Impacts Following Boom-and-Bust Invasion Dynamics: African Jewelfish

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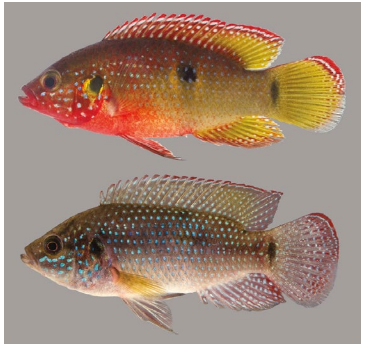
Invasion dynamics

Post-introduction population dynamics follow a diversity of patterns

Local establishment followed by

- apparent extinction
- stable persistence at modest density
- spread and subsequent explosive density growth and spatial expansion
- spread and subsequent explosive density growth followed by rapid decline… boom and bust

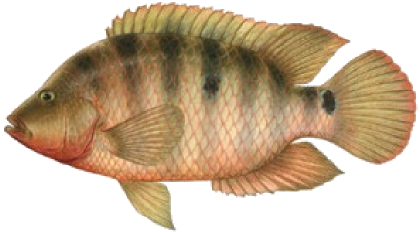


Invasion dynamics: Questions

Do native communities recover composition and function following 'bust' dynamics of a boom-bust invader?

We use a 26-year dataset of fish and decapod population dynamics in Shark River Slough to assess potential effects of African Jewelfish invasion on the native prey.

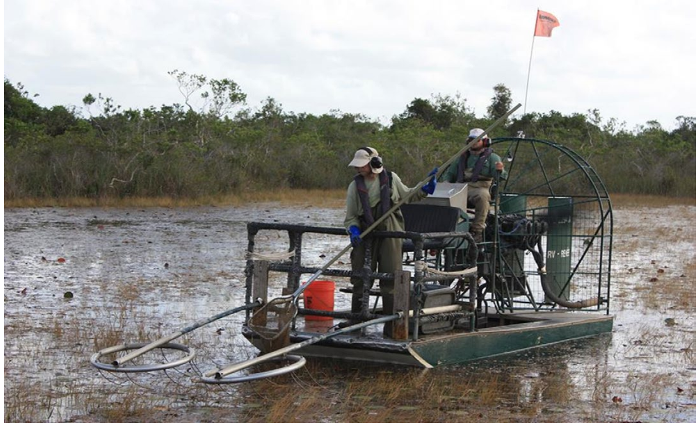
In a recent paper, we compared these effects to those of Asian Swamp Eels and a long-established non-native species, Mayan Cichlids.



Data collection

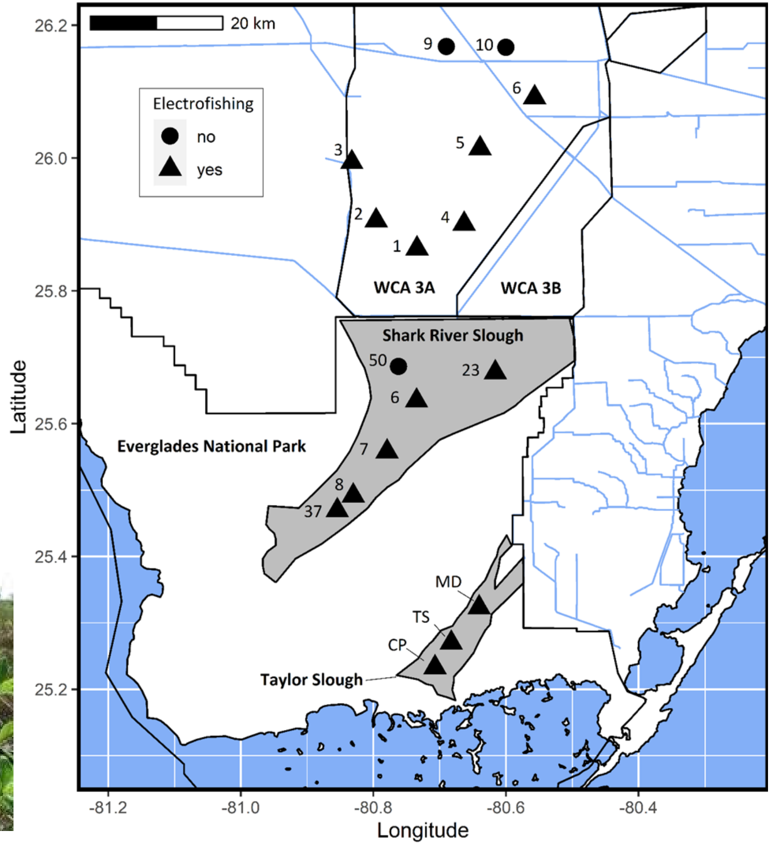
- Throw traps
  - Density and biomass (#/m^2 or g/m^2)
  - Fish ~0.1 cm to 8 cm SL
  - Macroinvertebrates retained on 0.2 cm sieve

