



This is a review and discussion of goliath grouper state and federal management history, an overview of recent public workshops, and stakeholder feedback. The presentation will cover goliath grouper life history, current research, and request for Commission direction on future goliath grouper management.

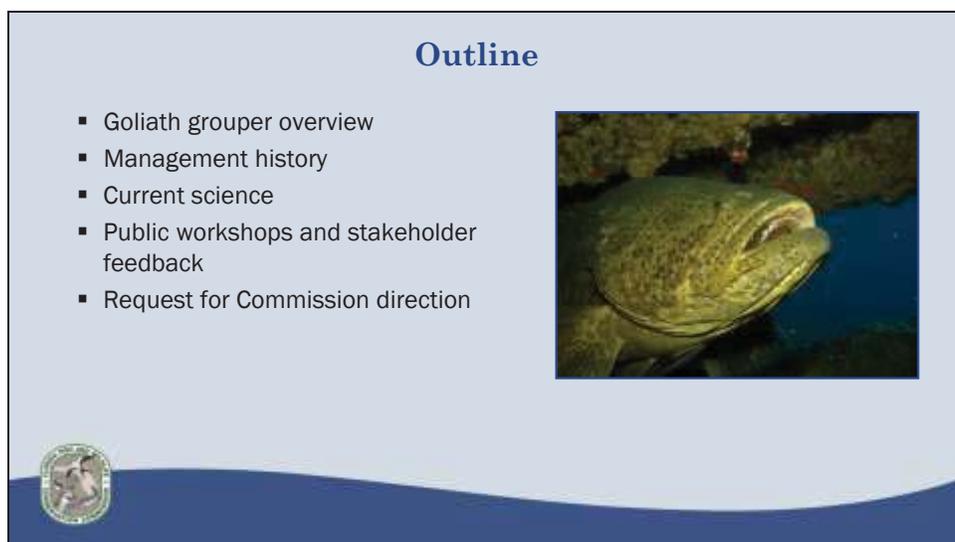
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Unless otherwise noted, images throughout the presentation are by FWC.



This is an outline for the presentation.

Overview

- Closed to harvest in state and federal waters since 1990 to address severe declines
- Recovering and becoming more abundant in areas of south Florida
- At February 2017 Commission meeting, staff presented information on goliath and 2016 stock assessment
 - Commissioners directed staff to gather public input on potential limited harvest

Today: Provide an update on stakeholder feedback and obtain direction on next steps



The goliath grouper fishery was closed in state and federal waters in 1990 to address severe decline in the fishery. There are a number of factors that contributed to this decline, such as their tendency to aggregate in the same areas where fishermen fish, declines in mangrove habitat used by juvenile goliath, and their long-lived nature.

Today, goliath is recovering and becoming more abundant in areas of south Florida. At the February 2017 Commission meeting, staff presented a review and discussion on a recent goliath stock assessment, life history, and an overview of potential management strategies. The Commissioners directed staff to gather public input on the possibility of a limited harvest in state waters for goliath.

We are returning today to provide an update on the stakeholder feedback and potential next steps.



Prior to 1983, there were no state or federal regulations regarding the harvest of goliath grouper. Although there were historical recreational and commercial fisheries for goliath, during the 1980s the fishery expanded quickly and the species became overfished. In response to the rapid growth of this fishery, several management actions were taken. In 1983, the South Atlantic Council prohibited the spearing of goliath in Atlantic federal waters. In 1985, the State of Florida implemented an 18-inch minimum size limit to protect juveniles. The next year, Florida established a five-fish grouper aggregate recreational bag limit which included goliath. In 1989, the Gulf Council implemented a minimum size limit of 50 inches in federal waters.

Ultimately, in 1990, both federal councils and the State of Florida prohibited harvest and possession of goliath because of concern that the stock was more severely depleted than previously thought. Because of the depleted status of goliath, the South Atlantic Council noted that, by 1990, goliath had greater value for non-consumptive purposes, like ecotourism, than consumptive value. Since 1990, some other governments throughout the species' range have followed suit and prohibited harvest. In 1991, NOAA Fisheries listed goliath grouper as a species of special concern. In 1994, goliath were listed as critically endangered on the International Union for the Conservation of Nature (IUCN), World Conservation Union's Red List of Threatened Species. The species has since been protected in Brazil (2002), Puerto Rico (2004), and the US Virgin Islands (2004). However, fisheries for goliath persist in other parts of the Caribbean (e.g., Honduras and Belize).

In 2006, in response to increasing goliath abundance in U.S. waters, NOAA Fisheries removed goliath from their Species of Special Concern list. However, the species continues to be considered "critically endangered" by the IUCN.

In 2011, the Councils requested NOAA Fisheries work with the FWC to determine how to move goliath beyond the moratorium. In order to complete this task, in 2013, the Councils formed the Joint Ad Hoc Council Goliath Grouper Committee to consider all the available data and determine if another stock assessment could be conducted. The Committee included FWC staff. After multiple meetings, the FWC agreed to take the lead on conducting a new stock assessment that would go through the federal Southeast Data Assessment Review (SEDAR) process. The Committee also discussed possible harvest scenarios and suggested that any harvest strategy be a coordinated approach in state and federal waters. Following the determination that the FWC would conduct a new assessment the Committee was dissolved.

