + Temp + Site type	1126.2	128.50	0.000	
Spatial (creek)	Creek + Depth + DO + Temp	1126.4	128.90	0.000	
Temporal (Season)	Year*Season + Year Type + Marsh Depth + Depth	1182.2	184.50	0.000	
Temporal (Season)	Season + Year Type + Marsh Depth + Depth	1211.4	213.70	0.000	
Temporal and Spatial	Year*Season*Creek + Depth + DO + Salinity + Temp +Site Type	1056.4	58.70	0.000	
Temporal and Spatial	Year*Season*Creek	1058.9	61.20	0.000	
TIDE	Year*Season*Creek + Tide + Depth + DO+Salinity	1008.6	10.90	0.002	
TIDE	Tide + Depth + DO + Salinity	1114.4	116.70	0.000	
TIDE	Tide	1156.6	158.90	0.000	
Global (full) model	**Year*Season*Creek + Depth + DO + Tide + Temp + Salinity + DSLD + 15 Day Ave + Marsh Depth + Wateryear + Sitetype + Freshwater prey CPUE**	**1004.5**	**6.80**	**0.017**	**0.65**

Our best fit model showed strong temporal, spatial, tidal and prey effects

Anova table for best fit model

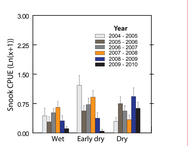
Source of Variation	DF	P-value
Year*Season*Creek	154, 302	<.001
Depth	1, 302	0.128
DO	1, 302	0.582
Prey CPUE	1, 302	0.013
Tide	1, 302	0.149

Temporal effects

- Snook abundance varies both yearly and seasonally.

- Abundance typically peaks in the early dry season.

- 2010 abundance was extremely low, reflecting possible mortality associated with February 2010 cold event.

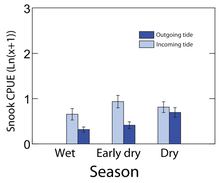


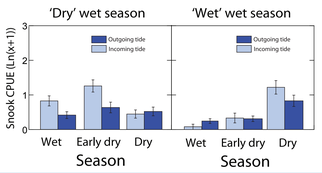
How does tide affect snook abundance?

- Snook abundance was consistently highest during incoming tides.

- Abundance was highest in the early dry season during years with 'dry' wet seasons.

- Abundance peaked during late dry season in years with 'wet' wet seasons.



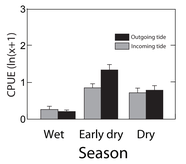


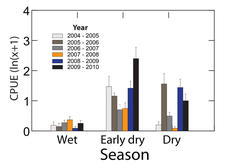
What are the factors influencing prey abundance?

- Freshwater prey increase seasonally during the early dry season in most years.

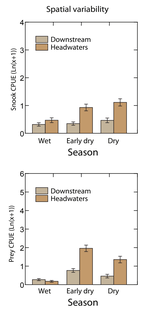
- Prey abundance is highest during outgoing tides, particularly in the early dry season.

- Freshwater prey abundance is lowest during the wet season.





Spatial and Temporal factors coupled with hydrology and prey availability

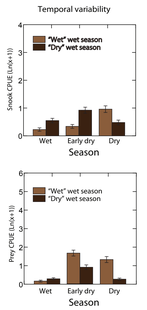


- Snook abundance increased seasonally in headwater reaches, while downstream CPUE remained constant

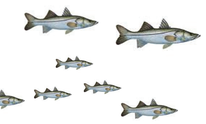
- Abundance in upstream reaches correlate with peaks of freshwater prey as marsh drydown progresses through the dry season.

- In years with "wet" wet seasons, snook abundance peaks later in the dry season.

- In drier years, snook abundance peaks early in the dry season & then decreases.



Do spatial and temporal abundance differ among life history stages?

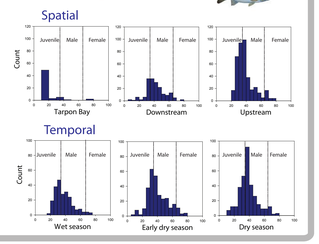


- Juvenile snook were most abundant in our downstream sites, reflecting use of the lower estuary as a nursery habitat.

- Size distributions did not differ significantly between seasons.

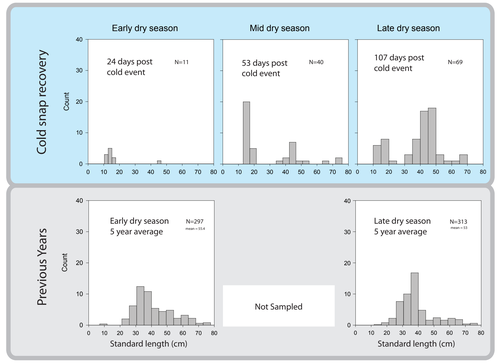
- Size distributions indicate the majority of fish captured in our study were sub-adults and males.

- Size distributions consistent with other gulf coast studies (Taylor & Muller 2005).



Cold Snap Effects & Recovery

Unusually cold temperatures were observed from January 1 through January 20, 2010 in all areas of ENP. The duration and severity of these low air temperatures caused unusually cold-marine water temperatures; Surveys conducted by NPS personnel reported substantial mortality in 28 marine fish species (Hallac et al.) Estimates indicate over 200,000 snook were killed. We compared electrofishing CPUE for snook pre and post cold snap from monitoring efforts in our upper Shark River sites.



- Snook abundances were unusually low during the early dry season, but continued to increase during the mid and late dry season.

- Juvenile size classes did not appear to be detrimentally affected by the cold events of January 2010.

Conclusions

- Snook abundances vary markedly both temporally and spatially.

- Tide, season and hydrological year all have significant effects on snook abundance.

- Freshwater prey are seasonally abundant in the upstream reaches of tidal mangrove creeks, especially duringoutgoing tides.

- Snook appear to be making directed movements into headwater creeks, capitalizing on pulses of freshwater prey swept into tidal mangrove creeks as upstream marshes dry.

- Snook appear to exhibit differential habitat use during ontogenetic development, separating along an estuary gradient. This trend is based on preliminary data from our expanded sampling effort in 2010, however future sampling will ecucidate these patterns further.

Acknowledgments

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