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REPORT OF THE SECOND AD HOC FINFISH STOCK ASSESSMENT PANEL

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Abbreviations Used in This Document

B Biomass

F Refers to an instantaneous rate of fishing mortality. This is often written with a subscript to indicate the fishing mortality rate at a given biological reference point, e.g.;

- $F_{0.1}$ The fishing mortality rate where the slope of the yield curve has dropped to 10% of the slope at the origin.
- $F_{30\%\ SPR}$ The fishing mortality rate corresponding to a 30 percent static spawning potential ratio
- F_{msy} The fishing mortality rate that theoretically produces maximum sustainable yield.
- F_{max} The fishing mortality rate that produces maximum yield-per-recruit. Note: this is NOT the same point as F_{msy}.
- F=M The fishing mortality rate is equal to natural mortality.

FMP Fishery Management Plan

MFMT Maximum fishing mortality threshold (an MSY control law component)

MSST Minimum stock size threshold (an MSY control law component)

MSY Maximum sustainable yield

OY Optimum yield

SPR Spawning Potential Ratio - the average reproductive capacity of a female recruit as a proportion of the reproductive capacity in the absence of fishing. There are two basic types of SPR values:

- Transitional SPR This is the SPR value at a given point in time, and may be suitable for use as a proxy for biomass levels in MSY control laws.
- Static SPR This is the SPR that will eventually be reached if fishing mortality and all other parameters that affect SPR are held constant. This may be suitable for use as a proxy for fishing mortality rates in MSY control laws.

SSB Spawning stock biomass

SSBR (1) Spawning stock biomass per recruit
(2) Spawning stock biomass ratio, as a proportion of the SSB in the absence of fishing

Panel Members Present

Mr. Douglas Gregory, Jr. (Acting Chair)	University of Florida/Monroe County
Dr. James Cowan, Jr.	University of South Alabama
Mr. Harry Blanchet	La. Dept. Of Wildlife and Fisheries
Dr. Mark Fisher	Texas Parks and Wildlife Department
Dr. Terry Henwood	NMFS/SEFSC - Pascagoula, MS
Dr. Joanne Lyczkowski-Shultz	NMFS/SEFSC - Pascagoula, MS
Mr. Mike Murphy	Florida Marine Research Institute
Dr. Clay Porch	NMFS/SEFSC - Miami, FL

Others present

Vernon Minton - Gulf Council Member
Bob Shipp - Gulf Council Member
Roy Williams - Gulf Council Member
Rick Leard - Gulf Council staff
Steven Atran - Gulf Council Staff
Tom McIlwain - NMFS/SERO

SUMMARY OF PANEL MSY RECOMMENDATIONS

Species	MSY Proxies	
	F_{MSY}	B_{MSY}
Red Snapper	30% static SPR	30% transitional SPR
Red Drum	20% static SPR	20% transitional SPR (minimum stock size threshold = 16% transitional SPR)
King and Spanish Mackerel	30% static SPR	30% transitional SPR
Gag	35-40% static SPR if no increased size limit or spawning season closure. 30% static SPR with increased size limit and/or spawning season closure.	35-40% transitional SPR if no increased size limit or spawning season closure. 30% transitional SPR with increased size limit and/or spawning season closure.
Jewfish and Nassau grouper	40-60% static SPR	40-60% transitional SPR
Other Gulf Finfish Species	30% static SPR	30% transitional SPR

INTRODUCTION

The previous Ad Hoc Finfish Panel report (GMFMC 1998a) recommended that the Gulf of Mexico Fishery Management Council establish maximum sustainable yield (MSY) proxies for Gulf fisheries based on levels of spawning potential ratios (SPR) between 30 and 40 percent, with specific levels based on a species relative ranking of the ratio of natural mortality rate to Brody growth coefficient (M/K). Subsequent to the report the use of the M/K ratio was questioned by some members of the Panel and of the Council. The Council, upon review of the report, expressed interest in evaluating the potential use of alternative MSY proxies in addition to SPR.

