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Sponsoring Faculty Member: Professor Randy Colvin
Cassie Bates

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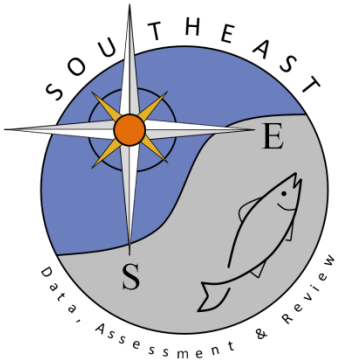

Biology

Comparison of scamp grouper (Mycteroperca phenax), growth off of the West Florida shelf and the coast of Louisiana

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Introduction

Scamp grouper (*Mycteroperca phenax*), member of the family Serranidae, are a deep water species which congregate at depths of 12-73 meters along the east coast of North America particularly from the Carolinas extending down into the Gulf of Mexico and along the coast of Mexico (Lombardi et al 2011). Scamps inhabit territory such as ledges, rocky bottom relief areas and artificial reefs in these regions along with other groupers and some porgies (Rocha 2008). This species has been estimated to live at least 30 years or more and exhibits a protogynous hermaphroditic sexual strategy. This behavior is exhibited as a portion of a population will provide some males and some females. When the sex ratio is disturbed, older and larger females develop male reproductive organs but do not digress back to females. Females mature around age 3 (Fork-length (FL):300-400) and transition into males at ages 11 or 12 (FL:550-600) (Lombardi et al 2012, Manooch 239, Bullock 143). Scamp generally spawn from February to June and peak in activity from April to May (Lombardi et al 2012, Manooch 238). While not being the most targeted fish in industries (≤ 3% commercial landings), scamps are more valuable in taste, therefore procuring higher prices on the market than other members of grouper family

(Lombardi et al 2011). Scamp grouper do not seem to heavily fluctuate in growth or reproductive habits due to fishing pressures according to a study done within a time period of three decades (Lombardi et al 2011). As of 2011, scamps are not considered to be over fished or subjected to over-fishing (Rocha 2008). However, little knowledge of the species' stock assessment, accompanied by hermaphrodites' susceptibility to sex ratio unbalance from fishing pressures, could easily lead to incorrect management of the grouper (Lombardi et al 2012).

In order to learn more about scamp grouper populations, specifically in the Gulf of Mexico, and how they correlate in terms of growth, a previous study was undertaken to compare scamp fork-lengths, ages, size-at-ages and band incre-

ments from scamp landed in 2008 from shrimp grids 4-6 in West Florida and grids 14-16 in Louisiana. While fork-lengths are acquired strictly through measuring the scamp, ages and measuring distances between band increments entails the use of scamp otoliths. The otolith is a bone located in the eardrum of most bony fish that assists hearing by reverberating sound underwater to allow the fish to detect directions of nearby activity (Jearld 1982). Otoliths present rings similar to that of a tree and can be counted to determine the age of the scamp. The distances between the core-to-bands 1-4 also gives insight into the growth rates of the separate populations, given a longer distance from core-to-band 1 in a scamp grouper caught off the coast of Louisiana than a scamp grouper caught near West Florida warrants a faster rate of growth. The year 2008 was selected simply because it provided the largest amount of samples collected by commercial hand line methods with the required age minimum of 4 years and enough samples considered to either be good or readable in band formation.

To further expound on recent scamp grouper population analysis, this study was undertaken to seek further support or denial of growth rate comparisons of scamp caught in the Gulf of Mexico for 2008. Previous research specified to this year indicate that there is a significant difference between fork-lengths and ages for spatially spaced grouper, yielding scamp grouper caught near Louisiana (grids 14-16) to be longer and older than those caught near West Florida (grids 4-6). No significant difference between growth in size-at-age and band increments in otoliths indicate that scamp grouper caught off the coast of Louisiana did not grow at a faster rate than those caught near West Florida. These results support the theory that over-fishing may be occurring in West Florida for the year 2008.

