Ecological Impacts of Climate-Related Ichthyofaunal Shifts and Invasive Lionfish on the nGOM Reef Fish Community

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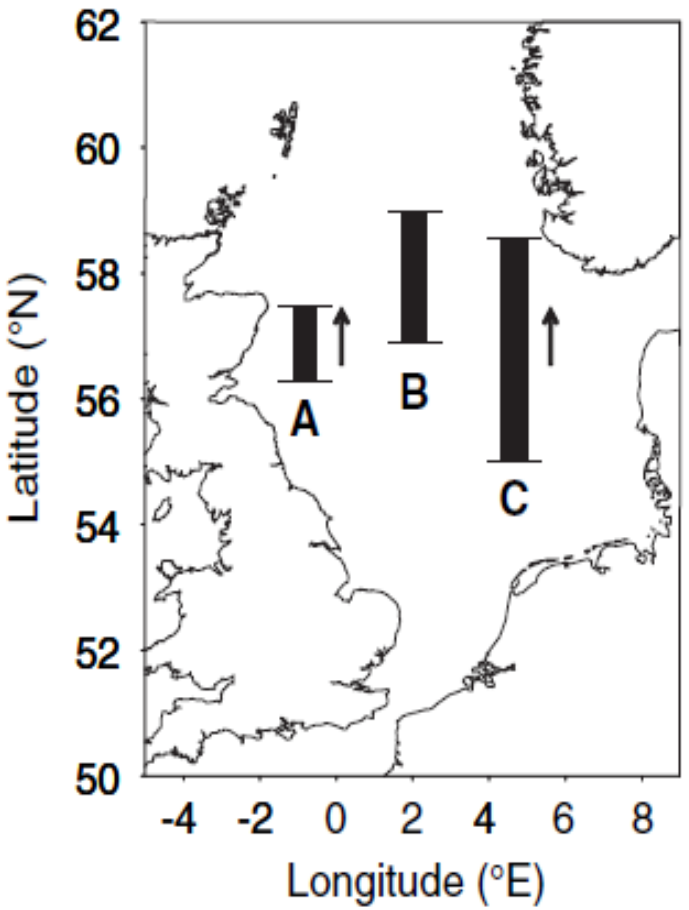
Regional warming results in a poleward shift in the species distribution of marine fishes, which could alter community interactions.

Climate Change and Distribution Shifts in Marine Fishes

Allison L. Perry,[1]* Paula J. Low,[2]† Jim R. Ellis,[2] John D. Reynolds[1]*



Atlantic Cod (*Gadus morhua*)

Anglerfish (*Lophius piscatorius*)

Snake blenny (*Lumpenus lampretaeformis*)

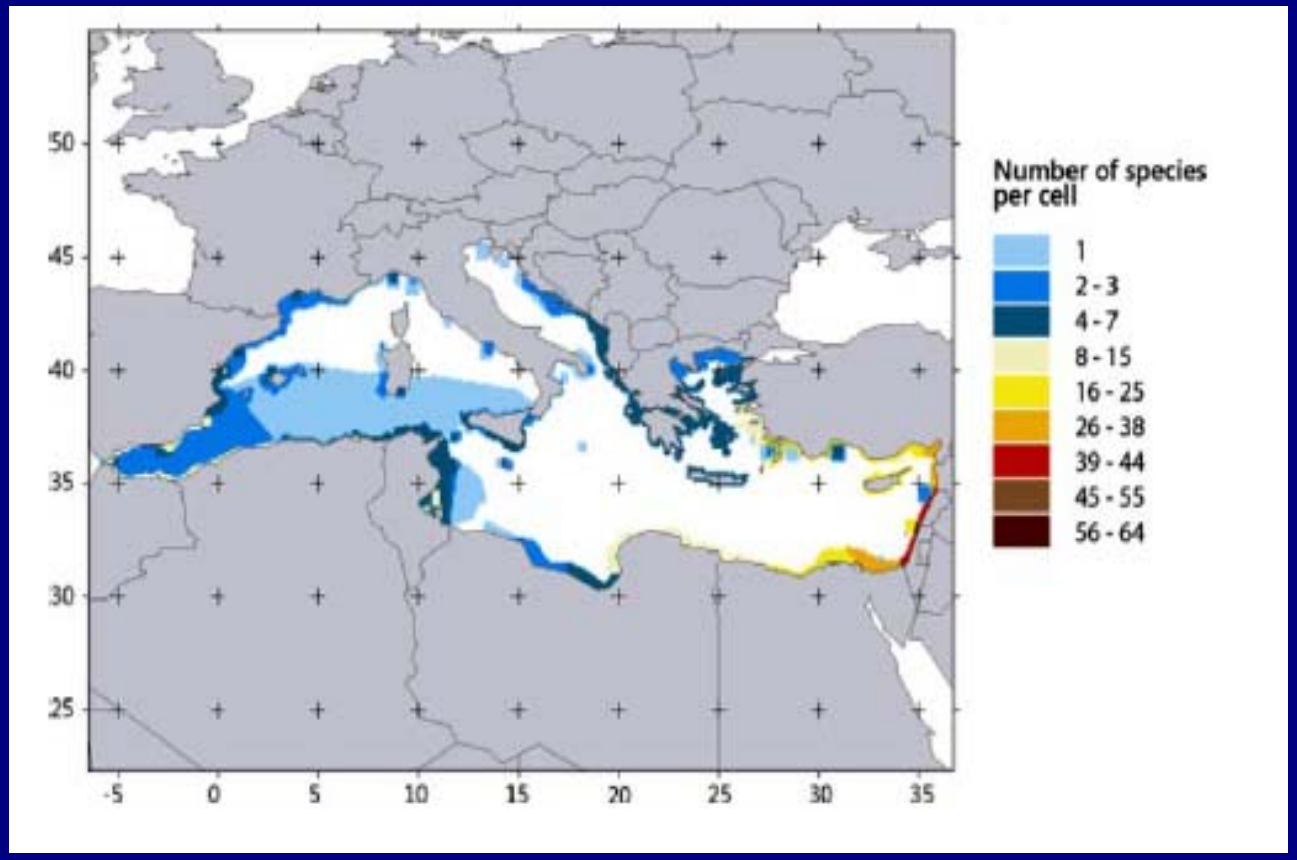
Regional warming results in a poleward shift in the species distribution of marine fishes, which could alter community interactions.

Biol Invasions (2009) 11:697–711
DOI 10.1007/s10530-008-9284-4

ORIGINAL PAPER

Increasing southern invasion enhances congruence between endemic and exotic Mediterranean fish fauna

Frida Ben Rais Lasram · David Mouillot



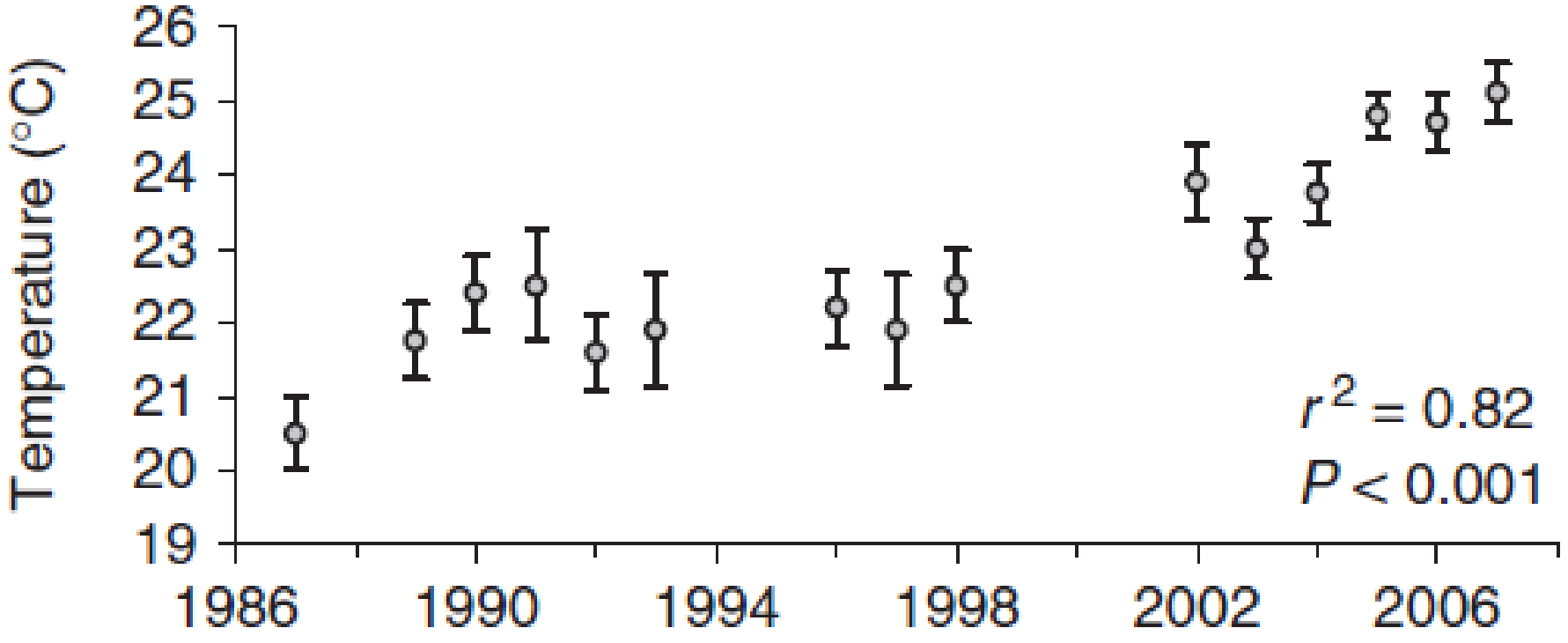
Guinean amberjack
(*Seriola carpenteri*)

