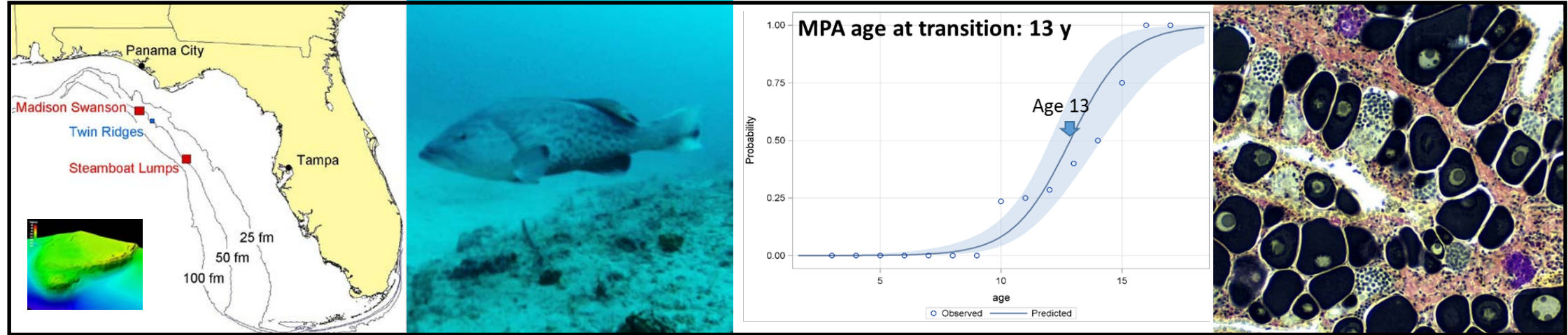


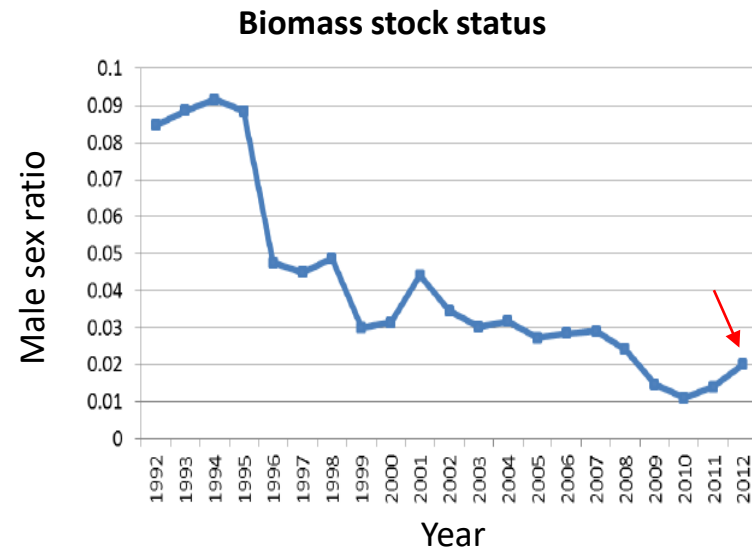
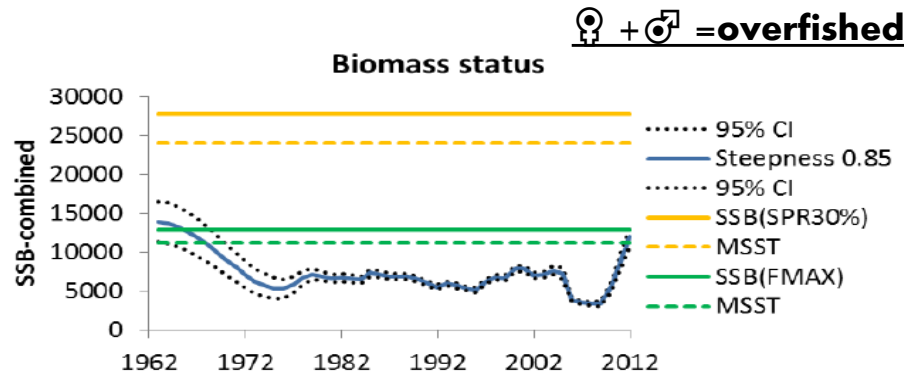
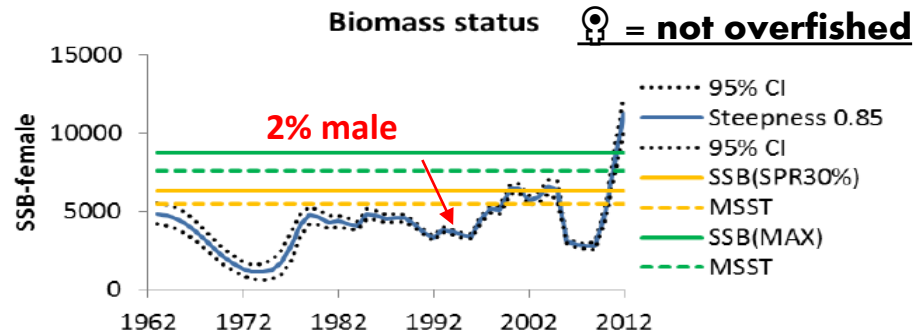
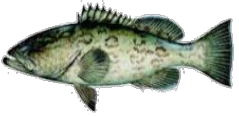
## Testing assumptions about sex change and spatial management in the protogynous gag grouper, *Mycteroperca microlepis*



