

The Red Grouper Question 1999 – 2000

prepared by

Trevor J. Kenchington Ph.D.
Gadus Associates,
Musquodoboit Harbour, Nova Scotia

for

Southeastern Fisheries Association

and

Southern Offshore Fishing Association

March 2001



The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

Introduction

In 1999, while the red grouper fishery out of west-coast Florida was enjoying its best year in a decade, Schirripa *et al.* (1999) produced a new stock assessment which concluded that the resource was both grossly overfished and undergoing extreme overfishing. Rebuilding the biomass to the target level was predicted to need a 75% reduction in catches, which would necessitate restrictions on all those fisheries which take incidental catches of red grouper and likely closure of all directed fishing, for a period of ten years. Such estimations, naturally enough, provoked the fishing industry into a critical examination of the scientific advice with the commercial sector, and particularly the longline fishermen, taking the lead role.

After nearly 18 months of meetings, reports and additional analyses, the formal advice to the Gulf of Mexico Fishery Management Council was amended to the point that simply holding red grouper catches at 1997 levels for ten years was seen to be sufficient to build the biomass to the target tonnage. The Council now has the task of developing an Amendment to the Reef Fish FMP that, among other objectives, provides an adequate response to that scientific perception of the state of the red grouper resource.

This report has been prepared, at the request of the Southeastern Fisheries Association and the Southern Offshore Fishing Association, in an attempt to clarify the many twists and turns of the scientific discussions leading to the revised advice and thus to facilitate the management deliberations. After an introductory summary of the fishery itself, it provides a largely-chronological account spanning from the first assessment of the red grouper resource west of Florida, performed in 1991, up to date. The author has been involved in this issue, as a science consultant to the fishing industry, since the fall of 1999. In that role, he attended as an observer the meetings of the Council's Reef Fish Stock Assessment Panel ("RFSAP") in 2000, though not the meeting held in 1999.

The Red Grouper Fishery

Red grouper has long been the principal reef-fish resource in the waters west of Florida. Indeed, with the decline of red snapper, red grouper now support the largest reef-fish fishery in U.S. waters of the Gulf of Mexico. Yet the west-coast Florida red grouper is only the smaller of two major concentrations of the species within the Gulf, the larger one inhabiting Mexican waters on Campeche Bank, off the northern Yucatan. There are few red grouper in U.S. Gulf waters west of the Alabama state line and there does not seem to be any significant interaction between the eastern and western concentrations.

Large-scale exploitation of red grouper began in the mid-19th century when Cuba developed its "high seas" fishery – the *pesca del alto*. That grew into a substantial schooner fishery which supplied fresh grouper to the Havana market until the 1950s. Following the Revolution, a modernized Cuban fleet appeared and fished west of Florida until the extension of U.S. jurisdiction in 1977. (Thereafter, the Cubans continued to fish

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

Campeche Bank under Mexican licenses.) The U.S. grouper fishery developed later, growing gradually through the mid-20th century, and took much smaller catches than the Cubans did until the 1960s. It has since expanded until, in the early 1990s, it was taking nearly as much red grouper as the combined efforts of both U.S. and Cuban fishermen had done twenty years earlier.

This fishery has always used primarily hook-and-line gear, though red grouper have also been taken by fish traps, as they still are. The Cubans used handlines until they began to adopt bottom-set longlines in 1965 (Tashiro & Coleman 1977). U.S. fishermen also used handlines at first but specialist red grouper fishermen increasingly turned to longlines after 1980 since this species tends to be scattered across wide areas rather than aggregated, as some other groupers are, making longline the logical and efficient gear. Those fishermen who have not adopted longlining have mostly turned to automated electric reels (“bandit” gear) in place of true handlines¹. Red grouper is primarily a commercial resource, since it predominates in areas far from shore, but there is nevertheless a not-inconsiderable recreational harvest of the species. As recently as 1995, recreational catches amounted to nearly a third of the total though that fraction has since dropped to not much more than 10%. As is to be expected for a reef fish, red grouper are taken in mixed-species fishing. It is the primary target of most of the bottom longliners working west of Florida but it is more often a secondary target or an incidental species for other fishermen.

Through the 1990s, the U.S. Gulf commercial reef-fish fleet comprised about 1600 vessels, though that number rose to 2215 in 1998. Of the total, about 200 were longliners and 1000 vertical-line boats². Some 1200 of the vessels in this reef-fish fleet annually file logbooks showing grouper fishing, the maximum number to date being 1436 in 1998. Only 1299 did so in 1999. The number of longliners filing such logbooks reached a maximum of 194 in 1994 and declined to 155 by 1999. In contrast, 1038 vertical-line boats filed grouper-fishing logbooks in 1998³. There is also a small trap fleet but by 1998 it had declined to about 50 boats landing less than half a million pounds of red grouper between them (SEP 1999).

The vertical-line boats make many short (one to two day) trips but land few red grouper, since it is only an incidental catch on most trips. The longliners, in contrast, make only about 1500 trips per year between them (1632 in 1998, 1431 in 1999)⁴ but those are longer, typically 12 to 14 days each (SEP 1999). In 1998, 90% of the vertical-line boats averaged less than 1,000 lb. of groupers (all species combined) per trip and half of those

¹ “Bandit” fishing is not separately identified in the various data sets and hence is frequently labeled “handlining”. To avoid confusion, I here label both gear types as “vertical line” to distinguish them from (horizontal) longlines.

² Numbers drawn from “Fishing activity for groupers in the Gulf of Mexico”, an April 2000 response to an information request from Mr. Robert Spaeth prepared by John Peffenberger of NMFS’s Southeast Fisheries Science Center.

³ Numbers drawn from handouts circulated at the December 2000 RFSAP meeting.

⁴ Numbers drawn from handouts circulated at the December 2000 RFSAP meeting.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

which filed grouper logbooks landed less than that much in the entire year. In contrast, half of the longliners landed an average of 3,000 lb. or more per trip and 15,000 lb. or more in the year, while one in ten of the longline fleet had annual grouper landings of 75,000 lb. or more. There are, nevertheless, some vertical-line boats which are grouper specialists. In 1998, 100 of them landed 10,000 lb. or more each⁵. These are, however, figures for all groupers combined while the relative catchabilities of the different species on various gears mean that red grouper are disproportionately taken by longlining. Indeed, in 1998, 53% of the red grouper catch was landed by just 50 boats on 701 trips (SEP 1999), likely all of them longliners. Thus, there is a small fleet of longliners, most of them heavily dependent on red grouper, which accounts for the bulk of the catches, plus a large fleet of vertical-line boats which take some groupers. Amongst the latter are a few grouper-specialists, some of whom may rely on red grouper for a substantial fraction of their catches.

The overall red grouper catch from U.S. Gulf waters declined through the early 1990s, reaching a minimum in 1996 of 4.9 million pounds. It increased little over the following two years but in 1999 jumped sharply to slightly exceed eight million pounds. That included nearly seven million pounds taken by the commercial fleet – the highest commercial red grouper landings in a decade and an amount that has only ever been equaled or exceeded by the U.S. fleet four times⁶. The recreational catch in 1999 was about 1.2 million pounds⁷. The dockside value of commercial red grouper landings in 1998 was \$8.6 million. However, after adjustment for inflation, the value of all commercial grouper landings that year (and hence likely also of red grouper landings alone) was only 60% of its 1986 peak (SEP 1999).

Development of Red Grouper Assessments

Despite its importance to the fisheries of the Gulf of Mexico, red grouper has been little studied until recently and knowledge of the species remains very weak. Assessments of the resource in U.S. waters only began a decade ago, with the work of Goodyear and Schirripa (1991). That was largely just a compilation of the then-available information, as was appropriate for the foundation for subsequent assessments. Goodyear and Schirripa (1991) did attempt to estimate mortality rates but, given the limitations of the available data, could only tentatively suggest that the fishing and natural mortality rates were approximately equal at about 0.2 each⁸. They also performed yield-per-recruit

⁵ Numbers drawn from “Fishing activity for groupers in the Gulf of Mexico”, an April 2000 response to an information request from Mr. Robert Spaeth prepared by John Peffenberger of NMFS’s Southeast Fisheries Science Center.

⁶ The record U.S. red grouper commercial catch, about eight million pounds, was taken in 1982 (Schirripa *et al.* 1999).

⁷ Details of recent catches drawn from handouts circulated at the December 2000 RFSAP meeting.

⁸ I would place no credence whatsoever in those estimates. Neither the estimation of the total mortality rate at 0.4 nor the assumption that the natural mortality rate in red grouper is 0.2 can be taken seriously.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

calculations to estimate the biological reference points $F_{0.1}$ and F_{MAX} ⁹ at 0.19 and 0.59 respectively, assuming that no red grouper less than the 20-inch minimum-size limit are killed by fishing. The same calculations suggested that fishing at $F_{0.1}$ should allow the spawning biomass-per-recruit (the “SPR”) to be 40% of what it would be in the absence of any fishing, while fishing at F_{MAX} would result in 19% SPR. If undersized fish are in reality subject to substantial discard mortality, the values of $F_{0.1}$ and F_{MAX} would be reduced (F_{MAX} to about 0.2), though the corresponding SPRs would remain steady or even increase slightly.

Goodyear and Schirripa (1991) did not draw any overall conclusions concerning the status of the red grouper resource or its fishery. A straightforward reading of their numerical estimates would suggest, however, that in 1990 the fishery was either operating at about the safely-conservative $F_{0.1}$ level, with high spawning biomass, or (if many small fish were being discarded dead) at about F_{MAX} with a spawning biomass around 30% SPR. In either case, it would have been within the limits of the then-recognized management thresholds, which set a lower acceptable limit of 20% SPR. Unfortunately, in my judgement, the available information on growth and death rates in red grouper was by no means sufficient to support such estimations and I would strongly recommend that Goodyear and Schirripa’s (1991) numbers be regarded as highly uncertain. They did all that could be done with what they had but the most that should be concluded is that there was no evidence that the red grouper fishery in 1990 had room for further expansion nor any that it required downsizing.

The next assessment was performed two years later (Goodyear & Schirripa 1993). The resulting document was to a large extent simply an updated version of the previous one, with the addition of information on sex ratio and genetic population structure, some new data on growth rates, plus an examination of trends in catch rates. Goodyear and Schirripa (1993) also reworked their estimates of mortality rates and biological reference points while adding a Virtual Population Analysis (“VPA”). The latter used the most advanced methodology available but, in the absence of a routine ageing program run over many years, its results cannot merit serious consideration: VPAs require extensive data on catches-at-age over time as their basic input information and, without them, produce “results” no more reliable than could be achieved by rolling dice.

Goodyear and Schirripa’s (1993) estimate of the current total mortality rate was increased to 0.50 from their earlier 0.40, though the fundamental flaws in the calculation arising from a lack of data could not be corrected. $F_{0.1}$ and F_{MAX} (in the absence of discard mortality) were re-estimated as 0.27 and 0.63, respectively, or significantly above (i.e.

⁹ The definition of $F_{0.1}$ cannot be explained in the space available here. Suffice to say that it is a level of fishing mortality (and hence of fishing effort) that in theory should provide safely-conservative fishing with high catch rates and yet landings not much less than the theoretical maximum achievable. F_{MAX} is the level of fishing mortality that is estimated to give the maximum catch per million recruiting fish, for some given mix of fish ages in the catch. Its calculation does not take account of any reduction in recruitment that may result from reductions in the spawning biomass resulting from fishing pressure.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

less conservative than) the earlier estimates. The corresponding spawning biomasses were above 45% and 25% SPR respectively. Should there be substantial mortality of discarded, under-sized fish however, Goodyear and Schirripa (1993) estimated F_{MAX} to be near 0.2, as in their previous assessment, while the spawning biomass under such fishing was calculated to be little over 20% SPR. Thus, provided that fishing-induced deaths of small red grouper were minimal, the numerical estimates (themselves no more reliable than those of two years earlier) still suggested that the fishery was operating at about the desirable $F_{0.1}$ level. If discard losses were high, however, fishing effort seemed to be near or even beyond the then-acceptable limit for management purposes.

Goodyear and Schirripa (1993) did not make much of their examination of temporal trends in catch rates, which they seem to have seen primarily as input to their VPA rather than as an indication of resource status that was free from the complexities of modeling. They did introduce a Cuban data set of catches and the corresponding fishing efforts, extending from 1940 to 1976, which is discussed in detail below. It appeared to show that catch rates had been high in the 1950s, declined after 1958 and then leveled off at low values. On its face, that suggested a substantial decline in biomass around 1960 with no subsequent recovery. U.S. catch rate data were only available from 1990 onwards, which meant that there was no overlap with the Cuban time series and too short a run of U.S. information for any trends to be seen. In so far as anything could be deduced, it was that the fishery had been stable since the start of the decade.

Further progress clearly required improved information on the ages and growth rates of red grouper. In 1994, Goodyear (1994a,b) presented some analyses of the existing data sets, exploring them for additional understanding. He showed that the estimation methods used previously (Goodyear & Schirripa 1991, 1993) produced values of mortality rates that were biased downwards, while he also remarked on their imprecision. Goodyear and Schirripa's (1993) estimate of 0.49 for the period before 1990 was replaced by the range 0.29–0.55. Unfortunately, corrected values for the 1990s, which were the only ones of immediate management value, could not be determined from the available data. Nevertheless, Goodyear (1994a,b) probably took analysis of the then-existing data sets as far as it could go, such that any further advance would need new data-collection programs. The implications were well stated by the RFSAP (1994):

[T]he stock assessment process cannot calculate a valid estimate of mortality from the data collected after the minimum size was enacted in 1990. After much discussion, the Panel concluded that it is imperative to develop annual area-gear specific age-length keys¹⁰

That Panel did note that the spawning biomass in the late 1980s could be estimated at between 20% and 52% SPR, while the 20-inch minimum size limit for red grouper set in

¹⁰ Unfortunately, the samples and data needed for the preparation of those age-length keys are still not being collected.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

1990 should have served to increase this biomass (RFSAP 1994). As such, the resource was likely above the then-prevailing 20% SPR management threshold.

