

**The Goliath Grouper in Southern Florida:
Assessment Review and Advisory Report**

**Report prepared for the
South Atlantic Fishery Management Council
Gulf of Mexico Fishery Management Council
National Marine Fisheries Service**

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Southeast Data and Assessment Review**

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PREFACE

Summary of the SEDAR review process

The South Atlantic Fishery Management Council, the Gulf of Mexico Fishery Management Council, and the Caribbean Fishery Management Council, in conjunction with NOAA Fisheries, have adopted the Southeast Data, Assessment and Review (SEDAR) process, a multi-step method for determining the status of fish stocks. SEDAR is structured around three workshops: 1) Data Workshop, 2) Stock Assessment Workshop and 3) Review Workshop. Participants in Data Workshops review input data, including catch statistics, fishery sampling and population monitoring data, and species life history. Participants in Assessment Workshops develop stock assessment models, estimate values for population parameters and stock status benchmarks, and project future population conditions. At Review Workshops an independent peer review panel provides a technical review of the data and of the assessment methods. The relevant Council committees, such as the Science and Statistics Committees, must then certify the final assessment report before it can become eligible for use in developing management actions. The goal of SEDAR is to provide an open and transparent process for developing and reviewing scientific information that is critical to management of species in the Southeastern United States, including the South Atlantic, Gulf of Mexico, and Caribbean. The SEDAR process includes data collectors, biologists, fishermen, environmental representatives, database managers, stock assessment scientists and Council members and staff.

The Goliath Grouper (*Epinephelus itajara*) has been identified as a species of concern, and was proposed for SEDAR Assessment. A workshop on the data available for the Goliath Grouper was held on 5-6 March 2003¹. The participants concluded, from a review of the data presented to them, that the data available on the species were not adequate to support a full assessment even in waters restricted to southern Florida, and still less adequate for the entire range of the species. However, as the report of the workshop mentions, another data set was identified *after* the meeting that might contribute to an assessment.

¹ Anon. n.d. [2003.] Goliath Grouper data workshop report. SEDAR3-DW-1. 11 pp.

A subsequent SEDAR Review Panel² revisited the question of an assessment of the Goliath Grouper and considered that “not conducting an assessment on this occasion had likely been an incorrect decision. It was suggested that the assessment option for Goliath Grouper be revisited at an early opportunity, initially looking specifically at assessment models that could operate in a data-poor arena.”

This recommendation was acted upon and an assessment document was prepared³; however, no assessment workshop was held at which the assessment could be examined or other models compared with the one that was used. Instead, the assessment document was presented to an Assessment Review Panel, normally the third and last stage of the SEDAR process, at a meeting in Tampa, Fla on 27–30 January 2004. The present document reports the results of that meeting. It does not present the assessment itself, but the Review Panel’s views on the validity and limitations of both the assessment and the data upon which it was based. An Advisory Report, prepared by the Review Panel, and based on the conclusions it could draw from the assessment as to the current state of the stock and forecasts for its future, is appended.

Purpose of the Terms of Reference and Advisory Report

The ‘Terms of Reference Report’ provides a brief review of the stock assessment and the underlying data, with the SEDAR Assessment Review Panel’s conclusions about the adequacy and appropriateness of both. The report does not repeat the detailed results of the assessment. An ‘Advisory Report’ on stock status and possible and appropriate management for the stock in accordance with SFA prescription is appended; however, as the Panel is specifically enjoined not to conduct an alternative assessment, the Advice that can be formulated is bounded by the adequacy of the assessment(s) that is (are) reviewed.

Acknowledgments

Thanks are due to the members of the SEDAR Assessment Review Panel who participated in the review—Ralph Allen (GMFMC Advisory Panel; Independent), Luiz Barbieri (GMFMC Scientific and

² SEDAR Peer Review of Yellowtail Snapper Assessment, with comments on Goliath Grouper (Tampa, Florida, 28–31 July, 2003).

³ Porch, C.E., A.-M. Eklund and G.P. Scott. 2003. An assessment of rebuilding times for Goliath Grouper. SEDAR6-RW-3. Contribution SFD-2003-0018, Sustainable Fisheries Div., SE Fisheries Science Center, National Marine Fisheries Service, Miami, Fla. 25 pp.