- Electrofishing
  - Catch per unit effort (CPUE; 5-minute samples)
  - Fish > 8 cm SL



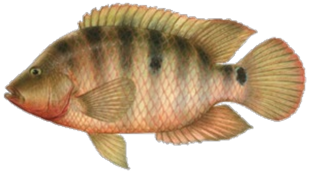
Data collection

- Sampled 1996 through 2021 (25 years)
  - Throw traps: Feb, Apr, July, Oct, Dec
  - Over 120 consecutive samples
  - Three or five plots at each site, 5-7 samples per plot visit
  - Electrofishing: Feb, Apr, July, Oct



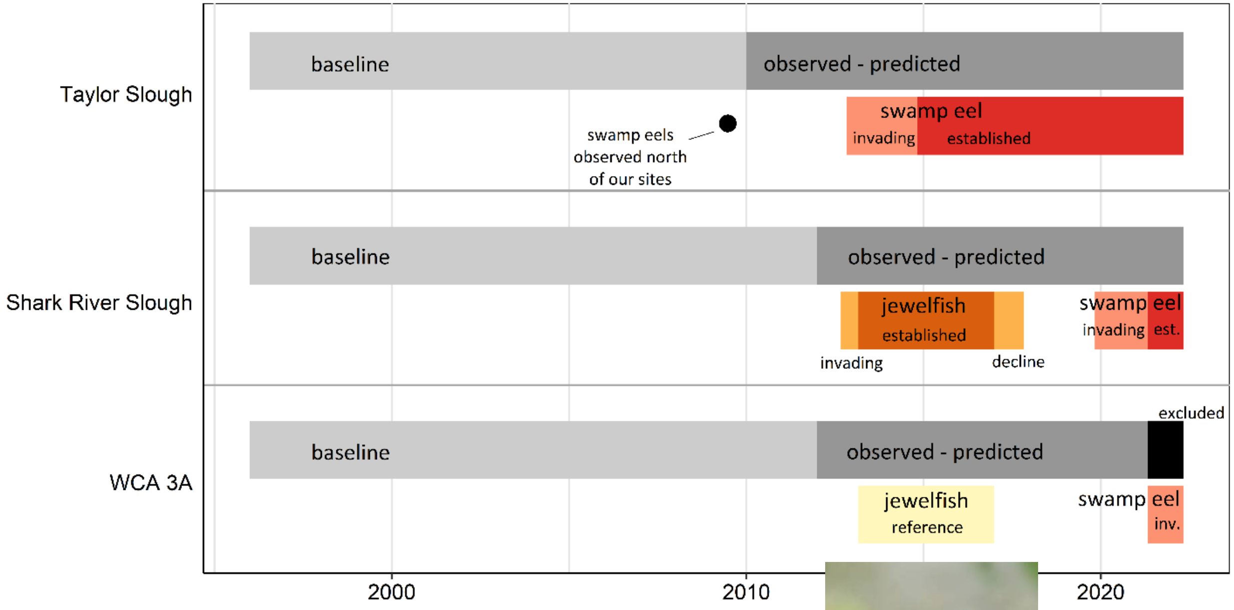
- Throw trap sampling at sites 6 and 23
  - 1977 through 2021 (44 years)
  - One plot from 1977 through 1984
  - Three plots from 1985 to present