Bandtail puffer
(*Sphoeroides spengleri*)

Gulf of Mexico: Tropical and Temperate Regions

- GOM bisected by the Tropic of Cancer
- Interconnected to the Caribbean Sea via Loop Current
- Strong potential for northern distribution shifts

The N Gulf of Mexico – *Gettin' Hot in Herre!*



Daily minimum sea surface temperatures near Mobile Bay, AL, fall 1987-2007 (mean ± 1 SE)

from Fodrie *et al*. 2010

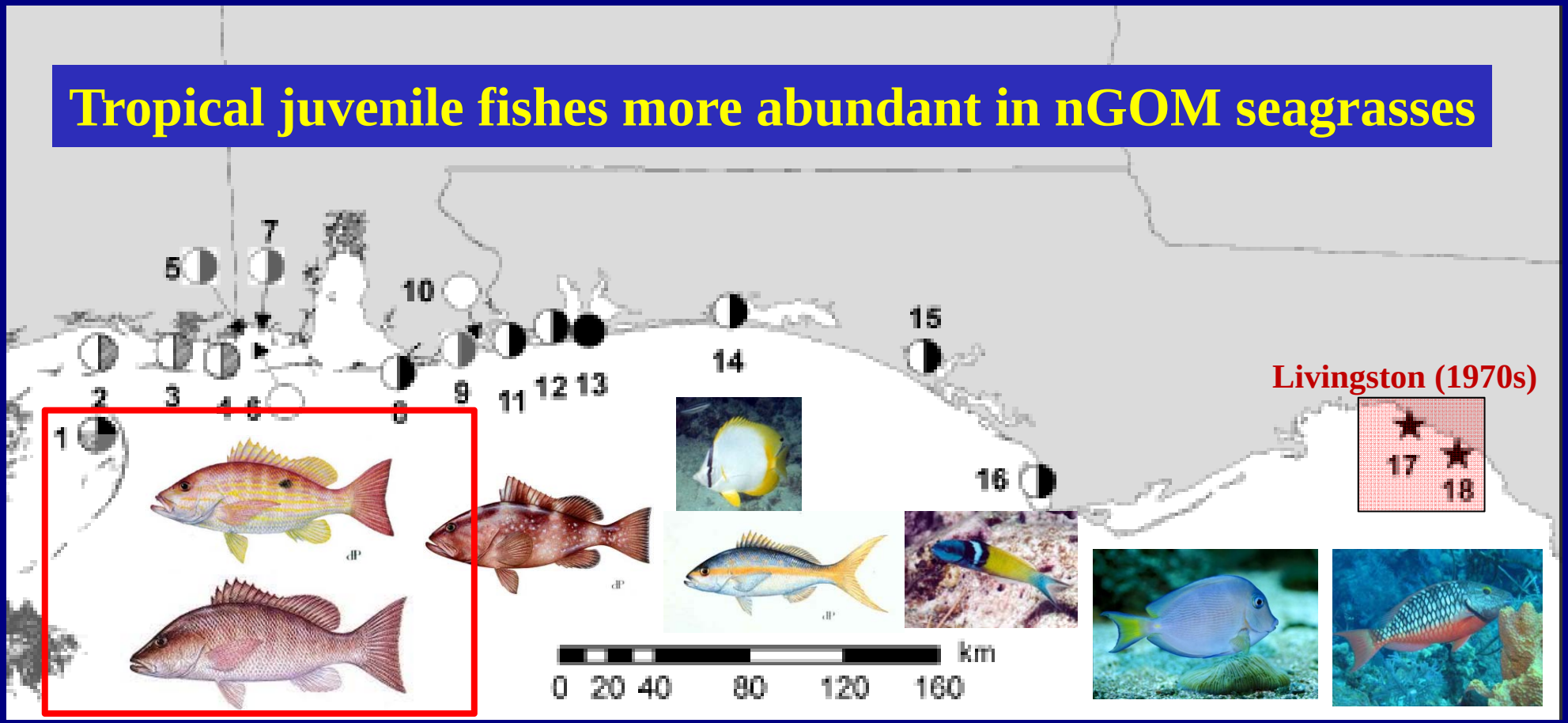
Global Change Biology (2010) 16, 48–59, doi: 10.1111/j.1365-2486.2009.01889.x

Climate-related, decadal-scale assemblage changes of seagrass-associated fishes in the northern Gulf of Mexico

F. JOEL FODRIE*†, KENNETH L. HECK, JR*†, SEAN P. POWERS*†, WILLIAM M. GRAHAM*† and KELLY L. ROBINSON*†

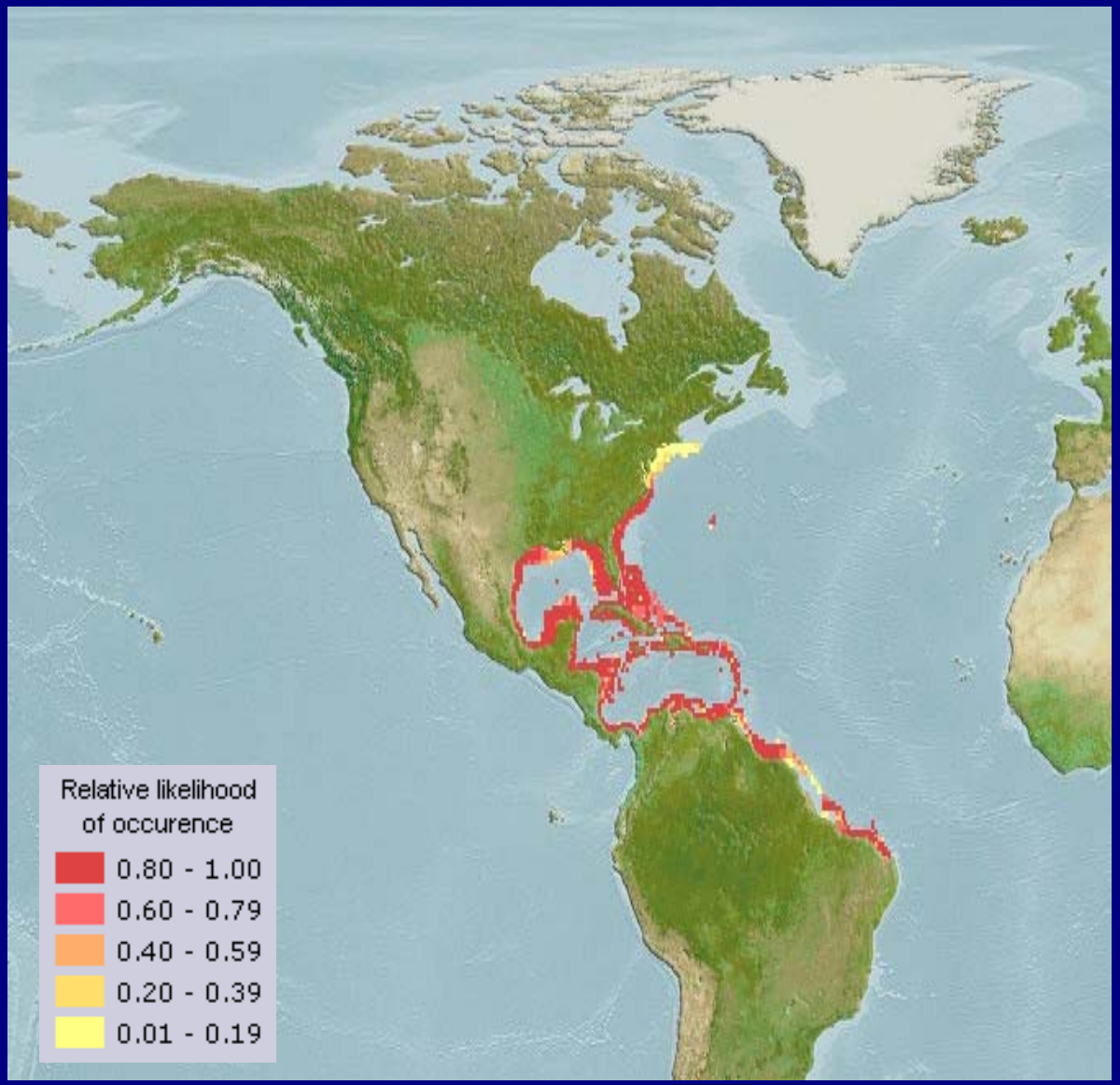
Tropicalization!

Tropical juvenile fishes more abundant in nGOM seagrasses



Increased abundance - **Lane snapper**, **Gray snapper**, Red grouper, Spotfin butterflyfish, Yellowtail snapper, Bluehead wrasse, Surgeonfishes, Stoplight parrotfish

nGOM Snapper Species



Red snapper (*Lutjanus campechanus*)

Lane snapper (*Lutjanus synagris*)

Gray snapper (*Lutjanus griseus*)

- Lane/Gray less abundant than Red
- Red snapper total offshore life history

Snapper Offshore Dynamics

Environment/Natural Resources
Families/Nutrition/Health
4-H Youth Programs

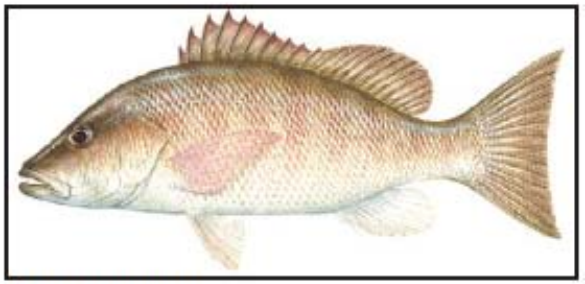
Lagniappe Sea Grant LOUISIANA

February 1, 2008 Volume 32, No. 2

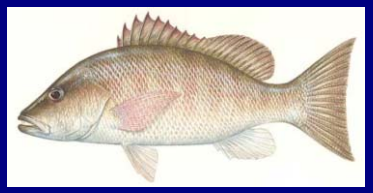
Gray Snapper Moving Up the List

The gray or mangrove snapper (*Lutjanus griseus*) is getting a lot of interest from coastal anglers who would have fished for red snapper but came up against closed seasons and short bag limits.