Statistical Committee; Florida Fish and Wildlife Conservation Commission), Jon Brodziak (Reviewer; Northeast Fisheries Science Center, NMFS), Marianne Cufone (Reviewer; The Ocean Conservancy), Don DeMaria (SAFMC Advisory Panel; Independent), Michael Kingsley (Chairman; Center for Independent Experts), Debra Murie (GMFMC Finfish Assessment Panel; University of Florida), Michael Murphy (GMFMC Finfish Assessment Panel; Florida Fish and Wildlife Conservation Commission), Julie A. Neer (Reviewer; Southeast Fisheries Science Center, NMFS), Jay Rooker (GMFMC Finfish Assessment Panel; Texas A&M University), Richard Taylor (GMFMC Reviewer; Independent), Eddie Toomer (GMFMC Advisory Panel; Independent) and John Wheeler (Reviewer; Center for Independent Experts). We thank the presenters and other scientific staff for their work beforehand and for their presentations at the meeting, and the members of the public, the fishermen, divers, and others, for cooperative and constructive input to the review meeting. We thank the staff of the Fishery Management Councils, the National Marine Fisheries Service and other organisations for their contributions to the running of the meeting and for their input to the Review Panel's deliberations.

BACKGROUND ON THE GOLIATH GROUPER.

The Goliath Grouper (*Epinephelus itajara*) is a long-lived reef fish that grows to unusually large size: fish weighing several hundred pounds are not unusual. Outside the spawning season, adults are typically solitary, sedentary, and territorial, unafraid and somewhat inquisitive; these characteristics make them an easy target for spearfishing. The species takes hooks easily, so is also vulnerable to angling. The large size it can reach makes it impressive as a trophy, but also makes it difficult to handle with the care necessary to ensure its survival on release. These factors combined to create an overfishing situation that depleted numbers in southern Florida and elsewhere, and the Fishery Management Councils imposed a moratorium on landings in 1990. Since then, anecdotal accounts and quantitative survey data agree that numbers of both adults and juveniles have increased, although a subjective consensus appears to be that pristine stock levels have not been reached. Prevailing comment on the state of the stock ranges from concern over the still-depleted numbers and reported continuing mortality from poaching and other fishing—mortality of released fish whether caught intentionally or as by-catch is reported to be high—to irritation at the effect of an increasing abundance of large territorial adults in restricting both the numbers, and the availability to divers, of other reef species.

I TERMS OF REFERENCE FOR THE REVIEW OF THE GOLIATH GROUPER ASSESSMENT.

Evaluate the adequacy and appropriateness of fishery-dependent and fishery-independent data used in the assessment (i.e., are the input data scientifically sound and up to date?).

The fishery-independent data comprised two time series consisting of visual-survey counts of adult fish carried out by divers⁴. The first series (made by Mr D. DeMaria) had the following characteristics: few (5) sites, all relatively distant from the coast in the eastern Gulf of Mexico; all observations were made by one observer; a 21-year series (1982–2002; although not at all sites were surveyed over the entire period). The second, made by the Reef Educational and Environmental Foundation (REEF), was a nine-year series covering 1994–2002. It had many sites, all relatively close to land in the reef tract off the east coast of Florida and the southern edge of the Florida Keys. Observations were made by many different observers but the methods were standardized, and all the counts were censored at a maximum of

⁴ Porch, C.E., and A.-M. Eklund. 2003. Standardized visual counts of goliath grouper off south Florida and their possible use as indices of abundance. Contribution SFD-0017, Sustainable Fisheries Division, SE Fisheries Science Center, NMFS, Miami, Fla.

two fish sighted. Both series were census-type surveys. There was no mention of the collection in the course of either survey or other data, such as estimated length.

The first series was questioned with respect of how well it reflects the abundance or density of the species over its entire range in south Florida waters. The fact that a single observer collected the data was considered a strength of the series, but its limited coverage of a small set of similar sites in a restricted area remained a concern. It was not clear whether these sites represent the predominant range for the species in the long term: observations were cited of historical aggregations near shore in shallow water in many locations around the coast. However, anecdotal observations were advanced that indicated broadly similar trends in other areas of western Florida further north, and it was also observed that the overall trend of the series is supported by that of the Everglades National Park creel survey series. It was concluded that the data series was acceptable for the assessment.

The inclusion of the data from 1982 and 1983 in the DeMaria series was also questioned. The assessment that was presented had omitted both these years on the grounds that large reductions in numbers observed from 1982 to 1984 reflected intensive fishing subsequent to, and consequent on, discovery of these sites and may therefore represent a localized effect. This decision was questioned. One of the arguments for including those two points was that the sites might have been fished before the survey was begun in 1982. Additionally, fishery landings data, which had been excluded at the data workshop, signaled a 40% drop in landings at the same time. However, the commercial landings were subject to problems of both over- and under-reporting, and therefore such a drop in commercial landings was not considered to be a reliable indicator of a corresponding reduction in overall stock abundance. Furthermore, including the 1982 data impaired the agreement between this series and the others. The Review Panel's final recommendation was to include the 1983 data, but to exclude the 1982 data from the assessment.