The primary charge of the Gulf of Mexico Fishery Management Council to the Second Ad Hoc Finfish Panel (see attached Memorandum from W. E. Swingle to the panel) was to:

> "...develop potential proxies for maximum sustainable yield (MSY) for at least red snapper, king mackerel, and red drum based on the empirical fishery- independent data collected in the summer SEAMAP and fall groundfish surveys, or other appropriate data sources, for juvenile fish recruitment. These proxies should be modified, as appropriate, by changes in other relevant population parameters such as fishing mortality, biomass of fishable ages, and/or biomass of all ages for a specific period of time."

Secondary charges to the panel were 1) to re-evaluate the M/K ratios as scaling factors for assigning SPR proxy levels for MSY, and 2) provide advice on alternative methods of assigning MSY SPR proxy levels for the Gulf finfish species listed in Table 14(attached).

Resilience vs Resistance

The NMFS technical guidance on the use of precautionary approaches for selection of MSY proxies (Restrepo 1998) recommend scaling the appropriate proxy for F_{msy} based on resilience of the stock to overfishing. However, the technical guidance document does not define resilience. The Panel discussed the meaning of resilience, and suggests that there are actually two related characteristics, “resistance” and “resiliency” which should be considered.

Resistance, as defined by the Panel, is the ability of a stock to withstand high levels of removals without recruitment failures occurring as a result. In general, longer-lived species that mature at an early age relative to their life-span are perceived to be relatively more resistant to overfishing than shorter-lived species with fewer spawning years. This is because species with numerous year-classes contributing to the spawning stock can still maintain themselves if several of those year-classes are lost, whether by recruitment failure or selective fishing mortality. It has been hypothesized that a large number of year classes in a spawning population could be an adaptation that ensures an adequate spawning population, even in the face of fluctuating recruitment (Murphy 1968; Leaman and Beamish 1984)

Resilience, as defined by the Panel, refers to the ability of a stock to recover from an overfished condition. Long-lived species, although resistant to overfishing, are slow to recover once they become overfished because of the large number of age-classes that must be rebuilt, and thus have generally low resiliency. Conversely, Short-lived species with very high fecundity levels may be able to compensate for high fishing mortalities by producing more offspring allowing them to recover quickly from an overfished condition.

The above definitions are generalizations, and may not be applicable in all situations. Factors other than lifespan, growth and fecundity also need to be considered. It is easy to cite counter examples such as pink shrimp, which are very resistant to overfishing despite having very few year classes, and jewfish, which are easily overfished despite having very many spawning year classes. Species with a strong aggregating behavior may be especially vulnerable to fishing and thus less resistant than nonaggregating species. Similarly, a species with a short spawning season may be more dependent on having favorable environmental conditions during a specific time period than one with a protracted spawning season. Therefore, a recovery from low stock levels within a given time period is more uncertain, perhaps making that species less resilient than one with a protracted spawning season.

M/K and Other Population Scalars

The M/K ratio has been criticized because the variability observed in available estimates of M and K estimates among species are more likely due to sampling or estimation errors than to actual interspecific differences. The difficulties in estimating M are well known. In fact, M is probably the most difficult parameter of a population to determine. The most common method of estimating M, based on maximum age observed in a fished population, may be biased by variations in harvest rates. Several Panel members noted that the estimates of M for some of the species were based on empirical regressions of K and perhaps other parameters (e.g. Pauly 1979). Therefore, the M/K ratio would tend to reflect the slope of the empirical regression equation rather than a fundamental property of the stock in question. Only M values estimated by methods independent of K would be free of this problem.

The estimation of K is difficult because growth studies may derive data from a variety of sources, and from stocks under different harvest regimes. Biases can occur from the use of fish from areas or gears that are not representative to the whole population. Variation in harvest regimes may also influence growth rates for a population, resulting in variable K.

Legault and Eklund (1998) have shown that the M and K estimates for Nassau grouper and jewfish are highly uncertain and produce M/K ratios with 80 percent confidence intervals of 0.39 to 1.27 (Nassau) and 0.30 to 1.28 (jewfish). The conventional M/K paradigm cited in the previous panel report (GMFMC 1998a) would therefore classify both species as moderately to highly resilient. Legault and Eklund (1998) pointed out that this goes against all current knowledge of these two stocks and questioned the utility of the M/K paradigm in general. Thus, while M/K ratios may provide some information on the relative resilience of a population, caution should be taken so that too much reliance is not placed on a given value of the index for any species without careful examination of all aspects of the stock and its fisheries.