**What makes a male, how many are there & does it matter?**

Susan K. Lowerre-Barbieri

# Gag grouper stock assessment 2014 results



- Stock status differed depending on measure of reproductive potential;
- But combined sexes seemed unrealistic, suggesting the stock had been over-fished since the 1960's
- Low male sex ratio predicted from the model; but little empirical data to confirm this (2 studies with low sample sizes ~ n=200).
- This was thought to be incorrect due to model predictions indicating spawning site MPAs would increase male abundance

## Our study to assess sex ratios and sex change (Methods)



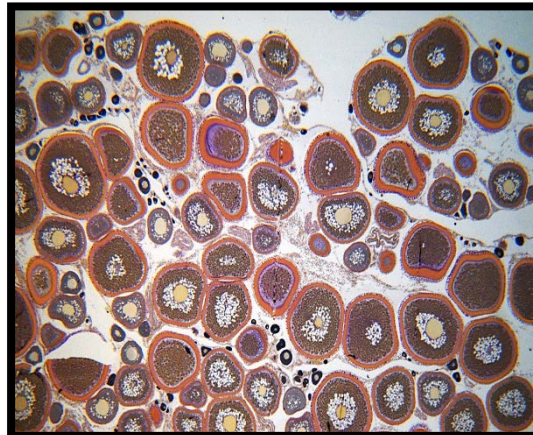
### Targeted study

- Sampled with hook and line and video;
  - MPA (Madison Swanson), the Edges (closed seasonally: Jan-April), & open area NE of Madison Swanson;
- Monthly sampling December-May 2016-2018; opportunistic sampling in additional months;
- Effort: zones were created ~6nm, with the goal to fish each zone once a month ~4hours;
- Hook and Line (electric and bandit reels), recorded fishing time for effort, live and/or cut bait
- Video: 300° view and deployed in each zone for 20 minutes prior to fishing.

Integrated data from the targeted study (n=615; 2016-2018) with data from: FWC reef fish survey (n = 345; 2009-2018), FWC fishery dependent sampling (n=639; 2015-2019) & commercial hook-and-line fisherman (n = 58);