Modeling Framework



Hypothesis testing in BACI-like framework

Shark River Slough in 'impact' space and 2010-present is 'impact' time



Posters: Nate Dorn #40; Brandon Güell #45; Alyssa Herrera #48

Biological Invasions 25:3887-3903

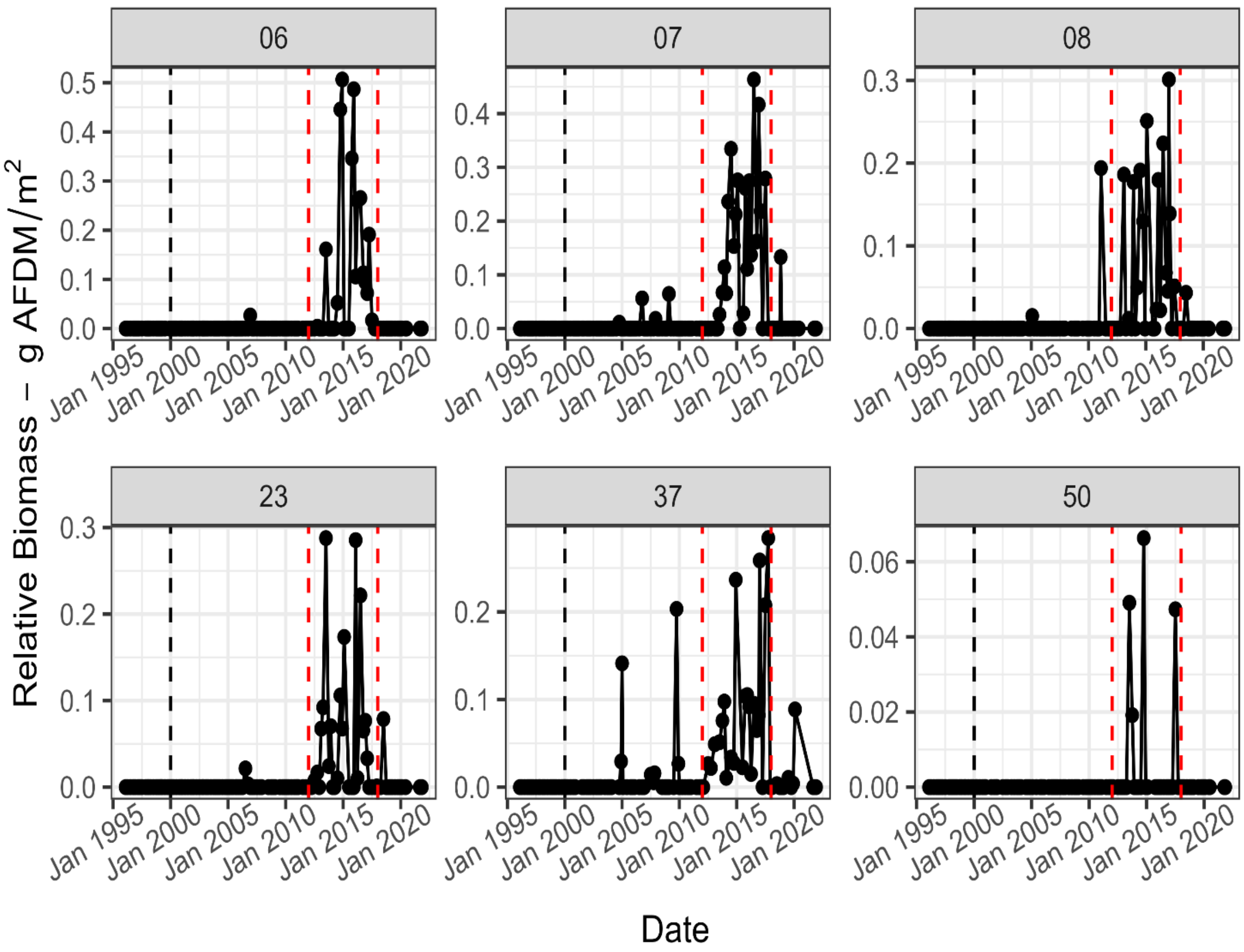
ORIGINAL PAPER

Contrasting invasion histories and effects of three non-native fishes observed with long-term monitoring data

Matthew R. Pintar · Nathan J. Dorn · Jeffrey L. Kline · Joel C. Trexler

Jewelfish invasion in Shark River Slough

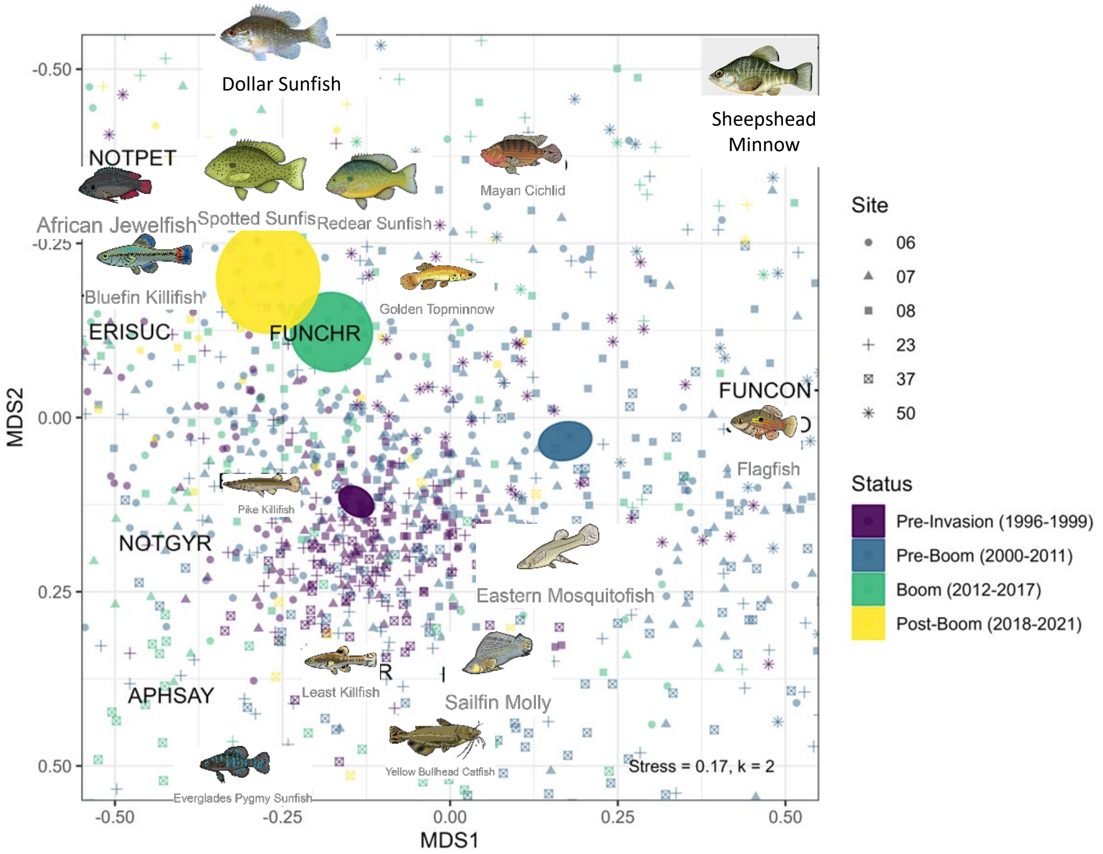
- Data from six long-term monitoring sites
- Relative Biomass (Jewelfish mass/Total fish mass)
- Black dotted line marks first Jewelfish
- Red dotted lines indicate ‘boom’ period