There was no new assessment of red grouper through the following few years and thus perceptions remained unchanged: The resource appeared to be above the minimum acceptable level but it was not possible to judge, with any useful precision, how much above that limit it might be. Mortality rates seemed to lie between acceptable and optimal. Such little as was documented of catch rates suggested that they were stable. The overall impression seems to have been that there was little reason for concern. In my opinion, however, even such vague generalizations place more reliance on the assessment calculations than the input data available for red grouper can support.

Any further scientific progress was then overtaken by legal changes with the passage, in 1996, of the Sustainable Fisheries Act. The resulting amendments to the Magnuson-Stevens Act, as they were subsequently interpreted in the National Standards Guidelines of 1998, required new, more conservative management targets and thresholds. The implications for the reef fisheries of the Gulf of Mexico are under discussion but, pending a final resolution, NMFS is using a minimum biomass threshold of 80% of B_{MSY} and a maximum fishing mortality threshold of F_{MSY} , while B_{MSY} and F_{MSY} are separately estimated in each assessment calculation¹¹. It is not clear where the results of the earlier assessments (Goodyear & Schirripa 1991, 1993) would have placed red grouper relative to these new thresholds.

A New Assessment in 1999

In the spring of 1999, Schirripa *et al.* (1999) produced a new assessment of Gulf of Mexico red grouper, updating and enhancing the work of Goodyear and Schirripa (1991, 1993). The new document again repeated much of the content of the previous ones, while adding further discussion of growth rates. A new model (based on Goodyear 1997) was used to estimate the age composition of the catches from data on the lengths of the fish. Schirripa *et al.* (1999) also made a special and substantial effort to extend the record of U.S. catches back to 1940 to match the available Cuban data, though that required the use of questionable assumptions about the proportion of total grouper landings from before 1986 that were red grouper (species-specific landings data not being available for earlier years) as well as the use of some rather dubious data for the early decades. A parallel attempt was made to reconstruct an index of U.S. red-grouper fishing effort for that same early time period, while the multiple new catch-rate indices (and two fishery-independent indices of abundance) that had become available during the 1990s were all examined.

¹¹ B_{MSY} is the biomass that should exist when the resource is in balance with annual catches equal to the MSY. F_{MSY} is the fishing mortality rate that would be needed to harvest the MSY from a resource at a biomass level of B_{MSY} . (Exact definitions of “MSY” vary. NMFS’s stated intent is that “Dynamic MSY” should be used.)

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

The objective of all of this data preparation was a series of “forward calculating” models, which replaced the mortality estimations, VPAs and yield-per-recruit analyses of Goodyear and Schirripa’s (1991, 1993) earlier assessments. The new form of model, developed from one first presented by Legault and Restrepo (1999), is fundamentally different to those previously used in stock assessments. Yield-per-recruit models, such as the one employed by Goodyear and Schirripa (1991, 1993), comprise a structure of equations firmly based in straightforward fish biology. In practical applications, the values of various parameters (such as growth and natural mortality rates) are estimated externally to the model (often using hundreds of data points to estimate each parameter), where biases and imprecisions in the estimation can be fully considered. Once the selected parameter values are input to the model, the output results are exactly determined, while it is easy to understand what effects any errors in the parameter estimation will have had on those results. VPAs, including the one used by Goodyear and Schirripa (1993), are more complex but are still founded on well-understood population dynamics. At its core, each VPA is nothing more than a repetitive calculation of a simple relationship which says the number of fish of age t alive last year must have been equal to the sum of the number alive this year of age $t+1$ plus the number caught last year at age t and the number that died of natural causes last year at that age. Besides the clear validity of relationship underlying these calculations¹², the primary input data to a VPA is a matrix of catches-at-age – data that are both available and relatively precise for many fishery resources (though not for red grouper). The calculations proceed backwards from the maximum observed age and the most recent year. Since the numbers of fish alive in the starting age and year are not known, it is necessary to guess at values and then “tune” the analysis by entering alternative values until the model’s output matches some independent measure of the resource, such as a catch-rate index. The input numbers-at-age in the most recent year which lead to results that are closest to the independent index are then accepted as the best available estimates of the current size of the resource.

The “tuning” step makes VPA results much less reliable and predictable than those from yield-per-recruit calculations. Indeed, a quarter-century of sometimes-difficult experience leading up to the 1990s has taught most fisheries scientists to be wary of VPA outputs and only to use that form of model where extensive, high-quality data sets are available. Nevertheless, VPAs work from well-established data (typically the best-founded data available on the resource being assessed) through firmly-understood steps towards their results. In consequence, experienced assessment scientists can judge not only the direction but also the size of changes in the outputs that would result from alterations to the input data. Thus, they are able to judge the validity of the results from an understanding of the precision of the available information.

The new family of “forward calculating” models, or at least that sub-family which Schirripa *et al.* (1999) employed, is fundamentally different. Its core is (typically though not necessarily) essentially the same equation as is used in a VPA, with the difference

¹² The only error in that relationship is that it makes no allowance for the movement of fish into or out of the unit being assessed.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

that next-year's numbers-at-age are calculated from this years (i.e. the computations run forward in time) whereas VPAs run backwards from the present. That apparently-small change means, however, that these models must start their calculations from the unknown and (for most fisheries) quite unknowable levels of recruitment in past years, while estimates of the numbers of later and older fish will be directly dependent on the guessed numbers of recruits¹³. (In contrast, the numbers-at-age estimated by a VPA are primarily dependent on the input catch-at-age data, with the assumed numbers alive at maximum ages making but a small contribution.) The “forward calculating” approach also does not primarily rely on data and well-established equations to generate estimates of a few outputs, which are refined under human control through “tuning”. Rather, it calls for all available data to be fed to a computer which then adjusts the unknown values of a very large number of parameters until the results of the equations approximate to the measured values of the tuning indices. In the case of one of the models used by Schirripa *et al.* (1999) about 1500 separate items of data were input and the computer was left to estimate about 1000 parameter values. It might be argued that this is not so very different to the fitting of a VPA or at most that the differences are ones of degree. I would suggest that, if so, the degree to which the “forward calculating” approach relies on a statistical fit of a very complex model to uncertain data, rather than on limited and well-founded calculations from the best available data, puts this family of models into a whole new league of uncertainty.

Where VPAs react in logical, predictable ways to alterations in input data, the effects of such alterations on “forward calculating” models are quite unpredictable even by the most experienced analysts – as was seen during the RFSAP's deliberations on Schirripa *et al.*'s (1999) assessment, when one requested new fit of a model to an altered data set produced results quite at variance with prior expectations. Indeed, these models will sometimes respond in bizarre ways, as the computer attempts to find the best statistical “fit”. Moreover, it should be remembered that the VPA model family had been very extensively used in stock assessments around the world for close to 30 years before its limitations began to become clear to assessment specialists. In contrast, “forward calculating” models, of the type used by Schirripa *et al.* (1999), have only emerged recently and, to date, have only been used in a few centers¹⁴. It is most unlikely that all of their pitfalls and weaknesses have yet been uncovered. There are, of course, advantages

¹³ In ASAP, the number of recruits is closely tied to the spawning biomass through a curvilinear relationship. In real fish populations, such relationships must exist but they are overlain by very considerable inter-annual variation. ASAP allows for such variation, over a defined range. However, in order to fit ASAP at all, it seems that Schirripa *et al.* (1999) had to constrain this range rather severely. At least, their plots of year-class strengths against spawning biomass when ASAP was fitted to the “long” (1940-1997) data set or when fitted to the 1986-1997 data with a low value of “steepness” (see their Figure 70) indicated a degree of inter-annual variability that was grossly less than I have ever seen in survey-based or VPA-based time series of recruitments for any teleost. It would appear that the only way to achieve acceptable stability in the model fits was to constrain year-class strengths to a quite unrealistic dependence on spawning biomass.

¹⁴ I am not aware that any “forward calculating” model has yet been used in a stock assessment by NMFS's North East Fisheries Science Center, for example.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

to the approach to set against these disadvantages, particularly in that “forward calculating” models can be tailored to specific fisheries, but I remain deeply concerned that the output results are grossly unreliable – particularly when such models are used in the assessment of a data-poor resource, like red grouper.

In practice, Schirripa *et al.* (1999) used their carefully-constructed data sets in two different “forward calculating” models. The first, termed “ASPIC”, was an adaptation of the well-known (and well-known to be misleading) “general production” concepts made famous in the Graham-Schaefer model of the 1950s. In keeping with those principles, ASPIC ignored the age structure of the resource. The second model, “ASAP”, was age-structured and thus to a degree resembled a forward-calculated alternative to a VPA. Schirripa *et al.* (1999) fitted ASPIC to the full, 1940-1997, data set. ASAP too was fitted to that same data set but also to a “short” one, restricted to 1986-1997, since only for those years were original catch data identified to species available. Unfortunately, with the restricted data set, the computer was unable to select a value for a key parameter, termed “steepness”. The model was therefore fitted five times, using fixed and arbitrary values of “steepness” which spanned the possible range – a sensible and conventional response to the problem.

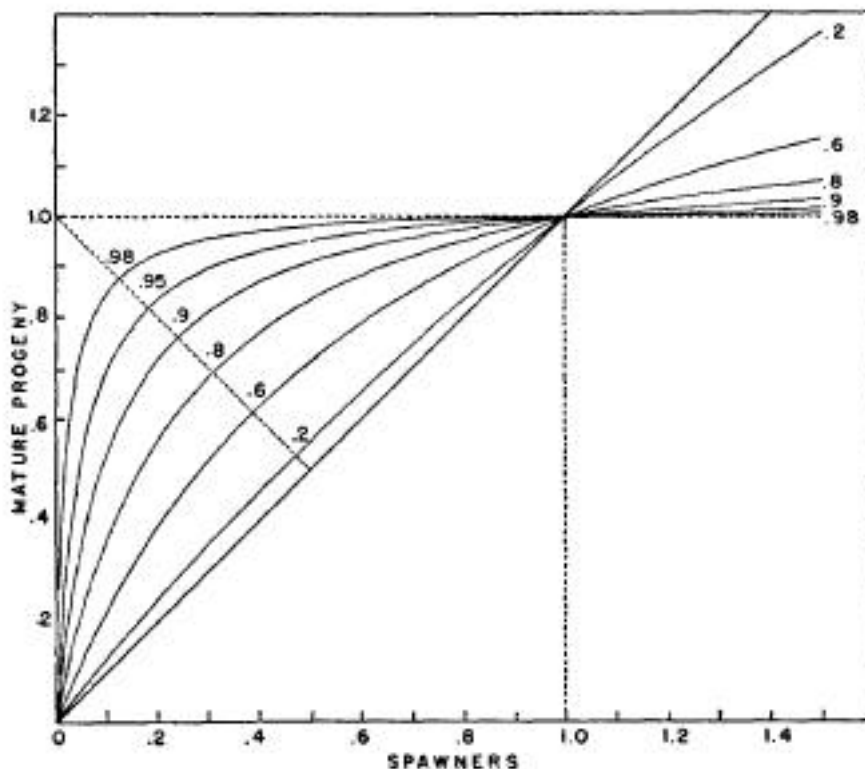


Figure 1: Series of hypothetical stock/recruitment curves based on the Beverton-Holt model used by Schirripa *et al.* (1999).

The label shown by each curve is the corresponding value of the model’s parameter “A”. It is not equal to the “steepness” of Schirripa *et al.* (1999). A “steepness” of 0.7 corresponds to an “A” value of 0.9 while a “steepness” of 0.8 approximates to an “A” of 0.95.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

“Steepness” is a parameter that helps to describe the relationship between the number of recruits and the spawning biomass that produces them. With zero biomass there can obviously only be zero recruits, whereas with high biomass there should (on average) be many recruits. For intermediate biomasses, the expected number of recruits can be represented by a curved line on a graph in which various levels of recruitment are plotted against the amount of biomass that is expected to produce them (see Figure 1). Resilient resources will produce nearly their maximum number of recruits even when the biomass is quite low and hence their curves will be steep when biomass is just above zero. Other resources (typified by the sharks) will have much shallower curves. In order to relate the shapes of various curves to one another, the practice has arisen among some fisheries scientists of measuring the height of the curve when the spawning biomass is at 20% of its unexploited level and expressing that as a proportion of the height when biomass is at the latter level. This proportion is what Schirripa *et al.* (1999) referred to as “steepness”. In theory, it can take any value between 0.2 and 1.0. In fitting their ASAP model to the 1986-1997 data, they rejected extreme values and used “steepnesses” of 0.4 to 0.8.

The net result of all of these computations was the output of seven different model runs which can be summarized as:

Table 1: Summary of results of Schirripa *et al.*'s (1999) assessment estimations.

