

Standing, Reef Fish, Socioeconomic, Shrimp, and Ecosystem SSC
Meeting Summary
September 27 – 28, 2023

Review of Gag Grouper Abundance, Movement, Spawning Behavior, Discard Mortality, and Environmental Influences

Reproductive resilience in the protogynous gag grouper: Dr. Sue Lowerre-Barbieri

Dr. Lowerre-Barbieri, from the Florida Fish and Wildlife Research Institute (FWRI), discussed the reproductive resilience paradigm (RRP), with reproductive resilience defined as the capacity of a population to maintain the reproductive success needed to result in long-term population stability despite disturbances such as climate change and fishing. Fish can display widely varied reproductive strategies, and often there is little discernible relationship between recruitment and adult abundance. Dr. Lowerre-Barbieri added that movement and reproductive strategies in marine fish are linked, and current conceptual models of life history do not capture this because they do not integrate movement. Specific to gag, which are protogynous hermaphrodites (beginning life as female and transitioning to male at larger sizes/older ages), mature individuals only coexist in spawning grounds. Because nursery areas do not overlap, females must undergo ontogenetic habitat shifts to the spawning grounds. Dr. Lowerre-Barbieri reviewed past research relevant to gag prior to 2015, before further characterizing her research.

Dr. Lowerre-Barbieri discussed two studies on gag reproductive potential, which included sampling inside and out of marine protected areas (MPAs) in the northeastern Gulf. The main points covered were: spatial ecology and sex ratios; factors affecting male recruitment; and, sex change, movement, catchability, and connectivity. Dr. Lowerre-Barbieri reviewed a conceptual model showing the gag life cycle, and identified the hypotheses tested relevant to that model. Testing of the first hypothesis, that gag exhibit sex-specific habitat use, showed that males are only really present in waters deeper than 50 meters, with all gag shallower than that only found to be female. Testing the next hypothesis, that gag only spawn north of 28-degrees north latitude, showed that gag do in fact spawn south of that line of latitude, as shown in gag collected from the Sticky Grounds due west of Tampa Bay and Anna Maria Island. When testing whether females exhibit spawning migrations, but males do not, Dr. Lowerre-Barbieri's team found that mean depth at capture differed significantly with gonadal development and age for females, but not males, and that skipped spawning was common in both studies (32%-41% of the time). Dr. Lowerre-Barbieri said that gonad histology is needed to assign sex, and that pigmentation alone is not always reliable. She added that female recruitment to the spawning population will affect sex ratios, both when there is a strong year class and if there is skip spawning and variable participation in any spawning migrations in any given year.

Dr. Lowerre-Barbieri discussed testing sex ratios, which Heppell et al. (2006) had predicted would return to 15% male in MPAs, and which she found did not exhibit such high male sex ratios (just under 5% male in Madison-Swanson and Steamboat Lumps). Outside the MPAs, in The Edges (a seasonally closed area, closed annually from January - April), no males were

captured in the spawning season, and 6.3% males were found in the Sticky Grounds. When testing whether the age at which 50% of individuals will be males (A50), the A50 was found to be older when including the MPAs versus excluding them. Dr. Lowerre-Barbieri's team also found that gag sex-specific size distributions do not overlap nearly as much as other groupers like red grouper; males are exclusively found in the upper portion of the length composition. Also, there does not seem to be the same sort of triggers for sex change for gag as would be expected from red grouper (i.e., if no males are present, the largest female red grouper may change sex to male). When discussing whether gag's mating strategy may be to form spawning aggregations, Dr. Lowerre-Barbieri said that no large-scale aggregations (e.g., four-fold increases in abundance) were consistently observed as they have been for other groupers that aggregate like Nassau grouper. However, she did show one video in which over 40 gag were observed aggregated in April 2023 in Steamboat Lumps. With regard to gag hermaphroditism and testing whether sex change occurs primarily over the spawning grounds, Dr. Lowerre-Barbieri stated that sex change in shallow water was as or more common than on the spawning grounds, but noted the small sample size for these data. She added that males are not needed to spurn sex change, and that sex ratio is not the main driver in gag hermaphroditism. Further, size and age of gag sex change appears dependent on the relative size of others in the social group, with shallow-water transitionals being younger and smaller than those in deeper waters.

Dr. Lowerre-Barbieri next discussed whether fishing effort increases in the fall when temperatures decline, which showed high fishing effort from November through January. The majority of recreational fishing trips sampled occurred in waters less than 50 meters, with 21 – 27% of gag caught in waters shallower than 20 meters during November – January versus the rest of the year, including the February – April spawning season. Dr. Lowerre-Barbieri's ongoing research is sampling estuarine, nearshore, and offshore habitats using remotely operated vehicles to assess seasonal density of gag during different seasons, and dart and acoustic tags to assess movement. Tags will help assess the fate of gag tagged and release in nearshore waters. Dr. Lowerre-Barbieri also noted that analysis of maturity and transitionals sampled in shallow water is on-going. Looking forward, Dr. Lowerre-Barbieri aims to develop best practices for protogynous species.