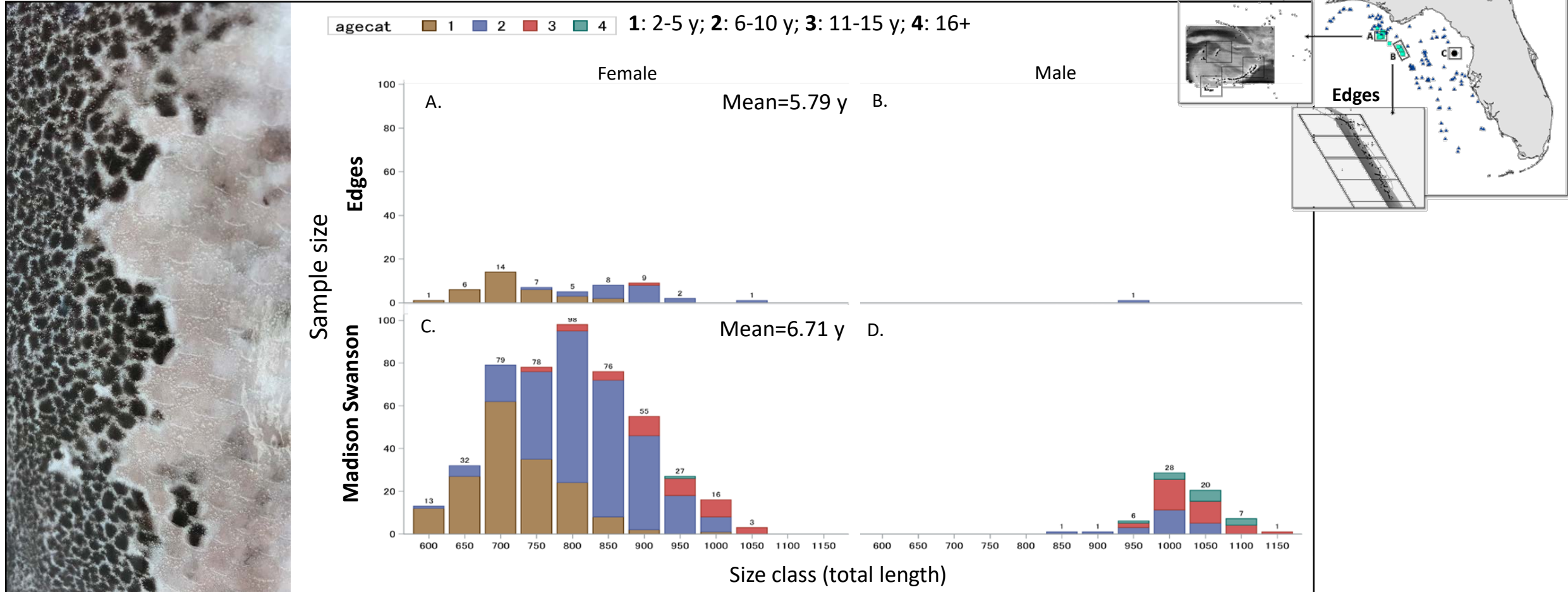
3) Biological data: Total length, total weight, gonad weight, external pigment, otoliths to assign age, gonadal tissue for histological processing and assignment of reproductive state, time and location of capture, blood for hormone analysis