Ordination Fish

- SRS six long-term monitoring sites
- Pre-invasion 1996-2011
- Boom 2012 – 2017
- Bust (Post-Boom) 2018-2021

*Jewelfish excluded from this ordination but when added they fall in top left corner

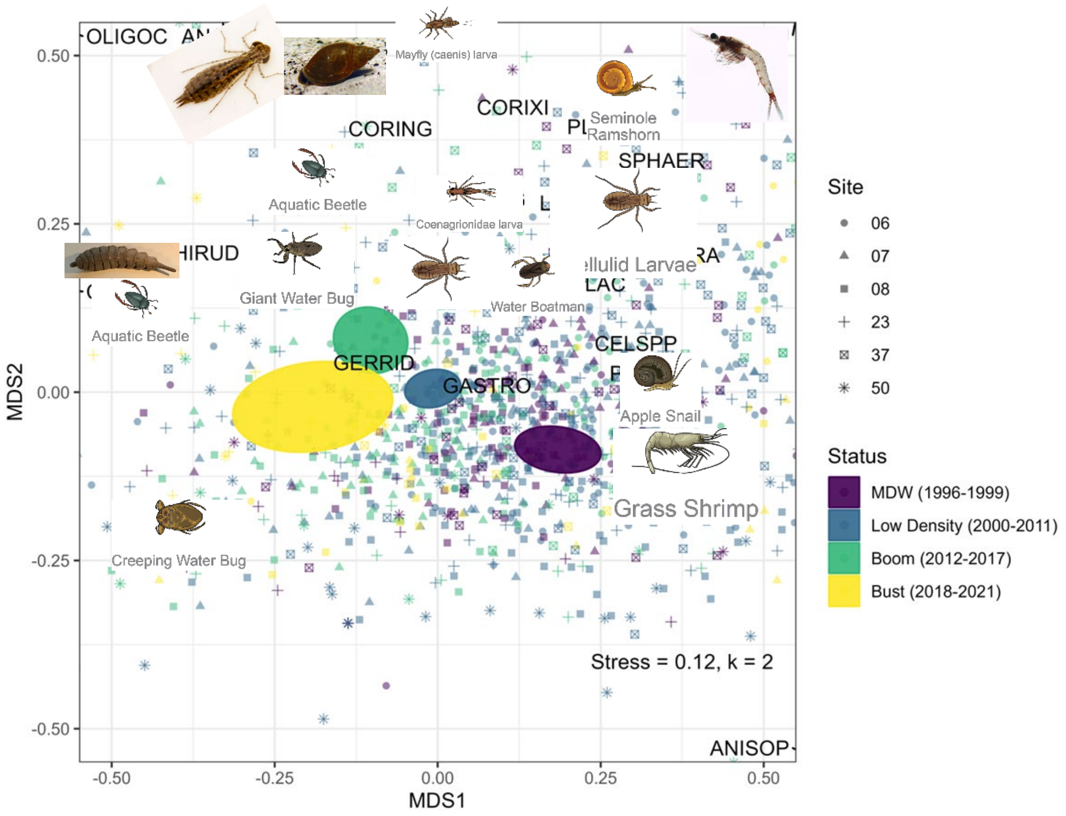


Similarity by Morisita-Horn distances
All groups different by pairwise PERMANOVA

Ordination

Macroinvertebrates

- SRS six long-term monitoring sites
- Pre-invasion 1996-1999
- Jewelfish low density (2000-2011)
- Boom 2012 – 2017
- Bust (Post-Boom) 2018-2021