Model	ASPIC	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP
Data Set	1940-97	1940-97	1986-97	1986-97	1986-97	1986-97	1986-97
Steep.	-	-	0.4	0.5	0.6	0.7	0.8
Yield₉₇	37%	62%	47%	53%	66%	75%	79%
Biomass₉₇	21%	26%	19%	25%	36%	49%	60%
F₉₇	208%	321%	264%	234%	197%	164%	138%
Rebuilding	2005	2008	2022	2013	2007	2004	2003
Catch	-	1.30	2.20	3.20	1.65	3.65	4.70

In the above table, the first three rows categorize the seven model fits by, respectively, the type of model, the input data set used and, where appropriate, the fixed value of “steepness” that was set. (The ASAP fit to the “long” data set estimated its own “steepness” value of 0.68. The ASPIC model does not include a “steepness” parameter.) The lower five columns summarize the results of each model fit:

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

- **Yield₉₇** is the 1997 catch (5.2 million pounds) expressed as a percentage of the MSY estimated by the model. All model fits suggested that catches could be considerably increased over the 1997 level by rebuilding the resource, with the potential increase varying between 25% and 170%.
- **Biomass₉₇** is the model's estimate of 1997 spawning biomass expressed as a percentage of the estimated B_{MSY} . All fits indicated that the resource was depressed below 80% of B_{MSY} , the interim minimum stock size threshold currently recognized by NMFS for red grouper, and thus that it was "overfished" in the meaning of the National Standards Guidelines (relative to the interim threshold). The less optimistic fits suggested that red grouper were severely depleted.
- **F₉₇** is the estimated 1997 fishing mortality rate as a percentage of the model's estimate of F_{MSY} , which itself is the legislated maximum fishing mortality threshold. All runs produced values of over 100%, indicating that there was "overfishing" (in the Magnuson-Stevens sense) in 1997. Some runs suggested that the overfishing was very severe.
- **Rebuilding** is the date by which the model predicted that the resource could be rebuilt to B_{MSY} in the absence of any fishing. While complete closure of the fishery is not a viable management option, this theoretical date is a necessary step in constructing a rebuilding plan under the requirements of the National Standards Guidelines.
- **Catch** is the estimated maximum constant annual catch (in millions of pounds) that could be taken without preventing the resource from rebuilding within the legally-mandated time limit, which Schirripa *et al.* (1999) took to be 2009 for those model runs with predicted rebuild dates no later than that year¹⁵ and, for the others, the date of rebuilding in the absence of fishing plus 11 years (a generous estimate of the mean generation time of red grouper)¹⁶. Since each model run had resulted in a suggestion that "overfishing" was occurring, it is not surprising that each also found that catches should be reduced if rebuilding was to occur within the permitted time. Estimates of the cut required, relative to 1997 catches, varied from 10% to 75%.

Looking beyond such numerical results, Schirripa *et al.*'s (1999) compilation of catch data showed that overall U.S. landings (including both recreational and commercial) had been as high as ten million pounds in 1989 but had then declined irregularly to only about

¹⁵ This date arose from a misunderstanding of the legal requirement. The correct limit is ten years from the date of implementation of a rebuilding plan, which itself is required to be submitted by the Council within one year of NMFS formally declaring a particular fishery as "overfished". For Gulf of Mexico red grouper, the declaration was made in the fall of 2000. Even if a rebuilding plan is submitted on time, it would then require Secretarial review and hence is unlikely to come into effect before the start of the 2003 fishing year. Thus, the latest target date for rebuilding would be the end of the 2012 fishing year (provided that rebuilding could be achieved by then in the absence of fishing).

¹⁶ Schirripa *et al.* (1999) did not report a maximum constant catch for the fit of their ASPIC model.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

five million in each of 1996 and 1997. They did not, of course, know that the 1999 landings would jump back a long way towards the level seen in 1989. The models suggested that the resource, as well as the catch, had declined, with increasing fishing mortality (i.e. increasing effective fishing effort) being needed to take even the diminished catch. The fishing mortality rate was estimated to have nearly doubled in the decade leading up to 1997 (Schirripa *et al.* 1999).

The various measures of commercial catch-rate available to Schirripa *et al.* (1999) showed vertical-line catches per hook-hour steady or declining slowly from 1990 to 1997, while the catches per hook-day by longliners had increased quite markedly after 1992. Catches per trap-hour were steady. Measured recreational catch rates, however, had fallen quite markedly through the early and mid-1990s, following promising increases in the 1980s and, in the case of headboats, a sharp decline when the 20-inch size limit was introduced in 1990. The fishery-independent indices showed a general decline estimated from tag records, a sharp increase in abundance estimates from a video survey and highly-variable results from a trap survey. (Because of very small sample sizes and restricted coverage of the red grouper resource, none of those three can be taken very seriously.) These conflicting trends suggest not only serious imprecisions in all data sets but also that the real experience of various sectors of the fishery has been markedly different.

It should be noted that the ASAP model generally fitted each of these catch-rate time series rather well, tracking their general trends while smoothing out their year-to-year variations. The exceptions were the sharp increase in abundance estimates from the inherently unreliable video survey and, in some cases, the increasing catch rate seen in the longline sector. When ASAP was fitted to 1986–1997 data, it did replicate the latter increase (regardless of which value was used for “steepness”) but it did not when fitted to the full 1940–1997 data set. Thus, at least when fitted to the “short” data set, ASAP replicated the recent experiences of the fishermen even though it led Schirripa *et al.* (1999) to very different conclusions about the state of the resource from those drawn by many in the industry.

It might further be noted that Schirripa *et al.*'s (1999) results agreed rather closely with those of Goodyear and Schirripa (1993). The two assessments led to very different management advice, with the earlier one suggesting that the resource was at or above the lowest acceptable limit whereas the results in 1999 suggested that severe cuts in the fishery were needed in order to rebuild the resource. However, much of that change resulted from the shift in management goals in wake of the Sustainable Fisheries Act, rather than an altered perception of the state of the resource. To the extent that the latter did change, Schirripa *et al.* (1999) saw a trend of increasing fishing mortality on red grouper through the mid-1990s, lifting it above its level early in the decade, but agreed with Goodyear and Schirripa (1993) as to where that mortality rate stood in 1990-1992: When the ASAP model was fitted to the “long” (1940-1997) data set, it produced an estimate of the fishing mortality rate in 1997 at 0.88. Schirripa *et al.* (1999) did not

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

tabulate corresponding estimates for earlier years but their Figure 66 suggests that the same fit estimated fishing mortality in the early 1990s as between 0.5 and 0.6. In comparison, Goodyear and Schirripa (1993) had estimated that same figure as 0.5. Likewise, Schirripa *et al.*'s (1999) ASAP fits produced estimates of the 1992 spawning biomass as being about 17% to 25% of “static” SPR¹⁷, compared to Goodyear and Schirripa's (1993) 25% or higher. Thus, the 1999 assessment “confirmed” and updated the previous results but changed them only slightly (albeit in a negative direction). It was the perceived worsening of resource status through the mid-1990s and the raised management standards following the Sustainable Fisheries Act which led to the apparent need to severely cut the red grouper fishery, rather than the slight change in scientific perceptions, arising from the use of new assessment techniques, of how things had stood in the early 1990s.

The Debates of 1999

Council Processes

Following the normal procedure, Schirripa *et al.*'s (1999) assessment was presented to the Gulf Council's RFSAP in September 1999. The Panel decided to set aside the ASPIC model, while noting that its results were similar to those from ASAP, and to concentrate on the results of fitting the latter model to the “long” (1940–1997) data set, since that both included all of the available information and allowed the model to estimate the “steepness” parameter, whereas the 1986-1997 data set did neither. Those choices led the Panel to conclude that the spawning biomass in 1997 was only about a quarter of its target level, while the fishing mortality rate was more than three times the allowable threshold (RFSAP 1999).

Schirripa *et al.*'s (1999) estimated rebuilding time, in the absence of any fishing, extended to 2008 when the ASAP model was fitted to the “long” data set. Under the sometimes-unfortunate terms of the Magnuson-Stevens Act, that meant that a resource which could not rebuild in less than nine years even with zero fishing had to be rebuilt within ten years. The result was a requirement for a draconian cut in red grouper catches, to only 25% of the 1997 level – a reduction which would have to be maintained for ten years. In response, the RFSAP decided to set aside the legislated requirements of the Act and to recommend that rebuilding be allowed to continue until 2018. The Panel further recommended that rebuilding proceed under a simple constant fishing mortality strategy with $F = 0.23$ (RFSAP 1999). That would have cut effective fishing effort by 75% of its estimated level in 1997, while the catch would have been reduced to 1.5 million pounds in the first year of the program but would have increased thereafter. By 2018, it would

¹⁷ Details drawn from a sheet of results circulated at an RFSAP meeting in 2000. This same sheet showed that, when fitted to the “long” data set, the ASAP model estimated that spawning biomass had been 17% SPR in 1992 and had not much increased since. When fitted to the “short” (1986-1997) data set, however, ASAP detected sharp increases in spawning biomass since 1993, such that by 1997 the resource was close to or above 30% SPR regardless of the preferred value for “steepness”.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

have reached seven million pounds, without any increase in mortality rate. Thereafter, effective effort would have had to increase 20% if the fishery was to harvest the entire 8.4 million pounds of the estimated MSY.

Limiting red grouper catches to a level as low as 1.5 million pounds would probably require complete closure of any directed fishing for the species since, in the multispecies reef-fish fishery, such a small allowable catch would need to be reserved for the inevitable incidental catches that would occur in both commercial and recreational fishing for other species. Indeed, considerable restrictions on fisheries for other groupers might be needed to bring the take of red grouper down to 1.5 million.

A meeting of the Council's Socioeconomic Panel (SEP 1999) then considered the various proposed rebuilding strategies and found that the constant-mortality and constant-catch alternatives offered essentially the same net present values (after discounting) of commercial catches if rebuilding was to be completed within the time frame allowed by the Magnuson-Stevens Act. If the plan was extended as the RFSAP had proposed, the constant-mortality option promised marginally-higher discounted revenues. These analyses, however, considered only the value of the landings, not the costs associated with the various management options. The SEP also noted that, should a TAC for red grouper be introduced at the level recommended by the RFSAP, it was "likely that the social impacts would be serious", with a list of consequences including "out migration from fishing communities, and possible impacts on community mental health." A need for buybacks, retraining programs and community-development incentives, among other possible measures, was noted (SEP 1999). The proposed management measures would have been truly severe.

Both Panels' reports were then conveyed to a Reef Fish SSC meeting in October 1999. That Committee's report¹⁸ lists various specific concerns raised by its members but does not fully set out their discussions. It does appear that the SSC was uneasy with advice calling for such a severe downsizing of a major fishery when that advice was based on a new model that most Committee members seem to have been uncomfortable with. The appearance of a sudden change from the previous advice on red grouper, as generated by Goodyear and Schirripa (1993), seems also to have been a concern even though (as explained) above that appearance was largely mistaken. Whatever their reasoning, following much debate the SSC finally decided to recommend "non-acceptance" of the RFSAP's advice on red grouper.

While it appears that their decision was based more on general doubts than on the few specific concerns outlined in the SSC's report, it may be noted that one of those concerns ultimately proved to be prescient: The tabulated numbers of Cuban days fished per year, which Schirripa *et al.* (1999) used as a measure of fishing effort, appeared excessive to one SSC member who wanted to see more analysis of the early fishery. While that

¹⁸ The SSC's report was distributed at the November 1999 meeting of the GMFMC as Tab.B No.7.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

observation had little impact at the time, it was ultimately the nature of a Cuban fishing day and the magnitude of the early catches by the *flotta del alto* that led to substantial changes in the perceived status of the red grouper resource, as is explained below.

The SSC's "non-acceptance" of the advice was reported to the Council at its Orlando meeting in November 1999. With no obvious alternative, the Council referred the red grouper issue back to the RFSAP, while calling on NMFS to provide, as soon as possible, the information needed by the Panel to address the concerns raised by the SSC.

On March 3, 2000, NMFS did provide an initial response to the Council, in the form of a letter from Dr. W.T. Hogarth (then Regional Administrator, Southeast Region) to Dr. R.L. Shipp, Chairman of the Council, which provided point-by-point comments on seven specific concerns mentioned in the SSC's report. At the request of the Southeastern Fisheries Association, on April 30 I prepared a response to NMFS's response, also in letter format. That exchange revealed a perhaps-troubling inability of NMFS's stock-assessment staff either to remember what they had done while preparing the red grouper assessment or else to communicate that information to their Regional Administrator for his signature. It also pointed up the Service's tendency to dismiss the concerns of outsiders, even including those of a Council's SSC. It did not, however, raise any new points of substance. Indeed, both Dr. Hogarth and I made the mistake of rejecting the SSC's point concerning the excessive levels of fishing effort by the Cuban fleet that were tabulated and used in Schirripa *et al.*'s (1999) document. We thereby missed the key to the principal error in the assessment.

With that exchange, the Council's 1999 processes finished with red grouper.

Longline Industry

While the Council's Panels and Committee deliberated, Schirripa *et al.*'s (1999) conclusions had caused considerable disturbance in the commercial red grouper fishery. Some of that was doubtless a reaction to proposed restrictions on future catches, particularly the draconian ones that Schirripa *et al.*'s (1999) estimations suggested were needed. There seems also to have been the same resistance that the SSC showed to what, at first glance, appeared to be a sharp change in the advice being put forward by NMFS. However, there was in addition a deep and genuine perception that the advice just did not accord with many fishermen's practical experience. To grouper fishermen from most (though seemingly not all) ports, and perhaps particularly to those longline fishermen who specialized on red grouper, it seemed that catch rates had been slowly increasing through the 1990s. Moreover, although the data would not be available until late in 2000, it is now known that 1999 red grouper commercial landings were the highest in a decade and were not far below the all-time record for the U.S. fleet¹⁹. The fishermen were doubtless aware of their own recent landings, even though they cannot have known the

¹⁹ Landings data drawn from handouts circulated at the December 2000 RFSAP meeting.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

fleet-wide total any more than NMFS did. Thus, the notion that the resource was severely overfished quite simply did not fit. On top of that, the fishermen themselves were well aware of deficiencies in the data-collecting systems, deficiencies which caused imperfections in the landings data for earlier years, concealed changes in targeting of effort over time and so forth. The possibility of being put out of business by restrictions founded in faulty data and analytical results that conflicted with practical experience was not a comfortable one.