The Panel discussed the potential use of other life history parameters/ratios, such as length-at-maturity to maximum length (L_{mat}/L_{∞}), age-at-maturity to maximum age (t_{mat}/t_{max}), and other compensation ratios that may be useful in providing a scaling factors for ranking the relative vulnerability of populations to overfishing, however, no scientific studies or data were available to evaluate the validity of such scaling factors. Estimation of these parameters is also subject to error/uncertainty, and may be affected by fishing on the population, as noted for M/K ratios. Therefore, at the present time, no life history scaling factor, including M/K, can be recommended for ranking populations relative to their vulnerability to overfishing.

A general characteristic of populations that seems to be emerging from population studies is that if the age or size of recruitment to the fishery is greater than the age or size at which all or most of the females have begun spawning, then yields very close to MSY are obtained for a wide range of fishing mortalities (Myers, memo, 1998). Thus, a spawn-at-least-once policy will help protect against a stock collapse if fishing mortality targets are exceeded (Myers and Mertz, 1998).

However, although a population protected by a size limit that is larger than the size of reproduction would be more resistant to overfishing than a similar population with fishing mortality exerted on both juvenile and adult fish, a post-maturity size limit or a size limit that allows spawning to occur only once before entering the fishery may not be sufficient. This relatively simple concept is also not applicable in stocks where undersize discard mortality is a significant factor or where management may prefer goals that in some instances specify harvest of juveniles over adults (e.g., red drum). In the latter case, management must be especially prudent in controlling fishing mortality rates to ensure adequate spawning stock size. The spawn-at-least-once policy must not be allowed to degenerate to a spawn-only-once policy, which would likely cause any population to collapse.

As in most situations, much of the information for this general concept is derived from temperate or boreal species, where relatively late maturity and other life history characteristics may mean that this same policy may provide more protection than in the subtropical/temperate species being considered by this Panel. It should be noted that high fishing mortality rates on spawning adults seems to be a significant issue in groupers, for instance. Very high fishing mortality rates on a long-lived, early-maturing spawning population could result in SPRs much lower than presently accepted as appropriate for most stocks. The note that a wide range of fishing mortality rates provide similar yields near MSY has long been noted as one of the dangers of management near MSY, since a production model of the stock may not indicate the true status of the fishing pressure, and its impact on spawning potential.

Direct Estimation of MSY and B_{MSY}

The necessary analyses for calculating MSY and stock biomass levels at MSY (B_{MSY}) from stock-recruit and stock production models with reasonable confidence do not exist for Gulf species. Therefore, MSY proxies are needed to fulfill the Sustainable Fisheries Act requirements, as specified in the National Standard Guidelines.

Use of Fishery Independent Data to Estimate MSY and B_{MSY}

The available fishery independent survey data for Gulf of Mexico finfish stocks are described below. Among the existing recruitment, larval, and adult surveys, the recruitment indices based on the northern Gulf groundfish trawl and SEAMAP trawl surveys are the most useful because of their longer time series, but they do not provide sufficient information on all species of interest.

Recruitment Indices

Part of the charge to the Panel was to review the potential use of juvenile fish recruitment indices that have been collected under fishery-independent data collection programs, with regard to their appropriateness for use in assessing proxies for MSY or overfishing/overfished thresholds. The Panel discussed the availability, utility, and time sequence of various databases. The Panel noted that various fishery-independent databases of recruitment are available, e.g. Summer SEAMAP and Fall Groundfish Surveys, as well as individual state surveys. However, the groundfish surveys are conducted in the central and western Gulf while many of the species of interest occur primarily in the eastern Gulf (e.g., jewfish, gag, etc.) Where they would not be sampled by the existing surveys. Furthermore, trawling gear isn't very effective in catching mackerel and other pelagic species.