## Sex ratio

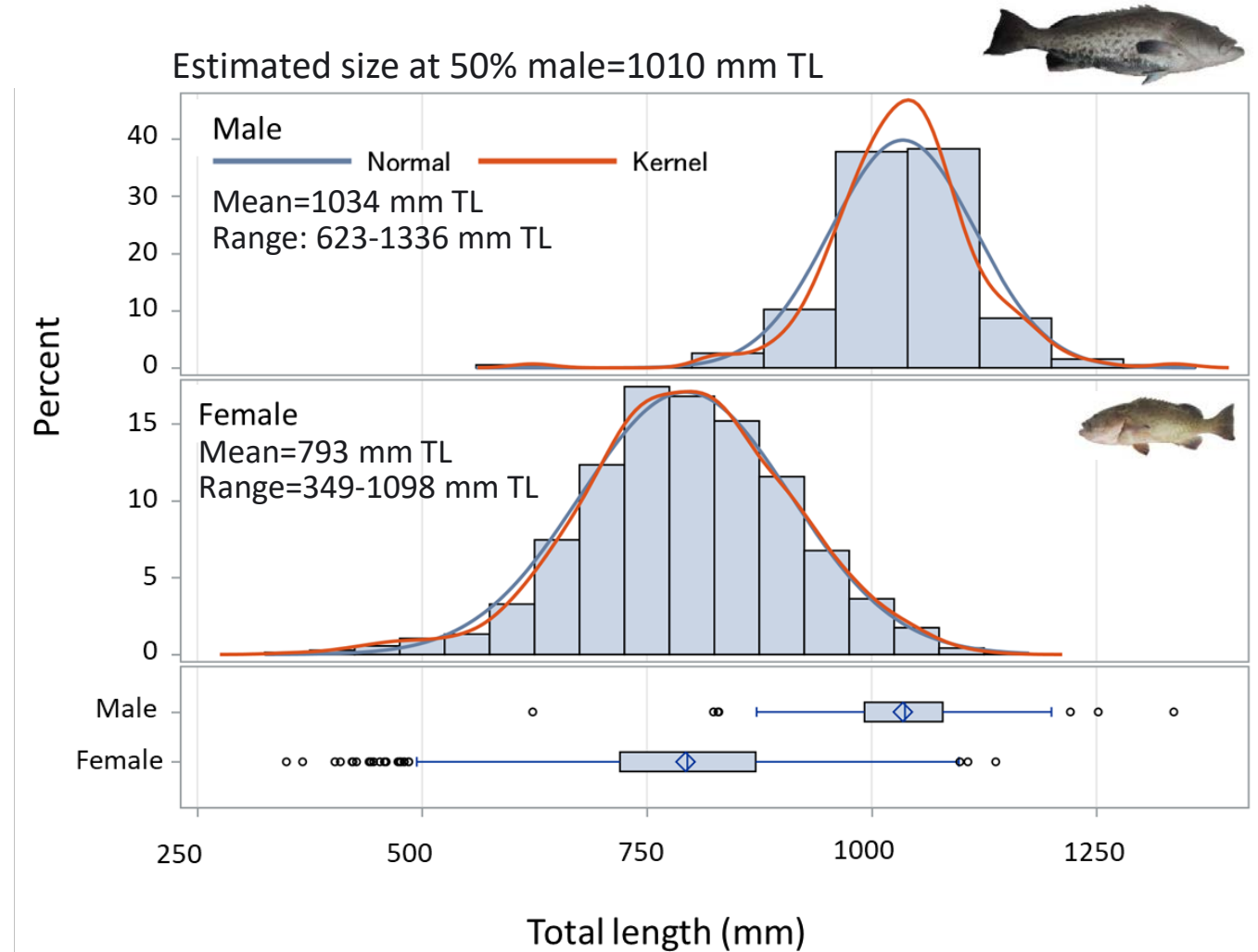
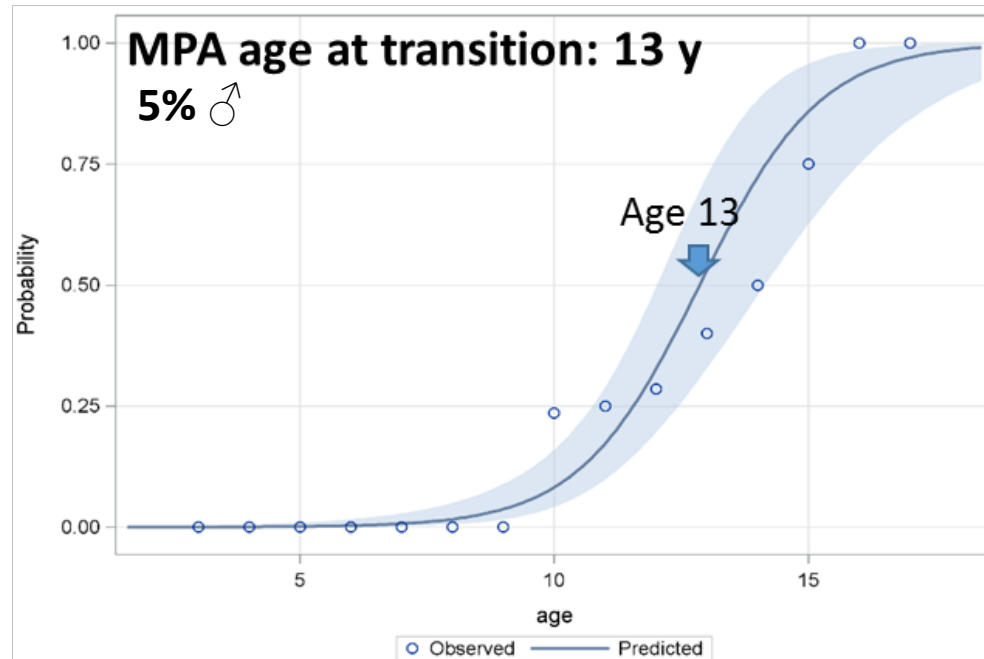
**Results (using data from within the spawning season)** MPA sex ratio=5% male; Edges & Open Area=0%; All fishery independent samples outside MPA (n=479) = 1%

