A Preliminary Discussion of Acceptable Harvest Levels for Scientific Sampling of Goliath Grouper in the U.S. South Atlantic and Gulf of Mexico

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Implications of assessment models to future harvest rates

The first full assessment of goliath grouper populations in Florida was conducted in 2004 as part of SEDAR 06. The results of that assessment agreed with anecdotal accounts of a swift decline during the 1980s and a substantial recovery after the moratorium on harvest was imposed in 1990. Less clear was the degree to which the population had recovered and the date when a full recovery could be expected, largely owing to uncertainty about the fishing mortality rate (F) after the harvest moratorium was imposed (ostensibly due to illegal harvest and release mortality of fish caught at depth). Following the recommendations of the SEDAR 06 review panel, Porch et al (2006) extended the SEDAR assessment by estimating the level of F under the moratorium. The base model suggested that the post-moratorium level of F was about 0.05 yr^{-1}, which is very similar to the estimate for the fishing mortality rate limit specified by the Gulf of Mexico Fishery Management Council's generic Sustainable Fisheries Act amendment ($F_{50\%}$, the level of F associated with a spawning potential ratio of 50%). Not surprisingly, the model suggests that there is less than a 40% chance that the stock will recover to the levels stipulated by the generic SFA within the next 10 years or so. Any additional harvest would therefore make a recovery even less likely.

A possible point of contention is the 50% SPR standard to which goliath grouper are expected to recover under the Gulf of Mexico Fishery Management Council's (GMFMC) Generic Sustainable Fisheries Act Amendment. A number of authors have suggested $F_{40\%}$ as a proxy for F_{MSY} that is relatively safe in terms of avoiding recruitment overfishing (e.g., Clark 1993, Mace 1994). If the respective management bodies wish to adopt this lower standard, then there is better than a 50% chance that the population has already recovered and will remain so if fishing resumes at $F_{40\%}$ levels (see Figure 1). With this lower standard, one could argue that the allowable harvest rate is about 0.017 yr^{-1} (the difference between $F_{40\%} = 0.070$ and the $F_{moratorium} = 0.053$). It is important to emphasize, however, that several more recent studies have indicated that $F_{40\%}$ appears to

be too high for many long-lived species and that F levels approaching $F_{50\%}$ or $F_{60\%}$ may be more appropriate (Ralston 1998, Punt 2000, Clark 2002, Dorn 2002)

Converting harvest rates to harvest in numbers

One of the difficulties faced by the 2004 SEDAR and subsequent assessment work on goliath grouper is that reliable catch data were unavailable. For this reason, it was impossible to estimate an allowable catch level. As discussed above, it was possible to estimate fishing mortality rates and relative trends in abundance. Hence, if an independent estimate of the average abundance of the population N were available, then an approximation to the allowable harvest may be obtained using the estimated allowable harvest rates discussed above via the catch equation, e.g.,

(1)   total harvest $= \Sigma_a \, F_a N_a$

where the subscript a indexes age-specific values (the F values discussed earlier without the a subscript represent the mortality rate on fully-selected age classes).

The only estimates of goliath grouper abundance available to date are by Koenig et al (in review), who used mark recapture techniques to estimate the density of juveniles (ages 1-6) at selected sites near mangrove islands and rivers within the Ten Thousand Islands area and everglades National Park. They then estimated the total abundance of juveniles in the region by extrapolating their density estimates across the total area of mangrove islands and rivers in the region. The results suggest a total population of about 71,000 juveniles. This number may underestimate the total population of juvenile goliath grouper in the Gulf of Mexico because the range of juveniles extends beyond the Ten Thousand Islands area. However, it is also possible that 71,000 fish is an over-estimate inasmuch as it is unclear if the habitat outside the study sites is, on average, as suitable for goliath grouper as the habitat in the study sites.

The Koenig et al. estimates, while pertaining only to juveniles, provide a convenient metric with which to scale the relative abundance estimates provided by the assessment model. The approach used here is to rescale the relative abundance at age vector projected for 2007 by the average value for ages 1-6 and then multiply this rescaled vector by the estimate of 71,000 fish. In this way one obtains an estimate for the size structure of the total population. An estimate for the harvest in numbers associated with the harvest rate at age estimates from the model can thereby be obtained using equation 1. The results are summarized in Table 1.