In 2016, the federal assessment was completed and rejected by independent reviewers for use for federal management. When the councils received an update on the assessment they chose to take no action for goliath in federal waters. In 2017, FWC held 16 public workshops throughout Florida to gain stakeholder feedback on goliath management.

The next few slides will cover some of the known data we have on goliath.

Fishery Background

- Severe decline 1950s-1980s caused by a number of factors
 - Popular fishing target
 - High catchability
 - Declining juvenile habitats
 - Concentrations of goliath grouper occur in places where fishermen congregate
- Councils set a 50% SPR management goal
- Stock assessments conducted in 2004, 2010, and 2016
 - All assessments rejected for use in federal management



Source: Florida Keys Public Libraries

Prior to 1983, there were no regulatory measures related to the harvest and possession of goliath grouper. The fishery expanded quickly and dramatically through the 1980s, which required the introduction of conservation and management measures. There were a number of factors that contributed to the decline of goliath grouper, including their tendency to form large aggregations that could be easily targeted by fishers. Goliath decline through the 1980s coincided with loss and degradation of habitat, particularly inshore mangrove habitat for juveniles.

Because of the life history of goliath grouper and its decline, the federal councils set a very high management goal of 50% Spawning Potential Ratio (SPR) for the species. For reference, in Florida, snook and redfish have a 40% management goal.

There have been three attempted stock assessments for goliath grouper in 2004, 2010, and most recently in 2016. All of these assessments were rejected by their reviewers and thus unable to be used for federal management.

Goliath Distribution and Biology

- Historically ranged from Florida to Brazil and throughout the Gulf of Mexico and Caribbean
- Current distribution in U.S. concentrated in south Florida
- Uncommon to absent outside of south Florida much of the year
- Long-lived (37+ yrs)
- Sexual maturity between ages 3-6 yrs
- Spawning aggregations in south Florida from July to September
- Susceptible to large-scale mortality events like red tide and cold-weather kills
- Juveniles highly dependent on mangrove nursery habitat



Historically, goliath grouper were found throughout Florida and the Gulf of Mexico and Caribbean, with seasonal movement farther north up the Atlantic Coast.

Presently goliath are uncommon to absent in much of their historical range outside of south Florida.

The oldest goliath documented was killed in 1984 and was 37 years old. By that time, larger fish were very rare in the population. It is likely that goliath live longer than 37 years, perhaps significantly longer.

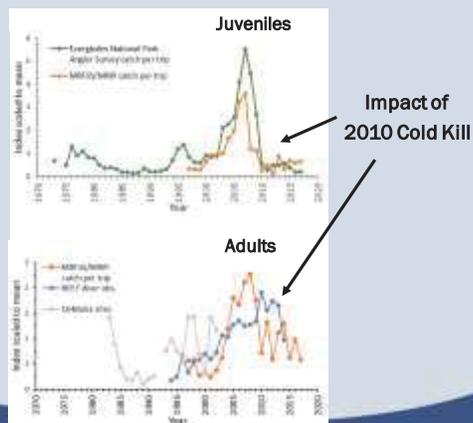
Many groupers are protogynous hermaphrodites, that is they begin life as females and some of them later switch to males. It is unknown at this time if these life history characteristics apply to goliath.

Like many fish species, goliath form spawning aggregations which can make them more vulnerable to fishing.

Goliath are particularly susceptible to large scale mortality events due to red tide and cold-weather. The severe cold weather in 2009-2010 resulted in the deaths of hundreds (perhaps thousands) of goliath grouper.

Are Goliath Recovered? What Abundance Indices Tell Us

- Not possible to evaluate stock status relative to 50% SPR benchmark
- Goliath stock considered a 'special case' that requires the use of non-traditional metrics (i.e., not like other reef fish)
- Indices of abundance from creel surveys and angler interviews increased 1970s-2008
- Extreme cold weather in 2009-2010 reversed increasing trends in these indices for both juveniles and adults



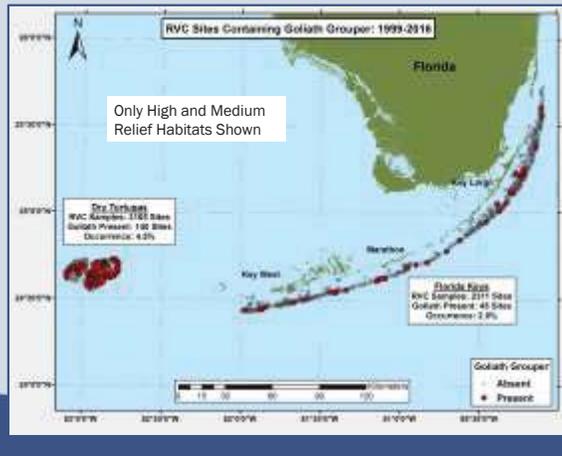
Even though the fishery management councils have set a target SPR value of 50% for goliath, it has not been possible to conduct the detailed analyses necessary to evaluate the status of the stock relative to this benchmark. Uncertainties associated with key life history characteristics and lack of data from an operating fishery limit the application of traditional stock assessment approaches for goliath.

Despite these data shortcomings, there are several long-term indices of abundance that are informative relative to trends in goliath abundance in south Florida. Catch rate data from the recreational fishery on both the Atlantic and Gulf coasts are available from the Marine Fisheries Recreational Information Program (MRIP), a set of surveys FWC conducts in partnership with NOAA. In addition, there is a long-running creel survey in Everglades National Park which surveys a fishery primarily focusing on juveniles. In addition, we produced indices from count data collected by commercial fishers and the Reef Environmental Education Foundation (REEF). REEF data are collected by volunteer divers using a standardized protocol.