The information gathered and analyzed from 2008 was used to further investigate scamp grouper populations to determine if the catches in 2008 were representative of a much larger trend in grouper fisheries. This continuation study is restricted to a comparison of only fork-lengths from year to year due to a limited amount of ages for each sample. Conclusively, size-at-age contrasts cannot be sufficiently addressed and therefore complete growth assessment is exempt from this study (except for 2008). My hypothesis was this trend of larger scamp grouper size-classes in Louisiana was true over a much longer time period. These regional comparisons between previous scamp populations will aid in future assessments of the grouper in the Gulf of Mexico.

Materials and Methods

2008 Analysis

Data Collection

Scamp samples (378) were randomly selected from the NOAA database with regards as to what regions the fish were harvested in 2008. Scamps were either caught in shrimp grids 4-6 off the West coast of Florida or 14-16 off the coast of Louisiana. All fish were caught by the

NOAA TIP program and captured by commercial hand line methods. FL were recorded (mm) and otoliths were removed in the field by portside samplers. Biologists at the NOAA Panama City Laboratory previously completed an analysis of aging. Ages used for size-at-age comparison (9-13) were chosen because they provided a sample size larger than 10, giving less variability in differences.

Statistical analysis was used for each comparison to verify significant differences between values and means from the different populations. A student t-test was chosen for this purpose with a $p < 0.05$. This measurement of comparison was used to either accept or reject the null hypothesis that there would be no difference between scamp grouper caught near West Florida and those caught near Louisiana in the Gulf of Mexico.

Decadal Analysis

Data Collection

Scamp grouper fork-lengths (FL) were obtained from the National Oceanic and Air Administration (NOAA) database with regards to what regions the fish were harvested in dating from 2000 to 2010. Scamps were either caught in shrimp grids 4-6 off the West coast of Florida or 14-16 off the coast of Louisiana. All fish were caught by the NOAA TIP program and captured by commercial hand line methods. Fork-lengths (mm) were recorded by portside samplers and sample sizes for each year were randomly selected based on presence of fork-lengths for both state catches. Fork-length comparisons were calculated using statistical software packages within Microsoft Excel 2013.

Years with Respective Sample Sizes		
Year	Sample Size	Random Sampling
2000	*	
2001	12	Y
2002	200	
2003	262	
2004	*	
2005	23	Y
2006	39	Y
2007	284	
2008	378	
2009	476	
2010	80	Y

Table 1. Categorization of years over a decadal time period. Sample sizes marked with * signify a lack of substantial numbers to compare between the two populations. Rows labeled with a Y insinuate disproportionate sample sizes which could only be further analyzed with random sampling.

Statistical analyses were used for each comparison to determine significant differences between values and means from the different populations of scamp grouper caught in both Florida and Louisiana. A student t-tests and random sampling of the datasets were used for this purpose with a determination of significance at the α level $p\text{-value} < 0.05$. This determination of the comparisons were used to either accept or reject the null hypothesis that there would be no significant differences between the fork-lengths of scamp grouper caught near West Florida and those caught near Louisiana in the Gulf of Mexico.

Results

2008 Analysis

A statistical analysis using a student's t-test indicated a statistically significant difference in fork-lengths (mm) between scamp grouper caught off the coast of West Florida and those caught near Louisiana in 2008 ($t\text{-stat} = 4.11$, $d.f. = 289$, $p < 0.05$). Based on these samples, scamp grouper caught in Louisiana indicated that they were much larger than those caught near West Florida (Figure 3).