Sample sizes: Open area n=9; Edges n=56; Madison Swanson n=568.



$H_0$ : Age at 50% male (A50) has increased since the 1990s

**Results:** Madison Swanson male A50 = 13 years and is older than previously estimated (10.9 years estimated in 1977 & 2004); males are significantly larger than females, but some small males were observed

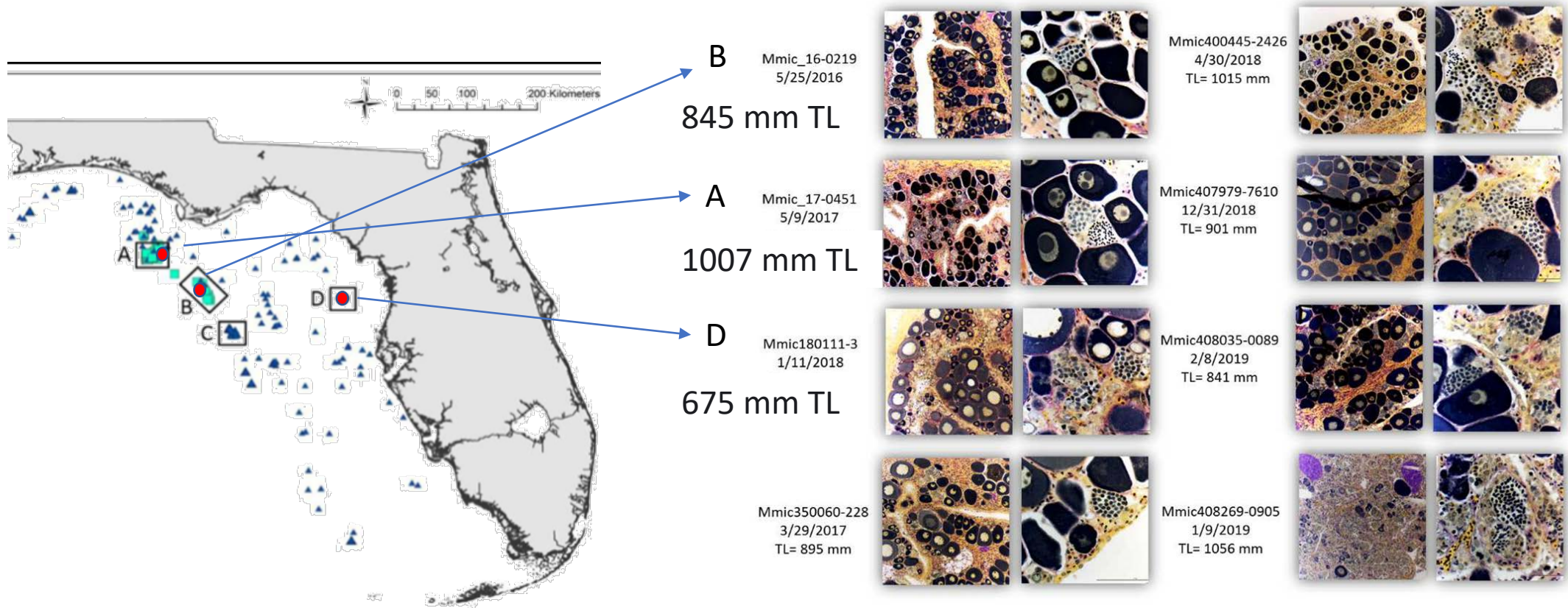
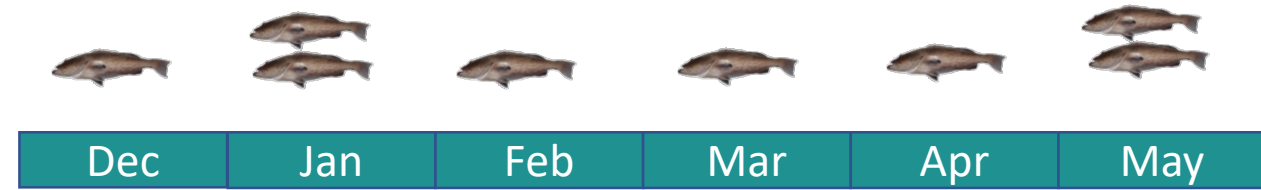