The SEAMAP surveys were investigated and are discussed under the individual species sections of this report. Although not totally fishery-independent, recruitment from bycatch was also reviewed, especially with regard to the king mackerel fishery. State juvenile bag seine surveys have provided an index of red drum young-of-the-year abundance in some Gulf states for variable time periods. These indices have been incorportated into stock assessments at both the state and Gulf-wide levels. In general, the Panel felt that estimates of recruitment either were too variable or at present could not be fully evaluated as a proxy for MSY and B_{MSY}.

Larval Indices

Estimates of annual mean larval abundance or frequency of occurrence derived from fishery independent larval surveys can be used to index trends in adult stocks in the Gulf of Mexico for those species in which the larvae have been adequately described. Ichthyoplankton collections taken during SEAMAP surveys conducted in Summer and Fall, 1982 to 1995, have provided just such a data set for king mackerel (Lyczkowski-Shultz 1996; Gledhill and Lyczkowski-Shultz ms). Larval frequency of occurrence has been used as a tuning variable in the king mackerel VPA stock assessment since 1996 (GMFMC 1996a).

A larval index for red snapper has only recently been feasible because of the difficulty in distinguishing snapper larvae (Drass et al. ms). Results of an examination of snapper larvae from Gulfwide SEAMAP collections in 1992 and 1993 indicated that 53% of snapper larvae captured are larger than 3 mm and can be identified to species and/or genus levels. Use of a red snapper larval index to follow trends in population size can now be attempted based on the identifiable size fraction of lutjanid larvae in SEAMAP collections. The examination and identification of lutjanid larvae from the remaining 14 years of SEAMAP collections will be a labor intensive process. Additional manpower is required for timely completion of this work.

With respect to red drum, there are no difficulties in identifying the larvae and SEAMAP collections could provide information on relative spawning stock levels since 1986 when a Gulfwide plankton survey during the month of September was established. A first-order approximation of red drum spawner biomass in the area between the Mississippi River and Mobile Bay underestimated stock size by an order of magnitude when compared to the Nichols (1988) mark and recapture estimate (Comyns et al. 1991). Variability associated with larval catch data was the primary cause for the underestimate. Sampling effort in subsequent surveys has been tripled (from 19 to 60 stations) and the resultant annual mean estimates of red drum abundance since 1989 may provide a valid fishery independent index for red drum off east Louisiana, Mississippi and Alabama (Bruce H. Comyns, Gulf Coast Research Laboratory/University of Southern Mississippi, unpublished data). Additional information is available from the annual estimates of the abundance of red drum larvae from east Louisiana, Mississippi and Alabama coastal waters that have been monitored by Bruce Comyns of the Gulf Coast Research Laboratory/University of Southern Mississippi since 1989.

The available larval indices are valuable as an independent estimate of spawning stock size and as an abundance index to tune VPAs, but the lack of a sufficient time series over a range of stock sizes precludes their use for estimating MSY or B_{MSY}. Use of annual abundance and occurrence of the early life stages of fishes in stock assessments is dependent on our ability to identify those early stages which for many species remain undescribed.

Adult Stock Indices

Fishery independent survey data on adults are valuable for tuning VPAs and calculating other population parameters such as MSY and B_{MSY}. The NMFS/SEAMAP groundfish and larval surveys were not designed, nor could they be, to assess populations of all species of fishes inhabiting the Gulf of Mexico. The NMFS currently conducts a Gulfwide reef fish video/acoustic survey which may prove useful in future stock assessments, but unfortunately, this time series began in 1992 and is of too short a duration to be useful in estimating MSY or B_{MSY}.

Potential proxies for MSY with Fishery-Independent Data

The Panel examined several fishery-independent indices of abundance that might be used to develop proxies for MSY. The major difficulty the Panel found was that there was no way to confidently relate fishery-independent abundance indices to the yield or biomass that would be produced by the directed fishery at any given abundance level in the index. For instance, the catchability of sizes from within the directed harvest was most often different from the catchability in the fishery-independent survey. This might be due to movement to different habitats with growth, or to differences in gear efficiency. Many of the datasets considered are used in VPA analyses of the stocks. Any comparison of recruitment from an index to the estimated harvestable stock size would need to be aware of possible autocorrelation between these parameters.