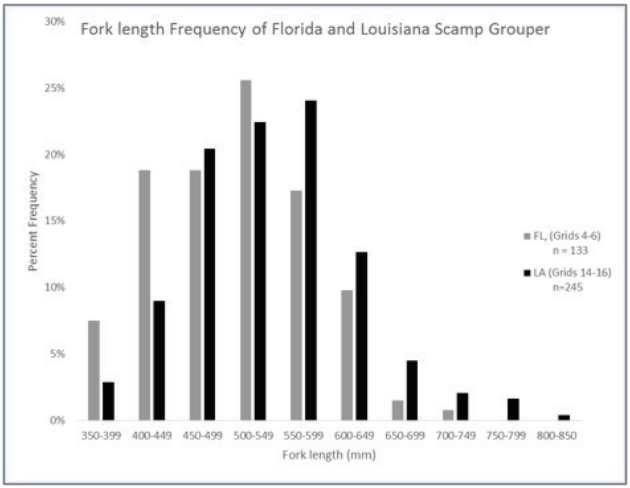

Figure 3. Fork-length (mm) frequency comparison between scamp grouper caught off the coast of West Florida and those caught near Louisiana in 2008.

A comparison of ages was also performed between the different scamp grouper populations showing that there was a notable difference in fork lengths (student's t-test, *t-stat* = 5.12, *d.f.*=288, $p < 0.05$). Scamp grouper caught off the coast of Louisiana seemed to not only be longer but also much older (Figure 4).

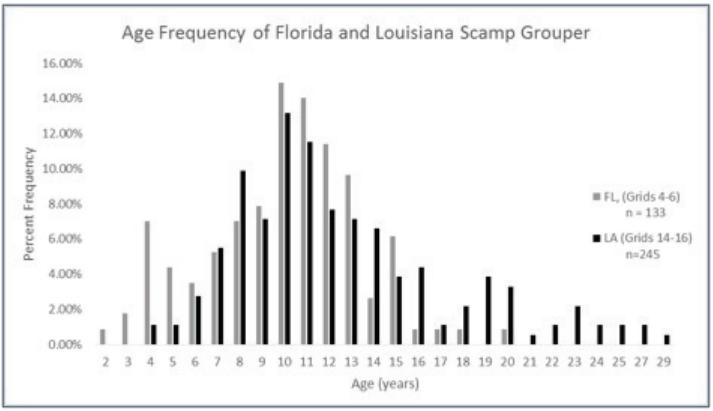

Figure (4). Age frequency comparison between scamp grouper caught near West Florida and those caught off the coast of Louisiana in 2008.

Size-at-age was also observed to investigate possible differences in growth rates between the spatially separated scamp groupers at ages 9-13. A student's t-test shows that their size-at-ages are initially identical with no substantial differences 1) Age 9: (*t-stat* = 0.624, *d.f.* = 15, $p > 0.05$) 2) Age 10: (*t-stat* = 1.719,

d.f. = 36, $p > 0.05$) 3) Age 11: *(t-stat* = 0.336, *d.f.* = 35, $p > 0.05$) 4) Age 12: (*t-stat* = 0.159, *d.f.* = 19, $p > 0.05$) 5) Age 13: *(t-stat* = 0.813, *d.f.* = 16, $p > 0.05$) (Figure 5). To further investigate growth rates, a comparison of band increments (µm) between scamp grouper caught near West Florida and those caught near Louisiana from the sub-sample set (49) was completed showing insignificant differences of distances from core-to-bands 1-4 (Figure 6).

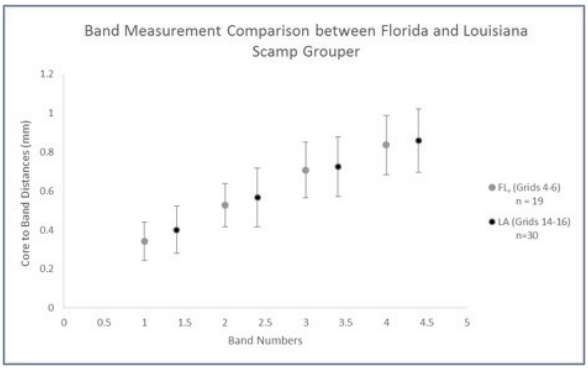

Figure 6. Band measurement comparison between scamp grouper caught near West Florida and those caught near Louisiana in 2008. This sub sample set collected from the originally provided data (n = 378) and was selected based on readability requirements (good or readable) and required a minimum age of 4. Core-to-band distances (µm) per band number were recorded and compared.