The REEF diver survey along the Florida reef tract was accepted for use in the assessment with little discussion. The censoring of the data at 2 fish per survey station was considered unlikely to be significant in terms of the assessment, since the numbers of observed Goliath Grouper in this survey were overall very small. The inclusion of a data series from a geographical fringe of the distribution was considered an advantage, because it might help the aggregated data to track the trend of the species in more of its range.

Another set of data consisted of subjective estimates of the decline in stock size between 1950 and 1990 obtained by telephone interviews with 9 experienced fishermen and divers who were active over the whole period. The Panel considered these estimates acceptable for the assessment.

The fishery-dependent data available consisted of a single creel-survey series from the Everglades National Park (ENP)—where coastal mangroves are principally considered habitat for juveniles—covering 1973–1999 and reporting catch and effort from a total of 165,734 trips⁵. The data were restricted to 14,026 trips that reported catching Goliath Grouper or species deemed, from analysis of the total set, ‘associated’ with Goliath Grouper. This restricted set was used to calculate a catch:effort series as an index of abundance of the sub-adult segment of the stock. Effort per observation was estimated.

The restriction method used on the ENP data series was discussed. Among the points raised were that some of the associations determined by the association analysis were biologically unconvincing, and suggestions were made both that the association threshold should be made more stringent and that it should be relaxed⁶. No consensus was reached for changing the assigned value either way, and the threshold was left unchanged. It was pointed out that the restriction was a numerical exercise to avoid gross biases due to time trends in the proportion of trips that were directed completely away from Goliath Grouper habitat. There was discussion on the effect of including all trips that caught Goliath Grouper, regardless of the presence of associated species, in the restricted set, but no consensus was reached that it induced a bias that would be significant to the assessment.

The Review Panel considered that this data series, and the treatment to standardize the catch: effort ratios, were acceptable for the assessment. There was a question about whether the relationship between catch: effort ratios and density would be different before the fishery was closed from after, but it was pointed out that even after the moratorium on landings of Goliath Grouper was instituted, a directed catch-and-release fishery continued. There were additional discussions on whether the skill of fishermen

⁵ Cass-Calay, S.L., and T.W. Schmidt. 2003. Standardized catch rates of juvenile Goliath Grouper, *Epinephelus itajara*, from the Everglades National Park Creel Survey, 1973-1999. SEDAR6-RW-2. Contribution SFD-2003-0016, Sustainable Fisheries Div. SE Fisheries Science Center, National Marine Fisheries Service, Miami, Fla. 17 pp.

⁶ It transpired after the Review Panel meeting that Cass-Calay and Schmidt had in fact tested the effect of different values of the association criterion. A more stringent value, excluding more species and more trips, gave trends in catch:effort ratios that were almost identical with those used. A lower, more inclusive, value gave trends that were somewhat more exaggerated—faster decrease at the beginning, faster increase at the end—but not very different.

in continuing to find fish, even when becoming scarce, could cause catch: effort ratios to be a non-linear indicator of average density.

By means of an existing age-length curve⁷, the ENP data were also used to calculate age-specific vulnerabilities to the fishery before the moratorium, and age-specific relative abundance after the moratorium for age classes within this stock segment (ages 0 to 5). The Review Panel questioned whether vulnerability in the pre-moratorium fishery might have reached asymptote as late as 9 or 10 yrs, and the sensitivity of the assessment to such a change was investigated. However, the study that suggested this hypothesis was not available to the Panel for review, nor designed to get this type of information. The Panel concluded to retain the vulnerability curve originally proposed.

Landings data from NOAA Fisheries exists for 1950–1990. This series ended with the imposition of the moratorium. The series had problems with both over- and under-reporting and is of limited relevance in the current state of the stock and the fishery, but might provide loose corroborative evidence for the trend of the population decline. Some catch-rate, and possibly mark-recapture, data exist from a tagging study on juveniles in the Ten Thousand Islands and Florida Bay area. These two data series were not used in the assessment.

Other life-history data were used in stock-dynamics modeling. Natural mortality estimates in the literature were used together with estimates derived from published longevity to generate a prior distribution for natural mortality^{8,9,10}. It was pointed out that the longevity estimate was obtained from an exploited population and could possibly underestimate the true natural longevity. Additional methods of determining longevity were discussed but no definite recommendations were made. Existing age-length and length-weight curves were used to generate a surrogate for age-specific fecundity. Metadata from

⁷ Bullock, L.H., M.D. Murphy, M.F. Godcharles and M.E. Mitchell. 1992. Age, growth and reproduction of jewfish *Epinephelus itajara* in the eastern Gulf of Mexico. Fish. Bull. 90: 243-249.