The indices all show a general increase in abundance until about 2008. Most indices, especially those for juveniles, indicate a significant drop in abundance due to the severe winter of 2009-2010.

Are Goliath Recovered? What Long Term Field Surveys Tell Us

- Reef Visual Census (RVC) data collected between 1999-2016
- Goliath grouper prefer habitats with higher relief, large shelters and prey availability
- Examined subset of high and medium relief habitat RVC stations
- Goliath grouper are rare on natural reef habitats
- Goliath mean occurrence rate
 - Florida Keys 2.0%
 - Dry Tortugas 4.5%



FWC has conducted a reef visual census (RVC) of fish communities in the Florida Keys and Dry Tortugas for nearly twenty years. The map presented in this slide shows the rate of occurrence of goliath grouper in this survey and includes only stations with medium or high relief (generally >5 feet) habitat, which are preferred by goliath. Throughout the survey, goliath have been relatively rare and the mean occurrence rate for the Keys is 2.0% while the Dry Tortugas is slightly higher at 4.5%. Ninety-five percent of stations where goliath occurred consisted of a single individual.

These data confirm that goliath continue to be fairly rare on what we would expect to be suitable natural habitat.

Is Goliath Increased Abundance Negatively Impacting Other Reef Fish or Lobster?

- Goliath's diet is composed mainly of crustaceans and smaller-sized fish and baitfish
- Consistent lobster landings in the last 10 years indicates little impact on lobsters
- Goliath appear to be more abundant on artificial reefs and still uncommon in many natural reef habitats
- Goliath are a Florida native species that historically helped shape healthy coastal ecosystems



While goliath may occasionally prey on hooked fish, their diet is composed mainly of crustaceans and smaller-sized fish and baitfish.

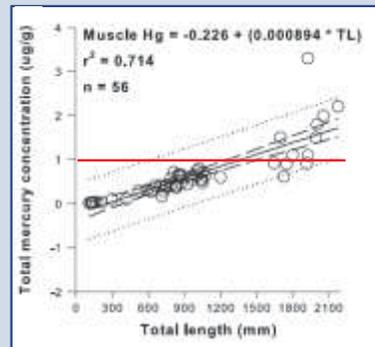
There is no indication that increasing numbers of goliath preying on lobsters is a management concern. In fact consistent landing of lobster in the last 10 years indicates otherwise.

It is important to note that goliath grouper are a Florida native species that, as apex predator, played a particularly strong role in shaping reef ecosystems.

Survey data indicate that goliath abundance is disproportionately higher at wrecks and other artificial reefs and they have yet to recolonize areas of natural reef habitat where they were likely historically present.

Are Goliath Safe to Eat?

- Mercury levels are high but not at levels uncommon to other groupers
- Larger, older fish are shown to have much higher mercury levels at which consumption is typically not recommended
- Additional sampling would likely be required for potential consumption advisories (DOH)



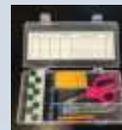
Like many fish in Florida, mercury levels in larger goliath are elevated and if a harvest were to be allowed, FWC would need to work with the FL Department of Health (DoH) on potential consumption advisories. In general mercury levels above 1 (ug/g), which is the same as 1 part per million, are considered a threshold above which consumption advisories may be warranted.

Goliath Monitoring and Research

- Existing MRIP, RVC, REEF and ENP programs continue to track abundance
- New goliath reporting module in FWC Reporter App will provide georeferenced data/photos directly from fishers
- Genetic analyses are ongoing: Angler fin clip program provides test kits for DNA collection



Goliath reporting module in FWC Reporter APP



Angler Fin Clip Kit



Goliath monitoring and research activities will continue and expand.

Stakeholder Perspectives

- Values and perceptions of goliath are highly divergent
 - Important catch-and-release opportunity
 - Recreational harvest opportunity
 - Can be a nuisance to some fishermen
 - Important to preserve ecotourism
 - Important part of the ecosystem
 - Conservation of the species is a priority



Over the past several years stakeholders have expressed different ideas about how to move forward regarding the management of goliath. These ideas have been heard at Commission meetings as well as state and federal workshops on various topics. These ideas include keeping goliath grouper status quo, which includes a thriving catch and release fishery as well as many dive viewing opportunities. Other ideas include providing a unique harvest opportunity through a limited harvest.

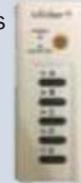
The management philosophies of goliath grouper are highly divergent. Some view goliath grouper as a robust catch-and release only fishery. Some anglers consider goliath a nuisance species because they often remove hooked fish from their line. Even though goliath grouper can currently be targeted for catch and release, there are also people who desire to harvest a goliath grouper as a unique harvest opportunity. There are many people, especially members of the dive community, that want to preserve goliath for ecotourism purposes. Dive charter businesses take people to dive with goliath grouper. Goliath are sedentary and tolerate divers in close proximity even while in spawning aggregations. There are others who think that goliath should be preserved for their role as a large predator in the marine ecosystem. Some of these people do not think that goliath should be harvested. Some have concerns about goliath distribution outside the state of Florida, throughout their historic range. Goliath are not abundant throughout their historic range, which includes the Gulf of Mexico and the southern part of the Atlantic Ocean. The population of goliath off Florida may contribute recruits to the historic range, or help seed these areas. Many feel that goliath grouper should be a conservation priority of the agency.