The mangrove is a fine fish; a game fighter and excellent table



Gray Snapper



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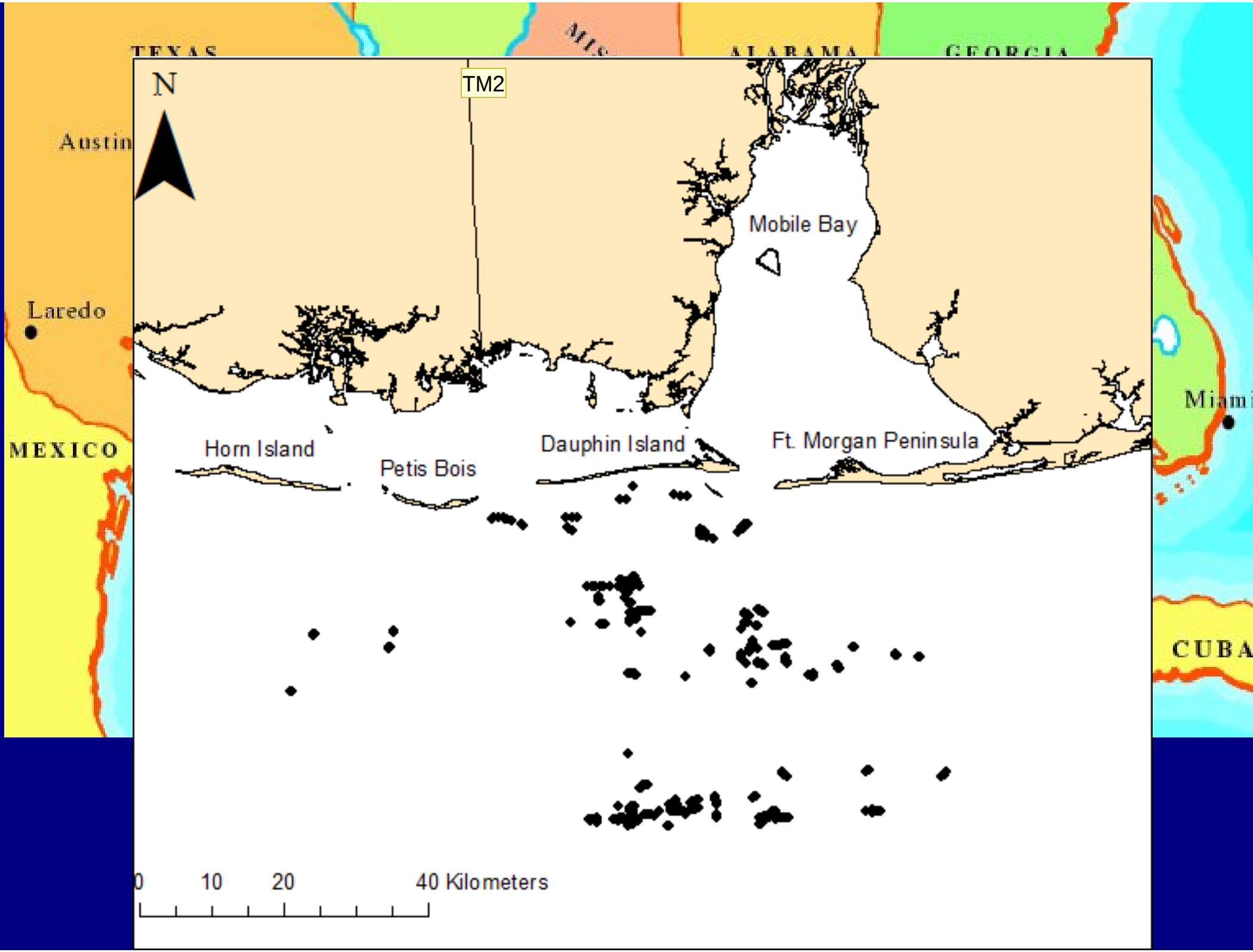
Could increased abundance of tropical snappers in the nGOM affect offshore resident reef fishes?

Investigations

- Offshore spatiotemporal dynamics of tropically associated snappers and the nGOM reef fish community

- Ecological interactions between:
  - Tropical snappers and red snapper
  - nGOM snappers and lionfish
  - Juvenile and adult red snapper-lane snapper

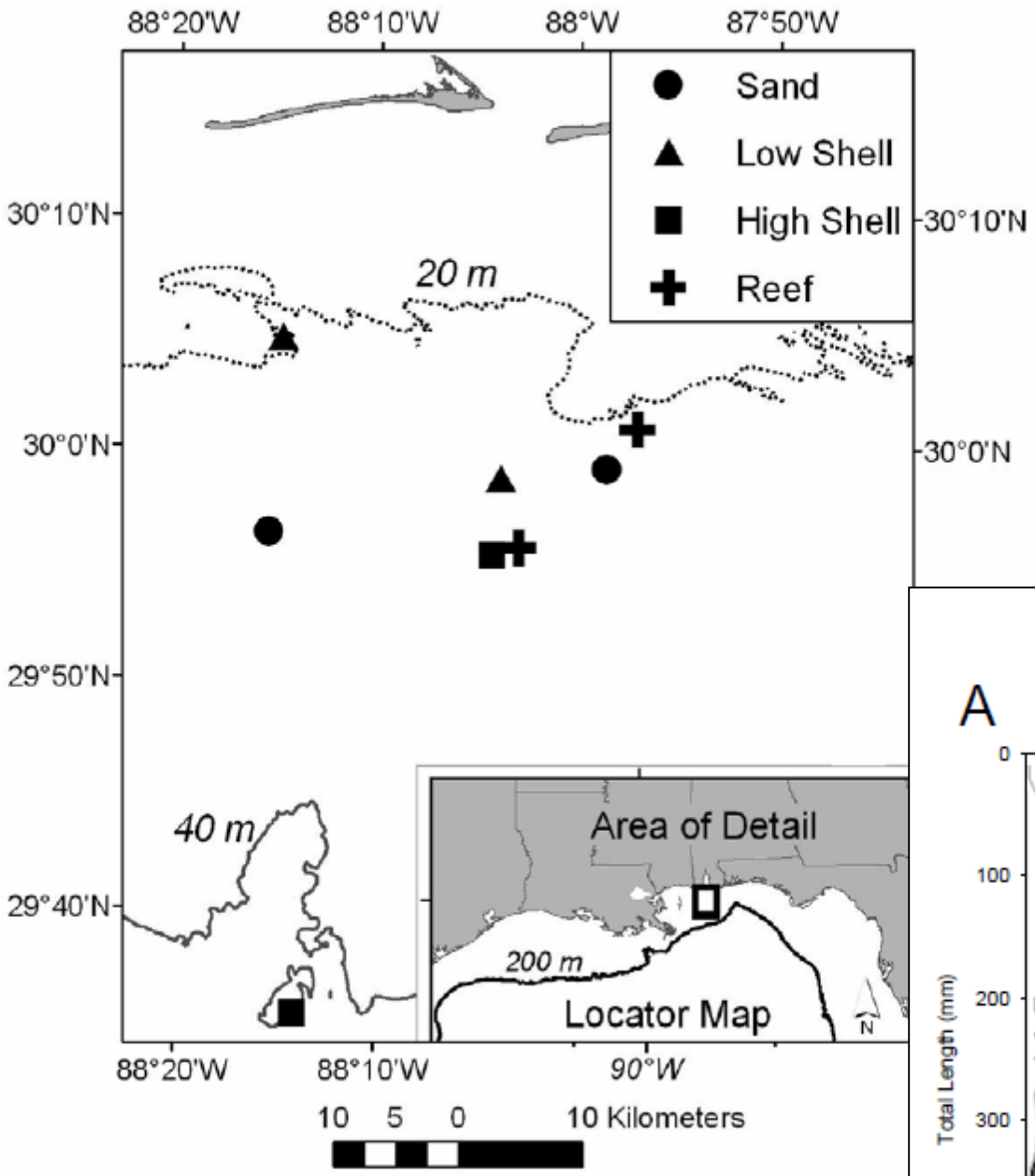

TEXAS
ALABAMA
GEORGIA
N
TM2
Austin
Laredo
MEXICO
Mobile Bay
Horn Island
Petis Bois
Dauphin Island
Ft. Morgan Peninsula
Miami
CUBA
0
10
20
40 Kilometers