Responding to these concerns, in July 1999 the Southeastern Fisheries Association, the Southern Offshore Fishing Association and the Florida Offshore Fishing Consortium collectively requested Gadus Associates to examine the red grouper assessment and provide a report. That initial commission has grown into a substantial involvement with red grouper management, though Gadus Associates' activity has not comprised the total or even the majority of industry involvement – industry representatives have continued to address the red grouper assessment intensively.

Several of the specific issues raised by the Southern Offshore Fishing Association (“SOFA”)²⁰ have been adequately answered. At least, it has been shown that the fishermen's observations may well be entirely correct and yet do not invalidate the results of Schirripa *et al.*'s (1999) assessment. Other issues, notably the perception that the available landings data are unreliable, may cast doubt on the assessment but alter neither its status as the “best science available” nor the need for precautionary management actions in the face of scientific uncertainty. Even the general doubt, held by many in the industry, about the reliability of pre-1986 U.S. data ceased to be relevant when severe errors were found in the early Cuban data since that revelation led the RFSAP, in December 2000, to concentrate on analyses restricted to the 1986-1997 data (see below).

One point of perhaps more lasting substance, since it involves key information which fishermen hold and scientists do not, relates to changes in targeting practices over time. The use of commercial or recreational catch rates as indices of resource abundance [as Schirripa *et al.* (1999) used various catch rates in fitting their models] requires an assumption that, on average, each measured unit of fishing effort results in the capture of the same fixed percentage of the fish then alive in the population. The many and serious failures of that assumption in a wide range of fisheries have long been well known. In the reef fish fisheries, however, there is a particularly-serious problem that is not so strongly developed elsewhere: Red grouper can be taken by directed fishing, in which the effort is targeted on that species, or as incidental catch from effort targeted on other groupers or indeed on any other reef fish. It is to be expected that a given amount of effort targeted on red grouper will catch a higher proportion of that resource than will the same amount of effort targeted on, say, gag or black grouper. Furthermore, in the 1990s some longline fishermen sometimes “split” trips, devoting part to bottom longlining for grouper and part to pelagic longlining for sharks, hence greatly reducing the real grouper effort per trip.

²⁰ These issues were noted in the report of the November 1999 SSC meeting and in comments, dated November 8, 1999, submitted to the Gulf Council by the Association.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

Small changes in regulations, fishing costs or fish availability will have caused fishermen to shift their targeting among the various reef fish may, likely with substantial effects on recorded catch rates of red grouper. Those rates may have increased or declined very substantially relative to the trends in the resource itself, masking real biomass reductions in some cases and creating the appearance of them in others.

The data needed to tease out directed red grouper catch rates do not exist and, in the absence of useful fishery-independent measures of resource abundance, Schirripa *et al.* (1999) had no alternative but to use the available catch rates as they stand. They did not, and could not, make any form of correction or allowance for any changes in targeting. What they could have done, but did not do, was to opt for assessment approaches that would have been robust to the resulting errors or at least ones which would have had transparent responses to those errors. Instead, they chose to rely on the results of complex, unpredictable and poorly-understood “forward-calculating” models that were themselves strongly dependent on the unreliable catch-rate time series. In consequence, the conclusions of their assessment are necessarily highly questionable.

On behalf of the industry groups, Gadus Associates prepared two reports. In one, Tupper (1999) reviewed available biological information on red grouper, as a supplement to the material that had been gathered and presented by Goodyear and Schirripa (1991, 1993) and by Schirripa *et al.* (1999). He produced considerable additional material, primarily from research in Mexico, though his report has not much influenced subsequent discussions, which have concerned applied population dynamics more than resource biology (though many of the participants have been experienced reef-fish biologists who have examined the dynamics in light of their knowledge of the biology of red grouper). Tupper (1999) did, however, stress one point that merited more attention than it has received even within the confines of the debates that have developed over the past months: Adult red grouper appear to prefer patch-reef habitats, living among octocorals around the fringes of such reefs, while their juveniles are found in inshore grassy and hard-bottom areas (Moe 1969; Rivas 1970, Sluka 1995). Both types of habitat have been reduced along the Florida coast in recent decades by rapid coastal-zone development. The eggs of this species also appear to need relatively-saline water (Colin *et al.* 1996). High freshwater runoff into coastal seas may limit their ability to utilize inshore nursery grounds (Tupper 1999). Thus, red grouper are not simply habitat-dependent, as all reef fish are, but also make use of inshore habitats that are vulnerable to the effects of coastal-zone development. Assessments of habitat-dependent resources which ignore the implications of habitat degradation, as Schirripa *et al.*'s (1999) assessment did, are apt to produce serious errors, particularly when those resources inhabit regions that have seen rapid coastal and inland development, as has occurred in Florida in recent decades.

The other report (Kenchington 1999) was the current writer's attempt to summarize the issues surrounding Schirripa *et al.*'s (1999) assessment in a suitable format for presentation to the Gulf Council at its November 1999 meeting. In the event, the SSC's “non-acceptance” of the RFSAP's advice negated the point of the presentation, which

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

was only offered in a highly-abbreviated form. Kenchington's (1999) report therefore became an input to subsequent scientific discussions, for which it was not really suited²¹. The points made were several, including:

- Schirripa *et al.*'s (1999) compilation of data from various sources into a time-series of annual landings from 1940 to 1997 was a valuable effort but produced highly-uncertain numbers.
- The only available indices of red grouper biomass (save for some small-scale monitoring in the late 1990s) are the catch rates in various commercial and recreational fisheries. Those must necessarily be used for the lack of anything else, yet even under the best circumstances catch rates are notoriously unreliable biomass indices and in a perfect world would always be rejected in favor of fishery-independent monitoring. Moreover, the red grouper fishery offers circumstances that are far from the best, being a multispecies, fixed-gear fishery. Any assessment of the red grouper fishery that relies on catch-rate indices (as any such assessment must) will, therefore, be very highly suspect.
- The pronounced fall in recorded Cuban catches and catch rates in the late 1950s and early 1960s, which Goodyear and Schirripa (1993) had noted and assumed was related to changes in the resource²², was suspiciously close in time to the dates of the Cuban Revolution. The last year before the decline was 1957 and it was largely over in 1961, while the Revolution began in March 1958 and, though it had no well-defined end, the Havana regime's nadir might be taken as the Missile Crisis of 1962. Without proposing a specific mechanism, Kenchington (1999) suggested that the fall in recorded catch rates may have been an artifact of political and administrative disruption in Havana, rather than reflective of changes in the resource.
- It was further suggested that the Cuban fishing industry itself may have been disrupted by the Revolution, perhaps leading to the emigration of the more efficient fishermen and the larger vessels. [Subsequent consideration has shown that the post-Revolution fishery was actually modernized and should have been considerably more efficient than the old schooner-handline fishing of the 1950s (see below).]
- Schirripa *et al.*'s (1999) use of recorded Cuban catch rates for the 1940-1976 period not only made the normal (if unstated) assumptions about catchability remaining constant over a prolonged period of technological, resource and market change but also an added one that the accuracy of fishery statistics is

²¹ Kenchington (1999) explicitly did not attempt to verify the data used by Schirripa *et al.* (1999) – an unfortunate choice since data problems later proved fatal to the analyses that the RFSAP had relied on.

²² Goodyear and Schirripa (1993) actually suggested that this decline was “possibly as a result of the removal of the accumulated biomass of older fish that often accompanies a new fishery”, despite the Cuban *pesca del alto* having been in operation for about a century by the time catch rates dropped precipitously in 1958.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

not significantly degraded when the government which compiles them is replaced through a violent revolution, while the accompanying upheaval impacts the entire society within which the fishery operates. The latter assumption is hardly tenable and its rejection should have led to the rejection of the Cuban catch-rate time series as an index of resource biomass.

- The only measure of U.S. fishing effort for 1940–1980 that Schirripa *et al.* (1999) used was actually the count of documented handline vessels based on the west coast of Florida. No such number can be taken very seriously as a measure of effort in a specific fishery, such as that for red grouper, particularly since neither Schirripa *et al.* (1999) nor anyone else has explored temporal patterns in the proportion of the fleet that opted for Coast Guard documentation. Moreover, through the 1940s and 1950s the recorded values of the index underwent erratic and unexplained fluctuations which were not consistent with the normal dynamics of a fishing fleet and cast great doubt on the tabulated numbers.
- For the period 1981–1997, for which multiple indices of resource abundance are available, there is no apparent consistency among those indices. While some of this may reflect genuine differences in trends within the red grouper population (e.g. declines in small inshore fish causing recreational indices to decline while abundant large fish in deep water lead to increases in longline catch rates), the mutual inconsistencies cannot build confidence in any of the individual indices.
- There are unexplained inconsistencies within and among the tabulations of fishing efforts and catch rates in Schirripa *et al.*'s (1999) document which may simply be mistakes in presentation or may indicate gross errors in the calculations. They must cast considerable doubt over the indices used to tune the ASAP model and hence over all results of the assessment.
- Schirripa *et al.* (1999) did not properly explain how they standardized the various catch-rate indices before using them to tune their models but such explanation as was provided seemed to indicate that the standardization was invalid.
- In one feature of their data which they did not point out in their text, Schirripa *et al.*'s (1999) plots of lengths of red grouper taken in various fisheries hinted at a decline in the relative proportion of large (more than 25 or 30 inches) fish caught on hooks (but not traps) north of Tampa. The trend was not evident from Fort Myers southwards. It is not clear whether this was a change in the resource, in catches (as a result of alterations to targeting) or an artifact of sampling. However, until otherwise explained, it stands as a warning of possible on-going increases in fishing mortality rates.
- Schirripa *et al.*'s (1999) ASAP model required estimates of catch-at-age as one of the most important inputs. Since there has never been a routine ageing program for red grouper, they were obliged to reconstruct the age

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

compositions of the catches from length data and an estimated growth curve²³. Instead of simply reading ages for particular lengths from the curve (a deficient process known as “cohort slicing”), Schirripa *et al.* (1999) used Goodyear’s (1997) “probabilistic” method though, lacking independent information on relative year-class strengths, they could not use all of its features. Indeed, they seem not to have used the method’s potential for correcting the age estimates for the effects of varying fishing mortality rates either. Thus, their age-compositions were little more accurate than those which could have been obtained by crude cohort slicing – a technique which is well known to produce wildly erroneous results absolutely unsuited for use in VPAs and probably equally unfortunate as inputs to age-structured “forward calculating” models such as ASAP.

- As a “general production” model, which in common with the rest of that family ignores the age structure of the resource, Schirripa *et al.*’s (1999) ASPIC could not be expected to give a reliable picture of the state of the resource. [It has not been given much weight by the RFSAP.]
- Each of the various ASAP model fits was an internally-consistent simulation model of a fishery²⁴ but whether each, or any, was a reasonable representation of the red grouper fishery in the Gulf of Mexico is a highly complex question which, in my view, has never been satisfactorily answered. This point is expanded below.
- The use of any model which ignores long-term environmental change risks grossly misleading answers if it is applied to a habitat-dependent resource, like red grouper, living in a region which has seen massive coastal-zone development in recent decades, as has Florida.

I also advanced (Kenchington 1999) two substantial arguments which have since been shown to have been based on my own erroneous assumptions:

- Schirripa *et al.* (1999) needed to include the numbers of red groupers discarded dead in their input data, along with information on the landed catches, if their analyses were to have any validity at all (and they deserve every credit for including discards when too many assessment scientists continue to ignore them). In order to do so, they had first to estimate the numbers of undersized fish discarded and then to apply some estimated discard-mortality rate. Kenchington (1999) criticized the method they used for the estimation, based on the description of it given in their document. However, at the December 2000 RFSAP, an account of the calculations was given which was rather different to that offered by Schirripa *et al.* (1999).

²³ A “growth curve” is a graph showing the average lengths at various fish ages.

²⁴ Internally-consistent save for an anomaly in the numbers of recruits seen in the 1940s and 1950s. That anomaly should have been an indication that the early catch data were faulty, as indeed they were (see below).

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

That version of the methods used avoided the massive “error” identified by Kenchington (1999), though it is still not fully clear how the estimates were generated nor whether the methods used produced valid answers.

What appears to have been done²⁵ was that, firstly, the age compositions of catches in the 1990s were estimated using Goodyear’s (1997) “probabilistic” method. Then some size-selective relationship (linking fish sizes to their likelihood of being caught) was generated using data from before the 20-inch minimum size limit was introduced in 1990. (The means by which that relationship was estimated have been nowhere documented.) Finally, from the numbers of young fish estimated to have been landed in recent years, the range of sizes of the young age-classes estimated from the available size-at-age data²⁶ and the vulnerabilities of various sizes based on pre-1990 selectivities, the numbers of fish of under 20 inches that were caught (and necessarily discarded) were estimated. Such a process will have over-estimated the number of discards by failing to allow for changes in fishermen’s targeting once they were not allowed to retain small fish and even more for ignoring the changed regulations which compelled longline fishermen to work outside the 20 fathom contour. It will not, however, have produced the extreme errors which Kenchington (1999) noted would have resulted from the method as it was described by Schirripa *et al.* (1999)²⁷.

