

Analyzing the impacts of *Cichlasoma urophthalmus* (Mayan cichlid) in the southern Everglades



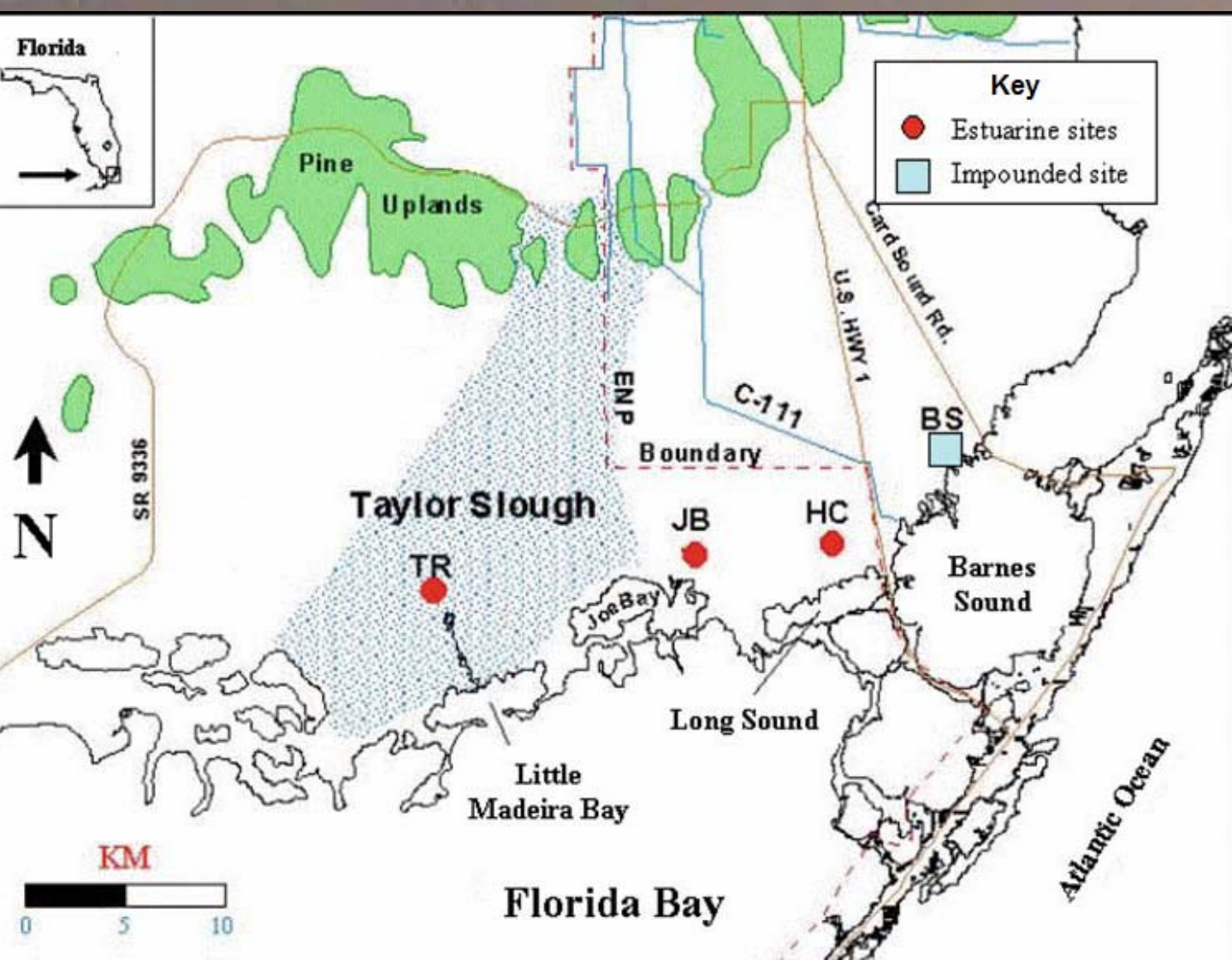
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Abstract