Similarity by Morisita-Horn distances
All groups different by pairwise PERMANOVA

Ordination

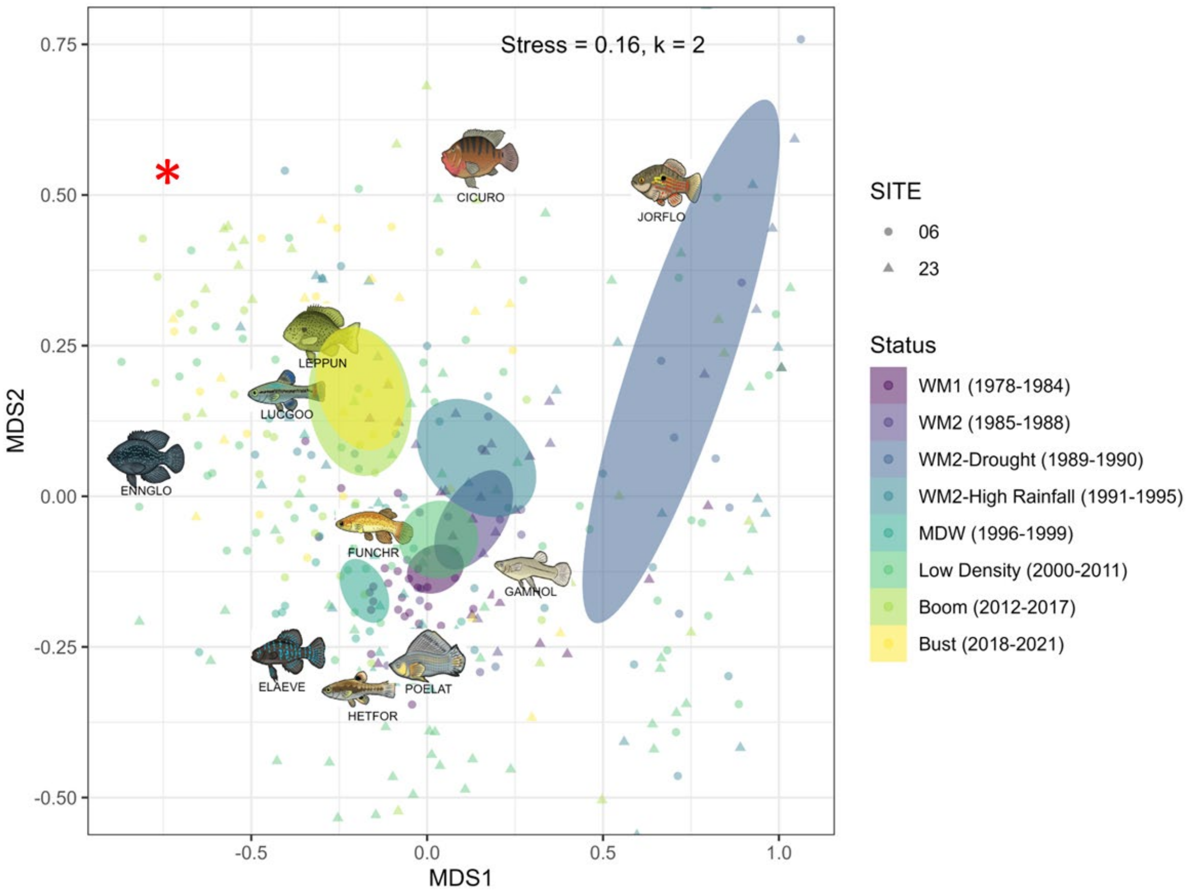
Expanding pre-invasion perspective

SRS sites 6 and 23: 44 years

Water Management Periods

- Pre-pre invasion 1977-1995
- Pre-invasion 1996-2011
- Post-invasion 2012 – 2021

*Jewelfish excluded from this ordination but when added they fall in top left corner