A stakeholder perspective study by the University of Florida found similar results that stakeholder experiences and attitude are diverse, particularly among the recreational fishermen.

Public Workshops

Goal: Gather public input on goliath management and potential limited harvest

- 16 in-person workshops with survey
 - iClicker system used to gather public comments
 - 520 people attended and 470 participated in survey
- Virtual workshop with survey
 - Workshop viewed 1,100 times and survey completed 340 times
- Participants included fishers and non-fishers
 - Reported interactions with goliath throughout the state
- Additional 5,000+ comments received



Between July 31, 2017, and Oct. 25., 2017, FWC staff held 16 in-person goliath grouper public workshops to gain public input on goliath grouper management and a potential limited harvest. Workshops were held in Pensacola, Panama City, Carrabelle, Tallahassee, Crystal River, Pinellas Park, Port Charlotte, Naples, Key West, Marathon, Key Largo, Lake Worth, Davie, Stuart, Titusville, and Jacksonville. Additionally, an online virtual workshop and survey was published for stakeholders who could not attend an in-person workshop. About 520 people attended the public workshops in-person and the virtual workshop was viewed almost 1,100 times (as of Feb. 27, 2018). Approximately 470 people participated in the clicker surveys at in-person workshops and the online survey was completed 340 times (online survey closed Dec. 1, 2017). Participants were a diverse group of stakeholders including recreational hook-and-line anglers, recreational spearfishers, for-hire captains, commercial fishermen, recreational divers (non-harvesters), and concerned citizens.

Stakeholders reported interacting with goliath grouper from Crystal River through Collier County, Miami to Cape Canaveral, and in the Florida Keys/Everglades National Park/Florida Bay. The most common interactions included trying to keep goliath from taking fish off their line, taking dive trips to view them, and targeting them for catch-and-release.

Additionally, over 5,000 comments were received through FWC online commenting portals, email, phone calls, and snail mail. In these comments, the management philosophies for goliath are highly divergent, and there were those who supported a limited harvest and those who supported maintaining status quo.

Workshop Format for Obtaining Public Feedback

- Presentation on population status, history of management, and hypothetical scenario for limited harvest
- Attendees were asked to complete a survey intended to
 - Describe their interactions with goliath
 - Explore stakeholder's values, beliefs, and concerns related to goliath
 - Gather opinions for potential limited harvest

Commenters were divided over whether harvest should be allowed



At each workshop, staff gave a presentation about goliath population status, history of state and federal management, life history review, and a hypothetical scenario for a limited harvest. After the presentation, attendees were given the opportunity to ask questions. Following questions and answers, FWC staff collected public input about goliath grouper management using an interactive question-response system known as clickers.

The questions in the clicker session and online survey explored stakeholder interactions with goliath, their values, beliefs, and concerns relating to goliath grouper, and also solicited input on administration and regulations for potential limited harvest. The questions were in multiple-choice format, with two to five possible responses for each question. Participants were not required to respond to every question and, in most cases, were given the opportunity to state their opposition to goliath grouper harvest when responding to each question if they felt other answers were not acceptable. The presentation and questions were the same for the in-person clicker session and online survey.

Stakeholder comments from the in-person workshop survey, online workshop survey, and submitted comments were divided over whether limited harvest should be allowed.

Limited Harvest Management Scenario Presented for Public Comment

- State waters only
- Recreational harvest only
- Harvest limited to 100 fish per year for four years
- Could be administered through harvest tags
 - Could charge up to \$300 per tag
- Hook-and-line only
- Slot limit: 47–67 inches
- Harvest not to encompass spawning aggregations
- Harvest not allowed during spawning months (July – September)



In the clicker survey session, attendees were asked to give their opinions on a possible limited harvest management scenario. This possible management scenario was also presented at the February 2017 Commission meeting. The goal would be to provide limited harvest opportunities on a recovering species. The Commission asked staff to take this scenario out to the public for comment.

The management scenario presented at workshops was as follows:

- Harvest allowed in state waters only, as the FWC does not have the authority to allow harvest in federal waters.
- Limited to recreational harvest only.
- Harvest limited to 100 fish per year.
- Participation in harvest administered through a tag program. Tag recipients could be selected via a random draw and once selected, a fee could be charged per 379.354(8)(f), F.S. This fee could be up to \$300 and the money from this opportunity could be used for goliath research.
- Recreational fishing license required to participate in this opportunity.
- Only hook-and-line gear allowed.
- Limit harvest to fish within a 47 to 67 inch slot limit.
- Harvest prohibited from spawning aggregation areas and during the spawning months of July – September.