Some larval and juvenile indices have been considered as fishery-independent indices of spawning stock size. While these indices may also be valuable sources of information on actual stock size and changes in stock size, the time series on most of these indices is relatively short, and the sampling program may only cover a portion of the species range. Evaluation of the accuracy and precision of these estimates must be carried out before they provide this type of information.

Species Specific Recommendations

Red Snapper

Stock assessments have been available for red snapper since at least 1988. Estimates of MSY have been made in the past but they do not appear to be reliable[1]. Current estimates of SPR show that red snapper are severely overfished. However, recent regulatory actions have reduced juvenile red snapper bycatch in shrimp trawls and these actions have coincided with increases in fishery-independent measures of recruitment.

Data are not available to directly estimate B_{MSY}. However, a likely range of estimates for the stock biomass at MSY could be calculated using the VPA-estimated abundance and a range of likely spawner-recruit relations. **The Panel requests that a stock assessment analyst responsible for red snapper perform these analyses.**

[1] The original Reef Fish FMP estimated MSY for snapper and grouper combined to be approximately 51 million pounds, based on a Graham-Schaefer yield model (GMFMC 1981).

The Panel investigated the use of fishery-independent data to estimate proxies for B_{MSY}. Recruitment indices are available for red snapper from the fall groundfish surveys (since 1972) and summer SEAMAP surveys (since 1984) conducted in the northern Gulf of Mexico. A B_{MSY} proxy can be approximated as the relative biomass that the average survey recruitment index would produce over the long term if the stock were fished at F_{MSY} (or a proxy thereof such as $F_{0.1}$ or F_{max}), provided of course recruitment is largely independent of stock size. For red snapper, the age-1 recruit abundance index in terms of standardized catch-per-hour from the summer SEAMAP and Fall groundfish surveys (Table 4; Schirripa and Legault 1997) ranged from 0.82 to 14.87 during 1972-96, with a median of 5.94. Red snapper yield per recruit at F_{max} (or $F_{0.1}$) is about 1.0 kg per recruit (Goodyear 1995; Fig. 86). Therefore, it would be expected that the median recruitment of 5.94 juvenile fish per tow-hour would result in 5.94 kilograms per tow-hour of post-recruit red snapper in the survey tows when the population biomass reached the biomass associated with F_{max} or $F_{0.1}$ (F_{MSY}). The actual catch observed in the survey could then be compared to this target survey catch to determine the yield relative to the expected yield at B_{MSY}. Unfortunately, this assumes that the survey gear is just as effective at catching post-recruit red snapper as it is at catching recruits and that a relationship can be defined between the juvenile survey and the resulting harvestable biomass. The differences in catchability and availability between these size groups would need to be determined if this method is to be used effectively. **The Panel decided that a better proxy for B_{MSY} is the equilibrium biomass of the stock size at $F_{30\%\ SPR}$.This can be expressed in terms of an SPR proxy as a 30 percent transitional SPR at MSY.** This biomass accrues when the stock comes into equilibrium with an F approximating $F_{0.1}$. Mace (1994) stated that when the age of 50 percent maturity is less than the age of 50 percent recruitment to the fishery, $F_{35\%\ SPR}$ will generally exceed $F_{0.1}$. Red snapper have 50 percent maturity at about 12 inches (Goodyear 1995, figure 19) and have a 15 inch size limit, so this scenario holds true for the directed fishery. Therefore, $F_{0.1}$ for red snapper occurs at an SPR lower than 35 percent. On this basis, **the Panel recommends that the fishing mortality MSY proxy for red snapper be set at 30 percent static SPR**.

Summer SEAMAP age-1 recruitment indices are used to tune the red snapper VPA with very good results (Figure 13, Schrippa and Legault 1997). Estimates of age-1 snapper from the stock assessment are highly correlated with results from the fishery-independent survey, demonstrating the effect of tuning on the VPA. Estimates of F needed to compare to the B_{MSY} threshold can be made from the current stock assessment.