⁸ Legault, C.M., and A.-M. Eklund. 1998. Generation times for Nassau grouper and jewfish with comments on M/K ratios. Contribution SFD-97/98-10A, Sustainable Fisheries Division, Southeast Science Center, National Marine Fisheries Service, Miami, Fla.

⁹ Hoenig, J. 1984. Empirical use of longevity data to estimate mortality rates. Fish. Bull. 81(4): 898–903.

¹⁰ Sadovy, Y., and A.-M. Eklund. 1999. Synopsis of biological data on the Nassau grouper, *Epinephelus striatus* (Bloch, 1792), and the jewfish, *E. itajara* (Lichtenstein, 1822). NOAA Tech. Report NMFS 146. 65 pp.

other 'periodic strategist' fishes was used to generate prior distributions for parameters of the stock-recruitment relationship^{11,12}.

Overall, the Review Panel considered that the data used were scientifically sound. However, the data sets available were very limited, and restricted the type of assessment model that could be built, and therefore the conclusions that could be drawn from it.

Evaluate the adequacy, appropriateness, application and results of models used to assess stocks (e.g., measures of exploitation, abundance, and biomass).

The stock to be considered was not defined. The data available were limited to southern Florida waters. The relationship between stocks, or sub-stocks, in these different areas appears not to be well known. The meeting therefore considered that it was reviewing an assessment covering all Goliath Grouper in waters off Florida south of 26°N. Conclusions from the assessment are restricted to the areas covered by the data.

Visual surveys to count adults (DeMaria and REEF surveys) were standardized using a stepwise approach to build general linear models of logged counts, so that year effects could be isolated. In addition to year, location and season effects were statistically significant. The diagnostic statistics of the model fits were satisfactory, and visual surveys were thought to give valid indices of abundance for adults. Catch rates of juveniles from creel survey data were standardized with sequential fitting of models to proportion successful trips and to catch per unit of effort (CPUE) of successful trips. Retained factors in the proportion of successful trips were whether trips targeted Goliath Grouper or not and year. Retained factors from the analysis of the CPUE of successful trips included year, skill level of the fishing party, fishing area, and an interaction between year and area. Diagnostic statistics were again satisfactory.

The Review Panel considered that these treatments of the series of abundance indices were acceptable.

¹¹ Rose, K.A., J.H. Cowan, K.O. Winemiller, R.A. Myers and R. Hilborn. 2001. Compensatory density dependence in fish populations: importance, controversy, understanding and prognosis. *Fish and Fisheries* 2: 293–327.

¹² Myers, R.A., and G. Mertz. 1998. Reducing uncertainty in the biological basis of fisheries management by meta-analysis of data from many populations: a synthesis. *Fish. Res.* 37: 51–60.

It was remarked in the report of the data workshop and in assessment documents that no measures of absolute abundance exist for any stock segment, and no data from which any such measure could be based. Therefore, all deductions on abundance from assessment modeling are relative to a pristine stock state; deductions on fishing mortality are, by contrast, absolute.

An assessment model was built to trace stock trajectory from an assumed pristine state in 1950 through increasing fishing mortality to low stock levels, the moratorium in 1990 and subsequent increasing indices of abundance. Stock levels in the model were expressed relative to pristine. Stock structure was governed by age-specific natural mortality and age-specific vulnerability to year-specific fishing mortality. Vulnerability was assumed to follow an increasing logistic. Recruitment was governed by weight at age in the spawning stock and pre-recruitment mortality.

The model was fitted to data using Bayesian methods, and ancillary information was sought to create informative priors, including stock-recruitment relationships. Under the assumption of a linear increase in fishing mortality from 1950 through 1979, the stock structure was tracked back to its pristine state. The stock trajectory fitted the series of standardized abundance indices reasonably well.

Three sensitivity trials were carried out. 1) 1950 was replaced by 1900 as the year for which the stock state was assumed pristine. The result of this sensitivity trial showed that recovery was lengthened by several years under the altered assumption. It was recommended to retain the 1950 starting point. 2) When the age of full selectivity in the model was increased from 6 years to about age 10 years, rebuilding would already have occurred, with 50% probability, by 2002. 3) The model showed that predictions of rebuilding time were very sensitive to the assumed on-going fishing-induced mortality after the moratorium was imposed. When it was assumed that the moratorium only reduced fishing mortality to 20% of its pre-moratorium level (i.e. 80% effective), the model suggested that the stock would be unlikely to recover.

The Review Panel recognised the importance of estimating the present mortality in trying to predict rebuilding times. However, even after much discussion, and considering anecdotal evidence of on-going mortality, the Panel could not reach a single conclusion on its magnitude for lack of data. By consensus,

it was agreed that it would be reasonable to bracket a range at end-points of 10% and 1% of pre-moratorium fishing mortality in order to provide an illustrative range of rebuilding-time predictions¹³.