Slide 10

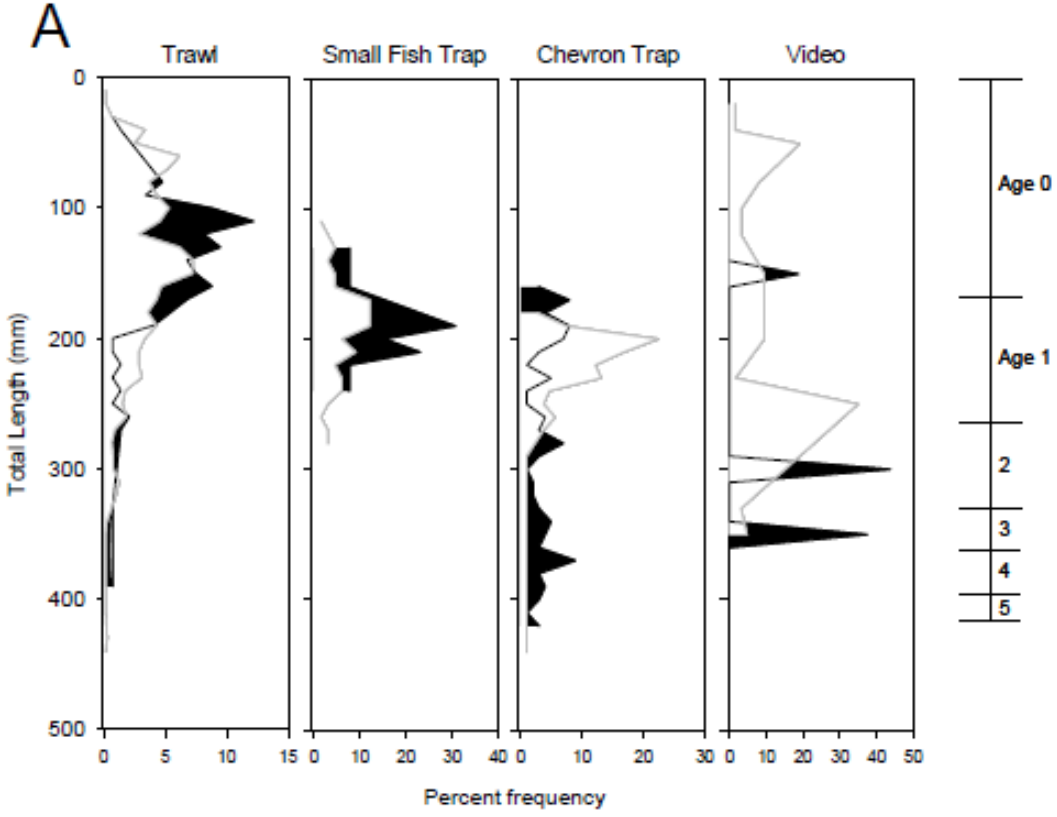
TM2 Also importance of using traps to sample juveniles in high relief habitats

Tony.Marshak, 8/13/2014

Wells 2007 Dissertation



Southeast Banks



Monitor nGOM reef fish community

Small Chevron traps to characterize reef fish community

- Fall 2009 – 2013
- Deploy 10-12 baited traps per location and soak for at least 24 hours.
- All fishes identified to species and length (TL) & weight measured.

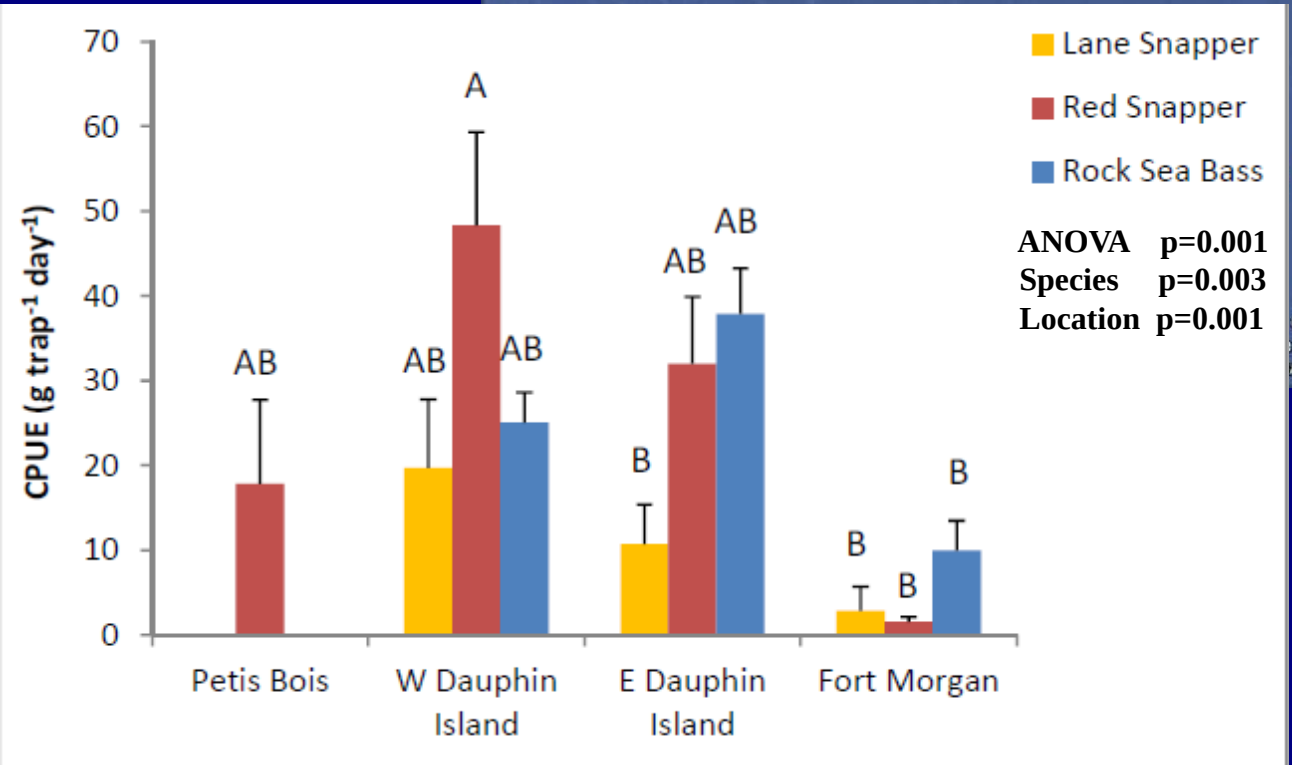
Catch Composition (37 species total)

Species	CPUE	Biomass	Number
Red snapper (*Lutjanus campechanus*)	35.51 ± 6.06	27949.99	375
Rock sea bass (*Centropristis philadelphica*)	26.51 ± 2.61	23304.17	518
Lane snapper (*Lutjanus synagris*)	13.61 ± 4.28	13434.42	82
Atlantic croaker (*Micropogonias undulatus*)	7.29 ± 1.84	5341.72	90
Longspine porgy (*Stenotomus caprinus*)	6.47 ± 1.06	5280.08	333

- Red snapper, Rock Sea Bass, and Lane snapper made up 63% of the total biomass.
- No gray snapper

Reef fish spatial trends (2009-13)

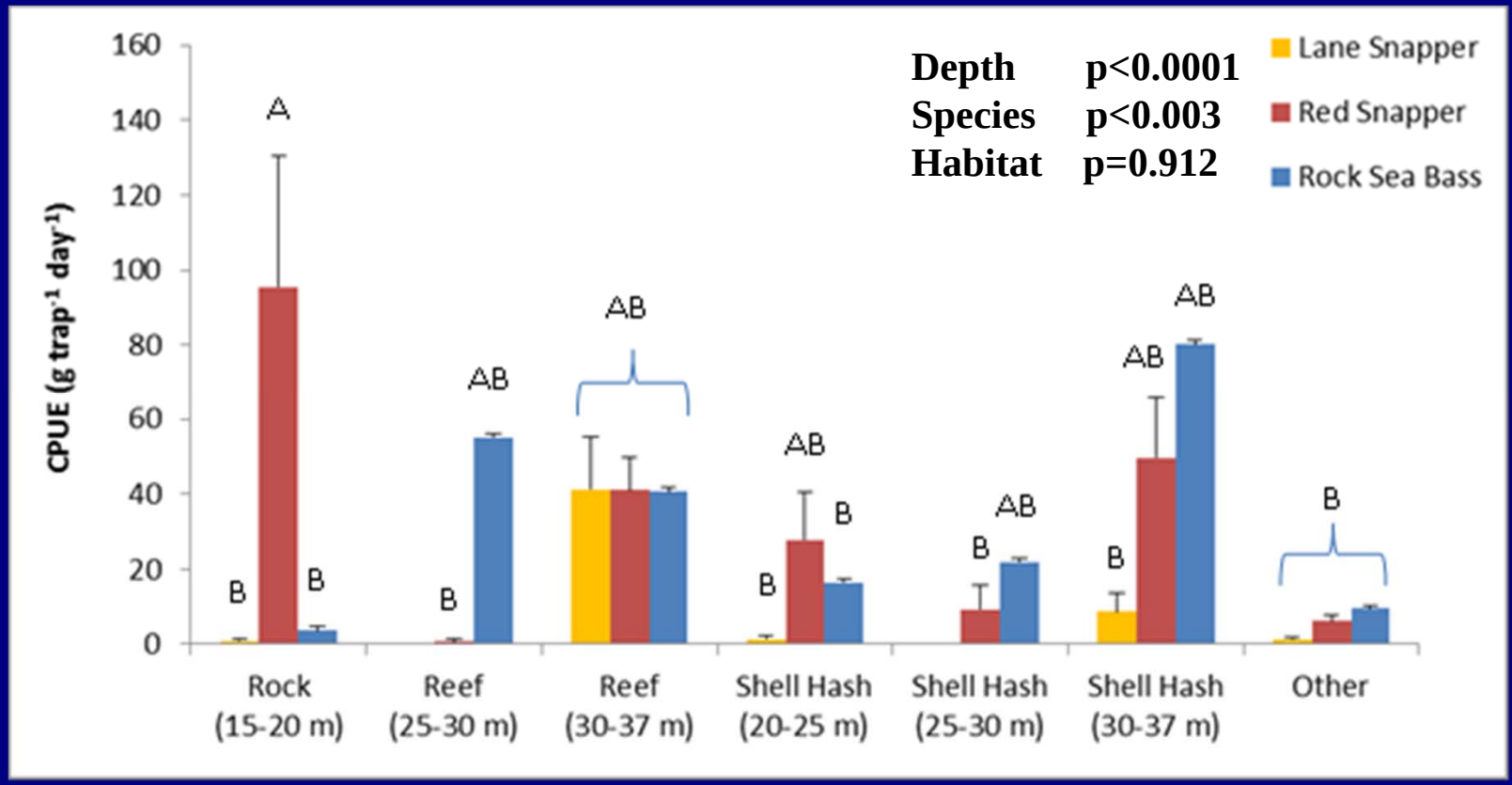
Lane-Red Overlap



Marshak and Heck *Env Biol Fish* (in review)