The estimated total harvest level (i.e., across all ages) presented in Table 1 is approximately 1,600 individuals. However, it is important to recognize the high degree of uncertainty associated with this estimate and that it is premised on raising the fishing mortality rate target from $F_{50\% \, SPR}$ (stipulated by the Gulf Council's generic Sustainable Fisheries Act amendment) to $F_{40\% \, SPR}$. Furthermore, a more precautionary harvest level is justified by the fact that goliath grouper life history and population dynamics make them highly susceptible to overexploitation. In a recent report (NMFS 2006) a team of

scientists concluded that the continental U.S. population of goliath grouper is highly "conservation dependent" and can be particularly affected by fishing pressure and habitat loss. This point was also made by the SEDAR panel in 2004, which noted that any fishery could risk rapidly depleting the population and would require careful monitoring. For these reasons, we recommend that no more than 800 individuals be harvested from the U.S. South Atlantic and eastern Gulf of Mexico.

Scientific use of constituent-based sampling

An unintended outcome of the harvest moratorium on goliath grouper is that it greatly reduced the number of specimens available for life history studies. Although some researchers have attempted to address this issue by using non-destructive sampling techniques (e.g., collection of fin rays and spines for aging and the use of catheters for sampling gonadal tissues) or by taking advantage of fish that died naturally (e.g., during red tide fish kill events) it is no coincidence that the majority of studies conducted during the past 16 years have focused on goliath grouper occurrence, size distribution, movements and abundance in different habitats. In other words, studies that do not require sacrificing fish for collection of hard-parts and other tissues.

Although these studies supplement the existing body of knowledge on goliath grouper biology and demographics they still fall short of addressing critical data needs on goliath grouper life history and population dynamics. For example, size and age at sexual maturity, batch fecundity and spawning frequency, spatial and temporal distribution of fish by age, etc. Accomplishing this would require sacrificing specimens for scientific purposes—especially if life history parameters are to be evaluated over a wide range of sizes/ages.

To address this issue, the Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute (FWC-FWRI) and the National Marine Fisheries Service, Southeast Fishery Science Center (NMFS-SEFSC) are proposing to develop a joint, collaborative research program directed at goliath grouper in the South Atlantic and eastern Gulf of Mexico. This research program would include the harvest of a limited number of goliath grouper for scientific purposes. Biological samples (otoliths, gonad tissue, etc.) collected through this limited harvest program would be used to augment our information base on goliath grouper age, growth, and reproduction, as well as supplement ongoing studies on feeding habits. However, besides providing specimens for life history studies, we believe that development of a State-Federal Cooperative Goliath Grouper Research Program will improve coordination of goliath grouper research activities being currently conducted or planned by scientists at FWC-FWRI, NMFS, and Florida State University, as well as facilitate consistent management of this species in State and Federal waters.

We propose that implementation of this cooperative research program be accomplished according to the following recommendations:

1. In response to the recent public interest in reopening the fishery we propose that scientific research projects developed under the Cooperative Goliath Grouper Research Program (CGGRP) be conducted with the assistance of commercial and/or recreational fishers (e.g. for the collection of specimens). Fishers participating in this program would be required to coordinate activities with scientists submitting proposals to the CGGRP so their names can be listed in scientific collection permits issued by the Florida Fish and Wildlife Conservation Commission (for state waters) and/or the National Marine Fisheries Service (for federal waters).

2. Based on the rationale described in "**Converting harvest rates to harvest in numbers**" above we recommend that a maximum of 800 goliath grouper be harvested in the South Atlantic and eastern Gulf of Mexico. As an additional precautionary measure we also recommend that the harvest of these 800 fish be distributed over a 2-year period with a maximum of 400 individuals harvested each year. We believe this precautionary harvest level would provide an appropriate number of specimens for scientific studies without compromising recovery of the stock.

3. As part of this program the Florida Fish and Wildlife Conservation Commission will issue 800 numbered plastic "harvest tags" (analogous to the tags FWC issues annually for harvest of tarpon in Florida) to be distributed to scientists participating in the CGGRP. Each goliath grouper harvested under this program will be required to have one of the numbered harvest tags attached to its lower jaw. This will facilitate identification of specimens harvested for scientific study (for enforcement purposes) as well as provide a high degree of coordination for when, where, and why goliath grouper specimens are being collected.