- In its 1999 report (RFSAP 1999), the RFSAP offered values of the Allowable Biological Catch (ABC) which extended from zero up to some figure extracted from Schirripa *et al.*’s (1999) results, the particular figure depending on which management strategy was being discussed. In my report (Kenchington 1999), I assumed that the RFSAP was trying to communicate confidence intervals to the Council by stating both a “best estimate” and a lower bound. I argued (correctly) that such intervals must extend above, as well as below, the best estimates. In fact, my assumption was wrong. What the RFSAP meant was that the maximum ABC was equal to the estimate drawn from Schirripa *et al.*’s (1999) work but that any lower catch would also be “biologically acceptable”.

Underlying the more specific comments, in my document (Kenchington 1999) I was seeking to express the reasons for a general discomfort with Schirripa *et al.*’s (1999) approach to their red grouper assessment. The weakness of the available data sets has been stressed above, as have some of the limitations of the ASAP model and the “forward calculating” approach in general. Fisheries data are always weak and stock assessments

²⁵ Based on an account that Mr. Legault presented to the RFSAP.

²⁶ Another set of estimates that were not documented by Schirripa *et al.* (1999).

²⁷ Schirripa *et al.*’s (1999) discard estimates included some fish discarded in the years before the 20-inch size limit was introduced in 1990. Yet, by Mr. Legault’s account, the estimation methods used could not have produced any numbers above zero for discards in those years. He was unable to explain this anomaly during the RFSAP meeting.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

are necessarily to some degree blind shots in the dark. Even the best of them can be far wide of the mark. When faced with situations that are extremely data-poor, even by fisheries standards, in my experience it is important to keep the analytical methods simple, robust to the data deficiencies and “transparent”, such that not only scientists but also decision-makers can understand what has been done and what reliance can be placed on the outcome. The cost of that approach can sometimes be an inability to draw any firm conclusions at all, though that may be a realistic response to weak data sets which cannot support anything such conclusions.

Schirripa *et al.* (1999) appear to have followed a quite opposed philosophy. It seems that they attempted to use complex analyses to milk the available data of every bit of information that might be squeezed from it. If so, they succeeded. In the process, however, they risked generating results which owed more to the unfounded assumptions necessary if models are to be built in the absence of empirical knowledge than to the data itself. Unfortunately, since all of the available information (aside from fishermen’s anecdotes) was used in the construction and tuning of those models, there is nothing left with which to independently test the validity of those results. Meanwhile their highly-complex models are so impenetrable that even their designer is not fully able to predict how they will respond to assorted variations in inputs or assumptions. Without the opportunity to experiment with a full-scale copy of ASAP running on a fast computer, nobody can really understand how the model is reacting to potentially-erroneous data and hence we cannot judge the overall reliability of its output. There is, however, every reason for caution.

It is important to understand something of the logic underlying the statistical fitting of models to data. Firstly, any model can always be fit to any data, provided that there are sufficient columns of numbers to represent all of the input variables that the model needs. Unless the fit is a close one, which is best judged statistically, the existence of a fit says nothing whatever about the validity of the model. Yet even a close fit does not necessarily prove anything. It is, for example, always possible to draw a perfect circle through any three points in space, just as the three points can always be joined to make a triangle. That does not mean that the factors which caused those points to lie where they do have any particular relationship to either circles or triangles. On the other hand, if data on a thousand points, once plotted on a graph, followed an approximately circular distribution, one could conclude that the circle was in some way meaningful. In technical terms, the equation for a circle would be an “overparameterized” model if fitted to fewer than three points but not if a dozen, let alone a thousand, were available.

When more complex models are fitted to data, it is necessary for computers to operate by iterative processes. That is, one set of possible parameter values are tested against the data, the computer determines which changes will improve the fit and then calculates again with those new values, continuing until the model’s output is as close to the tuning data as the computer can make it. When such calculations are made with an overparameterized model, no results can be achieved by the computer “algorithms” used

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

for this purpose because there will be an infinite range of possible combinations of parameter values that will give equally-close fits to the data²⁸. Even if a model does not have quite enough parameters to encounter this problem, if its number of data points is not very much greater than its number of parameters, its fits can become unstable. In effect, without a great number of data points, the model will cease calculating averages through the data and will start trying to match itself to every chance fluctuation in the data. Schirripa *et al.*'s (1999) ASAP, when fitted to their 1940-1997 data set, seems to have had about 1000 parameter values to select but only about 1500 input data points. It is not in the least surprising that it was able to fit the tuning data rather closely (their Figure 64) but that is in no way an indication that the fitted model approximated to reality. If the structure of equations within the model was firmly based, one might draw more confidence from such a fit. In practice, however, their model ignored the effects of environmental change, along with those of changes in catchability by the various fisheries and the like. Thus, there are no grounds for confidence that the model was “right” and “must” have provided a realistic representation of the red grouper fishery. Rather, the basic ASAP model should be seen as a speculative hypothesis in need of testing, while close agreement to the tuning data fails to provide such a test because of the excessive number of model parameters that the computer was left to select²⁹.

Considering all of the above, and in contradiction not only to Dr. Schirripa and his colleagues but also to the members of the RFSAP, I find it difficult to take the results of either ASAP or ASPIC seriously. They are currently the “best science available” (as stressed by Kenchington 1999) and hence must carry considerable weight under the Magnuson-Stevens Act. “Best”, however, does not necessarily mean “good” and, for my part, I would only give credence to the output of either model if it lay within the range of likely results suggested by much simpler, more robust ways of examining the available data.

All of the above notwithstanding, Kenchington's (1999) major contribution was an extended discussion of the meaning of the “Precautionary Approach” in the fisheries context and specifically in the case of resources (such as red grouper) which fall under the Magnuson-Stevens Act's rebuilding requirements. In brief, I argued that the changes introduced in 1996 by the Sustainable Fisheries Act, particularly the rigid requirement for fixed timelines for rebuilding, had produced a situation that was unique in global fisheries management: Instead of management aiming to take the sustainable catch and needing to err on the side of conservation (for all of the reasons well known for a quarter century), the objective became very rapid rebuilding with its speed dictated by an arbitrary,

²⁸ This appears to be why Schirripa *et al.* (1999) could not fit their ASAP model to the “short” data set without first specifying the value of “steepness”.

²⁹ Kenchington (1999) raised a further concern: That when fitting such a complex model there may be multiple “good” fits to the data of which only one is the “best”. Yet computer algorithms find only the first “good” fit (technically a “local minimum”) which they encounter and require human intervention to find others. Based on the many ASAP results developed by NMFS for the RFSAP, it now appears that, with the specific model and data used by Schirripa *et al.* (1999), this problem of local minima is not severe.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

legislated time limit. There was, I suggested, no longer a valid reason for additional conservatism. Rather, optimal management of the resource should involve aiming directly for completion of rebuilding at the end of the allowed time. In that context, I further suggested that conventional concepts of “Precaution” in fisheries were founded on a seriously-faulty assumption: It seems to be generally supposed that, when necessary, fisheries must be cut back by management action but that, when possible, they will expand through their own internal pressures. While that is an eminently reasonable contention in the normal run of fisheries management, I suggested that it cannot be relied upon in the extreme situations created by the Magnuson-Stevens rebuilding requirement, particularly in an area like Florida where there are many competitors with the fishing industry for coastal real estate. Rather, when a fishery is squeezed almost out of existence in order to rebuild its resources quickly, the industry may be unable to expand again once rebuilding is complete. That would appear to be contrary to the intent of the Act, which does not aim to maintain fishery resources at a biomass capable of supporting Optimum Yield but rather seeks to maintain catches at their optimum level – catches that can only be taken if a fishing fleet capable of exerting optimum fishing mortality also exists. Thus, I argued that the proper management response to scientific uncertainty in the red grouper situation (where the uncertainty is massive) is not a simplistic erring on the side of conservation but rather a measured attempt to achieve legislated rebuilding targets while protecting the ability of the fishing industry to harvest future optimum yields following rebuilding (Kenchington 1999).

The Debates of 2000

Center of Independent Experts Report

Aside from the final exchange following from the SSC’s debate, which is outlined above, there seems to have been little progress on red grouper issues before the RFSAP met again in August 2000. NMFS did not prepare another assessment, as requested by the Council.

The only substantial new contribution was a review prepared by Sullivan (2000) for NMFS’s “Center of Independent Experts”. That was necessarily a limited and focused effort, addressing four specific questions set by the Center and based only on an examination of some of the documentation generated over the previous year. While he found that the methodology used by Schirripa *et al.* (1999) was fundamentally sound³⁰, Sullivan (2000) did caution that the models were only able to fit to the data when there was sufficient “contrast” – which required the use of the 1940-1997 data sets. He also cautioned that the Cuban data could be looked at more critically, both with regard to its reliability and to whether or not it related to the same portion of the overall Gulf of Mexico red grouper resources as are currently exploited by the U.S. fleet. Sullivan (2000) also expressed some general cautions about the possible implications of the protogynous

³⁰ A conclusion that the present writer cannot agree with.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

hermaphroditism of red grouper. He did not advance any similar concerns about degradation of coastal habitats in Florida nor for its possible implications for the survival of juvenile red grouper. Otherwise, he offered only suggestions for additional and alternative analyses that might be undertaken, given time and resources.

August RFSAP

When the RFSAP met in August, I presented the major points made in Kenchington (1999), particularly those relating to the estimation of discard losses, doubts about the effects of the Revolution on the Cuban data and further ones concerning the validity of the U.S. long-term effort measure (the number of documented handliners). The RFSAP saw sufficient merit in the first two of those points to call on NMFS to calculate some new model fits with amended input values so as to examine the sensitivity of the ASAP results. The Cuban catch-rate issue could be straightforwardly handled by treating the data as two separate time series, one running from 1940 to 1957 and the other 1963-1976. A proper response to the discard issue was more complex.

As explained above, Schirripa *et al.* (1999) had adjusted their estimates of landed catch-at-age by allowing for the number of fish discarded dead or dying. To do so, they used a complex and poorly-documented calculation to estimate how many sublegal-sized fish were caught by each gear sector in the red grouper fishery (see above). They then assumed discard mortality rates of 90% for longline-caught fish (i.e. 90% of the undersized fish caught and released were assumed to die and 10% to survive), 33% for other commercially-caught fish and 10% for those taken in the recreational fisheries. While the longliners would be expected to have a higher discard mortality rate than the recreational sector, due to the greater average depths at which longlining occurs, Schirripa *et al.* (1999) did not substantiate the source of their discard-mortality rates and the 90% appeared to be very high. The RFSAP therefore examined the very limited published information on red grouper survival after release, primarily the paper of Wilson and Burns (1996) and the results of the single brief observer program which has been carried out in the red-grouper fishery³¹. After very prolonged debate, an alternative estimate of discarded losses was developed in which the discard mortality rate was set at 33% for all commercial fishing, while remaining at 10% for the recreational sector, and the rate of discarding by longliners was set at 30%. Some RFSAP members saw this as a “lowball” estimate, delimiting the opposite end of the likely range of values from that chosen by Schirripa *et al.* (1999), while others saw it as a “best estimate”.

The request to NMFS for new analyses amounted to four new fits of the ASAP model: One to the 1940-1997 data set with the Cuban catch rate split into two separate periods, two with the alternative discard estimates (one fitted to each of the 1940-1997 and 1986-1997 data sets) and one fitted to the 1940-1997 data with both modifications made. Even

³¹ Unpublished report prepared by the Galveston and Miami laboratories of the Southeast Fisheries Science Center and presented to the July 1995 meeting of the Gulf Council, entitled *Characterization of the reef fish fishery of the eastern U.S. Gulf of Mexico*.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

together, these did not come close to representing the true sensitivity analysis of ASAP which should have been performed before its results were applied to fisheries management. However, the new fits did promise to provide some indication of the stability of the results to two substantial changes in the input data³².

In my presentation to the RFSAP, I also stressed a further point made the previous year by Kenchington (1999): By not including model terms describing environmental change, Schirripa *et al.* (1999) necessarily assumed that all observed changes in the biomass indices were driven by fishing pressure. The output of their model, inevitably, conformed to that assumption. In contrast, in a recent and deeply flawed study of the Campeche Bank red grouper resource, Arreguín-Sánchez and Valero (1996) employed the ECOPATH modeling approach with the effects of fishing assumed constant. In consequence and quite naturally, they ascribed the observed fluctuations in their indices to ecosystem changes and not to fishing. The juxtaposition of these two analyses should not be taken to suggest that one is more reliable than the other, and certainly not that Arreguín-Sánchez and Valero's (1996) work is more credible than Schirripa *et al.*'s (1999). Rather, it should serve as a pointed reminder that, when working with a species as poorly known as red grouper, any complex model must be built on a number of sweeping assumptions. If those assumptions are poorly supported by field evidence and if they nevertheless strongly condition the results of the analyses, those results should not be taken too seriously. In my view, both Arreguín-Sánchez and Valero's (1996) suggestion that fluctuations in Campeche Bank red grouper are environmentally driven and Schirripa *et al.*'s (1999) *de facto* conclusion that the red grouper off the west coast of Florida have declined while their MSY has not (thus reducing current biomass to far below B_{MSY}) were products of the respective authors' assumptions more than they were results that grew from the field data to which the respective models were fitted. This was not an issue that the RFSAP chose to pursue.