Reef fish spatial trends (2009-13)

Lane-Red-Rock Seabass Overlap

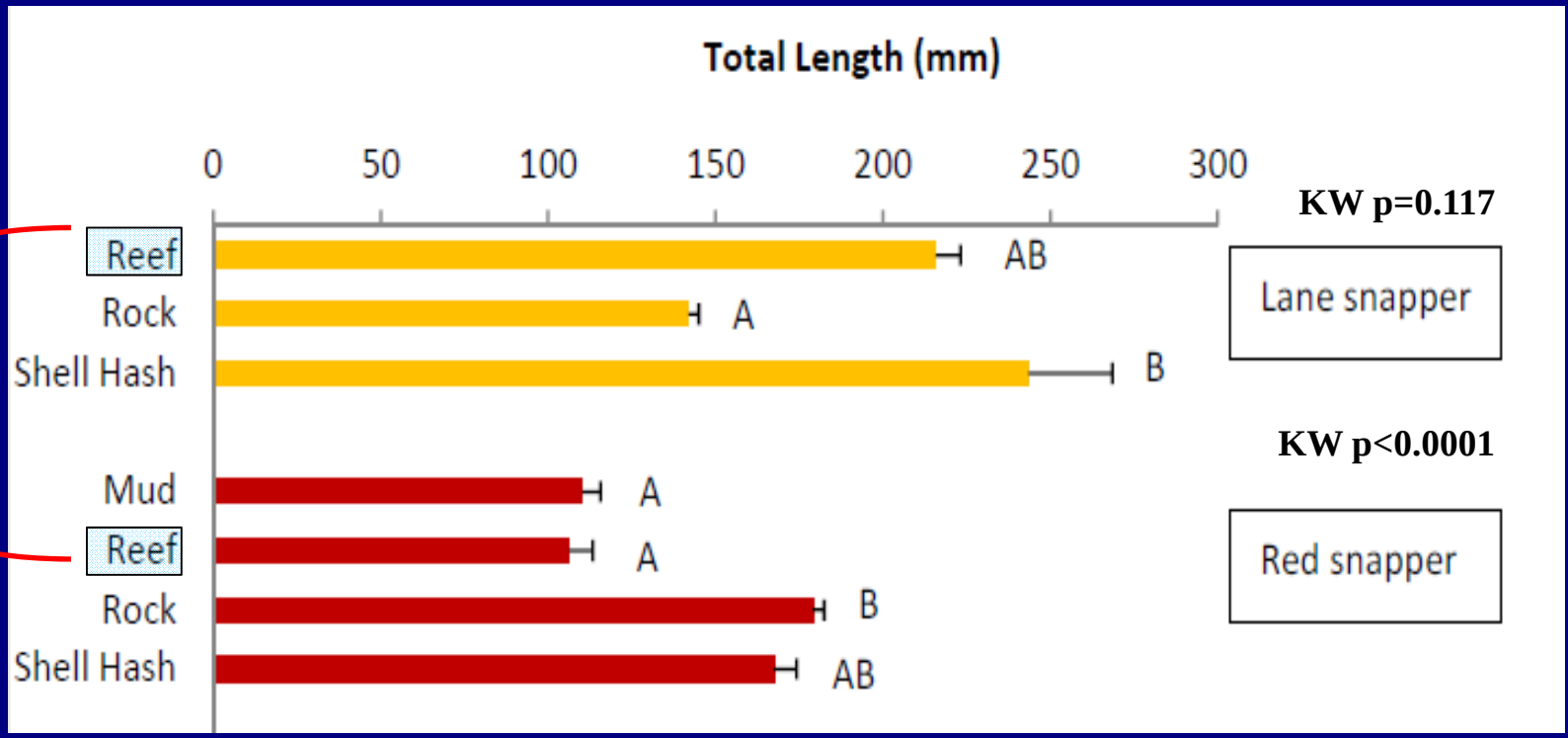


Highest red snapper in shallow rock

Highest coexisting lane snapper in deep reef

Reef fish spatial trends (2009-13)

MW
p<0.0001

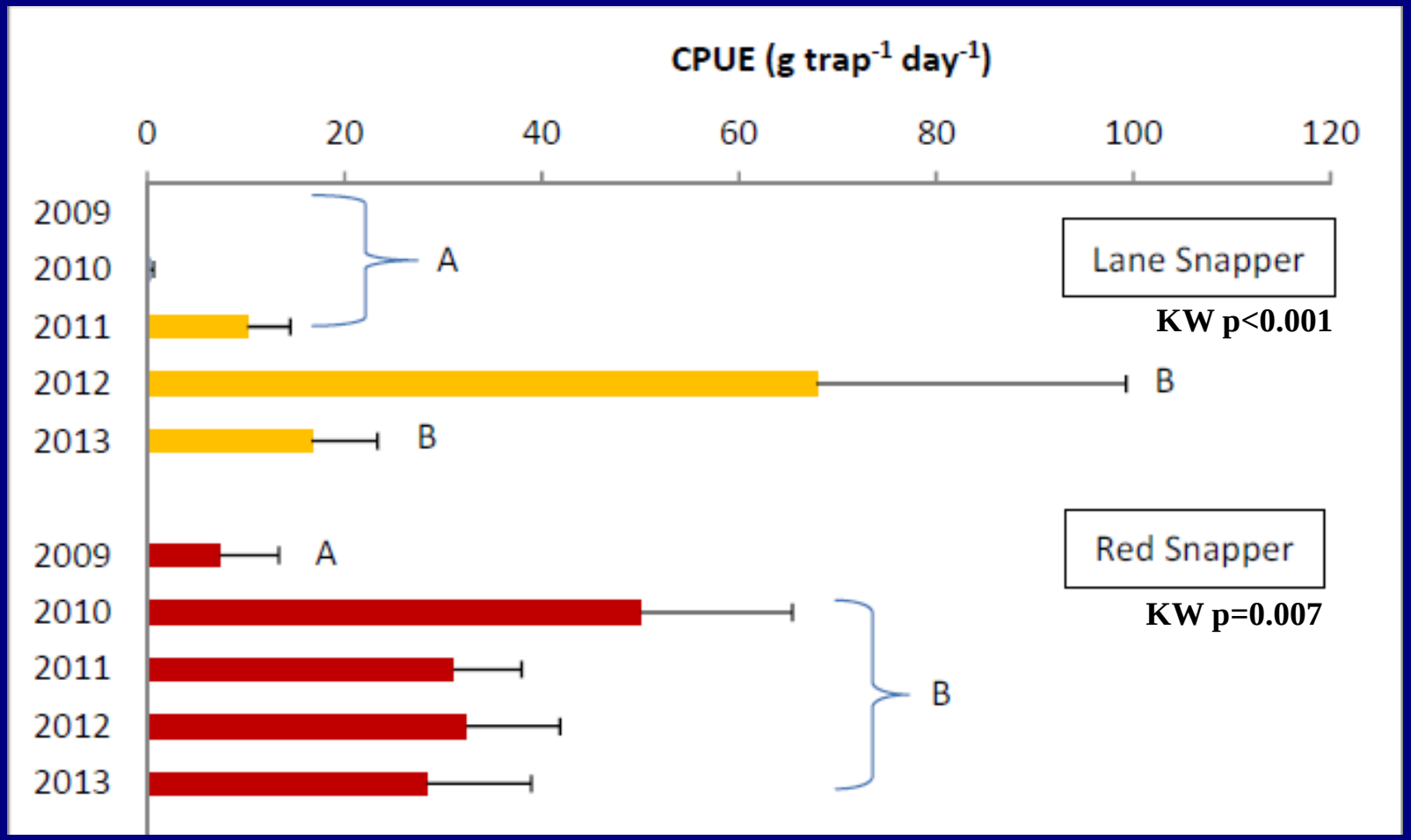


NS lane snapper, sig larger red snapper in rock

Sig larger lane snapper than red snapper in reef

Reef fish spatial trends (2009-13)