Red Drum

Historically, the bulk of the red drum harvest throughout the Gulf of Mexico was taken from state waters. Harvest from Federal waters was a small component of total harvest for most years of record (Goodyear 1996, Table 3). Present state regulations attempt to regulate harvest rates through minimum and maximum size limits, creel limits, and commercial quota, where allowed, and effectively establish nearly the entire harvest as recreational allocation, through gamefish status or prohibition on commercial harvest in Gulf states, except Mississippi. Therefore, the concept of maximum sustainable harvest for this species should consider recreational harvest opportunity along with yield in weight. This differs from the yield-per-recruit component that dominates commercial species analysis. Allowable numbers harvested, as well as the sizes allowed, may not be those that would be expected from a generalized yield-per-recruit estimation based on a constant F after initial recruitment to the fishery.

Red drum grow rapidly as juveniles, and mature relatively early in their expected lifetime. Maturity may be as early as 3 years, and Wilson and Nieland (1994) estimated 50% maturity as 4 years of age. At least 25 year-classes are represented in the spawning stock in significant numbers (Wilson and Nieland 1994, Goodyear 1996).. This life history, combined with the F profile of the existing fishery, provide a spawning stock biomass that should be relatively stable over time, and relatively resistant to overfishing. This is because existing fishing is concentrated on a few year-classes, while spawning is provided by a large number of year-classes. Yield from the fishery may be relatively variable due to the small number of year-classes exposed to the fishery, and the variability noted in recruitment indices from fishery-independent samples. However, if the stock becomes overfished, then these same life history parameters mean that stock recovery will require longer periods of rebuilding. This is because the relative contribution of a given year-class to the spawning biomass is small relative to the total.

Virtual population analyses have been used to estimate the status of the stock since 1987. Consistent findings include high fishing mortality rates on juveniles prior to implementation of conservation actions after about 1986. Estimates of escapement rates (probability of surviving fishing through age 4) declined from about 10% in the early 1980's to below 1% in 1986 and 1987. Spawning potential ratios declined from 13% in 1979 to a low of 6% in 1992 (Goodyear, 1996, GMFMC 1996b). In 1996, the Red Drum Stock Assessment Panel found that the spawning stock was below 20% SPR, but was increasing in response to conservation measures implemented by Gulf states. The projected estimate of escapement was less than expected based on the 1993 assessment, but the Red Drum Stock Assessment Panel reported that if fishing mortality rates estimated for 1995 were held steady, then the Council's SPR goal (20%) would be met in the year 2001.

The existing overfishing definition of red drum is 20% SPR, with a management goal of 30% escapement from the juvenile fishery estimated to provide that SPR level at equilibrium. This escapement rate includes some allowance for harvest of mature fish that occurs within state waters, so that the escapement rate to the spawning stock is a higher value than the SPR produced by that escapement rate.

The actual yield corresponding to MSY is defined as: All red drum recreationally and commercially harvested from state waters landed consistent with state laws and regulations under a goal of allowing 30 percent of the escapement of the juvenile population that would have occurred under unfished conditions.

The MSY proxy for maximum fishing mortality threshold (MFMT) (the fishing mortality rate equal to F_{MSY} when biomass is at the MSY levels), is recommended to be a fishing mortality rate corresponding to 20 percent static SPR. The MSY biomass proxy relative to SPR is therefore 20 percent transitional SPR.

Lacking a stock-recruitment relationship, the minimum stock size threshold (MSST) of adult red drum required to maintain current recruitment to the inshore nursery areas is estimated to be the minimum spawning stock biomass over the 1979-92 time period. However, in order to meet the requirement that a stock be capable of being rebuilt within 10 years from the MSST, it is recommended that the minimum stock size threshold (MSST) be set as the stock size that would result at equilibrium fishing of $F_{16\%SPR}$ (i.e., 16 percent transitional SPR) based on the NMFS formula in the technical guidance document ($M \cong 0.2$, $c=(1-0.2)$, $F(B)=F_{MSY}*B/c*B_{MSY}$). This measure will require examination and refinement by the red drum stock assessment panel in order to define any trajectory in fishing mortality rates that would be required in order to achieve the rebuilding schedule from the MSST. The minimum biomass of spawning stock over the 1979-92 period may be appropriate as a short-term measure of a lower limit on spawning stock size, below which much more stringent limits on fishing rates must be applied (severely overfished, B<<MSST in the first Ad Hoc SAP report). However, consideration of habitat issues (see below) may mean that this measure may need revision in the future, The other stock size measures, being relative to fishing mortality rates, would not need revision over time.