³² Following the RFSAP meeting but before the results of the new analyses became available, Mr. Wayne Swingle (Executive Director, Gulf of Mexico Fishery Management Council) raised a concern that the ASAP model was generating $MSY:B_{MSY}$ ratios that were more typical of sharks than of teleosts. (In Schirripa *et al.*'s original assessment, these ratios varied between 5% and 10%, depending on which model run was used.) NMFS responded, correctly, that the problem lay with estimates of the "steepness" of the stock-recruitment relationship, rather than with ASAP as such. In effect, if the model is told that red grouper have the recruitment dynamics of a shark, it will generate an $MSY:B_{MSY}$ ratio within the range normally expected of sharks. NMFS further tried to point to the equally-low ratios seen in Pacific rockfish, without noting that the very long life expectancies of those species (well over 100 years in some cases) mean that their natural mortality rates are very low and hence that F_{MSY} (itself closely linked to the $MSY:B_{MSY}$ ratio) must also be low. The Service did more reasonably say that the incidental catch of small red grouper meant that F_{MSY} was lower than if all sublegal fish were protected while the discarding of those small fish that are taken depresses MSY further. My own response to Mr. Swingle's concerns was presented in two e-mail messages, dated November 1 and December 10 respectively. The first was affected by my error concerning the meaning that NMFS was using for "steepness". The second was a withdrawal of the earlier claim and an acknowledgement that NMFS's latter two points of explanation appear correct.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

December RFSAP

Model Results

By the time that the RFSAP met again in December 2000, NMFS had prepared not only the new ASAP fits that the Panel had requested but also some further ones. When the Panel met, still other combinations of data and assumptions were used in yet more ASAP runs. For convenience, Table 2 lists the results of all of the model fits, including those in Schirripa *et al.*'s (1999) original document (which are also shown in Table 1 above), in a common format. In Table 2, the various rows and the codes entered in them have the same significance as they do in Table 1, with the addition of:

- **Data Set:** Analyses shown as using data through 1999 were fit only to data through 1997 but their results were projected forwards to 2000 using data on the actual catches in 1998 and 1999 [whereas Schirripa *et al.* (1999) had assumed that the catches in those years equaled the ones in 1997] before rebuilding options were estimated. For these runs, rebuilding was modeled as starting in 2001 and the tabulated maximum annual catch is that required to achieve target biomass by 2011, rather than 2009 as in Schirripa *et al.*'s (1999) original calculations.
- **Cuban** identifies the use made of the Cuban catch-rate data. “Single” indicates that the whole data set was used as a single time series. “Split” indicates that the 1940-1957 and 1963-1976 periods were treated as separate time series, while Cuban catch-rates from 1958 to 1962 were not used. (All analyses that used pre-1977 data necessarily used the Cuban catch data for the years that those analyses covered, typically 1940 through 1976.)
- **Discard** identifies the means by which the numbers of red grouper discarded dead or dying by the longline fleet were estimated. In the upper row, “Prob.” indicates that Schirripa *et al.*'s (1999) original probabilistic model was used to estimate the numbers discarded. “Tuned” indicates that that same model was used but the results were adjusted or “tuned” to match the observer data for 1995. (See below for explanation.) “30%” indicates that the number of discards was simply assumed to be 30% of the total number of grouper caught commercially.

In the second row, “High” indicates that 90% of red grouper discarded by longliners were assumed to die, while “Low” indicates that the assumed figure was 33%.

- The first panel in the table contains the results of Schirripa *et al.*'s (1999) original analyses. The second, along with the first two columns of the third panel, has the results produced by NMFS ahead of the December meeting while the remainder of the Table comprises results developed during that meeting.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

Table 2: Summary of results of all red grouper assessment estimations.

Model	ASPIC	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP
Data Set	1940-97	1940-97	1986-97	1986-97	1986-97	1986-97	1986-97
Cuban	Single	Single	-	-	-	-	-
Discard	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.
	High	High	High	High	High	High	High
Steep.	-	-	0.4	0.5	0.6	0.7	0.8
Yield₉₇	37%	62%	47%	53%	66%	75%	79%
Biomass₉₇	21%	26%	19%	25%	36%	49%	60%
F₉₇	208%	321%	264%	234%	197%	164%	138%
Rebuilding	2005	2008	2022	2013	2007	2004	2003
Catch		1.30	2.20	3.20	1.65	3.65	4.70

Model	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP
Data Set	1940-97	1940-97	1940-97	1986-97	1940-97	1940-97	1986-97
Cuban	Split	Single	Split	-	Single	Split	-
Discard	Prob.	30%	30%	30%	Prob.	Prob.	Prob.
	High	Low	Low	Low	Low	Low	Low
Steep.	-	-	-	0.7	-	-	0.7
Yield₉₇	62%	61%	60%	76%	61%	62%	79%
Biomass₉₇	51%	26%	71%	71%	25%	56%	58%
F₉₇	140%	243%	73%	100%	300%	112%	137%
Rebuilding	2002	2009	2001	2002	2009	2002	2003
Catch	6.75	0.17	8.11	5.18	0.64	7.20	4.11

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

Model	ASAP	ASAP	ASAP	ASAP	ASAP
Data Set	1940-97	1940-97	1986-99	1986-99	1986-99
Cuban	Split	Split	-	-	-
Discard	Prob.	30%	Prob.	Prob.	Prob.
	High	Low	Low	Low	Low
Steep.	0.68	0.68	0.6	0.7	0.8
Yield₉₇	58%	59%		79%	
Biomass₉₇	25%	33%		58%	
F₉₇	308%	175%		137%	
Rebuilding	2008	2006		2003	
Catch	1.29	2.87		4.11	

Model	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP
Data Set	1986-99	1986-99	1986-99	1963-97	1963-97	1963-97
Cuban	-	-	-	-	-	-
Discard	Tuned	Tuned	Tuned	Tuned	Tuned	Tuned
	Low	Low	Low	Low	Low	Low
Steep.	0.6	0.7	0.8	0.6	0.7	0.8
Yield₉₇	66%	74%	77%			
Biomass₉₇		56%	70%			
F₉₇		136%	112%			
Rebuilding		2004	2002			
Catch	2.57	4.29	5.24			

- The two columns highlighted in bold represent the model fits which the RFSAP finally concluded gave the most realistic picture of the state of the red grouper resource.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

- Not all of the output values are available for every permutation of model fit.

While undertaking the additional analyses that the RFSAP had requested in August, NMFS deemed that Schirripa *et al.*'s (1999) original estimates of the number of fish discarded were appropriate, even if the fraction of those discards which died were not³³. Thus, the Service prepared further model fits which replicated three of the ones requested by the Panel except for the use of the “probabilistic” model for estimating discard numbers in place of an assumed 30% discard rate. (The fourth fit that the RFSAP requested already used that model.) In addition, NMFS noted that splitting the Cuban catch-rate time series resulted in the model (when fit to 1940-1997 data) estimating that recruitment is independent of spawning biomass. That is to say, the number of future recruits does not decline as the biomass drops – a result represented in the model by a “steepness” of 1.0. The Service regarded that as unrealistic, and therefore conducted two extra model fits with “steepness” constrained to 0.68, the value estimated by Schirripa *et al.*'s (1999) original ASAP fit to the “long” data set³⁴.

The NMFS report on these analyses threw into sharper relief a point that had been noted but not stressed by Schirripa *et al.* (1999) and taken up but not thoroughly discussed by Kenchington (1999): The ASAP model fits to 1940-1997 data consistently showed that the model's estimates of recruitment from 1940 until the mid-1950s were substantially higher than would be expected from ASAP's own estimated relationship between spawning biomass and recruitment, whereas the recruitments from the late 1950s to the 1990s were close to or below the predicted line. That anomaly, which should have raised doubts about the original assessment results, most likely arose from gross over-estimates of the Cuban catches for the years up to 1957, as discussed below.

In advance of the RFSAP meeting, I prepared a summary of the new information from NMFS for SFA and SOFA (Kenchington 2000a). That document was primarily concerned with explaining the meaning of the results but it also addressed the problems involved in any use of the Cuban data (taken up at more length later and discussed below) while returning to Kenchington's (1999) erroneous understanding of Schirripa *et al.*'s (1999) method for estimating the number of discards. Kenchington (2000a) also introduced another major error. “Steepness”, as NMFS measures it, takes values from 0.2 to 1.0 with the curves for each 0.1 increment being evenly spaced in a graph similar to Figure 1 above. Schirripa *et al.* (1999) however described this measure as “the steepness parameter of the reparameterized Beverton-Holt stock-recruitment relationship” which I

³³ Unpublished document entitled “RFSAP requested red grouper analyses” circulated at the December 2000 RFSAP meeting.

³⁴ Unpublished document entitled “Addendum to RFSAP requested red grouper analyses” circulated at the December 2000 RFSAP meeting. I would consider the computer's conclusion that “steepness” is 1.0 to be nothing worse than an imprecise estimate of a weak dependence of recruitment on spawning biomass and hence of equal status to Schirripa *et al.*'s (1999) earlier estimate that “steepness” was 0.68. Both could be equally-poor approaches to a true value of 0.84. This disagreement was, however, rendered moot by Kenchington's (2000b) discovery that the early Cuban catch data are seriously erroneous. That eliminated the 1940-1962 data from serious consideration.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

wrongly understood to mean the value of the “A” parameter that relationship, as graphed in Figure 1. The values of “A” and “steepness” for any particular curve in such a graph are similar but not equal. I argued (Kenchington 2000a) that the correct value of “A” for red grouper should be around 0.9 and that Schirripa *et al.* (1999) had been wrong to only use values from 0.4 to 0.8. However, as became clear during the RFSAP meeting, setting “A” to 0.9 yields a curve with a “steepness” (as NMFS uses the term) of about 0.75. Thus, the relationship between stock and recruitment that I had recommended was already within the range of values that Schirripa *et al.* (1999) had used in their various fits of the ASAP model to 1986-1997 data. In short, while Kenchington (2000a) may have provided some useful explanation of NMFS’s results for its intended audience, it spread unnecessary confusion and it did not contribute anything of lasting substance to discussions of the status of the red grouper resource.

Cuban Complications

Also in the interval between the two RFSAP meetings, I had undertaken some basic examination of the history of the Cuban *pesca del alto* in an attempt to learn more about the catch and effort records which dominate the red-grouper data sets for the period before 1977 (Kenchington 2000b). That effort revealed some key points.

The Cuban data used by Schirripa *et al.* (1999) had been presented to Dr. Klima of NMFS in 1977 by officials of the Castro administration, following the withdrawal of the *flotta del alto* from the new U.S. EEZ. The numbers were published by the Gulf Council in 1980, in an appendix to the reef-fish FMP of that year³⁵ but the unofficial nature of the transfer seems to have prevented anyone from properly documenting the sources of the data. All that can be said is that it was supplied by the Cubans. The Council was wise to warn: “These data should be used with caution since [...] validity of the data presented to Klima is not known. Also, the exact area fished for which the data are reported, is not known.”³⁶

In an attempt to provide some of the background, without which no data set should be used in any scientific analysis, Kenchington (2000b) reviewed contemporary reports on the Cuban “high seas” grouper fishery, the *pesca del alto*, that had either been prepared by U.S. officials (Fiedler *et al.* 1947; Martinez 1948; Tashiro & Coleman 1977) or published in the U.S. (Suarez Caabro 1957). Those reports made clear that the pre-1958 fishery involved handlining from the decks of schooners (some motorized) by eight to ten men and that catches of several hundred pounds per day were normal. The catch-rate data used by Schirripa *et al.* (1999) averaged 829 lb. per boat-day for 1940–1957 and appear to have represented the catch by the entire schooner crew handlining for the day.

³⁵ See Table 36 of the Appendix to the *Environmental Impact Statement and Fishery Management Plan for Reef Fish Resources of the Gulf of Mexico* as revised in 1980.

³⁶ The *Environmental Impact Statement and Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico*, as revised by the Gulf Council in 1981, advised (p.3-21). Goodyear and Schirripa (1993) appear to have ignored that advice when they began to use the Cuban data set in their assessments without first establishing its validity.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

After the Revolution, the new Cuban government started a program of modernization of the fisheries in 1961. In contrast to the earlier practice of fishing from the deck of a schooner, the new fishery employed two-man “launches” working around powered mother ships. From 1965, the two men in each launch worked longlines, rather than handlines. Interestingly, unlike Schirripa *et al.*'s (1999) version of the tabulation, the original (1980) published listing of Dr. Klima's data set³⁷ identified the effort measure specifically as “launch days fished”, suggesting that the numbers represent the activity of two-man units rather than that of the mother ships. Indeed, the very high numbers of boat-days worked off the Florida coast (reaching 19,269 in 1976) mean that the tabulated figures cannot have represented mother-ship activity since there were only 55 vessels in the *flotta del alto* in the mid-1970s (Tashiro & Coleman 1977) and their effort was divided between the Florida and Campeche Bank grounds. It therefore seems certain that the Cuban catch rates for the 1960s and 1970s used by Schirripa *et al.* (1999) represent the catches by two men longlining from a launch for a day³⁸.

This technological difference between the pre- and post-Revolutionary fisheries can now be seen to explain the marked drop in recorded Cuban catch rates between 1957 and the early 1960s which Schirripa *et al.* (1999) identified as a decline in the resource and Kenchington (1999) suggested might be a result of unspecified disruptions in the fishery or its monitoring arising from the Revolution itself. In reality, the catch rates from the two periods are simply not comparable since the effort units used are entirely different. If the Cuban catch rates are to be used in assessment models, it is essential that they be treated as separate time series, one ending in 1957 and the other beginning in, perhaps, 1965.