Decadal Analysis

In addition to the 2008 analysis, I performed another statistical analysis which used multiple student's t-tests and that indicated differences in fork-lengths (mm) between scamp grouper caught near West Florida and Louisiana for the following years: 2002 (t-stat = 2.07, d.f. = 17, p = 0.05), 2003 (*t-stat* = 5.72, *d.f.* = 89, $p < 0.05$), 2007 (*t-stat* = 5.32, *d.f.* = 259, $p < 0.05$), and 2009 (*t-stat* = 3.20, *d.f.* = 144, $p < 0.05$). Based on these samples along with the in-depth fork-length and age comparisons in 2008 (*t-stat* = 4.11, *d.f.* = 289, $p < 0.05$); scamp grouper caught near Louisiana not only are larger than those caught near West Florida in 2008, our data indicate this trend was true for a majority decade (Figure 10).

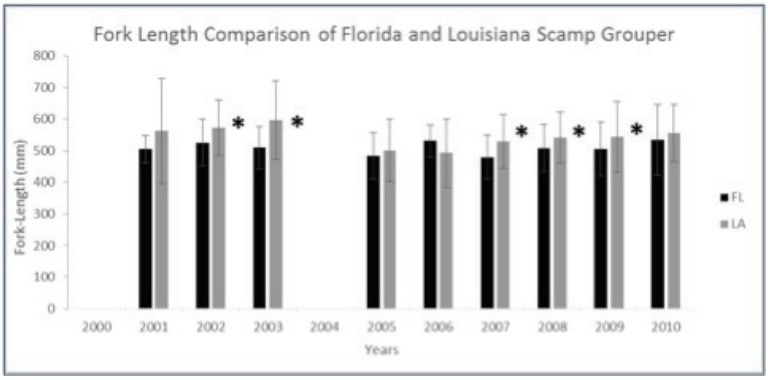

Figure 10. Comparison of fork-lengths between scamp grouper caught near West Florida and those caught near Louisiana over the period of a decade (2000-2010). Years marked with * are significantly different in terms of fork-length.

Discussion

2008 Analysis

The analysis of the comparisons between fork-lengths between scamp grouper caught in West Florida and caught off the coast of Louisiana, this species tended to be much longer west of the Gulf of Mexico. A visual analysis of Figure 3 showed that scamp grouper caught off the coast of West Florida had shorter fork-lengths (mm) and are more to the left in Figure 3, and rarely extended into the higher ranges (750 – 850 mm) of fork-lengths like scamp grouper caught near Louisiana. The same visual analysis appears in the age frequency graph shown in Figure 4 as scamp grouper caught in West Florida are found farther to the left, which indicate much younger fish compared to the older ages (21-29 years) found in the Louisiana population.

Size-at-age comparisons were presented by means of each age (9-13) being a certain size when landed in 2008 (Figure 5). Error bars provide visual discrepancies between each sample set, and in this case exhibit no distinct differences in size-at-age. The ages 10 and 13 looked slightly different from one another, and the student's t-test confirmed that no statistical difference was present between the ages, but in terms of which ages showed any variance, these two showed more separation than 9,11 and 12. The same procedure was used to show differences between band increments. A similar pattern was shown here, with little variation in mean and error bar placement at each band (1-4) and indicated no significant difference in growth rates (Figure 6).

The results from this study indicated that scamp grouper found off the coast of Louisiana were much longer and older compared to scamp grouper caught off the coast of West Florida, however, the two populations' growth rates were not significantly different based on size-at-age and band increment comparisons. According to this information, an assumption was made that there must be are other factors involved in affecting length and age outcome besides a difference in growth rates. Scamp grouper caught near Louisiana, although older and longer, were not growing as fast as the scamp grouper caught near West Florida. Two reasons were considered for these results, one could be a lack of size variability in random sampling. Although the Louisiana fishery resulted in longer and older fish, this may not accurately reflect the vast majority of scamp

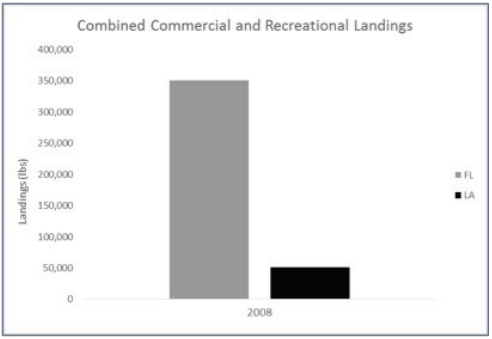

Figure 7. Combined commercial and recreational landings (lbs) for scamp grouper in 2008.