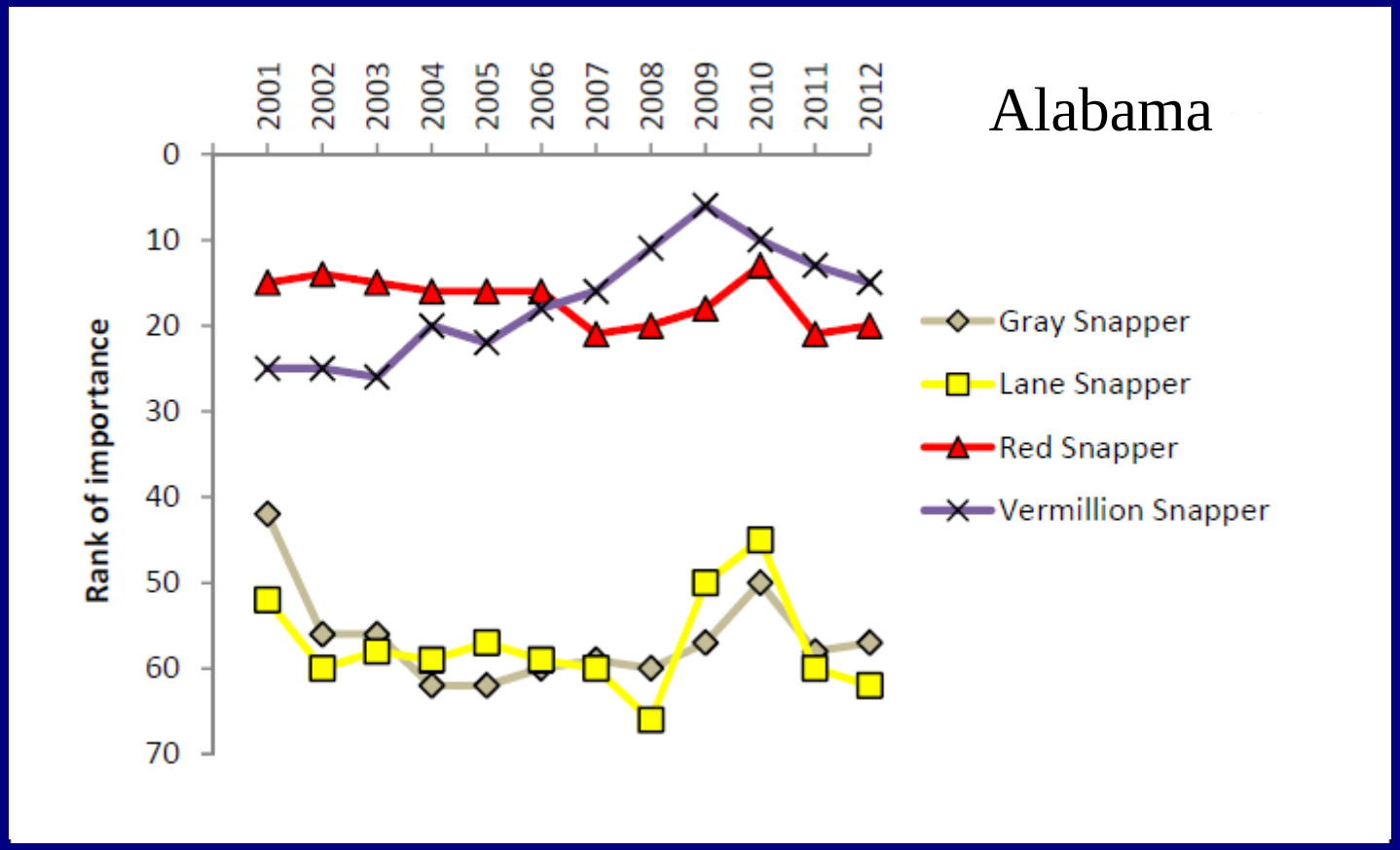
Lane-Red Overlap

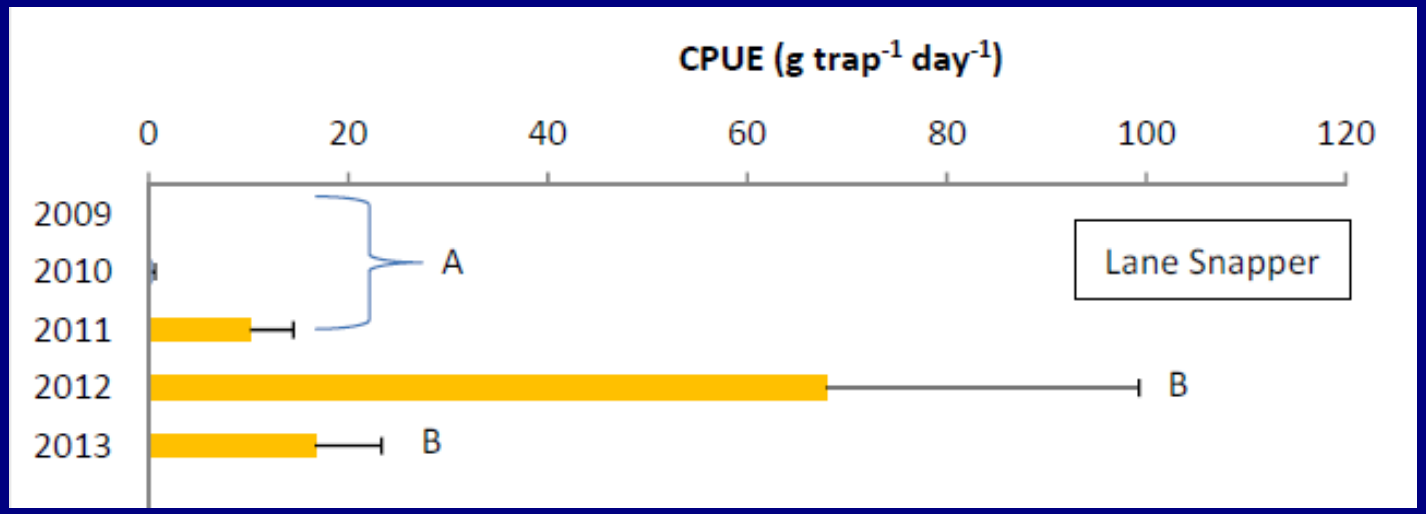


More pronounced sig increases lane snapper over time

Reef fish spatial trends (2009-13)

Lane-Red Overlap





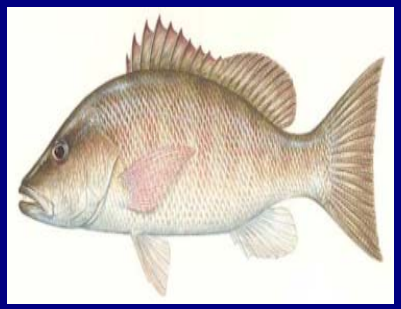
Discussion

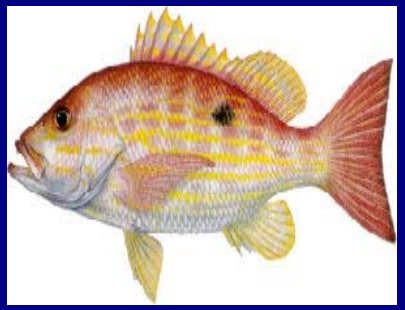
- Highest captures of larger lane snapper in deep reef.
- Red snapper larger & dominant in low relief shallow rock, but smaller & coexist with lanes in reef.

- Increased structural complexity facilitates higher numbers of snapper species over time
  - mitigates apparent competitive dominance of red snapper?

- Differential vulnerability per depth-habitat to ecological effects of climate change.

Quantifying Interactions among tropical snappers and red snapper





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Experimental Objectives

- 1) Quantify competitive interactions between juvenile red, gray, and lane snappers using experimental mesocosms

- 2) Determine consumption rates, swimming activities, and fish behaviors in the presence and absence of each species to infer +/- interactions:
  - H_0 = There are no significant differences in these parameters in the presence/absence of the 3 spp.
  - H_A = There are significant differences in these parameters in the presence/absence of the 3 spp.

Experimental Design (Additive/Substitutive)

Species Interactions Experiments

Red snapper

Gray snapper

N=3

Red snapper

Lane snapper

Also, three replicates of all snapper species together

Lane snapper

Gray snapper

N=3

Experimental Design (Additive/Substitutive)