The Mayan cichlid (*Cichlasoma urophthalmus*), which is endemic to Central America, was first recorded in the Everglades National Park in 1983. The impact of this species on native biota has not been well quantified, but recent observational data suggests that Mayan cichlids negatively impact native fish species through predation. This research will examine the effect of Mayan cichlids on native fish populations from 1991 to 2006. Fish community data from throw traps and drop traps were collected and analyzed from three estuarine sites and one impounded site within the Everglades (Taylor River, Joe Bay, Highway Creek and Barnes Sound respectively). These sites range in salinity from 0 - 49ppt and were sampled eight months per year from 1990 to 2006. Analysis of similarity (ANOSIM), nonmetric multi-dimensional scaling (NMDS) plots, and SIMPER analyses showed that the four sites differed in community composition as a result of the presence of Mayan cichlids. It was hypothesized that Mayan cichlids contributed to the community differences by altering the densities of native fish. Analysis of the axes from NMDS showed that several of these native fish species were negatively correlated with Mayan cichlid relative abundance and GLM analysis indicated strong negative relationships between the densities of Mayan cichlids and native fish.

Objective: To analyze the impacts of Mayan cichlids on densities of native fish



Site	BS	HC	JB	TR
Avg. Mayan density per trap	0.086	1.452	5.218	6.402
Mean salinity	20.7	7.9	7.9	4.8
Salinity range	1-46	0-49	0-46	0-43
95% C.I.	2.111	2.032	1.97	1.73
Mean temperature	23.8	23.7	23.7	23.9
Temperature range	21-32	13-32	14-34	15-31
95% C.I.	0.717	0.732	0.733	0.625

Comparison of the four sites sampled. All sites exhibit similar temperature and salinity regimes except for BS, which is impounded. The sites are divided into pairs based on their similarities in Mayan cichlid densities: BS and HC, and JB and TR.

The four study sites: BS, HC, JB and TR (Lorenz & Serafy 2006).

Study Sites and Sampling Methods

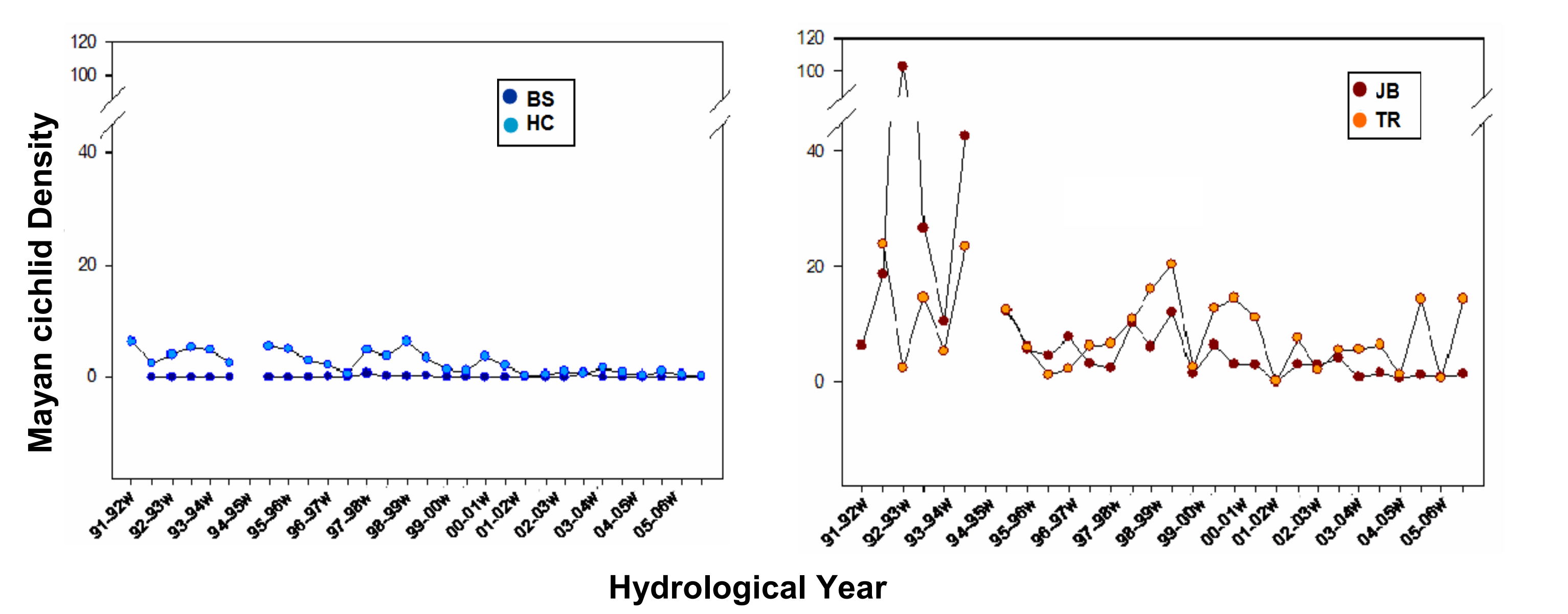
Four sites were sampled eight months a year from 1991-2006. Two different habitats sampled per site: continuously inundated creeks and the seasonally inundated flats.