The Review Panel considered that the models used were appropriate for the available data, and adequately addressed questions of exploitation and relative abundance, within the limits of the data.

Evaluate the adequacy, appropriateness, application, and results of models used to estimate population benchmarks and Sustainable Fisheries Act status determination criteria (e.g., MSY, F_{msy} , B_{msy} , MFMT, MSST, and OY).

In the absence of estimates of biomass, it was not possible to estimate all standard stock benchmarks. MSY and other benchmarks referencing absolute biomass could not be estimated. An MSST relative to pristine stock state could be estimated.

The model, and the available data, are together adequate for estimating fishing mortality reference points, such as fishing mortality corresponding to any percentage SPR, and a wide range of other fishing mortality benchmarks. F_{msy} could not be reliably estimated on account of concerns over selectivity and the exact stock-recruitment relationship.

The Review Panel used a proxy for F_{msy} , $F_{50\%SPR}$, in accordance with the Gulf Council's selection of that proxy in its generic SFA Amendment. $F_{50\%SPR}$ was also the proxy for F_{OY} used by the South Atlantic Council, which in Amendment 11 to its FMP for the snapper/grouper complex had selected $F_{40\%SPR}$ as its proxy for F_{msy} .

The Review Panel considered that OY, which depends on socio-economic and other inputs, is outside its scope.

¹³ After the meeting, two members of the panel expressed reservations about the use of a value of 90% as an 'ineffective' endpoint of the illustrative range, considering it likely that the moratorium had been even less effective than this would imply. (See also 'Stakeholder Comments' below.)

Evaluate the adequacy, appropriateness, and application of models used for rebuilding analyses where appropriate, and estimate, to the extent possible, generation time and rebuilding time in the absence of fishing mortality.

The Review Panel reviewed the assessment model as a device for predicting rebuilding times for this stock, and considered the model to be adequate for estimating rebuilding times for any level of F. The Panel did not consider a scenario in which current and future fishing mortality is zero. The Panel did not review the available information on generation time⁸ as it was not part of the current assessment.

Develop recommendations for improving data collection and assessment and future research (both field and assessment).

The Review Panel concurs with the recommendations of the data workshop that the following topics be pursued in research programs on the Goliath Grouper. It recommended the following rough priority listing, as determined by the difficulty encountered in treating these topics in the course of this review:

Estimation of population size: Estimates of population size were considered to be of highest importance for future management. It was noted that because of the apparently restricted home range and high site fidelity characteristic of adults, sampling throughout the geographic range would be important. Tag/recapture studies were mentioned as a potential monitoring tool.

Estimates of on-going mortality: The issue of ongoing mortality was of critical concern to the Review Panel. Anecdotal information with regard to various sources of this mortality was presented. These sources included longline by-catch, post-release mortality, and illegal harvest. It is extremely important that these sources of ongoing mortality be identified and the magnitude of this mortality estimated.

Investigations of stock structure: This question was repeatedly raised. The assessment reviewed by the Panel was of necessity limited to south Florida owing to the geographic coverage of the data and the absence of data concerning the stock structure.

Demographics: Monitoring the demographics of the population, particularly age composition, could provide valuable information.

Reproductive biology: Developing further understanding of the reproductive biology of Goliath Grouper was considered important.

Historical abundance and exploitation: Obtaining information on historical abundance was also considered important.

Survey data. While the Review Panel considered it in the highest degree important to continue the current surveys, it recommended that data collection could be improved by extending survey efforts to better cover the full historical range of the stock.

ADDITIONAL COMMENTS

There were none.

III. STAKEHOLDER COMMENTS

From Ralph Allen: 'The fact that adult Goliath Grouper heavily aggregate at a small number of well known and easily located sites would make them extremely vulnerable to rapid depletion in the event that a directed fishery were ever opened.'

From Marianne Cufone and Don DeMaria: 'We are uncomfortable with the assumed values of post-moratorium fishing mortality on Goliath grouper. The discussion was difficult to follow and keep in perspective, as it ranged back and forth between the panel and the audience and discussion of assumptions regarding mortality rates, mortality reductions, moratorium effectiveness, and the number of fish killed per 100 in the population. Upon further consideration and reviewing the final assumed values, assuming the moratorium is 90-99% effective might be overly optimistic. The mathematics of these stock assessments is quite impressive, but we fail to see how unknown parameters such as human nature and environmental conditions can be factored into an equation. Considering the slow growth and long life of Goliath grouper, the number of dead Goliath grouper observed, and reports of fish being intentionally killed, we feel more comfortable erring on the side of conservation and not attempting to estimate moratorium effectiveness.'