Species Identity and Density Controls

Red snapper

Lane snapper

Gray snapper

Intraspecific Competition

Monoculture controls of 3, 6, and 9 individuals

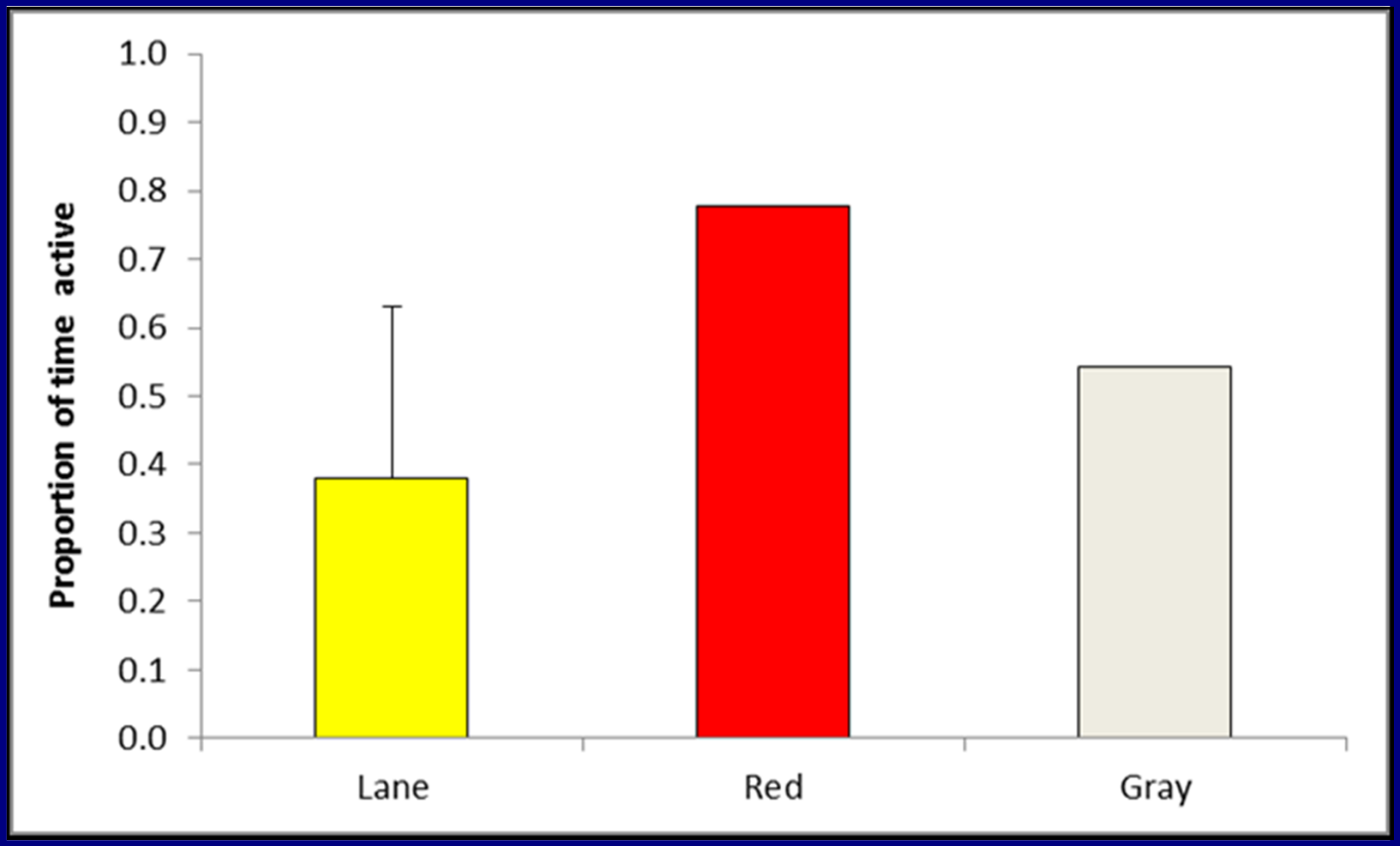
N=27

Experimental Methodology

- Temp: 20.6 ± 0.4 ºC
- Snappers 15-25 cm TL
- Three hour video fish observations

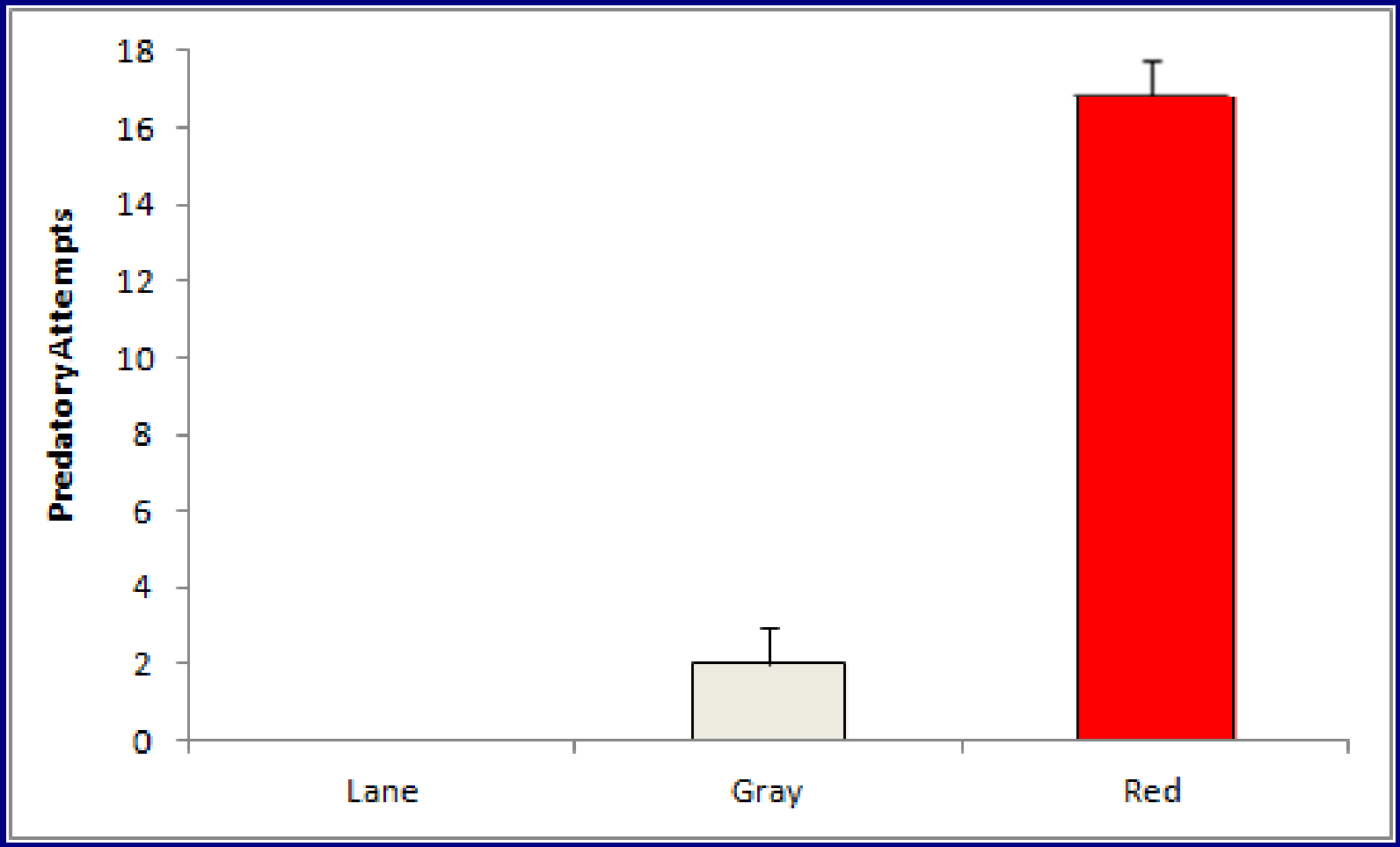
Mesocosm interior with concrete blocks and sediment/shell as habitat

Swimming Activity



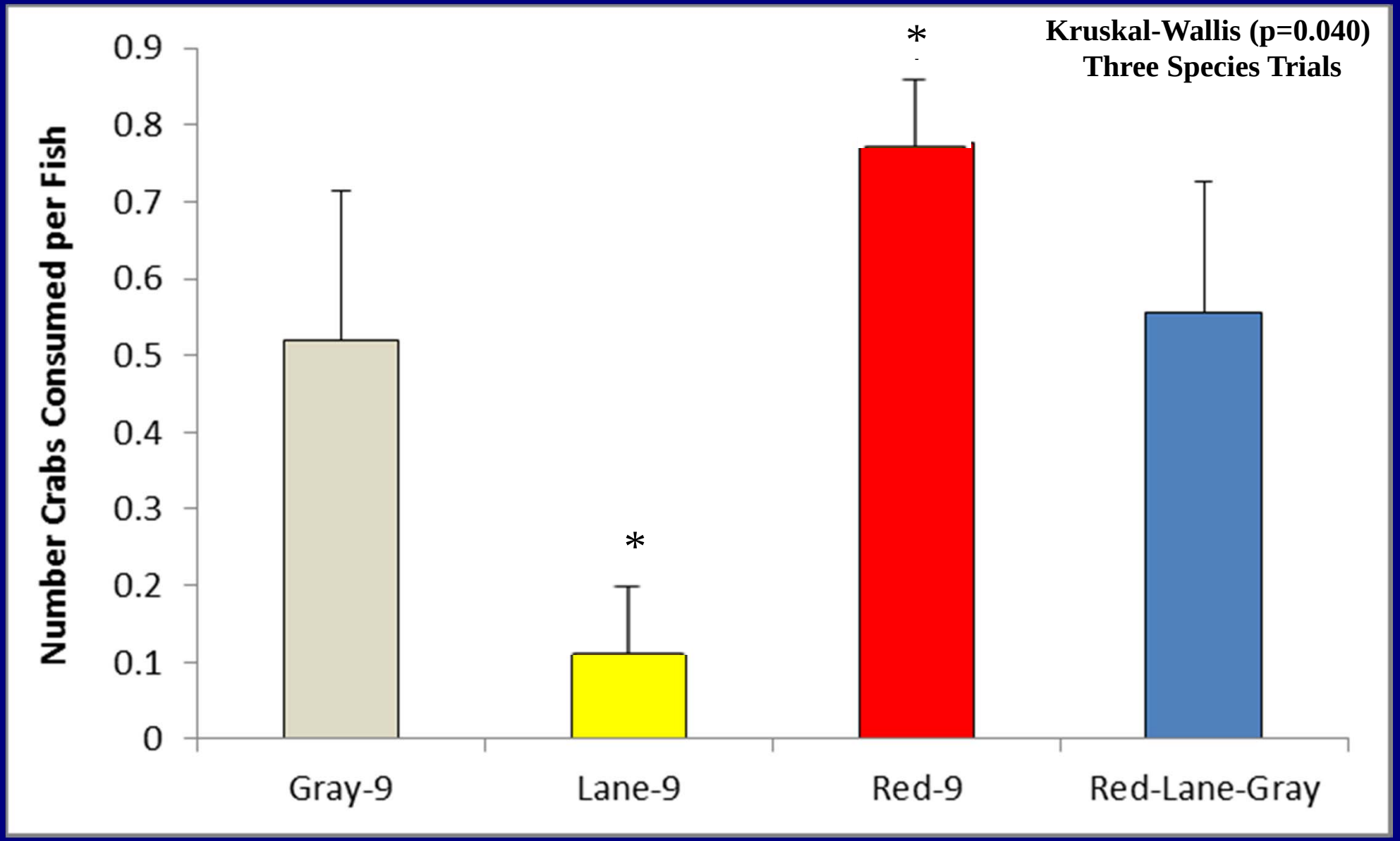
- Red snapper spend higher proportion of time swimming than lanes or grays