- Taylor River (TR), Joe Bay (JB), and Highway Creek (HC) in Taylor Slough/C-111 drainage area of Everglades National Park.
- Barnes Sound (BS), an impounded coastal wetland site
- 9-m² drop traps used to sample species abundance and biomass.
- Traps were set, left in place overnight and deployed within 2 hours of sunrise.
- All fish were cleared from the trap using rotenone.

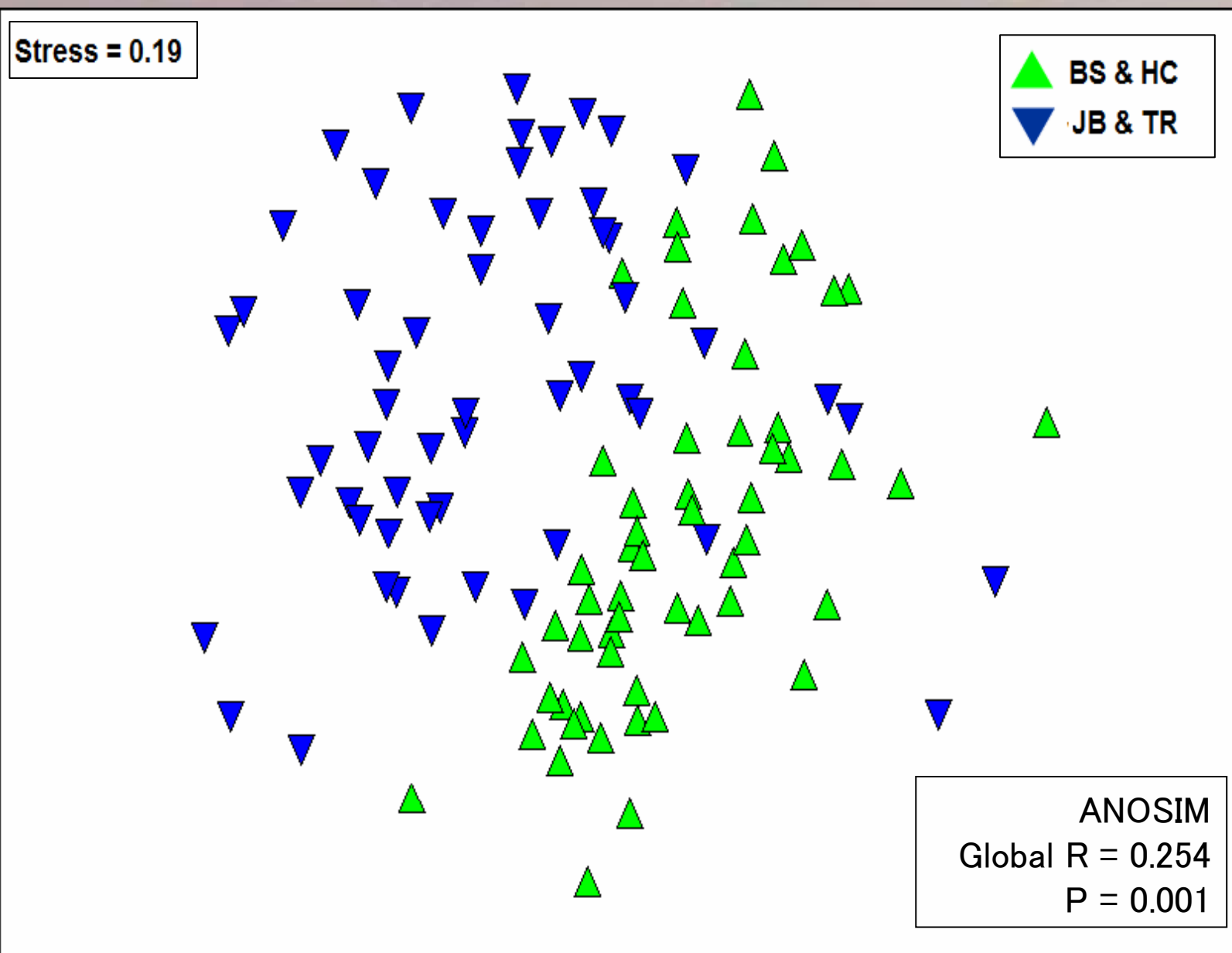
Data analysis

- Only creek data analyzed.
- Averaged all samples for a given day, and calculated species relative abundance per meter-squared.
- Species that comprised less than 0.1% of total fish captured were removed from the data
- Fourth-root transformed all relative abundance and data.
- Sites were divided into two groups: two sites where Mayan cichlids were scarce (BS and HC) and two sites where Mayan cichlids were very abundant (JB and TR).
- Analysis of similarity (ANOSIM), Nonmetric multi-dimensional scaling (NMDS) plots and SIMPER® procedure used to determine differences in fish communities between two site groups and to identify the species that Mayan cichlids impacted (Primer 5).
- JB and TR data used to evaluate Mayan cichlid impact on fish species indicated by community analyses.