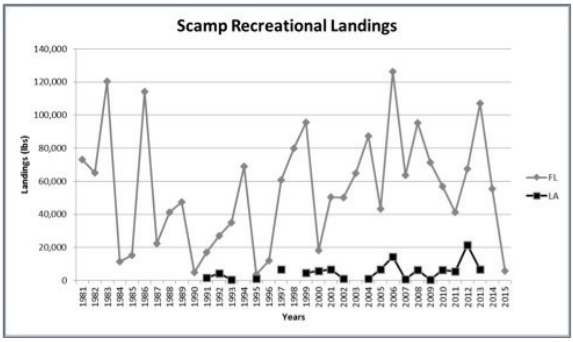

Figure 8. Scamp grouper commercial landings (lbs) over time from 1985 to 2013. Consistency in higher landings appear in West Florida as the blue line recedes no further than 150,000 lbs and extends to 300,000 lbs. Louisiana landings stay within 50,000 – 100,000 lbs.

grouper in this area as opposed to West Florida's smaller and younger scamp grouper population. The difference could be due to selectivity towards longer and older scamp grouper further west in the Gulf of Mexico. Another possible explanation of this study's results may be an imbalance in fishing pressures.

Investigation in total landings (lbs) for scamp grouper caught commercially and recreationally in the two regions for 2008 was taken into consideration. Both investigations showed a significant visual difference in amount of landings, which indicates that much more scamp grouper were caught east of the Gulf of Mexico (Figure 7). To further investigate this phenomenon, I performed more general inquiries on scamp grouper landings in the two regions, but this time I extended the time series from the earliest years available to the most recent (commercial 1985-2013; recreational 1981-2015). The differences in landings (lbs) were continuous, indicating that scamp grouper caught near West Florida face far heavier fishing pressures/effort than Louisiana (Figures 7 and 8). According to a NOAA study assessing scamp grouper in the Gulf of Mexico, the majority of scamp groupers are landed commercially, with only 12% being landed by recreational fishers and most (76%) of those are caught in Florida waters (Lombardi et al 2012). Heavier fishing pressures may explain why scamp grouper caught in West Florida are shorter in length and younger as they are unable to reach these sizes before fishing mortality impacts their populations.

Another factor that may have affected results from this study was an unequal sample size. The scamp grouper caught in Louisiana samples (n = 245) were disproportionate to West Florida's (n = 133). A future study with more equal sample sets to work with would help to ensure that numbers did not play a role in impacting the results. A second influential factor could be choice in gear selectivity. Most scamp groupers are caught by hand line methods; however a categorical isolation of data provided by other fishing methods may or may not yield similar results (Manooch 239). Future studies that could take place to further knowledge acquired by these reported results include: comparing fishery-independent research on regional scamp grouper in 2008, investigating size-at-age and band increments for scamp grouper in other years, and researching differences in habitats present between these two regions.

Since scamp grouper caught off the coast of Louisiana seem to be longer and older in this study for this sample set, it may be highly possible that Louisiana fisheries and recreational fishermen target longer and older scamp grouper while West Florida fishermen and fisheries collect a broader range of sizes. Comparing fishery-independent data that targets a specific age and length group per state waters may provide more clarity on whether or not these trends still apply outside of Louisiana possibly being exclusive to landing longer and older scamp grouper (Bullock, NOAA Intern Project on Scamp Grouper).