## Why aren't sex ratios higher in the MPA?

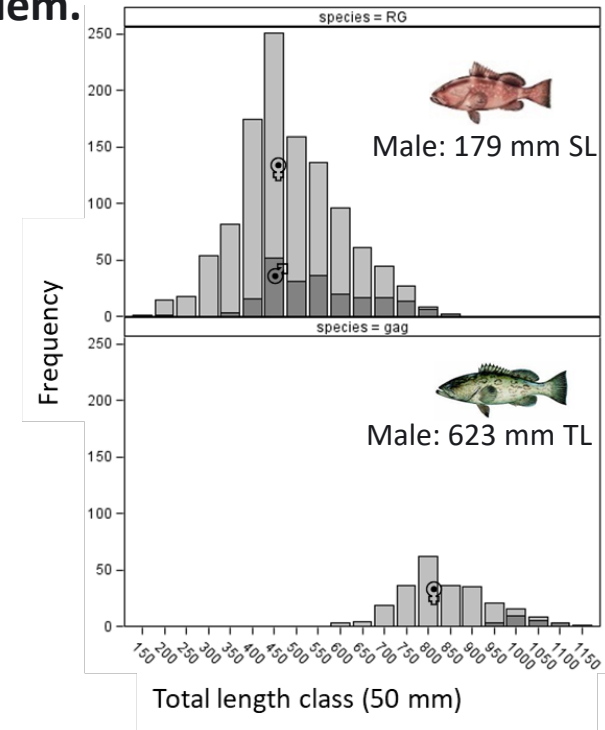
It was previously thought that sex change only occurred on the spawning grounds and was socially mediated by male abundance or size (possible threshold size of 800 mm TL)

**Results:** Transitionals were rare (n=8) but not limited to the spawning grounds or by a threshold size; clearly not endogenously driven; size range: 675 mm TL to 1056 mm TL



**What is the relationship between productivity and sex ratio? We know zero males is a problem. Are other harvested protogynous species showing similar male sex ratio declines?**

- Scamp: male sex ratios declined from ~38 to 18% from the 1970s to the 1990s; currently: 41%  
Lowerre-Barbieri et al., 2020 SEDAR68
- Red Grouper: male sex ratios increased from ~14% in the 1960s to 22% in the 1990s  
 • 2008-2013 19% male; 2014-2017 14% male  
 Lowerre-Barbieri et al. SEDAR42 & 61
- Hogfish: male sex ratio estimated as ~12–17%  
Collins & McBride 2011