- Correlations between Mayan cichlids and relative abundances of focal fish were calculated from the axes produced by the NMDS ordination. The species whose relative abundances were negatively correlated with Mayan cichlid relative abundance were further analyzed using GLM procedure (SAS 9.2).
- GLM procedure used to determine whether Mayan cichlid density significantly affected density of the fish whose relative abundances were negatively correlated with Mayan cichlids.
- Akaike's Information Criteria and likelihood-R² were used to evaluate best GLM models.

Results



Mayan cichlid densities at the two site groups from 1991-2006. JB and TR have higher Mayan cichlid densities than BS and HC. At JB and TR, Mayan cichlid densities fluctuated greatly through time.



NMDS plot of the two site groups: low Mayan cichlid density (BS & HC) and high density (JB & TR), showing the differences in community composition (p < 0.01).

Species	BS & HC		JB & TR		Contribution %
	Avg. Rel Abundance	Avg. Rel Abundance	Avg. Rel Abundance	Avg. Rel Abundance	
Sheepshead minnow	0.01	0.02		9.72	
Goldspotted killifish	0	0.01		9.22	
Clown goby	0.01	0.01		8.59	
Sailfin molly	0.01	0.01		7.81	
Mosquitofish	0.01	0		6.88	
Marsh killifish	0	0.01		6.46	
Rainwater killifish	0.04	0.02		6.19	
Gulf killifish	0	0.01		6.05	
Crested goby	0	0		5.47	
Tidewater silverside	0	0		5.03	
Bluefin killifish	0	0		4.65	
<i>Lepomis</i> species	0	0		3.71	
Spotted tilapia	0	0		3.34	
Spotted sunfish	0	0		2.71	
Diamond killifish	0	0		2.16	