An SSC member recalled that only 22 transitionals were found in the completed work, and that it was difficult to determine seasonality of transition. Dr. Lowerre-Barbieri added that transition is possible in shallow waters, thus providing evidence against the idea that transition only occurs in spawning grounds. The SSC member also recalled that the Sticky Grounds showed a sex ratio of 6.3% male, which was higher than both MPAs (Madison-Swanson and Steamboat Lumps, but just less than 5% male), and the seasonally closed area (The Edges, 0% male).

Another SSC member discussed how to best inform the stock assessment modeling setup for gag, and how to best inform recommendations to the Council. They thought it could be useful to time block the recruitment parameters in Stock Synthesis (SS), and to fix the gender component within SS as well. If spawners are skipping spawning, that may affect the perceptions of reproductive output and success. Dr. Lowerre-Barbieri said that year class strength is usually examined, which is not always an indicator of long-term reproductive success, and said that was part of the rethinking of the RRP. The SSC member then recalled that transition to male does not seem to occur until after a gag is at least 10 years old; and thus, how rebuilding should be

structured was of concern. Dr. Lowerre-Barbieri replied that there is a balance to be achieved between rebuilding quickly and allowing fishing mortality during rebuilding.

An SSC member asked which critical life history facet is not being captured by the stock assessment process. Dr. Lowerre-Barbieri replied that sex ratios must be examined to determine whether there is in fact a sperm limitation. How reproductive success is assessed when a fish is overfished versus rebuilt may be very different. For gag, there may be considerable female biomass before the male sex ratio appreciably improves. Dr. Lowerre-Barbieri added that if there really are so few males, answering whether it was most important to protect the current male population or recruitment to the male population was necessary. Either way, she stated that the current sex ratio of 2% was undeniably too low.

Dr. Tom Frazer (Gulf Council member) asked whether the current sex ratio was an artifact of decades of fishing pressure. He noted photos of past harvests of very large, visually characteristically male, gag, and wondered whether sustained fishing pressure has altered the spatial distribution of gag by sex. Dr. Lowerre-Barbieri replied that there is still much to learn about the sex-specific spatial distribution of male gag. She added that all immature gag are female, all gag in shallow water are females (immature and mature), and that no males have been found in waters shallower than 50 meters. She thought it unlikely that males would be, or would have been, present in nearshore waters prior to the historic increase in fishing pressure. Dr. Frazer asked about the demonstration of a threshold for sex change based on size or age alone. Dr. Lowerre-Barbieri replied that she thought there was much more to what drives sex change in gag than just size or age.

An SSC member thought the historical sex ratios discussed at the beginning of the presentation were less relevant due to differences in sampling strategies, and added that some prior historical work identified sex ratios not dissimilar from those observed today (5-6%). The SSC member also recalled past stock assessments that showed much improved historical recruitment, despite then low sex ratios comparable to today's ratios. The SSC member asked about the potential contamination of gag reproductive organs, perhaps from anthropogenic forces like the *Deepwater Horizon* oil spill, and whether any work had been done on that topic. Dr. Lowerre-Barbieri replied that future work would be examining oceanographic conditions and their potential linkage to sex ratio, movement, catchability, and connectivity. She postulated that a higher proportion of males may be possible if those males are just not being recovered by the fisheries or by fishery-independent sampling. Dr. Lowerre-Barbieri replied that while an oil spill effect may be temporally present, it has not been explicitly detected. She added that her team has observed gag with less healthy gonads, and females with "plugs", whereby the mature female abruptly halts spawning activity due to stress, perhaps including due to being caught by fishing, and may not be able to spawn again for the rest of that spawning season. She did not think it likely that males would undergo the same response to such stress. Dr. Lowerre-Barbieri added that looking at sperm and egg quality would be interesting to examine for gag.

Effects of Recreational Catch and Release Angling on the Survival of Gag, and Gear and Strategies Designed to Reduce Barotrauma: Dr. Angela Collins

Dr. Angela Collins (Florida Sea Grant) presented on research examining survivorship of gag grouper captured using recreational fishing catch and release methods. The three-year study focused on offshore areas of Tampa Bay, Florida where 90 fish, ranging from 17-32 inches total length, were acoustically tagged. Study results indicated low observed release mortality (<10%) in water depths less than 40 meters, provided evidence of high site fidelity, and illustrated that both barotrauma mitigation release measures (venting or descending devices) resulted in favorable survivorship outcomes when properly applied.

An SSC member asked Dr. Collins about any stakeholder responses to the study results. She replied that most feedback she had received had been favorable. She continued that, while the study results may be expected, empirically documenting how on-the-water practices affect fishing mortality estimates is important and that stakeholders are crucial for helping to understand these linkages. The SSC inquired about the handling time of the study fish. Dr. Collins stated that the handling time was as quick as practicable and that fish were acoustically tagged externally to reduce deck time, which is more reflective of handling on a typical recreational trip than a surgical implementation tagging technique.