Koenig and Coleman 2011

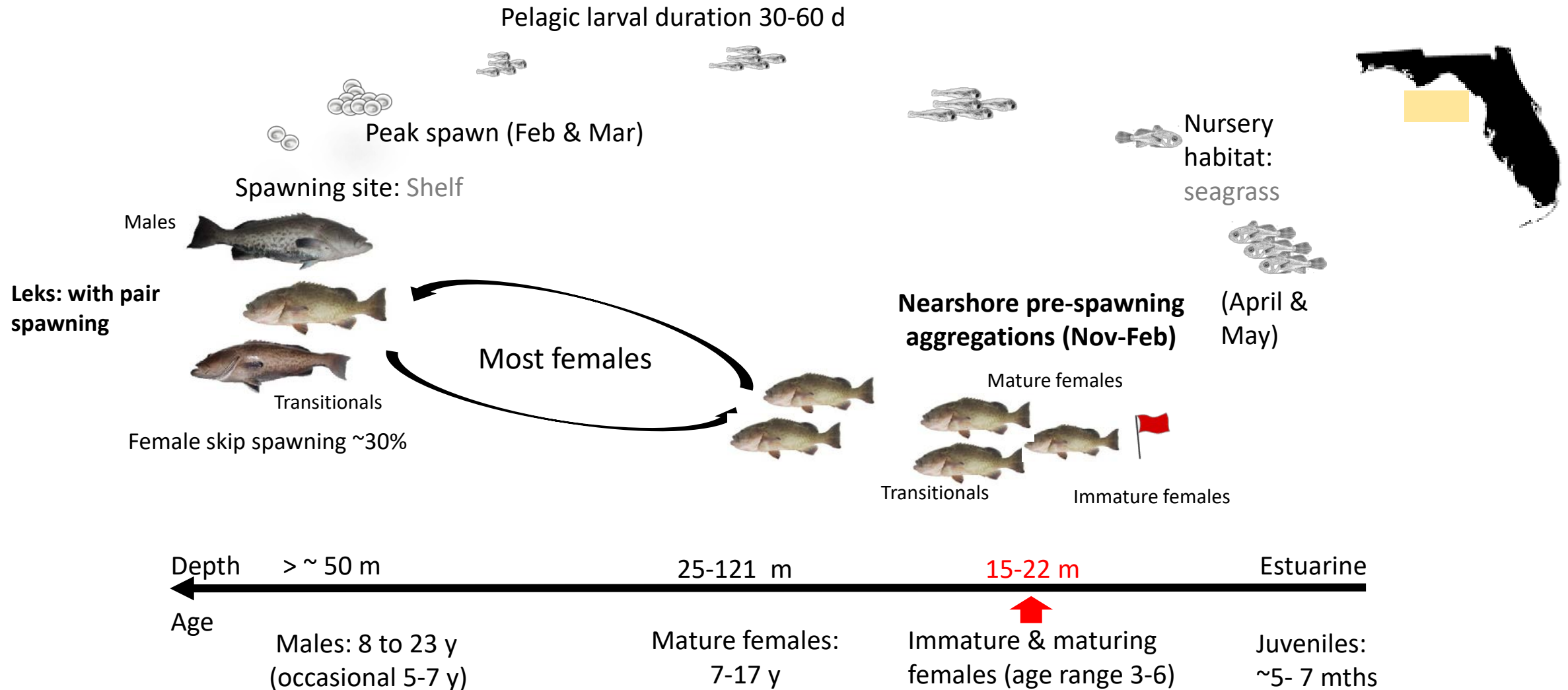
**Table 7.** Gag sex ratio: Gulf of Mexico comparison of historical 1970s (Hood and Schleider 1992) with more recent data 1990s (Koenig et al. 1996). The numbers of females: males plus transitionals and the percentage of males plus transitionals (in parentheses) in the catch data are presented.

Period of Observation	Gulf of Mexico		p-value
	1970s	1990s	
Dec-Mar (Aggregation)	301:52 (15%)	311:6 (2%)	<0.001
Apr-Jul (Post-aggregation)	188:48 (20%)	119:6 (5%)	<0.001
Aug-Nov (Pre-aggregation)	163:39 (19%)	24:0 (0%)	<0.01



## Take home message

- The spatial distribution of the Gag life cycle, their gender system, and their mating strategy all impact sex change, male recruitment, and the spatio-temporal level of fishing mortality they can sustain.



# Acknowledgements