From Dennis O'Hern of Largo, Fla, recreational angler, diver, spearfisher and representative for the Florida Skin Divers Association (FSDA) whose numbers represent over 500 divers: 'Goliath Grouper populations in our area of West Central Florida, roughly north of the 26 degree latitude line, are large, growing and becoming increasingly aggressive toward divers. Examples of the over-population abound, with local anglers and divers reporting goliath encounters on every wreck in the area. Even small, natural ledges are holding one or two medium to large fish. A small wreck will hold 6 fish at least, with the *Mexican Pride* (a popular local wreck) having 25 or more that appear to exceed 300 #. Many local divers, including myself, have been bumped aggressively and had fish taken from them by these large grouper.

'There are no scientific estimates or ideas of total jewfish population whatsoever. A value needs to be determined for virgin stock levels or even 1950s stock levels. Responsibility for the definition of a specific value continues to be passed from one entity to another. Without the value, there is no way to declare the Goliath population recovered. In the meantime, the goliath population is growing rapidly and unchecked at an admittedly unknown rate. This species's over-protection must be having some detrimental effects on other species' populations. By their sheer numbers, goliaths are consuming large quantities of shellfish and fish. No consumption data is currently available.

'All data used seemed to revolve around one of the nursery areas for goliaths, along with a few sites in the southwestern gulf. The data from the Gulf sites are the anecdotal observations of one individual.

'The non-natural mortality rate discussion considered what percentage of the population was poached or killed unnaturally, with no quantitative data being presented. The figure of one percent was discussed. That is ten thousand poached fish per million, a figure that is way too high. Even a thousand fish per million is too high. There is simply no evidence of poaching or non-natural mortality that would make one percent even close to a reasonable estimate. This one value can swing the goliath from being considered recovered today, to not being recovered for at least 15 more years.'

From Richard Taylor: 'Extensive visual evidence by the 60 members of the St. Petersburg Underwater Club (SPUC) shows a dramatic increase in Goliath Grouper populations occurring west of the Tampa Bay Peninsula. Goliath Grouper are being observed in all age sizes and locations. Many solitary fish are being observed at the area's numerous local ledges and outcroppings. Larger structures often hold a dozen or more Goliaths. The incidence of non-natural mortality was debated at length during the SEDAR workshop. SPUC members strongly believe that the incidence of non-natural mortality occurring is

miniscule compared to the overall population and statistically insignificant. SPUC members have not seen nor heard of any unlawful incidents with regard to Goliath Grouper and no evidence of a high rate of non-natural mortality was presented during the SEDAR workshop.'

RECOMMENDATIONS FOR THE CONDUCT OF FUTURE WORKSHOPS

The review would have been facilitated if the assessment had been examined by an assessment workshop. It would have been helpful to have the authors of all the relevant documents available to make presentations and answer questions.

ANNEX I: ADVISORY REPORT

Advisory Report Goliath Grouper

Stock Identification and Distribution: The stock is not defined and the current distribution of the species is not completely known. The conclusions of this assessment are applicable to Goliath Grouper within the limited area covered by the available data.

State of Stock: Goliath Grouper in south Florida (south of latitude 26° N) are overfished, and overfishing may or may not be occurring, depending on the effectiveness of the moratorium, which is unknown. Fishing-related mortality is known to occur, but lack of data prevents estimation of rates. If the moratorium has been at least 90% effective in reducing fishing mortality, overfishing is unlikely, and biomass in 2003 could be estimated as 76% of the target biomass, taken to be that corresponding to 50% SPR. If the moratorium had been 99% effective, biomass in 2003 would be predicted to lie at about 91% of the target biomass. Indications from the assessment were that the biomass has continuously increased since imposition of the moratorium.

Status Table: Goliath Grouper relative biomass and estimated fishing mortality, 1993–2002 with maximum, minimum, and mean for 1950–2002. (Catch was considered unreliable and was not included in the stock assessment.)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	max ¹	min ¹	mean ¹
Moratorium 90% effective ²													
B/B _{ref} ³	0.22	0.25	0.28	0.34	0.41	0.49	0.56	0.62	0.67	0.72	2.27	0.12	0.78
F ⁴ (/yr)	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.254	0.010	0.124
Moratorium 99% effective ⁵													
B/B _{ref} ³	0.25	0.29	0.33	0.39	0.48	0.57	0.65	0.72	0.79	0.85	2.34	0.14	0.84
F ⁴ (/yr)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.237	0.002	0.111

¹ Statistics based on estimates for entire period 1950–2002.

² I.e. fishing-induced mortality under the moratorium has been set for illustrative purposes at 10% of estimated pre-moratorium (1979–1990) fishing mortality.