Stakeholders Opinions Supporting Status Quo (No Harvest)

Why they support no harvest

- Important part of the ecosystem
- Valuable recreational dive viewing opportunity
 - Significant economic benefit through dive tourism
- Consumption of goliath could be harmful due to high mercury levels
- Recovery is not complete throughout historic range
- Because they are vulnerable to overfishing, they need more conservative management



Stakeholders who supported maintaining status-quo (no harvest) self-identified as recreational anglers and spearfishers, commercial fishermen, charter captains, recreational divers, environmental NGOs, and concerned citizens. They noted several reasons for why they supported no harvest. Stakeholders noted that goliath grouper are important for reef ecosystems as they help increase species diversity and density around reefs. Many stakeholders noted the importance of goliath as a valuable recreational dive viewing opportunity, and that the species provides a significant economic benefit through dive tourism. Some noted their concern for the high levels of methylmercury in large grouper, and that these are higher than levels considered safe for human consumption. Additionally, many stakeholders felt that goliath recovery is not complete throughout their historic range, and that the species should still be considered endangered and overfished. The majority of stakeholders stated that goliath are vulnerable to overfishing because of their unique biology and behavior, which makes them easy to target. They also noted that because of their unique nature there should be more stringent conservative management measures than for other species.

Stakeholders Opinions Supporting Limited Harvest

Why they support harvest

- Moratorium has achieved its goal and population has recovered in Florida
- Overpopulated and harming ecosystem
 - Harvest is needed to increase reef health
- Nuisance and/or aggressive to fishers
- Want people to have the opportunity to harvest
- Should be open if science supports a harvest



Stakeholders who supported a limited harvest self-identified as recreational anglers, spearfishers, charter captains, and divers (including recreational and commercial). They noted several reasons for why they supported a limited harvest. Many stakeholders felt that the moratorium on harvest has achieved its goal and the population has recovered in Florida. Many also felt that goliath are overpopulated in Florida, and are contributing to the decline of reef ecosystems and biodiversity. Others viewed goliath as a nuisance, believe they steal fish off lines/spears, and that they make it impossible to catch/harvest other species. Others felt that goliath are aggressive on reefs and pose a danger to divers. Some felt that this is a unique fishing opportunity and a way to land a true trophy fish. Others felt that the fishery should be open to harvest if science shows the populations can sustain it.

Stakeholder management philosophies are highly divergent, and there are many factors, such as goliath's life history and fishery management bodies, to take into consideration for goliath grouper management in Florida.



Future of Goliath Management



- Managed in state waters by FWC and federal waters by Gulf and South Atlantic Councils

Federal waters

- The Acceptable Biological Catch (ABC) is zero
 - Includes state and federal waters
- Councils have no immediate plans to consider a harvest strategy for federal waters
- Unlikely to change without an accepted stock assessment

State waters

- FWC can allow harvest in state waters



Goliath grouper is managed in state waters by the FWC and in federal waters by the Gulf and South Atlantic councils.

The Gulf and South Atlantic councils cannot allow any harvest without a conclusive stock assessment. The councils' Science and Statistical Committees must be able to set an Acceptable Biological Catch (ABC) for the councils to consider any harvest. The ABC could be set after a conclusive assessment is completed. At this time the ABC for goliath grouper is set at zero for state and federal waters.

When both the Gulf and South Atlantic councils received the results of the goliath assessment in late 2016, neither council showed any interest in considering a harvest strategy for federal waters. This is unlikely to change without an accepted assessment.

In discussions about whether FWC could allow harvest of goliath grouper in state waters, FWC attorneys believe that harvest in state waters can be considered by the agency.

Where Are We Now?

- Recovering stock and becoming more abundant in parts of Florida, especially on artificial reefs
- Opportunistic feeders, primarily consuming bait fish and crustaceans
- Unknowns in life history and biology, especially maximum age
- Limited harvest data will not result in accepted stock assessment
- High levels of mercury in large goliath
- User conflicts and nuisance behavior not likely reduced with a limited harvest
- FWC manages state waters only
- Limited harvest would provide a new opportunity



Management of goliath grouper is controversial and challenging due to the many unknowns in life history and biology, rejected federal stock assessments, and the divergent opinions and concerns of stakeholders.

Goliath grouper is a recovering stock, and research shows that they are becoming more abundant in parts of Florida, especially on artificial reefs. Studies show that goliath are opportunistic predators, primarily consuming bait fish and crustaceans. While they will opportunistically take species like snappers and groupers off anglers lines, those species represent a very small portion of their diet. Additionally, there are many unknowns in goliath life history and biology. These unknowns, particularly the uncertainty in maximum age, makes it challenging to determine the status of the fishery.

It is important to note that any data gathered from a limited harvest will not result in accepted stock assessment. Even though we would gain some life history information, critical information for the stock assessment is still lacking, including 20 years of no landings, historical landings being uncertain, inability to determine the status of the fishery, and unknowns in life history. Also, FWC only manages state waters, and does not have authority to allow harvest in federal waters.

A limited harvest would provide a unique fishing opportunity for Florida recreational anglers. However, there are concerns about consumption of such harvest because of high levels of mercury in large goliath.

Even with a harvest, user conflicts and nuisance behavior will not likely be greatly reduced as the harvest would need to be very limited. For example, a harvest would be limited to only 100 goliath annually with a slot size so the largest, oldest individuals would not be removed.

Next Steps

- Staff will continue current goliath efforts and return with an update in 3 to 5 years
- Staff is seeking Commission direction whether to pursue a draft rule for limited harvest



Staff will continue current goliath efforts and return with an update on goliath in 3 to 5 years. If directed, staff will return with a draft rule at a future Commission meeting.