Predatory Attempts



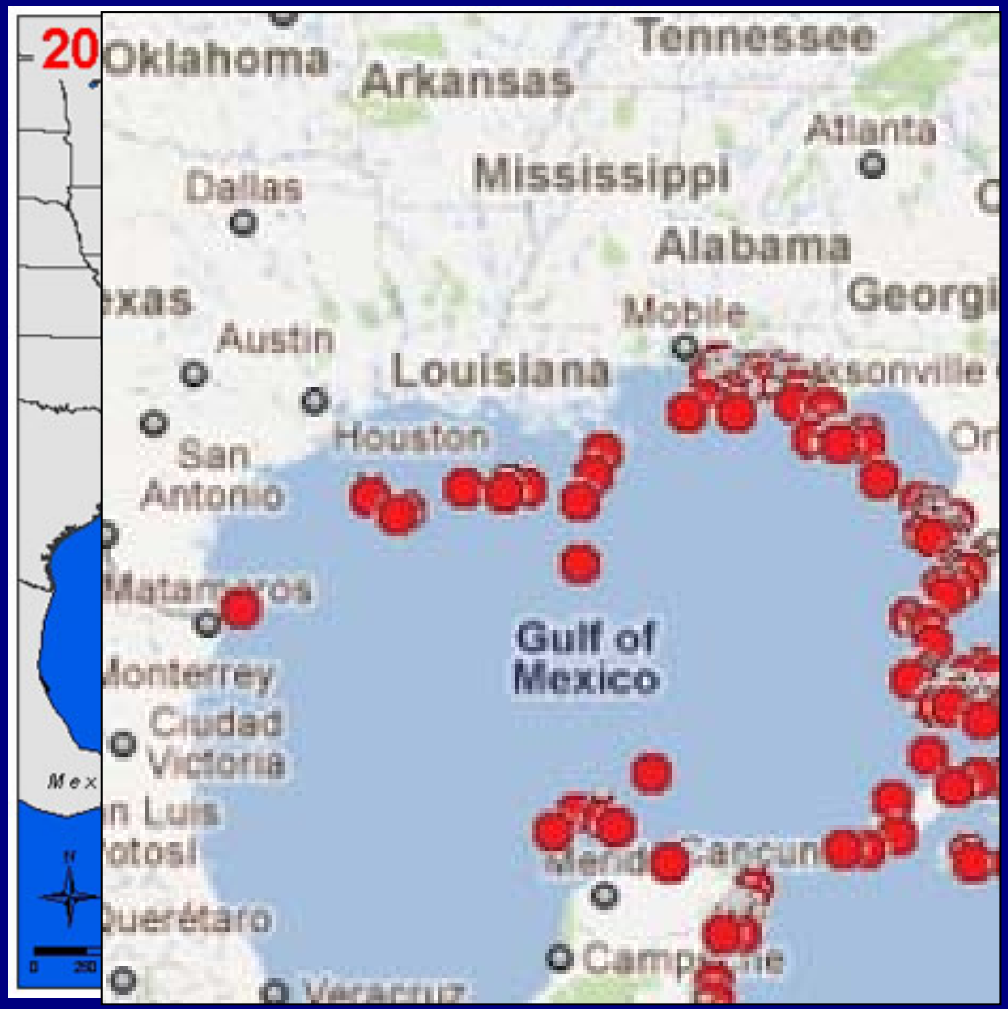
- Much higher number of predatory attempts by red snapper than by lane or gray snapper

Consumption by Snappers



Red snapper more active, aggressive, and consume more prey than tropicals

Lionfish in the nGOM



- Indo-Pacific ornamental fish
- Voracious predators
- Prolific spawners
- May displace native species

Lionfish sighted off Alabama coastline; could pose threat to some native species (w/video)

Published: Thursday, September 16, 2010, 5:00 AM Updated: Thursday, September 16, 2010, 1:50 PM

By Ben Raines, Press-Register

Follow

Lionfish in the nGOM

- Concentrated in reef habitats 30-40 m depth
- Ongoing lionfish derbies off FL Panhandle

- Continue documenting further inshore, including seagrasses.

- Competitive displacements to resident reef fishes? In habitats?

Lionfish – nGOM snappers (3:1 ratio)

Species Interactions Experiments

Red snapper

Lionfish

N=3

Gray Snapper

Lionfish

N=3

Lane snapper

Lionfish

N=3

Experimental Design (Additive/Substitutive)

Species Identity and Density Controls

Red snapper

Lane snapper

Gray snapper

10 blue crabs/trial (Dahl et al. in prep)

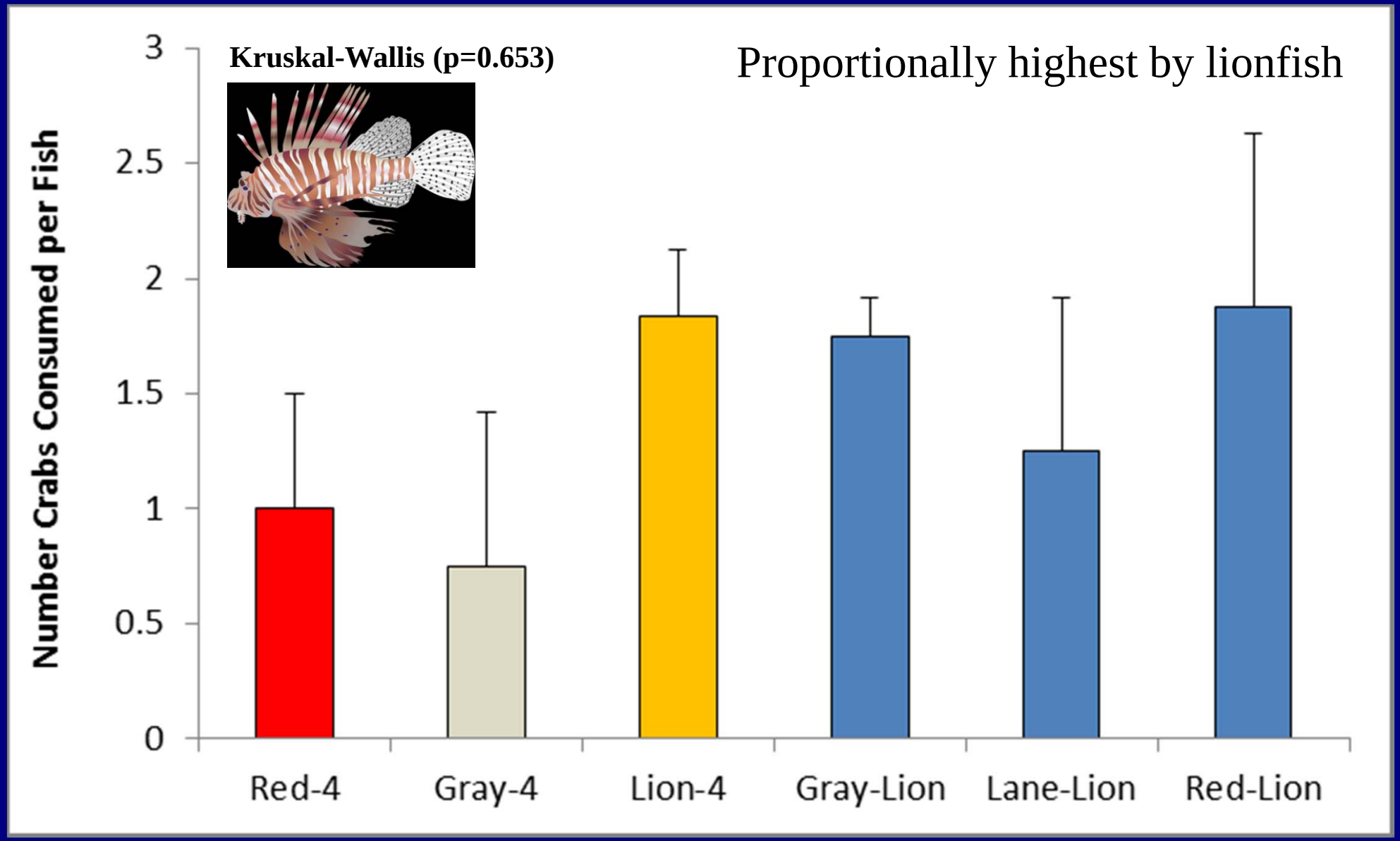
Intraspecific Competition

Monoculture snapper controls of 3, 4 individuals

Monoculture lionfish controls of 1, 4 individuals

N=24

Consumption by Snappers-Lionfish



Summary

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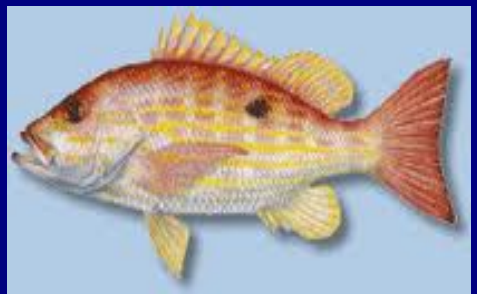

Conclusions

- nGOM reef fishes appear to be more active/aggressive than tropically associated counterparts.
  - Lane snapper larger/more abundant in higher habitat complexity, but adults/juveniles less active-aggressive in experiments.
  - However, with regional warming these trends may reverse, esp in rocky habitats.
- Suggests nGOM reef fishes may currently be better able to exploitatively outcompete lanes, and to a lesser extent grays.
  - But lionfish have competitive advantage on all snappers.
- Competitive displacement appears to be mitigated in higher complexity habitats.
  - Increased inshore presence of lionfish and regional warming of rocky habitats may lead to greater displacements in these vulnerable regions.

Acknowledgements

University of South Alabama – Dept. Marine Sciences

Richard C. Shelby Center for Ecosystem Based Fisheries Management

Dauphin Island Sea Lab

- Dr. Ken L. Heck Laboratory Staff
- Dr. Sean P. Powers and Laboratory Staff
- DISL Technical Support
- DISL Vessel Operations (esp. Capt. Tom Guoba)

Florida Keys Marine Lab

Florida Int'l University (Zack Jud & Craig Layman)