A consideration of benefits or drawbacks in either Louisiana and or West Florida habitats may affect the longevity of the populations' survival rates to reaching

older ages. Louisiana offers habitat in the form of oil rigs acting as artificial reefs for scamp grouper and other marine invertebrates (Bullock 143). West Florida provides high-relief rocky bottom habitat and other types of reef areas (Bullock 143). Perhaps scamp grouper near Louisiana thrive in oil rig environments, or perhaps fishing regulations in amongst these artificial reefs are different than those found in West Florida.

Decadal Analysis

Investigating the difference in fork-lengths in the span of a decade yield similar results to the 2008 spatial comparison, scamp grouper caught near Louisiana have longer fork-lengths than those landed off the coast of West Florida. Not including data from 2000 and 2004 due to insufficient sample sizes, five years reflect this general trend (Figure 10). Although growth comparisons were not considered to fully support this general trend, an indication of fork-length variance still suggests that some factors are contributing to the presence of scamp grouper off the coast of Louisiana. As mentioned previously, scamp grouper populations in West Florida face far heavier fishing pressures than Louisiana, which may consequently be affecting the range in sizes between regions. Possible reasons as to why fishing pressures between the two regions are significantly different could be a result from a variety of habitat differences off the coast of West Florida and Louisiana.

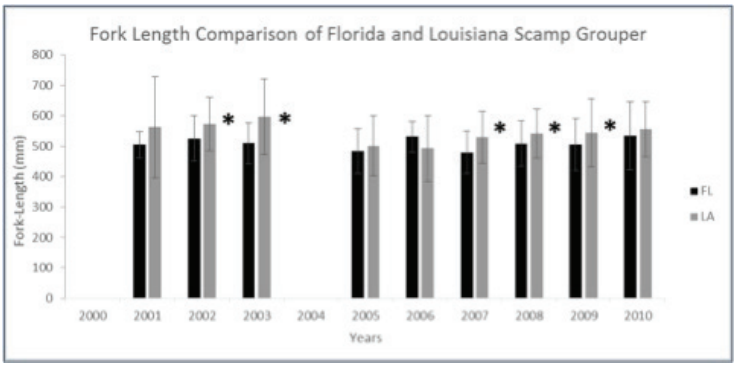

Figure 10. Comparison of fork-lengths between scamp grouper caught near West Florida and those caught near Louisiana over the period of a decade (2000-2010). Years marked with * are significantly different in terms of fork-length.

A study conducted on scamp grouper and other members of the grouper family connects the importance of habitat preference of a species to the preservation of congregation sites that they show selectivity towards (Coleman 2011). Results from this study, and others, suggest that scamp grouper aggregate towards high relief rocky bottom shelf edges, which incidentally support a majority of reef formations off the West coast of Florida (Coleman 2011). As previously mentioned, scamp grouper caught near West Florida have been continuously over-fished in comparison to scamp grouper caught off the coast of Louisiana for over a period of thirty years in both commercial and recreational landings (Figure 8, 9). The susceptibility of certain portions of scamp grouper populations to be caught disproportionately can become alarming as "activity of fishing on spawning sites is notoriously unsustainable because fish are vulnerable to capture due to their aggregating behaviors and strong site fidelity" (Coleman 2011). Since this species tends to gather in high relief areas and do not migrate to other locations regularly, continuous and hefty withdrawal of scamp grouper from the same reef and bank areas could initially cause imbalance in the age-structure of the population as the window of recovery time between catches does not allot for numbers to build up again or for the fish to grow longer and older (Manooch 1991).

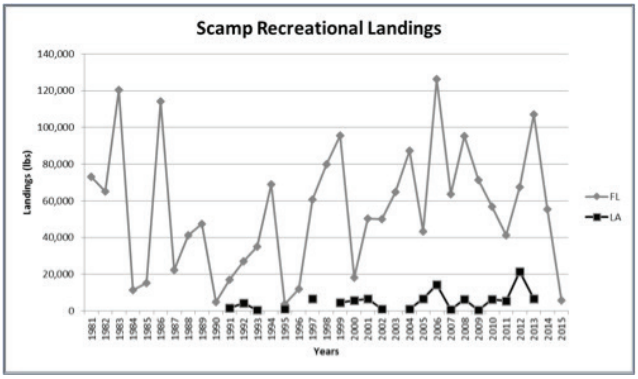

Figure 9. Scamp grouper commercial landings (lbs) overtime from 1981 – 2015. Louisiana landings (red line) are inconsistent and do not exceed 30,000 lbs. West Florida landings are continuous and range in higher numbers (130,000 lbs).