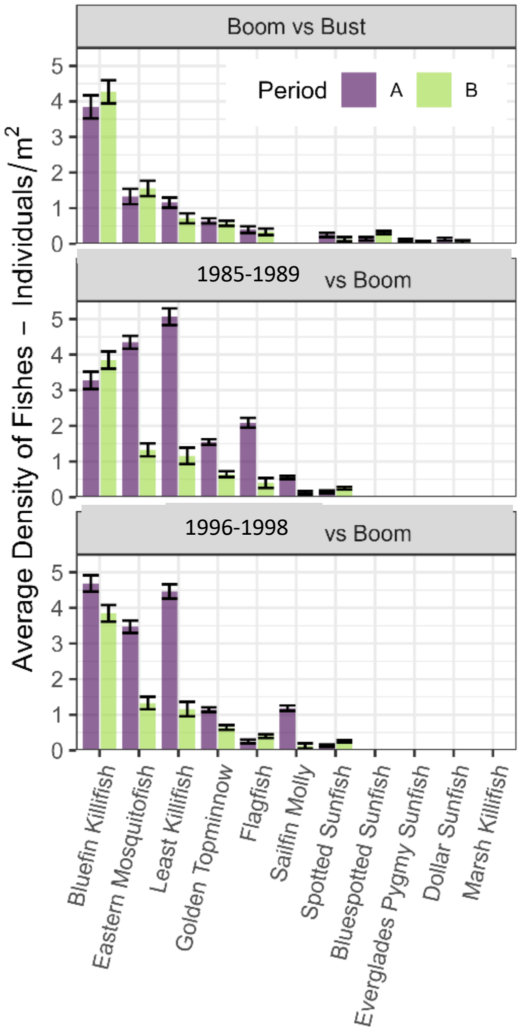


Similarity by Morisita-Horn distances

All groups different by pairwise PERMANOVA

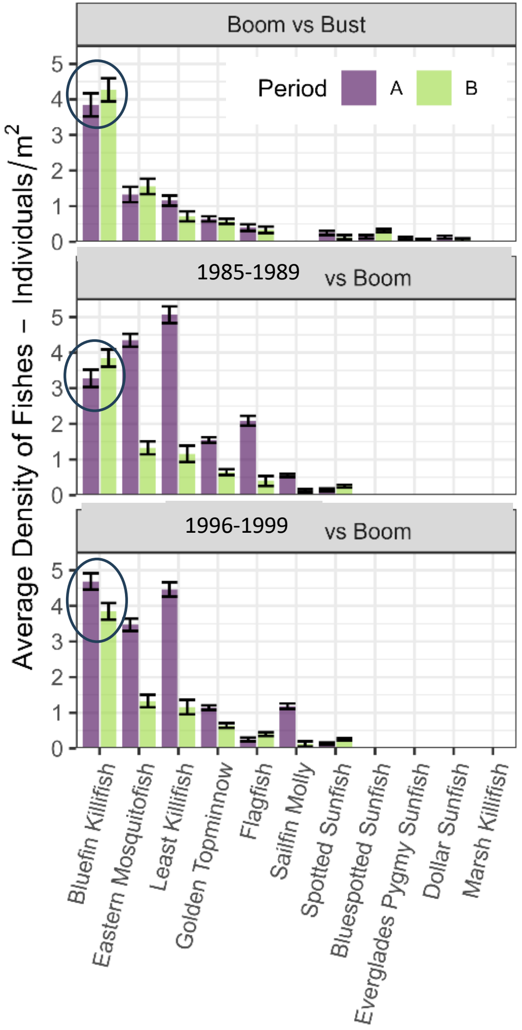
Species pairwise comparisons contributing to ordination patterns

- Dominance diversity curve using SIMPER output to show the species contributing to 95% of the variance among phases of invasion.
- Error bars represent two standard deviations
- Boom (2012-2017) and Bust (2018-2021), 1996-199 MDW before invasion, 1985-1988 pre-MDW.



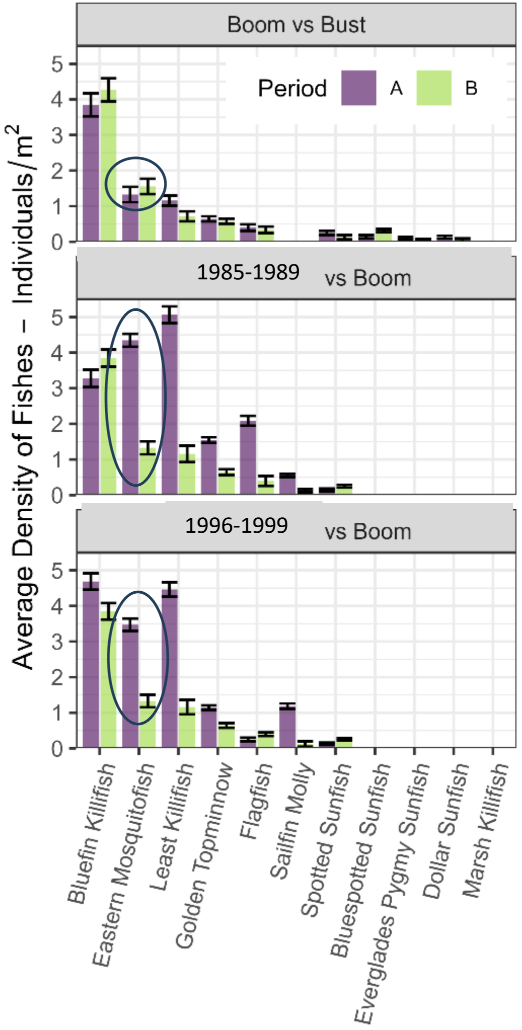
Species pairwise comparisons contributing to ordination patterns

- Bluefin killifish were the most abundance species in Boom-Bust period and in 1996-1999
- There was relatively little change in their density in any of these comparisons.