The following slides are considered backup material
and are not anticipated to be part of the actual
presentation



Limited Harvest Opportunity Considerations

- State waters only
- Could have random draw to choose participants
- If chosen, a fee could be charged
 - Fee could be up to \$300
 - Could be used to fund goliath research
 - Could require participants to purchase recreational fishing license
- Recreational harvest tag could be issued
 - Could allow harvest of one fish per tag per person per year
 - 100 tags could be issued annually for 4 years via random drawing
 - Tags could be issued to recreational fishermen who could choose to hire guide
- Participants could be asked to “hail in” when they have a goliath



If a limited harvest opportunity is considered, staff has some suggested sideboards. The harvest should be in state waters only as the FWC does not have the authority to allow harvest in federal waters. Staff suggests that interested anglers could apply and then could be chosen via a random draw. Once selected, a fee could be charged per 379.354(8)(f) F.S. This fee could be up to \$300 and the money from this opportunity could be used for goliath research. The Commission could also require people to have a recreational fishing license to participate in this opportunity.

A successful draw could qualify a single angler for a single tag. An angler could only be allowed to take one goliath a year with this tag. Staff suggests that 100 tags could be issued annually for 4 years. This random draw could be split into a certain number of tags available for each coast. Staff suggests that tags could be issued to the angler, who could then choose to hire a guide if they desired. Participants could be required to “hail in” to LE and/or FWRI when they had a harvested goliath on board their boat.

Limited Harvest Opportunity Considerations (cont.)

- Suggest allowable gear : hook-and-line only
- Suggest slot limit : 47 inches to 67 inches
- Suggest open areas that do not encompass spawning aggregations
- Suggest harvest not allowed during spawning months (July – September)
- Suggest no commercial harvest or sale
- Scientific sampling could occur either at check points or via cooler drop offs
- People could use app to report harvest locations as well as non-consumptive divers and anglers can use to report sightings



Specifically, staff is suggesting only harvesting goliath using hook-and-line gear and only taking fish within a narrow slot limit of 47 to 67 inches. It is suggested that fish not be taken from spawning aggregation areas and that harvest not be allowed during the spawning months of July – September. It is suggested that no commercial harvest or sale be allowed of the harvested fish. Fish could be scientifically sampled by yet to be determined methods, but it could include being met by a FWRI researcher or dropping off the carcass at a specified location to be placed in a cooler.

Whether people are practicing catch and release of goliath, viewing goliath underwater, or harvesting goliath, they will all be able to report the location of the fish sightings and harvest via the app that will be developed by FWRI. This will give researchers much needed distribution and abundance information.

Economic Study on Dive Value

2016 study done by Univ. of Miami on recreational diver willingness to pay for goliath grouper encounters:

- Recreational divers are willing to pay around \$100 for one goliath grouper sighting
- Diver willingness to pay for goliath grouper spawning aggregation sites is almost \$200
- There is high consumer surplus for divers targeting goliath grouper aggregations
- This consumer surplus would diminish with decreases in abundance of goliath grouper



A recent economic study conducted by the University of Miami evaluated how much recreational divers were willing to pay for goliath grouper encounters. A previous study estimated that resident anglers in Florida who wanted the fishery open were willing to pay between \$34 and \$79 to harvest a goliath grouper. Using a survey instrument with choice experiments, the recent University of Miami study estimated that divers off eastern Florida would be willing to pay approximately \$103 for a dive trip with one goliath grouper encounter during the months of their spawning aggregation (August–October), and \$202 if there are 40 Goliath Grouper (such as is common on a many spawning aggregation sites). Results suggested that divers coming from outside of Florida were willing to pay higher rates for dive trips with Goliath Grouper encounters; and at spawning aggregations sites, willingness to pay was estimated around \$336 for these non-Florida divers.

Stakeholders Perspective Study by UF

Stakeholder experiences and attitudes are diverse, particularly within the recreational fishing groups

- Recreational rod-and-line fishers: Have a positive attitude toward goliath encounters and the species' contribution to biodiversity
 - Very moderately in favor of opening the fishery
- Recreational spearfishers and commercial fishers: View goliath encounters and ecological impacts more negatively
 - More strongly in favor of opening the fishery to harvest
- Sightseeing divers, dive charters and non-fishing conservation organization members: View contribution of goliath to biodiversity as positive
 - Oppose opening of the fishery to harvest



Scientific uncertainty is only one aspect of the goliath grouper management controversy. FWC partnered with University of Florida and Florida Sea Grant to better understand and manage the stakeholder conflict surrounding goliath grouper. This project had two parts, an in-depth stakeholder survey and a focused stakeholder workshop. The internet-based survey was aimed at capturing the diversity of stakeholders' views and experiences regarding goliath grouper and its management. The stakeholder workshop included invited participants representing a diversity of stakeholder interests and was aimed at developing a shared understanding of management issues and options.

There were 5,882 responses received from the online survey and the responses represented all major stakeholder groups:

Stakeholder experiences and attitudes are diverse, particularly within the recreational fishing groups

- Recreational rod-and-line fishers: Have a positive attitude toward goliath encounters and contribution to biodiversity. Very moderately in favor of opening the fishery
- Recreational spear fishers and commercial fishers: View goliath encounters and ecological impacts more negatively. More strongly in favor of opening the fishery to harvest
- Sightseeing divers, dive charters and non-fishing conservation organization members: View contribution of goliath to biodiversity as positive. Oppose opening of the fishery to harvest

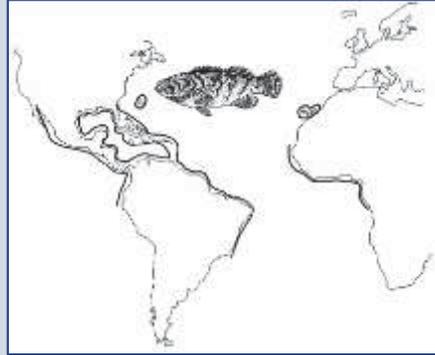
Those who view the ecological impacts of goliath as negative nonetheless rank the importance of those impacts as low relative to other impacts (coastal development, etc.)