Goodyear was unable to reconcile estimates of adult stock size with those from the NMFS tag-recapture study of Nichols (1988), so this report will not specify a specific value for MSST (or B_{MSY}) , but rather recommend that any evaluation of present condition use available comparable information from the 1979-92 time period.

It should be noted that the above recommendations are based on maximizing the benefits of a (mainly) recreational fishery that is conducted primarily on juveniles. Therefore, the recommendations are contingent upon a continuation of the moratorium of adult red drum in federal waters.

Optimum Yield for Red Drum

More precautionary SPRs might be considered for optimum yield (OY) targets, potentially with yield-per-recruit benefits. These may require substantial reductions in fishing mortality rates. The Panel noted that fishing mortality rates may be the best surrogate presently available for "recreational opportunities" in the OY definition, while yield-per-recruit may be the best surrogate for yield in terms of food production. Establishing OY targets at SPR levels higher than those required to maintain MSY allows managers to enhance some aspects of the fishery, without compromising possible recruitment..

Ecosystem Effects

The Panel notes that the nursery areas for red drum are being substantially reduced through coastal wetlands losses, especially in Louisiana. As Louisiana coastal waters provide a substantial portion of current and historic red drum harvest, it is reasonable to assume that losses of these nursery areas may eventually impact the ability of the red drum stock to maintain itself, independent of fishing mortality issues. For some estuarine-marine species, the loss of these habitats may already be impacting the ability of the stocks to maintain themselves at levels seen in recent history. These aspects of essential fishery habitat may eventually lead to re-establishment of any absolute stock size benchmarks that would more accurately reflect the ability of those habitats to sustain stocks. The result of such habitats would most directly impact the indices of recruitment to the fishery, which would be expected to decline from current levels. This would produce lower harvests with no change in the F profile. The resulting long-term adult biomass would also be expected to decline.

King and Spanish Mackerel

Stock assessments for king and Spanish mackerel have been available since 1983. Restrictive management measures were enacted in the early 1980's to correct overfishing conditions and to rebuild the stocks. As the result of these management actions the king and Spanish mackerel populations have exhibited a high resiliency to the resulting lower fishing mortality rates; during the past decade increased spawning stock biomass (king and Spanish) and increased recruitment (king) trends have been evident. It is currently estimated the Gulf king and Spanish mackerel populations are at transitional SPR levels of 23 percent and 35 percent, respectively and being prosecuted at a fishing mortality rate equivalent to 21 percent and 47 percent static SPR, respectively.

The data are not available to estimate MSY or B_{MSY} directly and the recruitment indices from the

SEAMAP and fall groundfish surveys are too imprecise and incomplete to use for estimating MSY or B_{MSY}. **The Panel determined the best available proxy for MSY is SPR and recommends the Gulf Council establish a MSY SPR proxy of 30% for king and Spanish mackerel because the empirical evidence suggests these species are resilient to overfishing.**

Gag

Stock assessments for gag have been available since 1994. It is currently estimated the gag population is at a transitional SPR level of 21% and being prosecuted at a fishing mortality rate between 18 to 23% SPR (GMFMC 1998a). The Panel noted that concern existed about the lack of resistance of gag to overfishing because it forms large spawning aggregations that are easily targeted by fishermen. Some biologists fear that the decreasing percentage of males in the population during the past two decades may be negatively impacting reproductive productivity.

The data are not available to estimate MSY or B_{MSY} directly and the only available recruitment index represents too short a time series for use in estimating MSY or B_{MSY}. Therefore the best available MSY proxy is SPR. **The panel recommends that the MSY SPR proxy should be 35-40% if no action is taken by the Gulf Council to further protect mature fish through an increased size limit and/or a spawning season closure when they are aggregated. However, if protection of spawning fish is implemented, then the panel believes a MSY SPR proxy of 30% is appropriate for the gag population because specific protection of the mature stock improves the population's resistance to overfishing.** Although two scenarios for MSY proxies are presented, the Panel feels that the preferred scenario should be the one that protects mature fish and spawning aggregations through an increased size limit and spawning season closure.