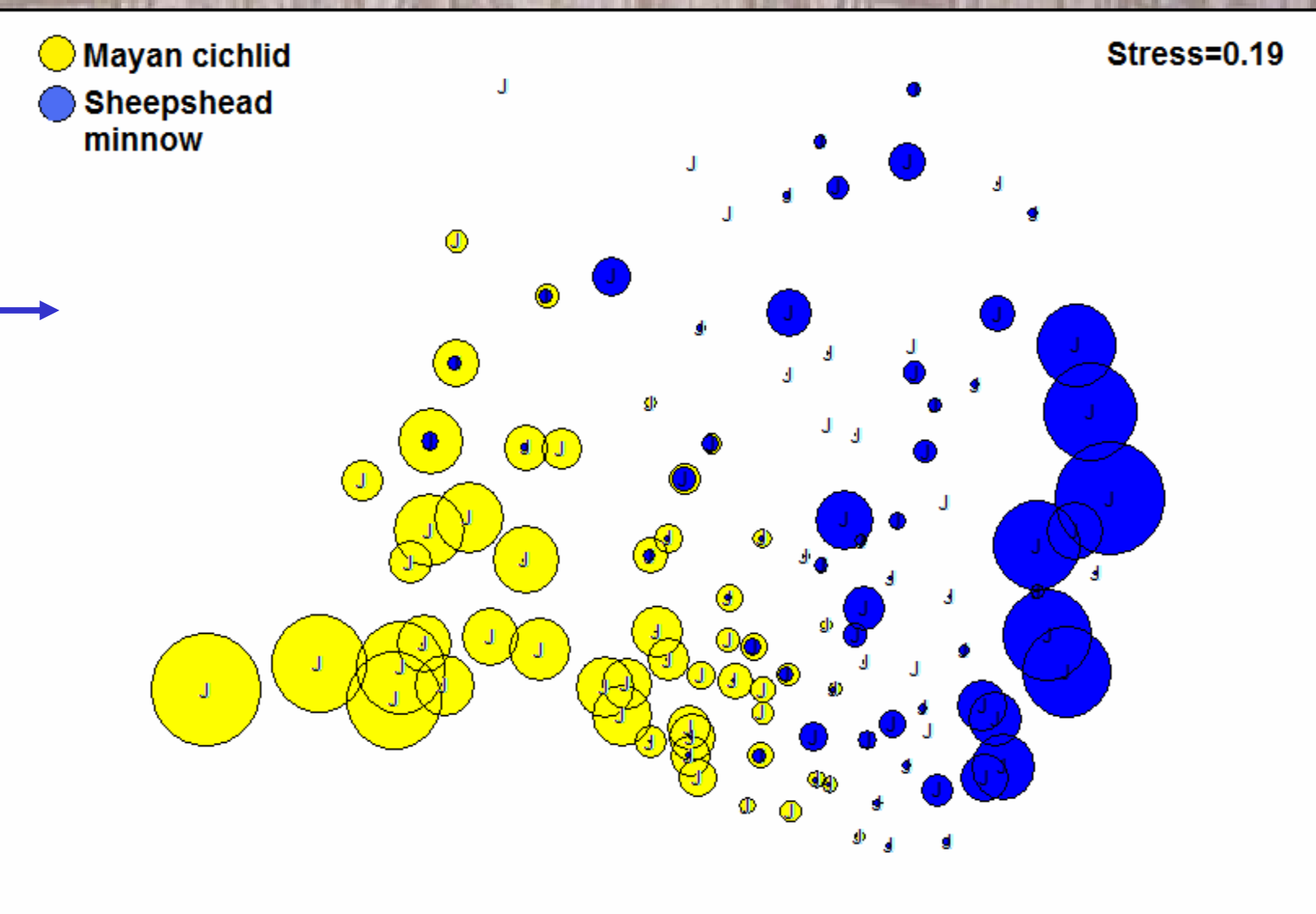
SIMPER indicating the fish species that contribute to the community differences between the two site groups.

Hypothesis: Mayan cichlids impact densities of those fish that contributed strongly to the community differences between the two site groups (BS and HC, and JB and TR).

Joe Bay (JB)

Species	Creeks		
	Pearson's r	Axis 1	Axis 2
Mayan cichlid	0.624	-0.666	
Sheepshead minnow	-0.679		
Golden topminnow			0.445
Marsh killifish			0.563
Gulf killifish			0.572
Mosquitofish			0.584
Least killifish			
Flagfish			0.482
Rainwater killifish	-0.445		
Sailfin molly			0.695