Another critical observation that may be damaging towards West Florida shelf habitat is the effect of trawling and dredging on seafloor habitat. Although all scamp grouper in this study were caught by commercial hand line methods, destruction of their rocky bottom habitat can occur due to bottom trawling and use of other similar mobile gear (National Research Council 2002). According to a study, the frequency of fishing disturbance is much higher for communities in

rocky high relief habitat. These areas are deeper than higher sediment sections that endure frequent movement and turbulence and adapt to the disruptive atmosphere (National Research Council 2002). The effect of damaging these reef formations can therefore be more detrimental and in return could disrupt the surrounding ecosystem and species that rely on the sites for congregation such as the scamp grouper. This chain of reactions is less direct in affecting the population than selective fishing for scamp grouper, however it is just as important in preservation of spawning sites.

An extended analysis of just West Florida near-shore habitats provides several possibilities for the results found in this study, however another interesting explanation could lead to differences between the state waters themselves. Louisiana nearshore habitat is similar in bathymetry to the eastern most part of the Gulf of Mexico, yet it differs tremendously in oil rig abundance compared to the West Florida shelf. Reef surveys conducted by NOAA Fisheries show that from 2001 to 2010 (exempting 2004) scamp grouper sightings were numerous in Louisiana and were particularly frequent around oil rigs (Campbell 2016) (Figure 11). Reasoning as to why this clustering of scamp grouper is so apparent west of the Gulf of Mexico is most likely due to site fidelity based on protection that oil rig communities can provide. Fishing in areas such as those heavily populated with oil rig platforms can become more challenging, leaving scamp grouper and other marine invertebrates places to thrive with a lower catch rate (Bullock 1991). Further studies may be able to show further connections as to why habitat surrounding and growing on oil rigs may show more favorable conditions for scamp grouper rather than rocky bottom relief areas that may be at risk to over-fishing off the coast of Florida.

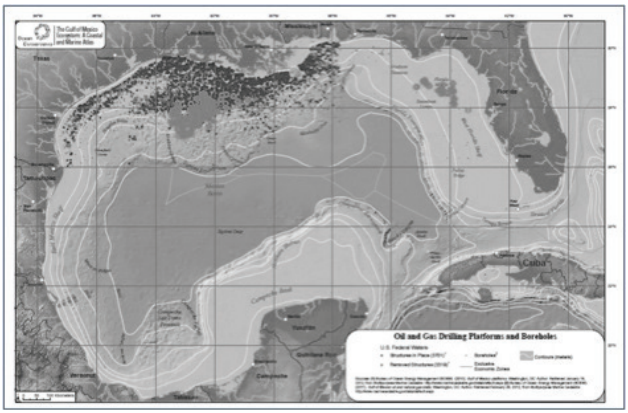

Figure 11. Atlas map of Gulf of Mexico platforms and oil and natural gas wells. Edit to the map shows locations of scamp grouper sighted from 2001 – 2010 (exempting 2004). These points do not represent the number of scamp grouper in each area, but only where they were seen.

Conclusion

The purpose of building upon previous data and conclusions that I had accomplished previously was to further investigate whether or not my initial conclusions were true over the past decade. The conclusion that the trend of scamp grouper found off the coast of Louisiana being significantly longer than scamp grouper caught off the coast of West Florida. Some things that may have affected the results in this study were unbalanced sample sizes and the lack of a complete growth analysis for each of the samples. Due to widely varying sample sizes for six out

of eleven years, four years had to be subsampled and randomly sampled and two years had to be dismissed from the analysis altogether. The other years had enough samples to be fully investigated, however, more conclusive results could have been drawn if each of the years could have been equally represented. Also, due to lack of age data in the decadal analysis I could only investigate the scamp grouper caught near Louisiana were longer than those caught near West Florida. I could not assume that in addition to these results that their ages were significantly different or that their growth rates were significantly different to 2008.