Kenchington's (2000b) examination of the early reports revealed a still more serious problem with the Cuban data, however. The total Cuban grouper landings in the early 1940s can be estimated from figures that Martinez (1948) provided and those estimates suggest that catches on the Florida grounds were as low as one half those tabulated in the data set used by Schirripa *et al.* (1999). More seriously, Suarez Caabro (1957) presented monthly landings for 47 of the 68 vessels in the *flotta del alto* in 1955, which figures suggest that the entire fleet landed under 5.2 million pounds that year – the majority of which should have come from Campeche Bank. Yet, for that same year, the Cuban catch from west of Florida recorded in the data set provided to Dr. Klima was 13.3 million pounds. The tabulation also shows 19,182 boat-days fished off Florida in 1955, when the *flotta* included only 68 schooners (with no evidence that any carried launches), which implies an unreasonable average of 282 fishing days per schooner that year, even without allowing for the fleet spending most of its working time on Campeche Bank. Thus,

³⁷ See Table 36 of the Appendix to the *Environmental Impact Statement and Fishery Management Plan for Reef Fish Resources of the Gulf of Mexico* as revised in 1980.

³⁸ The SSC's 1999 comment that the tabulated Cuban days fished per year were excessive can thus now be answered: They are excessive if taken to represent mother-ship-days but they appropriately represent launch-days.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

neither the catches nor the fishing efforts for the mid-1950s in the data set are consistent with the information in reliable contemporary sources, though the tabulated catch rates do seem reasonable.

It is not possible to say for certain what produced the errors in the Cuban data for the pre-Revolutionary period when it was compiled, long after the event, by officials of the Castro administration. Kenchington (2000b) did, however, note that Suarez Caabro (1957) reported that the total seafood landings (all species combined) in Havana, the home port of the *flotta del alto*, had been stable at about 11 million pounds annually for the previous ten years. In comparison, the average catch during 1946-1955 in the data set given to Dr. Klima was 10.9 million pounds. Thus it is possible that, following the disruption of the Revolution, somebody misunderstood old data and substituted the numbers for the entire Havana landings for those of the *pesca del alto* alone and then forgot to deduct the large fraction (more than half) of the latter's landings which were taken on Campeche Bank. The result would have been grossly inflated landings data. If those were then combined with real figures for the *flotta del alto*'s catch rates, drawn from some undocumented source, in order to back-calculate the annual fishing efforts, the result would have been the excessive numbers of fishing days seen in Schirripa *et al.*'s (1999) tabulations.

Whether or not that really was the source of the errors, it is quite clear that the Cuban catch data for pre-Revolutionary years, as given to Dr. Klima, cannot be used in assessments of the red grouper resource west of Florida. Any ASAP, ASPIC or similar model that used the Cuban data for years before about 1965 would produce seriously misleading results and must be rejected.

For the later years, the Cuban data are perhaps neither more nor less reliable than most other figures on fisheries landings and fishing effort. Some independent support for them is available since, for the years where they overlap, the tabulated catches are similar to, but not the same as, the estimates which Tashiro and Coleman (1977) developed for the fishery west of Florida from assorted surveillance sources. Such confirmation notwithstanding, whether the data set is sufficiently precise and reliable to form a foundation for an advanced modeling approach, such as ASAP, is a complex question that has yet to be properly addressed in the red grouper debates³⁹.

³⁹ There has been considerable, but probably sterile, discussion over whether the recorded Cuban and U.S. catch-rate trends from 1940 to 1976 were similar to one another or highly different. Schirripa *et al.* (1999) argued that their similarity allowed each to give the other some validation. Kenchington (1999) countered that the Cuban series suggested two periods of stasis, separated by one of sharp decline, whereas the U.S. data suggested more of a steady drop – with the implication that they could not both be tracking resource biomass and thus that neither could be trusted. NMFS, in an unpublished contribution to the August 2000 RFSAP meeting, later showed that both time series closely followed the same linear trend, albeit with the Cuban residuals showing some tendency towards periods of stasis and decline. Once it became clear, however, that the Cuban time series was not internally consistent, while each of its halves suggested long-term stability, the putative similarity of the two indices only served to draw the U.S. landings and fleet-size data for the 1940-1976 period into further disrepute.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

These observations were outlined to the RFSAP in December and the Panel agreed with my contention that the erroneous pre-Revolutionary landings data prevented any valid ASAP fits unless they were confined to data from the early 1960s onwards. At the request of the RFSAP, NMFS did attempt some analysis using 1963-1997 data (see Table 2 above). That, however, encountered a conflict between the U.S. and Cuban catch rates for the 1963-1976 period – the inter-annual variation for the one time series being almost a mirror image of that for the other. Meanwhile, the recorded catches rose through the 1960s without any obvious corresponding trends in catch rates, which may have been a result of increasing efficiency of the modernizing fisheries but the models could make no allowance for such a change since Schirripa *et al.* (1999) had assumed that catchability was constant. Instead, ASAP responded to these data trends by creating a single, unrealistic “super-cohort” in the early 1960s, though the year of its supposed spawning varied depending on the value of “steepness” input to the calculations. Clearly, the results of these analyses were not meaningful.

The RFSAP fell back on analysis of the 1986-1997 data set as the only viable alternative.

Discards Revisited

NMFS’s “probabilistic” method for estimating the numbers of small red grouper discarded has one conceptual advantage over using some fixed percentage of the landed catch, such as the 30% selected by the RFSAP in August: When a strong year-class is recruiting, the relative proportion of small fish in the catch (and hence the fraction of the catch which is discarded) will increase, as it will when the abundance of commercial-sized fish declines despite stable recruitment. The reverse processes will also occur. A fixed discard percentage cannot allow for these fluctuations but the NMFS model can – to the degree that it can represent strong and weak year-classes realistically, which it may not do very successfully. This feature of the “probabilistic” method is valuable. On the other hand, as originally used by Schirripa *et al.* (1999), the method suggested that, in some years, the longline fleet was discarding substantially more fish than were landed, which did not seem reasonable.

Following several hours of discussion, the RFSAP decided to combine the “probabilistic” model with more realistic overall discard rates by scaling (or “tuning”) the model’s output for each year by a fixed factor that brought it into agreement with the single available point estimate, drawn from the very limited available observer data⁴⁰. That estimate suggested that the discard rate in the longline fishery in 1994 was 47%. The “probabilistic” method had estimated 62% discards for that same year. Thus all estimates of the numbers of longline discards per year were scaled downwards by a factor of 0.76.

⁴⁰ Based on unpublished report prepared by the Galveston and Miami laboratories of the Southeast Fisheries Science Center and presented to the July 1995 meeting of the Gulf Council, entitled *Characterization of the reef fish fishery of the eastern U.S. Gulf of Mexico*.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

The same prolonged debate eventually confirmed the Panel’s opinion that the most reasonable assumption for the discard mortality rate in the commercial fishery was that 33% of the discarded red grouper died, whether they were caught by longlines or commercial vertical lines. [Discard mortality in the recreational fishery continued to be estimated as the 10% used by Schirripa *et al.* (1999).]

NMFS re-ran the ASAP fits to 1986-1997 data using this 33% discard-mortality rate, with “steepness” set at 0.6, 0.7 and 0.8 and with the number of discards both “tuned” and as calculated directly by the “probabilistic” model – the latter serving as a check on the “tuning”. In a final elaboration, the examination of future rebuilding options for these six ASAP runs used actual landings data for 1998 and 1999 in estimating the starting biomass in 2001, rather than supposing that rebuilding would begin in 2000 and estimating the biomass in that year by assuming that 1998 and 1999 catches were equal to those in 1997, as all previous such calculations had done.

Armed with the results of those final computations, the RFSAP eventually decided to rely on the “tuned” discard numbers and a “steepness” in the range of 0.7 or 0.8⁴¹. Thus, its conclusion was that the biomass in 1997 was 56% to 70% of the B_{MSY} target (up from the 26% determined in 1999), while the 1997 fishing mortality rate was 112% to 136% of the legislated maximum threshold, F_{MSY} (down from the 321% of 1999). With both of the latter figures above 100%, the Panel necessarily concluded that “overfishing”, in the Magnuson-Stevens Act’s sense of the term, was occurring in 1997. Equally, while the minimum stock size threshold for red grouper is seen as 80% of the B_{MSY} target (as it currently is by NMFS if not by the Gulf Council), the resource is still “overfished” in the meaning of the National Standards Guidelines and requires rebuilding. Rebuilding to the target level was, however, estimated to be achievable within ten years by holding catches to a constant level of 4.3 to 5.2 million pounds annually (up from the 1.3 million estimated in 1999), though the RFSAP correctly recommended that a constant-effort strategy would be preferable to a constant-catch one. It may be noted that the more optimistic of these model fits suggests that rebuilding could be achieved simply by holding catches to their 1997 level with no reduction at all – though returning to 1997 catches from those of 1999 would require substantial downsizing.

The RFSAP’s conclusions were reported to an SSC meeting in New Orleans in January 2001. Apart from some inquiries to clarify the advice, it was accepted without discussion. The Committee voted its concurrence without dissent.

⁴¹ While there is no firm scientific grounds for estimating what the true value of “steepness” may be for red grouper, the Panel’s decision drew not only on the depth of experience of its members but also on the yet-unpublished results of an extensive meta-analysis of multiple data sets which some RFSAP members have undertaken. Coincidentally, the chosen values bracketed my own estimate that the “A” parameter should be about 0.95.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

Overfishing Definitions

The same RFSAP meetings that re-considered Schirripa *et al.*'s (1999) red grouper assessment were also presented with overfishing definitions for the various Gulf grouper resources, including red grouper, proposed by NMFS. Those proposals, while of great importance, are outside the scope of the present report and will not be discussed here, save for one point relevant to the interpretation of the RFSAP's conclusions on red grouper.

As noted above, the Panel concluded that red grouper biomass in 1997 was 56% to 70% of B_{MSY} . Being below that target biomass does not, however, constitute being “overfished” in the meaning of the National Standards Guidelines. Rather, “overfished” means a biomass below a “minimum stock size threshold” to be established by the Council at a level that should be no lower than one half B_{MSY} and should be high enough that the stock could rebuild to B_{MSY} in ten years, starting from the threshold and when fished at the threshold level of fishing mortality defined by the control rule for the particular stock⁴². The Guidelines contain further recommendations that minimum stock size thresholds should not be set too high, since natural fluctuations in fish populations would then trigger multiple “overfished” designations, and specifically that they should not, in general, be set as high as 80% of B_{MSY} ⁴³.

Quite at variance with that recommendation, Restrepo *et al.* (1998) suggested that minimum stock size thresholds should be set at $(1-M)$ times B_{MSY} . The proposed grouper overfishing definitions follow that suggestion, along with the now-common assumption that the rate of natural mortality, M , in red grouper is 0.2 – itself an improbably-low value for a species with rather moderate maximum observed ages. The proposed minimum stock size threshold for the species was thus 80% B_{MSY} , by which standard the RFSAP's estimated 56% to 70% clearly constitutes an “overfished” status.

Responsibility for setting the threshold lies, however, with the Council and not with NMFS. Moreover, in making its final decision, the Council would be well advised to heed the requirements and recommendations of the National Standard Guidelines, rather than the narrowly-technical concepts advanced by Restrepo *et al.* (1998). Finally, should that decision place the minimum stock size threshold at 50% of B_{MSY} , red grouper could not be considered “overfished” in the meaning of the Guidelines, and even if the threshold were set at 70% B_{MSY} it would arguably not merit that status.

The practical consequences of setting this threshold higher or lower would not, however, be great in the short term. The reduction in fishing mortality rates which the RFSAP estimated was needed in order to rebuild the resource within ten years are little different from, and may indeed be higher than, those which would be set by a control rule that

⁴² Since the threshold mortality rate can vary with biomass, it will usually be possible to set the biomass threshold at $\frac{1}{2}B_{MSY}$ by adjusting the mortality threshold to low values when biomass is between its target and threshold levels.

⁴³ p. 24218, response to Comment 20.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

allowed a minimum stock size threshold as low as 50% B_{MSY} . Nevertheless, it should not be forgotten that the RFSAP's conclusions only mean that red grouper is "overfished" if they are evaluated against a standard that, has yet to be accepted and indeed one that is not consistent with the recommendations of the National Standards Guidelines.

Conclusions

The RFSAP thus concluded, and the SSC concurred, that red grouper biomass in 1997 was 56% to 70% of the B_{MSY} target while the fishing mortality rate was 112% to 136% of the F_{MSY} threshold. "Overfishing", in the Magnuson-Stevens sense, was occurring and the resource was "overfished", at least relative to NMFS's proposed minimum stock size threshold. Rebuilding was seen to be necessary, though it could be achieved within ten years with no more than a moderate reduction in fishing effort. That conclusion represented a major change in the RFSAP's position from the judgement that it reached in 1999 and it stands very much to the Panel's credit that its members were willing to consider, in great depth, and then respond to the new information that was brought forward by the fishing industry, particularly that which had been unwritten by the longliners through SFA and SOFA.

The altered results arose from rejection of the Cuban data, particularly the pre-Revolutionary catch data, and from substantial downward revisions in estimates of the number of red grouper discarded dead by the longline fleet. The former eliminated any analyses of early data and with them Schirripa *et al.*'s (1999) estimate of "steepness", leaving the RFSAP free to select biologically-realistic values for that parameter. With those changes, the ASAP model produced numerical results which, if not necessarily accurate, at least accord with fishermen's perceptions.