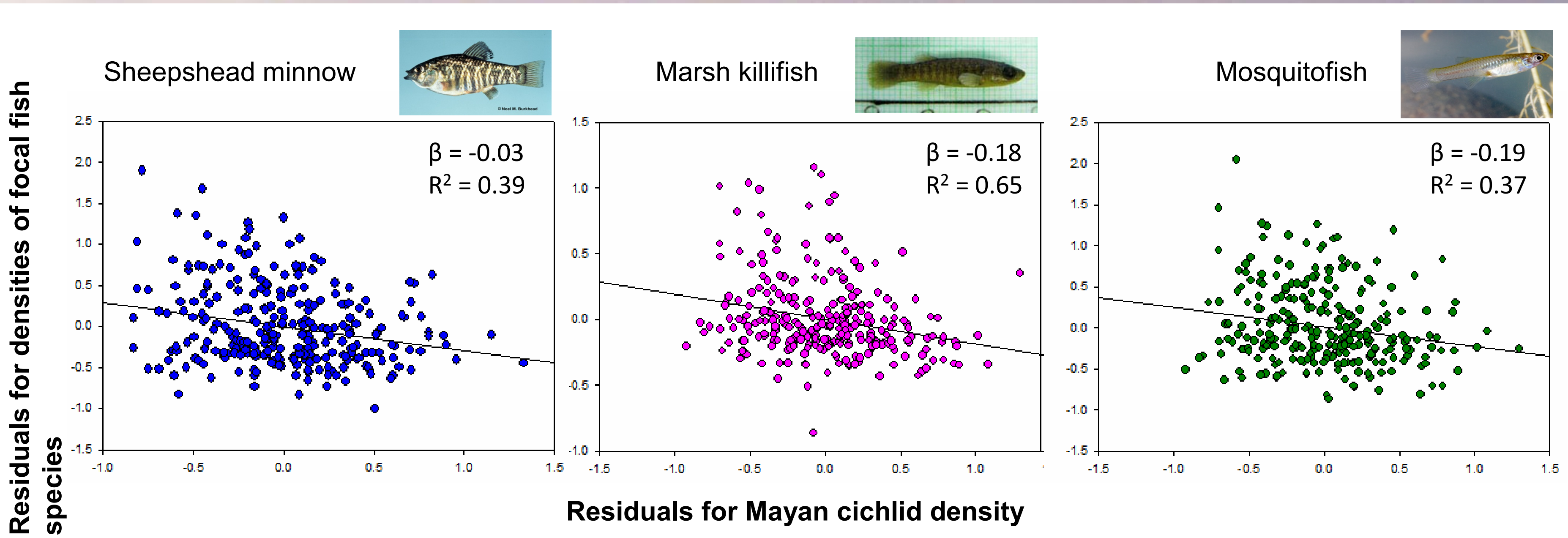
Correlations with NMDS axes of Mayan cichlids and native fish. Only fish with strong negative correlations shown.



Bubble plot of Mayan cichlid abundance and sheepshead minnow abundance demonstrating a negative NMDS axis correlation. The second NMDS axis for sheepshead minnows was strongly negatively correlated to the Mayan cichlid axis. Each J represents a sample from Joe Bay; the size of each bubble is proportional to species abundance.

Joe Bay

Partial regression plots (only the models where Mayan cichlids were significant ; $\alpha = 0.01$)



• The fish indicated in the correlation table were used in mixed regression models.

• Mayan cichlid densities had significant ($\alpha = 0.01$) negative relationships with densities of sheepshead minnows, marsh killifish and mosquitofish in the creek habitats of Joe Bay.

Taylor River

Species	Creeks		
	Pearson's r	Axis 1	Axis 2
Mayan cichlid	-0.656	-0.387	
Marsh killifish			0.696
Mosquitofish			0.728
Least killifish			0.616
Flagfish			0.673
Crested goby			-0.567
Bluefin killifish			0.406
Rainwater killifish	0.592		
Clown goby	0.698		
Sailfin molly			0.542

Correlations with NMDS axes of Mayan cichlids and native fish. Only fish with strong negative (red) and positive (blue) correlations shown.

• The fish indicated in the correlation table were then used in mixed regression models.

• Mayan cichlid densities had a significant ($\alpha = 0.01$) negative relationship with mosquitofish densities in creeks of Taylor River.

Conclusions

- The presence of Mayan cichlids was correlated with fish communities at the 4 sites, apparently by affecting densities of native fish through predation and/or competition.
- We noted negative relationships between density of Mayan cichlids and sheepshead minnows, marsh killifish and mosquitofish in creeks of Joe Bay.
- We also noted negative relationships between Mayan cichlid density and mosquitofish density in creeks of Taylor River.

Future Work

- We need to determine if Mayan cichlid impacts on fish community composition in turn affect fish predators such as wading birds, piscivorous fish, and alligators. Do Mayan cichlid impacts cascade through the food web and harm or benefit top trophic levels?

Acknowledgements

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