An SSC member remarked that nearly all the acute release mortality appeared to be observed within 48 hours. Dr. Collins agreed and continued that an increase in sample size and study duration would help tease apart better some of the possible contributing factors to acute release mortality (i.e., time of year, water temperature, habitat type, water depth, etc.). She also stated that there is an observed increase in release mortality in the summer relative to the cooler temperature months. She has observed that experienced recreational anglers who have been trained to release fish quickly (especially during the summer) and properly vent or descend fish can influence the probability of survivorship of released gag grouper. She suggested that outreach and education approaches may be an effective management tool to mitigate release mortality for gag grouper.

Age-specific Mortality of Gag from Red Tide on the West Florida Shelf: Dr. David Chagaris

Dr. Chagaris (UF) presented an update to his red tide modeling and ecosystem work on gag. Since 2021, a red tide event was recorded in that year coinciding with the Piney Point nutrient-laden water inflow. Following in 2022, a red tide bloom formed following Hurricane Ian off Lee County, and lingered through March 2023 and was largely constrained to nearshore waters. No further red tide has been detected since March 2023. Dr. Chagaris updated the West Florida Shelf (WFS) ecosystem model with these new mortality events, and demonstrated the predicted mortality of age-0 through age-6 gag from 2005 to 2022. Mortality is predicted to be highest on younger fish (i.e., age-0).

Dr. Chagaris discussed future efforts to evaluate alternative spatial extrapolation approaches for mapping red tide. This work is expected to improve mapping and inclusion of effects of red tide into the WFS ecosystem model. Dr. Chagaris has also secured funding to operationalize the WFS Ecospace model, with the overall goal of accounting for red tide more align when assessing Gulf reef fish species and setting their acceptable biological catch (ABC) limits. Operationalizing the WFS model will require changing satellites to NOAA's Visible Infrared

Imager Radiometer Suite (VIIRS), incorporating oxygen and *Karenia brevis* dynamics into a physical biogeochemical model, updating and calibrating the WFS Ecospace model, and then operationalizing WFS for use in stock assessments and catch limit analysis. Dr. Chagaris intends to engage stakeholders to gather local knowledge to complement model predictions and serve as a reality check to model estimates and performance.

Discard Mortality of Gag on the West Florida Shelf: Ms. Beverly Sauls

Ms. Sauls (FWRI) presented trends in gag discard mortality. Florida funds two monitoring programs that capture recreational catch and effort data, including methods used for fish released, length composition, condition of the released fish, areas fished and habitat type. Complementing the regulations in the Gulf EEZ, the requirement to have a descending device rigged and ready was extended to Florida state waters in 2023. Fishery-dependent data suggest that anglers target reef fish on natural hardbottom and artificial reefs, with the highest effort occurring in state waters along the western peninsula. The majority of trips targeting gag took place on natural bottom with 90% of the total catch being regulatory discards. Gag grouper is vulnerable to fishing pressure throughout its entire life history. Juveniles are targeted by recreational catch and release practices on seagrass habitat; sub-adults are targeted in nearshore natural hardbottom by recreational anglers; and, adults are targeted offshore by the recreational and commercial sectors. Recreational gag landings and discards follow two peaks: one in the summer and another in the late fall. Data also suggest the majority of discards occur closer to shore.

The FWRI conducted a fishery-dependent discard mortality study from 2009-2012 to assess the condition of discards by the recreational fishery and estimate the survival rate of discarded gag. The study areas included the Florida Panhandle, the Big Bend area, Tampa Bay nearshore, and Tampa Bay offshore. The use of descending devices was rare and not observed during the study. The majority of tagged gag discards came from Tampa Bay nearshore and were released in good condition. The mean depths of capture ranged between 20 – 30 m. Fish caught offshore or around the Panhandle more frequently required venting. The study reports that gag released in good condition tended to be smaller and caught in shallower depths. Gag caught in deeper waters tended to be in fair to poor condition and were estimated to have a lesser rate of survival. Gag discard mortality in the hook and line fishery was estimated to be 15%. Discard mortality increased significantly with depth. For comparison, SEDAR 10 had estimated as high as a 40% discard mortality.

An SSC member asked if the study compared how many anglers had venting tools in lieu of, or in addition to, a descending device. Ms. Saul noted that the state survey captures those responses for both coasts of Florida, but that no analysis had been performed this time. Ms. Saul also commented about the summer and all recreational landings peaks. Anglers tend to target what is in season and what meets the minimum size limit- in the summer, being mostly red snapper and gag. Reef fish share similar habitat requirements, so it is expected that more than one species can be caught from a specific site on a single trip.

General Discussion

Dr. Frazer asked, in reference to commercial longline data, what proportion of those trips carry a reef fish observer, and do those observers collect biological data such as sex. An SSC member noted that the NMFS Reef Fish Observer Program coverage is very low, at about 1% of commercial reef trips annually. Dr. Lowerre-Barbieri replied that FWC does work with willing captains to sample gonads from gutted fish, along with animal-specific data about length and weight for each gonad sample. Dr. Frazer noted that some recent longline effort has been thought to be comprised of a higher proportion of males. Dr. Lowerre-Barbieri added that FWC would work with any fishermen willing to preserve gonads from gutted fish. An SSC member also noted a new study underway to examine fin clips from a suite of reef fish species to determine sex.