One might ask why the current conclusion could not have been reached in 1999. I would suggest that Dr. Schirripa and his colleagues not only could but should have examined the Cuban data much more closely before using it. I would further suggest that if they had submitted their discard estimates to a test of common sense and fishermen's experience, they would have concluded that their "probabilistic" model was returning numbers that were unreasonably high. I would not, however, level similar criticisms at either the RFSAP or the SSC. (Though the latter did not endorse the assessment's conclusions, its reasons for declining to do so did not fully match the deficiencies eventually found.) Clearly, an ideal scientific-review system would identify all errors in the assessments brought before it. Unfortunately, while committee reviews serve to pick between various alternatives laid before them and to sign off on the basic logic of assessments, they do not and cannot provide an adequate mechanism to ensure that the data sets used in an assessment are valid. Nor, come to that, can any committee ensure that the data were correctly extracted from some database, that the mathematical models were correctly programmed into a computer, that the output was properly read off the screen or a host of other similarly-important details. Such errors have occurred in fishery stock assessments in the past and doubtless they will again. When they are not caught by the authors of the

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

assessments in question, no committee review will detect them and it is unlikely that they will be noticed at all unless the end results of the assessment are sufficiently anomalous as to encourage someone to have the work closely scrutinized.

I would by no means suggest that committee reviews of stock assessments are useless. They are not, though they might well be supplemented with closer reviews by individuals. I am suggesting that such reviews are not, of themselves, any guarantee that scientific advice to fisheries managers is free of errors – not even of major errors, as were seen in the 1999 advice on red grouper.

While I think that the revised advice from the RFSAP provides a reasonable picture of the state of the red grouper fishery, I am far from convinced that the means by which it was estimated were reliable. Rather, I fear that multiple errors may have cancelled one another through the estimation process. The major errors in the early Cuban catch data, by leading to the concentration on post-1986 data in the final analyses, served to eliminate from consideration all doubts about the species composition of earlier U.S. landings as well as most concern over the use of documented vessel numbers as an index of U.S. fishing effort, the possibility of long-term increases in fishing efficiency and the likelihood of inter-decadal environmental trends, including habitat degradation as a result of coastal-zone development. The RFSAP's revised estimates of longline discard rates and discard mortalities, while quite likely too high and too low respectively, seem to result in reasonable estimates of losses through that cause. I remain concerned, however, that for all of the reasons set out above the ASAP model itself may be too great a burden to place on the limited and deficient data sets available for red grouper. That model may be capable of providing broad, quantitative indications of resource status but those are equally available from simpler, more robust and more transparent methods. Without very extensive sets of high-quality data, I would not trust ASAP to provide the more precise answers which it appears at first sight to offer. Meanwhile, points of uncertainty, if not of error, have been identified in Schirripa *et al.*'s (1999) assessment, particularly in their preparation of catch-rate series but also in their estimation of the natural mortality rate and other items, which still lead me to doubt the input data presented to ASAP – a model which behaves rather erratically in response to input errors.

Thus, I cannot fully endorse the assessment, even as modified in response to the RFSAP's requests, though I do recognize it as the "best science available" and hence the appropriate starting point for the Council's management of the red grouper fishery. There are indications that the fishery would benefit in the long term from some restraint and perhaps some scaling back of effort. Some sectors of the fishery have seen falling catch rates in recent years, even though the directed longline sector has not, while overall catches dropped through the middle 1990s (a trend reversed in 1999), and large fish seem to have become relatively scarce in parts of the fishery. All are pointers to the need for some management action. From a more legalistic perspective, even if the current fishing mortality rate is not greater than the F_{MSY} threshold, it almost certainly is above the thus-far-undefined target level that the National Standards Guidelines require.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

Such generalizations as these cannot justify eliminating the red grouper fishery in order to save it, by rebuilding its resource, but they do suggest that a measured reduction in fishing pressure would be sensible, if only as a precautionary measure. Just such a reduction should be the result of implementing the RFSAP's advice – whether the ASAP calculations on which it was based were reliable or not.

Indeed, there a further case can be made that the broad pattern of that advice is correct. The contemporary accounts from the 1940s and 1950s (Fiedler *et al.* 1947; Martinez 1948; Suarez Caabro 1957) indicate not only that Cuban catches from 1945 to 1957 were of the order of five million pounds per year but also that they had been higher, perhaps 8 million pounds annually, from the late 1930s until German U-boat activity hampered the fishery in the early 1940s. The data compiled by Schirripa *et al.* (1999) shows that U.S. catches increased while the Cuban ones were depressed in the years around 1960. Once the Cuban fleet was modernized and expanded, however, the combined red grouper catches of the two nations, from the grounds west of Florida, rose to some ten million pounds a year from about 1965 until 1976. Exclusion of the Cuban effort in 1977 saw a fall in total catches but they recovered in the 1980s, averaging some eight million pounds a year for a while, before declining to the low level of 1996.

Unless the red grouper resource is now and always has been overfished, which seems improbable in light of fishermen's impressions as well as of quantitative analyses, and setting aside the possibility of substantial environmental trends over the past several decades, this catch history is really only consistent with MSY being well above five million pounds per year and yet substantially less than ten million – likely around seven or eight million. Catches were at or rather below such a level for a least a few decades (from the 1930s onwards, if not before) but the Cuban modernization of the 1960s, when added on top of the slowly-expanding U.S. fishery, pushed the total harvest beyond MSY. Even if one were to assume that there has been a long-term decline in red grouper habitat extent or quality, the trend in catches is really only consistent with the fishery having been sustainable until the 1960s, when catches exceeded MSY. Thus, the resource evidently endured the same sad over-exploitation in the third quarter of the 20th century as so many other fisheries worldwide did and for just the same reason: post-1945 technological advances and economic demands increased catches to unsustainable levels, though in the case of red grouper the timing of that change was driven by the Cuban Revolution rather than the invention of the factory-freezer trawler.

The declaration of the 200-mile EEZ in 1977 clearly led to both a reduction in fishing effort and the Americanization of the fishery. The latter involved the adoption of longline gear, necessary for the efficient exploitation of red grouper and hence for the replacement of Cuban effort. Unfortunately, and again in common with too many other fisheries, the expansion of U.S. catches proceeded too quickly and the resource was not able to fully rebuild from the excess fishing of the years up to 1976. Continuing habitat loss may have been an additional problem. Thus, sustainable yields did not recover to the seven or eight

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

million pound range, though catches did. The consequence seems to have been a slow slide in red grouper biomass through the mid-1990s.

While it thus seems straightforward to account for the long-term, fishery-wide trends in the red grouper resource, it is not possible with the available data to explain such detailed features as the maintenance of longline catch rates through the 1990s, when recreational catch rates in particular were falling, nor the sudden increase in catches in 1999. Both are likely to involve inter-annual variations in year-class strengths but exactly how remains unclear. Nevertheless, the above history does strongly suggest that the current situation is not the “fault” of any one sector of the U.S. fishery, as has been recently suggested, but rather an expected consequence of the considerable investment that the Castro regime made in developing its distant-water fisheries.

A more detailed understanding of the red grouper resource is badly needed as a basis for the management of the fishery. It can only be achieved through new data-collection programs. The existing data sets, limited as they are, have certainly been taken as far as they can be and probably further than they should have been. The new data should include information from observers or else from an equivalent, industry-based system for gathering at-sea data. It should also include a program for routine ageing of samples from red grouper catches. Moreover, some fishery-independent measure of resource biomass would be highly desirable, though hard to provide for a reef-fish resource.

Given the constraints on institutional reef-fish science, gathering these new data sets will require collaboration between scientists and all sectors of the red grouper fishery.

References

- Arreguín-Sánchez, F. & E. Valero (1996) Trophic role of the red grouper (*Epinephelus morio*) in the ecosystem of the northern continental shelf of Yucatan, Mexico. pp. 19-27 in: F. Arreguín-Sánchez, J.L. Munro, M.C. Balgos & D. Pauly (eds.) *Biology, fisheries and culture of tropical groupers and snappers. ICLARM Conference Proceedings* 48: 449p.
- Colin, P.L., C.C. Koenig & W.A. Laroche (1996) Development from egg to juvenile of the red grouper (*Epinephelus morio*) (Pisces: Serranidae) in the laboratory. pp. 399-414 in: F. Arreguín-Sánchez, J.L. Munro, M.C. Balgos & D. Pauly (eds.) *Biology, fisheries and culture of tropical groupers and snappers. ICLARM Conference Proceedings* 48: 449p. [Cited by Tupper 1999]
- Fiedler, R.H., M.J. Lobell & C.R. Lucas (1947) The fisheries and fishery resources of the Caribbean area. *U.S. Fish & Wildlife Service, Fishery Leaflet* 259.
- Goodyear, C.P. (1994a) Red grouper mean size at age: an evaluation of sampling strategies using simulated data. *Unpublished document from Southeast Fisheries Center, Miami.*

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

- Goodyear, C.P. (1994b) Biological reference points for red grouper: effects of uncertainty about growth. *Unpublished document from Southeast Fisheries Center, Miami.*
- Goodyear, C.P. (1997) Fish age determined from length: an evaluation of three methods using simulated red snapper data. *Fishery Bulletin* 95: 39-46.
- Goodyear, C.P. & M.J. Schirripa (1991) The red grouper fishery of the Gulf of Mexico. *Southeast Fisheries Center, Miami Laboratory Contribution MIA-90/91-86.*
- Goodyear, C.P. & M.J. Schirripa (1993) The red grouper fishery of the Gulf of Mexico. *Southeast Fisheries Center, Miami Laboratory Contribution MIA-92/93-75.*
- Kenchington, T.J. (1999) Gulf of Mexico red grouper: a review of the scientific advice and its management implications. *Gadus Associates report for SFA, FOFC & SOFA*: 44p.
- Kenchington, T.J. (2000a) NMFS additional analyses on red grouper: Explanation and comment. *Gadus Associates report for SFA & SOFA*: 13p.
- Kenchington, T.J. (2000b) A re-examination of Cuban catch rates in the west-Florida red grouper fishery 1940-1976. *Gadus Associates report for SFA & SOFA*: 14p.
- Legault, C.M. & V.R. Restrepo (1999) A flexible forward age-structured assessment program. *ICCAT Working Document SCRS/98/58, ICCAT Collective Volume of Scientific Papers* 49(2): 246-253.
- Martinez, J.L. (1948) The Cuban fishing industry. *U.S. Fish & Wildlife Service, Fishery Leaflet* 308: 67p.
- Moe, M.A. (1969) Biology of the red grouper, *Epinephelus morio* (Valenciennes) from the eastern Gulf of Mexico. *Prof.Pap.Ser.Fla.Dep.Nat.Resour.Mar.Sci.Lab.* 34: 1-331. [Cited by Tupper 1999]
- Restrepo, V.R., G.G. Thompson, P.M. Mace, W.L. Gabriel, L.L. Low, A.D. McCall, R.D. Methot, J.E. Powers, B.L. Taylor, P.R. Wade & J.E. Witzig (1998) Technical Guidance on the Use of Precautionary Approaches to Implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act. *NOAA Technical Memorandum NMFS-F/SPO* 31: iv+54p.
- RFSAP (1994) *1994 Report of the Reef Fish Stock Assessment Panel.* Gulf of Mexico Fishery Management Council, Tampa: 22p.
- RFSAP (1999) *September 1999 Report of the Reef Fish Stock Assessment Panel.* Gulf of Mexico Fishery Management Council, Tampa: 28p.
- Rivas, L.R. (1970) The red grouper of the Gulf of Mexico. *Commercial Fisheries Review* 32: 24-30. [Cited by Tupper 1999]
- SEP (1999) *September 1999 Report of the Socioeconomic Panel on Reef Fish.* Gulf of Mexico Fishery Management Council, Tampa: 64p.

The Red Grouper Question 1999–2000

Gadus Associates for SFA and SOFA

- Schirripa, M.J., C.M. Legault & M. Ortiz (1999) The red grouper fishery of the Gulf of Mexico: Assessment 3.0. *Southeast Fisheries Center, Sustainable Fisheries Division Contribution SFD-98/99-56*.
- Sluka, R.D. (1995) Influence of habitat on density, species richness, and size distribution of groupers in the upper Florida Keys, USA, and central Bahamas. *Ph.D. Dissertation, University of Miami, Coral Gables, Fl.* [Cited by Tupper 1999]
- Suarez Caabro, J.A. (1957) The present situation in the fishing industry of Cuba. *Proc. Gulf & Caribbean Fisheries Institute 9th Annual Session*: 136-143.
- Sullivan, P.J. (2000) Review of Gulf of Mexico red grouper assessment 3.0 with analysis of scientific support for management options. *Report to the Center of Independent Experts, University of Miami*.
- Tashiro, J.E. & S.E. Coleman (1977) The Cuban grouper and snapper fishery in the Gulf of Mexico. *Marine Fisheries Review* 39(10): 1-6.
- Tupper, M.H. (1999) Biology and ecology of the red grouper (*Epinephelus morio*): implications for management of the U.S. Gulf of Mexico fishery. *Gadus Associates report for SFA, FOFC & SOFA*: 14p.
- Wilson, R.R. & K.M. Burns (1996) Potential survival of released groupers caught deeper than 40 m based on shipboard and in-situ observations and tag-recapture data. *Bulletin of Marine Science* 58(1): 234-247.