Species pairwise comparisons contributing to ordination patterns

- Eastern Mosquitofish were the second or third most abundant species before Jewelfish invasion.
- Bluefin Killifish, Eastern Mosquitofish, and Least Killifish were similarly abundant from 1977 through 2011, except for 1989-1999 drought.
- Eastern Mosquitofish (and Least Killifish) decreased dramatically (70-75%) during Jewelfish Boom period and remained low in Bust.

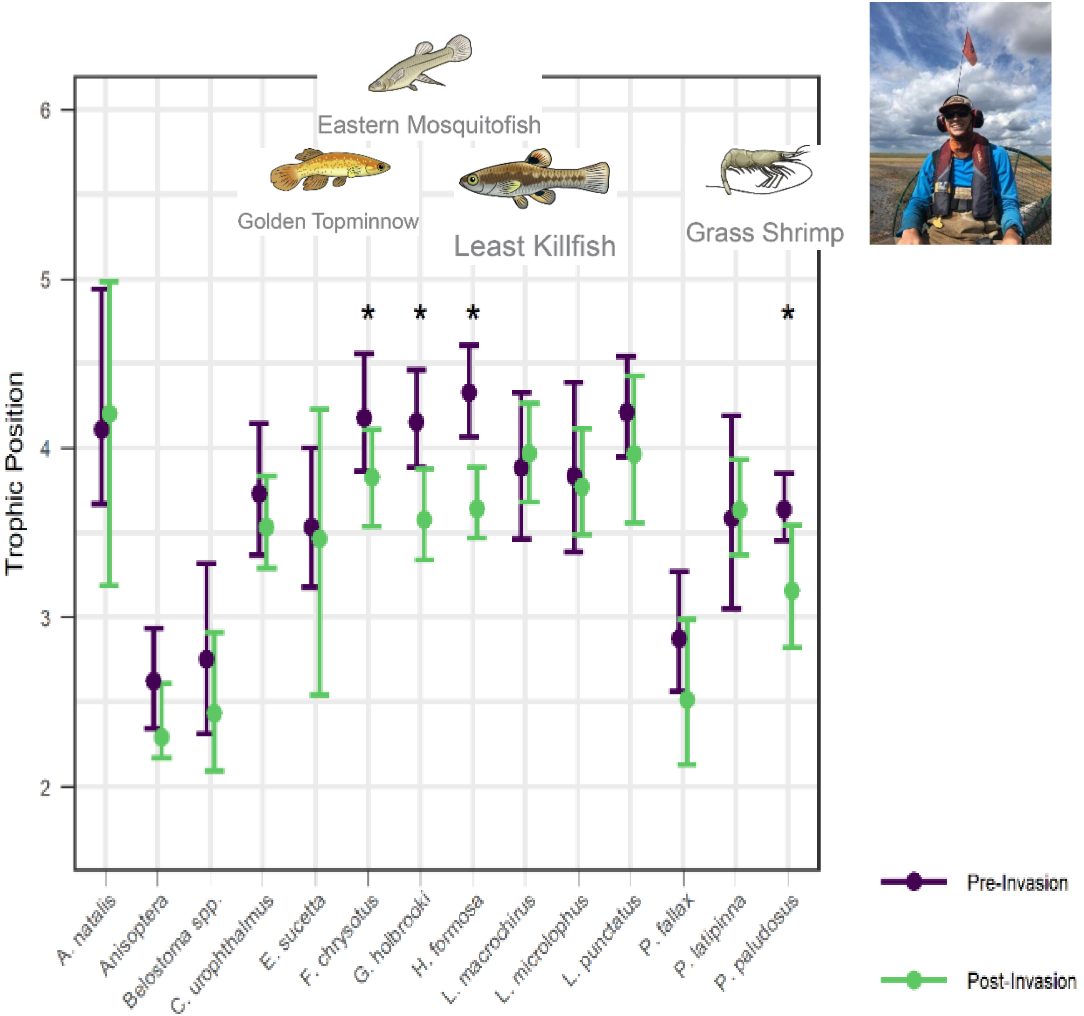


Food web analysis

δ^{15}N and δ^{13}C Isotopic Data reported here

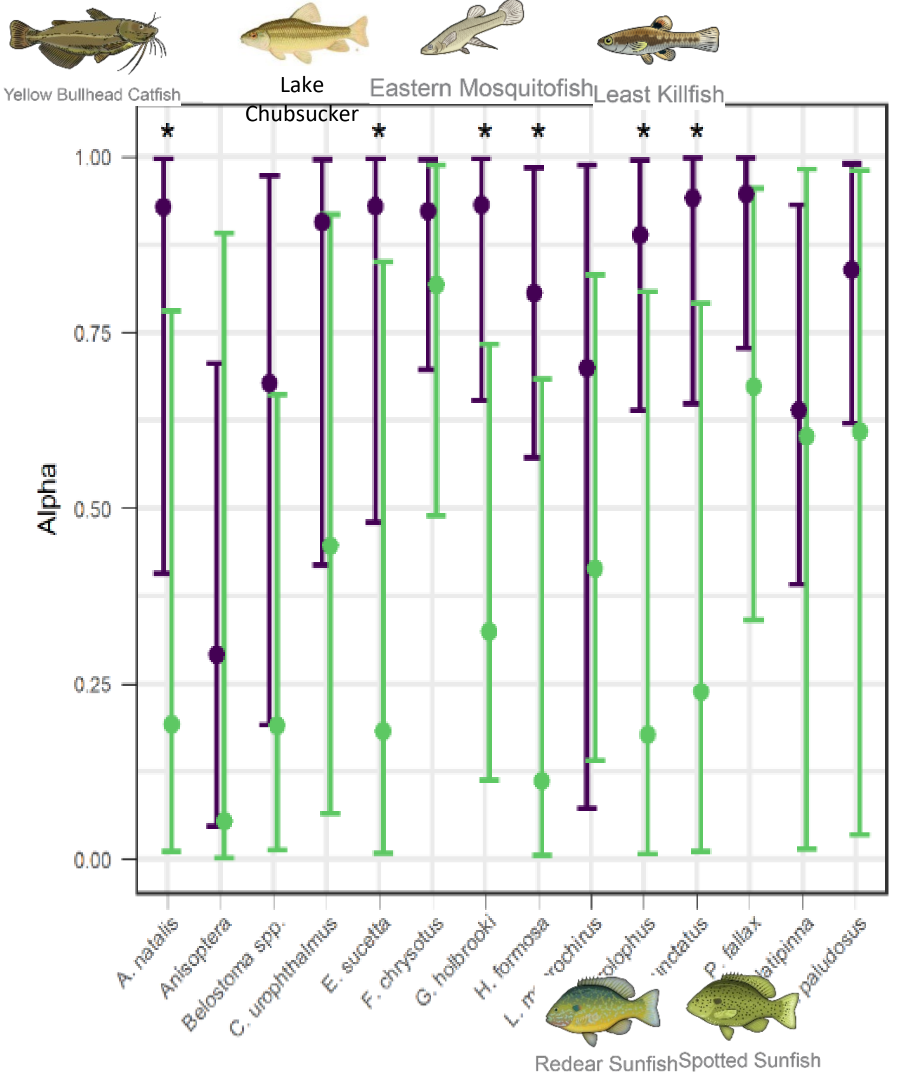
- Pre-invasion isotopic data from 1994; stomach content data from 1977 to 1981 (not reported here)
- Post-boom data from 2018-2019

- Trophic niches were modeled using the tRophicPosition package in R.
- All significant changes shift to lower trophic position in post-invasion (indicated by asterisk)



Energy sources for diets estimated with δ^{15}N isotopes

- Alpha was the proportion of δ^{15}N in a consumer's tissues derived from detritus
- Detrital "brown" (alpha > 0.5) and algal "green" (alpha < 0.5) energy
- All significant changes shift to greener diet in post-invasion (indicated by asterisk)



Conclusions

- After accounting for effects of hydrologic variation, several native species were reduced following boom of jewelfish (discussed in 2023 paper).
- Several invertebrate taxa also decreased during the jewelfish boom, notably planorbid snails decreased by 65%. Taxa that underwent the largest declines were those that are likely consumed by jewelfish.
- Our findings for jewelfish were consistent with some, but not all, findings from experimental mesocosm and solution-hole studies... Grass shrimp were not dramatically impacted.

Conclusions continued

- Community compositional changes (relative abundance) persisted from boom (2012-2017) into 'bust' period (2018-2021).
- Isotopic and gut content data are consistent with changes in trophic position for several abundant species with implications for food-web function.
- Long-term monitoring data provide opportunities to probe for novel population-level effects at field scales.

Acknowledgements

- Funding and other support from the National Park Service, US Army Corps of Engineers, and the National Science Foundation was necessary to produce the information reported here.
- Many FIU post-docs, graduate and undergraduate students, and technicians made collection of the data reported here possible.
- Permits and technical support was provided from the Everglades National Park

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