³ B_{ref} is taken to be B_{50%SPR}

⁴ F for 1990–2002 is the stated proportion (10% or 1%) of the estimated pre-moratorium F.

⁵ I.e. fishing-induced mortality under the moratorium has been set for illustrative purposes at 1% of estimated pre-moratorium (1979–1990) fishing mortality

Management Advice: The moratorium should be maintained at least until a future assessment shows that the biomass achieves the rebuilding target. Any fishery could risk rapidly depleting the stock, and would require careful monitoring.

Forecasts: Forecasts of future biomass were critically dependent upon the level of fishing mortality during the moratorium, but were also associated with large uncertainties due to imprecise fits of the model to available data. When these two sources of uncertainty are combined, the year by which the biomass in south Florida waters can be expected (with 80% confidence) to be rebuilt is estimated to lie between 1999 and sometime beyond 2020 (Figure 1).

Forecast Table: Forecast point estimates of biomass relative to MSST, 2003-2012, for two illustrative values of moratorium effectiveness.

	Moratorium Effectiveness	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
B/B _{ref}	90%	0.76	0.81	0.85	0.89	0.93	0.97	1.01	1.05	1.08	1.11
	99%	0.91	0.98	1.04	1.10	1.16	1.22	1.28	1.34	1.39	1.45

Catches: The stock is under moratorium. There are data on catch and release, mostly of juveniles, but no data on associated mortality and no data on poaching or other directed takes, or on by-catch. Catch data prior to the moratorium are considered unreliable.

Data and Assessment: An age-structured production model was fitted to visual count data from offshore south Florida in the eastern Gulf of Mexico, catch and effort data from inshore mangrove habitat in Everglades National Park, and visual count data from the Florida Atlantic Reef Tract (Figure 2). The model assumed a pristine stock in 1950, fishing mortality increasing linearly with time until 1979, and stable fishing mortality from 1980 until 1990 when the moratorium was imposed. Assessment runs were made under suppositions that the moratorium had been 90% or 99% effective. No data were available to support either supposition. No reliable catch data were available to tune the model, which therefore provided a trajectory of relative biomass.

Biological Reference Points: Absolute values of biological reference points related to biomass (MSY, OY) are not available. Point estimates of F_{msy} range between 0.083/yr and 0.093/yr. The point estimate of $F_{50\%SPR}$ is 0.095/yr. MSY is assumed to occur at $F_{50\%SPR}$ based on the current generic SFA Amendment adopted by the Gulf of Mexico Fishery Management Council, and at $F_{40\%SPR}$ based on Amendment 11 to the South Atlantic Fishery Management Council FMP for the snapper-grouper complex. Given the life history and low natural mortality of Goliath Grouper, the Review Panel recommends that the MSST proxy be $(1-M)*B_{msy}$.

Biological Reference Points Table. Goliath Grouper in South Florida, for two illustrative levels of moratorium effectiveness.

	Effectiveness of Moratorium ($(F_{before} - F_{after})/F_{before}$)			
	90%		99%	
	Estimate	SE	Estimate	SE
F_{msy} (/yr)	0.09	0.0174	0.08	0.0190
$F_{50\%SPR}$ (/yr)	0.05	0.0158	0.05	0.0159
$F_{40\%SPR}$ (/yr)	0.07	0.021	0.07	0.021

Fishing Mortality: The assessment model assumed fishing mortality to increase linearly from a low value in 1950 to a plateau in 1979. Estimated maximum annual fishing mortality was around $F=0.25$ /yr, experienced from 1979-1989. The moratorium is known to be imperfect. Assessment runs were made under suppositions that it had reduced the fishing mortality by 90% or 99% of the maximum. No data were available to support either supposition.

Recruitment: No estimates of recruitment are available.

Stock Biomass: The assessment was limited to southern Florida waters. Only relative measures of biomass are available. Relative biomass has increased steadily since the moratorium was imposed in 1990, at which time it appears that biomass had fallen to around 5% of the pristine level. 2002 biomass is estimated to be 31% of pristine if the moratorium were 90% effective, and 36% of pristine assuming 99% moratorium effectiveness. Three independent surveys indicated that biomass has increased since the early 1990s (Fig. 2).

Special Comments: The panel noted that it is difficult to infer stock status owing to a lack of reliable catch data and to the limited geographic range of available survey data. A stock definition combined with expanded monitoring efforts to cover the stock range would benefit future assessment efforts.

Sources of Information:

- Porch, C.E. and A.-M. Eklund. 2003. Standardized visual counts of goliath grouper off south Florida and their possible use as indices of abundance. SEDAR6-RW1, 25pp.
- Cass-Calay, S.L. and T.W. Schmidt. 2003. Standardized catch rates of juvenile goliath grouper from the everglades national park creel survey, 1973-1999. SEDAR6-RW2. 17pp.
- Porch, C., A.-M. Eklund and G.P. Scott. 2003. An assessment of rebuilding times for goliath grouper. SEDAR6-RW3. 23pp.
- Anon. n.d. [2003]. Goliath grouper data workshop report. SEDAR3-DW1. 11 pp.