Additional Stakeholder experiences and attitudes

- Charter operators view goliath impacts as predominantly neutral (fishing charters) or positive (dive charters)
- Fishing charters expect a positive, dive charters a negative business impact from re-opening the fishery
- Stakeholders have developed a range of measures to reduce incidental catch of goliath or depredation on hooked or speared fish, which could be assessed and summarized in best practice guidelines
- A stakeholder workshop demonstrated the potential for achieving greater shared understanding of issues and options among stakeholders
- The workshop also highlighted concerns over the practicality of controlling a possible, very limited harvest

Goliath Grouper Distribution and Biology

- Historically ranged from Florida to Brazil and throughout the Gulf of Mexico and Caribbean
- Current distribution in U.S. concentrated in south Florida
- Long-lived (37+ yrs), slow growth
- Late maturity (3-6 yrs)
- Spawning occurs in aggregations from July to Sept.
- Susceptible to large-scale mortality events like red tide and cold-weather kills

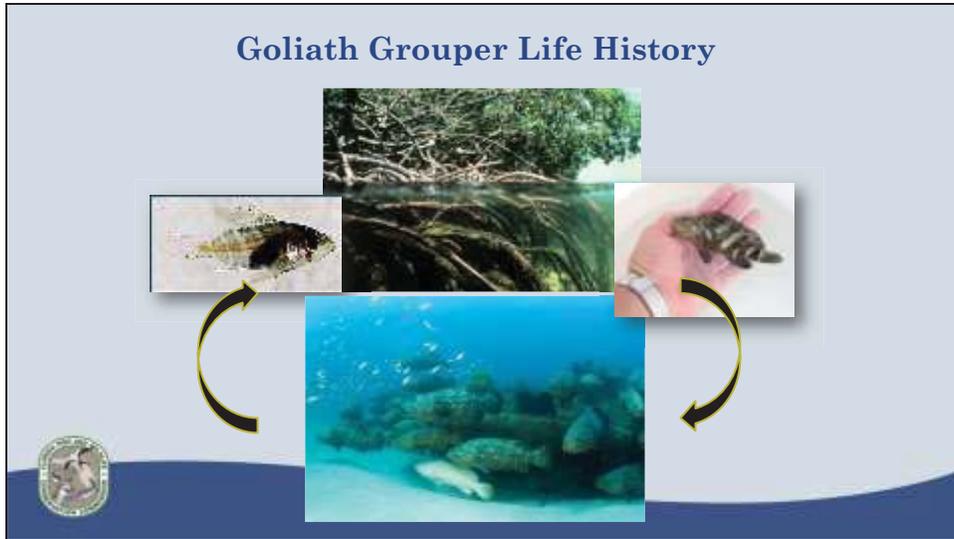


Goliath grouper are found in subtropical and tropical waters of the northwest Atlantic. The center of population abundance has historically been along the southwest coast of Florida, but their geographic range spans the subtropical and tropical Atlantic Ocean, Caribbean Sea, and Gulf of Mexico down to the southeast coast of Brazil. Mixing between the Gulf and Atlantic is likely limited, but there is evidence that individuals are capable of migrating between regions. It is believed that there is a single stock throughout the Caribbean and that the U.S. population may serve as a source of larvae to the wider Caribbean. In the U.S., local extirpations have resulted in a distribution being restricted to South Florida.

Goliath grouper are slow growing and long-lived. The oldest age recorded is 37 years, but they are presumed to live over 40 years. They also exhibit late maturity (3-6 years).

Goliath are sedentary and gather predictably in large groups to spawn at specific, high relief sites in late summer months (July – September). The majority of reported landings for goliath grouper coincided with their spawning season. Aggregations are typically reported from relatively shallow water (<50 m), making goliath grouper aggregations accessible to a larger group of fishers and divers. Increasing coastal development and the resulting loss of mangrove nursery habitat has also been suggested as a bottleneck to the recovery of goliath grouper. In addition, this species is susceptible to large-scale mortality events from red tide or cold weather kills.

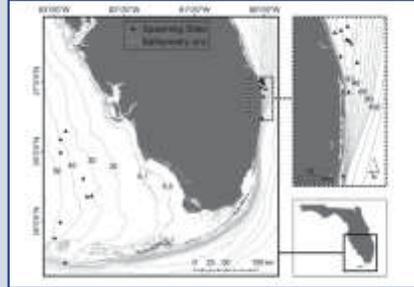
Goliath Grouper Life History



Like many marine fishes, the life history of goliath grouper is linked intimately with both inshore and offshore habitats. They aggregate to spawn offshore-spawning occurs at defined sites in the late summer months (July - Sept). Larvae spend several weeks as plankton and settle out within shallow inshore nursery habitat. This species is dependent upon suitable estuaries that act as nurseries and it is believed that mangroves may provide critical habitat for juvenile growth and development. Juvenile emigration to offshore waters occurs at the age of 5 or 6 years, probably at the onset of maturity that likely occurs when they approach 1,000 mm TL.