Jewfish and Nassau Grouper

Jewfish and Nassau grouper species have been fully protected by the Gulf Council with ABCs of zero harvest. These fisheries were closed due to concerns that they were especially susceptible to overfishing because their populations were small in size and at depressed levels as the result of fishermen being able to easily find and target large sedentary individuals, as well as, spawning aggregations. These species are, therefore, generally believed to be neither very resistant not resilientto overfishing. **Therefore, the Panel recommends that the Gulf Council establish a MSY SPR proxy of 40-60 percent for jewfish and Nassau grouper.**

Other Gulf Finfish Species

Based on the finding by Mace (1994) that, when the age of 50 percent maturity is less than the age of 50 percent recruitment to the fishery, $F_{35\%\ SPR}$ will generally exceed $F_{0.1}$, **the Panel recommends that the other Gulf finfish species under the jurisdiction of the Gulf Council be managed with an MSY and B_{MSY} SPR proxy level of 30%, provided there is a minimum size limit of at least the size at 50 percent maturity, unless certain life history characteristics or management strategies warrant a more precautionary approach.**

Conclusions and Recommendations

1. Future stock assessments should evaluate the utility and uncertainty of estimating MSY and B_{MSY} directly from the available stock production models and ancillary data.

2. Fishery independent surveys of larval, juvenile, and adult components of the Gulf fishery stocks need to be expanded and designed specifically to assist in stock assessments.

3. Future stock assessments should use a consistent reporting format for the following parameters to assist in the type of cross-fishery analyses needed to evaluate the relative resiliency or resistance of the Gulf populations: F, SPR, and yield levels associated with all of the commonly used biological reference points life history traits such as age and length at recruitment to the fishery, age and length of maturity, maximum age and L_∞, M, K, etc..

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TABLE 14 (from Generic SFA Amendment)

Summary of M/K Ratios for Gulf Finfish Stocks

Group One: M/K Ratio ≤ 1.0

Species	M	K	M/K
Black Grouper	0.15	0.160	0.94
Red Hind	0.18	0.207	0.87
Cubera Snapper	0.15	0.160	0.93
Red Snapper*	0.10	0.160	0.63
Yellowtail Snapper*	0.20	0.250	0.80
Greater Amberjack*	0.20	0.250	0.80
Red Drum*	0.20	0.367	0.55
Cobia*	0.35	0.350	1.00
Red Grouper*	0.20	0.210	0.95
Jewfish**			0.92
Nassau Grouper**			0.94

Group Two: M/K Ratio > 1.0 ≤ 1.5

Species	M	K	M/K
Coney	0.18	0.145	1.24
Rock Hind	0.25	0.191	1.31
Scamp	0.14	0.126	1.13
Snowy Grouper	0.13	0.113	1.15
Warsaw Grouper	0.08	0.054	1.48
Yellowedge Grouper	0.18	0.170	1.05
Yellowfin Grouper	0.18	0.170	1.05
Schoolmaster	0.25	0.180	1.38
Vermilion Snapper*	0.20	0.198	1.01
Mutton Snapper*	0.21	0.153	1.36
Hogfish	0.25	0.190	1.32
King mackerel*	0.20	0.170	1.18
Spanish mackerel*	0.30	0.270	1.11

Group Three: M/K Ratio > 1.5

Species	M	K	M/K
Gag*	0.20	0.150	1.63
Graysby	0.20	0.130	1.54
Speckled Hind	0.20	0.130	1.54
Yellowmouth Grouper	0.18	0.063	2.86
Black Snapper	0.30	0.097	3.09
Blackfin Snapper	0.23	0.084	2.74
Dog Snapper	0.33	0.100	3.30
Gray Snapper	0.30	0.136	2.21
Lane Snapper	0.30	0.097	3.09
Mahogany Snapper	0.30	0.097	3.09
Silk Snapper	0.23	0.092	2.50

Source: Ault, et al. (1997 (Except for species marked by *). **from Legault and Eklund (1998)

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