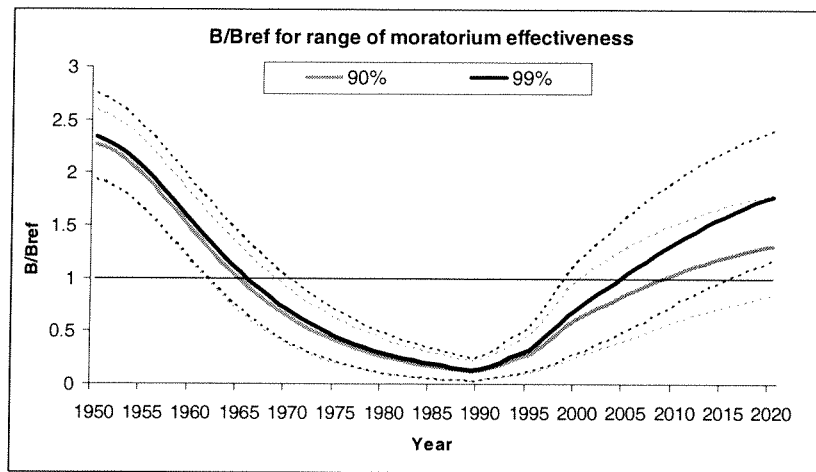


Figure 1. Estimated trend in biomass relative to the reference biomass from 1950 to 2020 for two assumed levels of moratorium effectiveness.

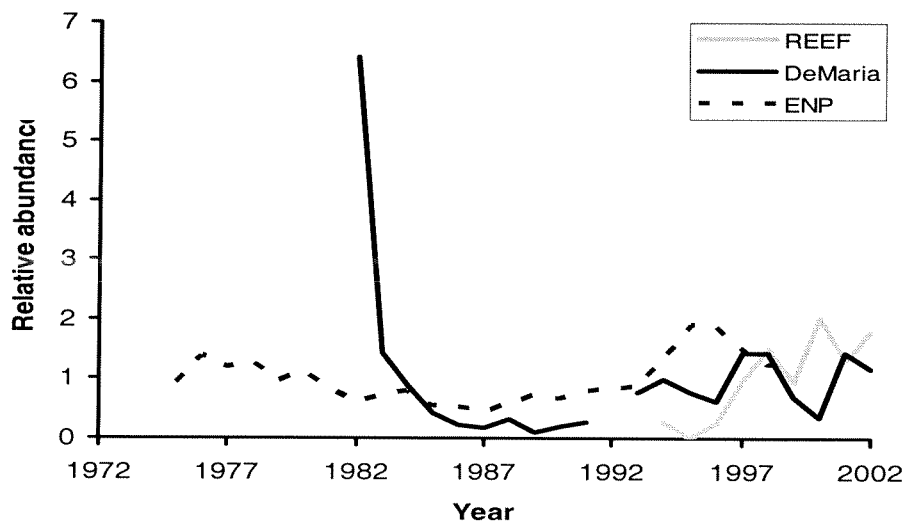


Figure 2. Trends in relative abundance for 3 surveys of Goliath Grouper.

ANNEX II: GLOSSARY AND ABBREVIATIONS

B	stock biomass level
B_{msy}	value of B capable of producing MSY on a continuing basis
B_{ref}	value of B used as a proxy to represent B_{msy}
$B_{50\% SPR}$	value of B corresponding to 50% of the spawning potential in an unfished stock
CPUE	catch per unit of effort
ENP	Everglades National Park
GMFMC	Gulf of Mexico Fishery Management Council
F	(instantaneous) fishing mortality
F_{msy}	fishing mortality to produce MSY under equilibrium conditions
$F_{50\% SPR}$	fishing mortality that will result in $B_{50\% SPR}$ under equilibrium conditions
M	(instantaneous) natural mortality
MFMT	maximum fishing mortality threshold, a value of F above which overfishing is deemed to be occurring
MSST	minimum stock size threshold, a value of B below which the stock is deemed to be overfished
MSY	maximum sustainable yield (equals F_{msy} times B_{msy})
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
OY	optimum yield
REEF	Reef Educational and Environmental Foundation
SAFMC	South Atlantic Fishery Management Council
SEDAR	Southeast Data, Assessment and Review
SFA	Sustainable Fisheries Act of 1996
SPR	spawning potential ratio, stock biomass relative to an unfished state of the stock