4. Research projects developed under the CGGRP will cover a wide range of topics with emphasis on goliath grouper life history and population dynamics. We propose that a Research Planning Meeting (specific dates and locations to be determined) be conducted as the first step in implementing the CGGRP. During this meeting scientists from federal and state agencies, and academic institutions, as well as stakeholders (industry representatives, non-governmental organizations, etc.) will jointly identify research priorities and coordinate the development of specific research projects that maximize the amount of information collected from each goliath grouper being harvested.

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Table 1. Estimates of number of fish in the population (extrapolated from Koenig et al)
and the harvest level (number of fish) corresponding to fishing at a level for which there
is at least a 50 percent chance that the stock will remain at or above 40% SPR.

| age	selectivity	fishing mortality	abundance	harvest
1	0.062	0.001	15513	16
2	0.308	0.005	14080	74
3	0.749	0.013	12607	161
4	0.953	0.016	11018	178
5	0.993	0.017	9518	161
6	0.999	0.017	8263	140
7	1.000	0.017	7172	122
8	1.000	0.017	6249	106
9	1.000	0.017	5465	93
10	1.000	0.017	4779	81
11	1.000	0.017	3938	67
12	1.000	0.017	3106	53
13	1.000	0.017	3070	52
14	1.000	0.017	3806	65
15	1.000	0.017	4352	74
16	1.000	0.017	2773	47
17	1.000	0.017	1332	23
18	1.000	0.017	907	15
19	1.000	0.017	812	14
20	1.000	0.017	2468	42
1-6			71000	730
7+			50228	854
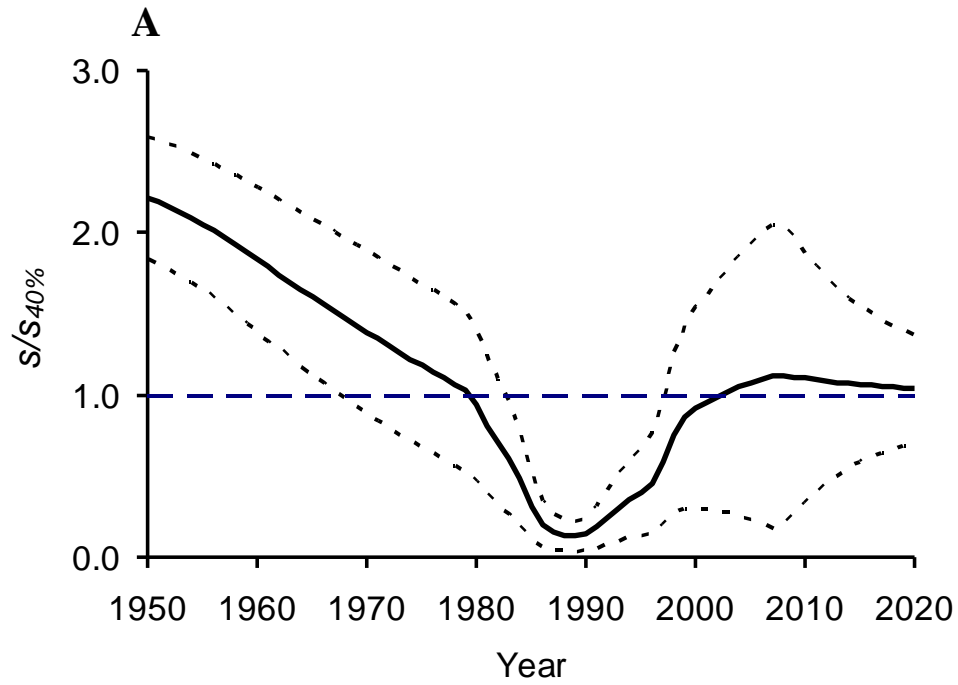
Figure 1. Base projections of spawning biomass of goliath grouper in southern Florida in relation to the equilibrium level associated with a spawning potential ratio of 40% ($s/s_{40\%}$). The dotted lines indicate 80% confidence limits.