It may be of interest for future studies to include previous data from before 2000 or to study other regions of the Gulf of Mexico to see if this trend is similar or different. The data that I was able to provide from NOAA Fisheries was important in understanding how we affect the ocean and its inhabitants and to what extent we as humans can affect them. Scamp grouper status in the Gulf of Mexico has not been fully evaluated in several years, however the species' hermaphroditic life history lend it to being much more susceptible to threats more so than non-hermaphroditic fish. This study as well as future studies in the area may be able to give researchers more insight as to how the species are doing in the Gulf of Mexico and if further precautions must be made in fishing limitations or if there could be a shift in guidelines in the near future.

Literature Cited

Bullock, Lewis, and Gregor Y Smith. "Mycteroperca Phenax Jordan and Swain, 1885 Scamp." Memoirs of the Hourglass Cruises. 2nd ed. Vol. VIII. St. Petersburg: Florida Marine Research Institute Department of Natural Resources, 1991. 144-146. Print

Bullock, Lew. "NOAA Intern Project on Scamp Grouper." E-mail interview. 27 July 2015

Campbell, Matthew. "Scamp Project." E-mail interview. 23 March 2016

Coleman, Felicia C., Kathryn M. Scanlon, and Christopher C. Koenig. "Groupers On The Edge: Shelf Edge Spawning Habitat In And Around Marine Reserves Of The Northeastern Gulf

Of Mexico*." Professional Geographer 63.4 (2011): 456-474. Science & Technology Collection. Web. 2 Mar. 2016.

Jearld, Ambrose, Jr. "Age Determination." NOAA Fisheries Service. National Marine Fisheries Service, 10 Dec. 1982. Web. 12 Apr. 2016.

Lombardi, Linda, Melissa Cook, Hope Lyon, Beverly Barnett, and Lew Bullock. "A Description of Age, Growth, and Reproductive Life History Traits of Scamps from the Northern Gulf of Mexico." (2012): 129,130,136,138. Web. 20 July 2015

Lombardi, L., Cook, M., Lyon, H., Barnett, B., & Bullock, L. (2011). Decadal fluctuations in life history parameters of scamp (Mycteroperca phenax) collected by commercial hand-line vessels from the west coast of Florida. 2-15. Retrieved July 21, 2015, from National Marine Fisheries Service

Manooch, C. (1991). Scamp. In Fishes of the Southeastern United States(Vol. 3, pp. 238-239). Raleigh, North Carolina: North Carolina State Museum of Natural History

National Research Council, (U.S.). Effects Of Trawling And Dredging On Seafloor Habitat. Washington, D.C.: National Academies Press, 2002. eBook Collection (EBSCOhost). Web. 19 Apr. 2016.

Provost, Mikaela. "Understanding Sex Change in Exploited Fish Populations: A Review of East Coast Fish Stocks and Assesment of Selectivity and Sex Change in Black Sea Bass (Centropristis Striata) in New Jersey." (2013): 4-5. Web. 20 July 2015

Rocha, L., McGovern, J.C., Craig, M.T., Choat, J.H., Ferreira, B., Bertoncini, A.A. & Craig, M. 2008. Mycteroperca phenax. The IUCN Red List of Threatened Species. Version 2015.2. Web. 20 July 2015

Zatcoff, M., Ball, A., & Sedberry, G. (2003). Population genetic analysis of red grouper, Epinephelus morio, and scamp, Mycteroperca phenax, from the southeastern U.S. Atlantic and Gulf of Mexico. Marine Biology,144, 769-770. doi:10.1007/s00227-003-1236-z Landings data provided by: http://www.st.nmfs.noaa.gov/index Oil Rig Map provided by: https://coast.noaa.gov/digitalcoast/stories/ecosystem-restoration