Goliath Grouper Spawning

- Confirmed spawning aggregation sites identified in south Florida
- SE Florida sites attract fish from long distances (e.g., south GA)
- Recent research indicates goliath grouper might be hermaphroditic
- Fin ray-based aging indicates fish at these spawning sites are ≤ 20 years old



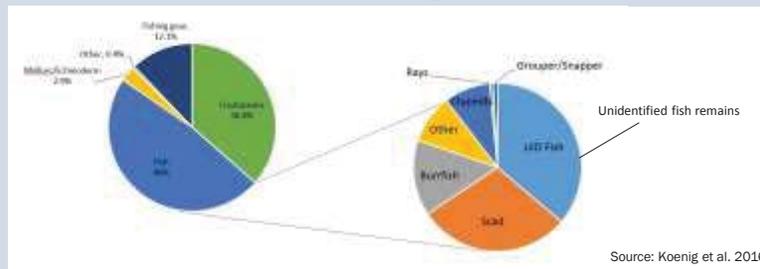
Source: Koenig et al. 2016

Recent research conducted by a group of Florida scientists has shed some light into their life history and biology. Goliath grouper spawning sites have been identified off the southeastern and southwestern coasts of Florida. Spawning habitats consisted of relatively high-relief rocky reefs and artificial reefs (including wrecks and towers) in water depths of 15–50 m. Researchers found no spawning sites on or near coral reefs along the Florida Keys reef tract, an area in which the abundance of goliath grouper seems to be relatively low.

Microscopic evaluation of goliath grouper ovaries showed some evidence that they are sequential hermaphrodites (i.e., they are born as females and switch to being males later in life). Further research is needed to confirm these preliminary results.

Age determination of goliath grouper in spawning aggregation sites have been based on sectioned fin rays (to avoid sacrificing spawning individuals). Results from this analysis indicates that goliath grouper at spawning aggregation sites are between 4 and 20 years of age.

Goliath Grouper Diet



- Goliath grouper are opportunistic feeders that consume a variety of benthic crustaceans and bottom fishes
- Most common fishes in diet were bait fish (e.g. scad, sardines) and burrfish
 - < 1% of diet was grouper or snapper



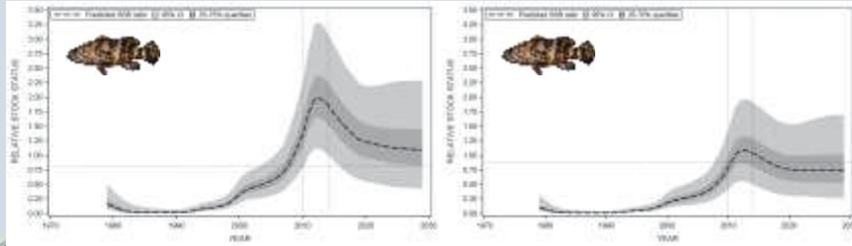
Results of a comprehensive diet study show that goliath grouper are opportunistic predators, but consume primarily prey at lower trophic levels. Benthic invertebrates, mostly crab species (but also lobster in the Florida Keys), make up a majority of the goliath grouper diet. Scad, also common in their diet, are a small shoaling species of jack that often occur near the sea floor near immobile reef structure or surrounding goliath grouper, likely for protection. It is probable that some individuals are ingested accidentally through feeding events on other targeted prey; but many stomach samples included only scad, thus indicating that they also target this small prey. Snappers and groupers represent less than 1% of their diet.

A significant portion of goliath grouper stomach contents were composed of fish remains already too digested to allow identification of what type of fish they were (unidentified fish remains = IUD).

Uncertain Maximum Age Contributes to Uncertainty in Stock Status

Stock status for an assumed maximum age of 37 years

Stock status for an assumed maximum age of 56 years



This graph shows the spawning stock biomass ratio (annual biomass relative to biomass at 50% spawning potential ratio) of goliath grouper for the period 1950-2025 as estimated by the stock assessment model (values beyond 2014 represent model projections). Results indicate that goliath grouper abundance has greatly increased since the fishery was closed in 1990 and suggest the stock could be already recovered (although results are highly uncertain).

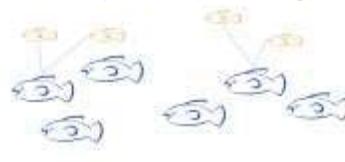
Potential Use of Genetic Analysis for Population Abundance

- 'Close Kin' analysis is a novel, non-lethal genetic method to estimate population abundance
- It uses the proportion of Parent-Offspring-Pairs (POP's) to estimate the number of adults in the population
- Researchers are actively exploring this technique for goliath grouper

Adults and juveniles in the population



6 adults and 4 juveniles and parent-offspring-pairs



FWC-FWRI is working with a group of Florida researchers to evaluate the potential use of a non-lethal genetic technique for estimating goliath grouper population abundance. The technique, called Close-Kin analysis, is a novel approach to ecological assessment in circumstances that are not amenable to traditional fishery stock assessments. Close-kin analysis estimates spawning stock abundance through genetic kinship analysis, coupled with statistical demographic modeling. Simply put, genetic analysis determines if Parent-Offspring-Pairs (POPs) are present among tissue samples.