

# **SEDAR**

*SouthEast Data, Assessment, and Review*

**Consolidated SEDAR Workshop Recommendations  
for Research, Monitoring, and  
SEDAR Procedures**

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## *PREFACE*

This document is a compilation of the research, monitoring, and procedural recommendations provided by SEDAR workshop panels. It is intended to provide a single-source reference for those interested in conducting research and improving monitoring. It is also intended to enhance future SEDAR stock assessments by highlighting areas identified as needing improvement in previous assessments.

Items are presented as provided in SEDAR reports with only minor editing where necessary for clarification or to reduce duplication. Prioritizations are noted and preserved for those instances where recommendations were prioritized.

This document is only a summary of specific research recommendations and is not intended to replace detailed SEDAR assessment reports in any way. The complete reports may contain further details of and justification for the various research recommendations summarized here.

Each SEDAR project is listed in a separate heading within which recommendations are listed by workshop (e.g., data, assessment, and review). Research and monitoring recommendations are listed separately from process recommendations. Recommendations of the independent experts provided through the CIE (Center for Independent Experts) are listed separately from the workshop panel recommendations.



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## I. SEDAR 1 South Atlantic Red Porgy

### A. Assessment Workshop

- The discrepancy between SC and NC aging is a major need that must be resolved, preferably before the next assessment. The SAW recommends that as soon as possible, the NC and SC investigators meet and share age readings techniques, to resolve the systematic discrepancies in age determinations, if possible. The SAW further recommends that research be undertaken that will accomplish verification of aging in red porgy.
- The protogeny of red porgy is a life history feature that complicates assessment and management. The SAW recommends that sampling for sex ratio at length be instituted in each fishery and that population sampling for sex ratio at length be continued by the MARMAP program. The SAW further recommends that research be instituted into assessment and population-projection methods that can make better use of sex-ratio data that exist now and that may exist in the future.
- Under many forms of management, considerable discarding of red porgy could be expected to occur. The SAW recommends that sampling programs be initiated to quantify discard rates, especially in the commercial fishery, where the discard mortality rate is believed higher, and to estimate discard mortality rates. The SAW recommends that research be instituted on management strategies that could reduce discard mortality and also research to illustrate the effects of discard mortality. The SAW also recommends that socioeconomic research be considered on educational measures to assist fishery participants in minimizing discard mortality and understanding the value of doing so.
- Fishery-independent data collected by the MARMAP program have served an important role in understanding the dynamics of this population, and the National Research Council has recommended that fishery-independent data play a more important role in stock assessment generally. However, the MARMAP sampling programs have been criticized by some as not having ideal extent, both in area coverage and in sampling intensity, for red porgy. The SAW recommends that the MARMAP program expand its coverage as needed.
- During the DW and SAW, it was noted that some incomplete, or misleading data have been entered in the NMFS general canvass data base. In particular, some data are available only under aggregated categories (e.\,g., porgies), even when accepted corrections to provide estimates of red porgy landings exist. The SAW recommends that state agencies contact and work with NMFS personnel maintaining the general canvass data base to make sure that data in that central data base are at the most disaggregated level possible and as accurate as possible. The goal is that future red porgy assessment should be able to use data from the general canvass data base with confidence and without further corrections.
- A hook and line index of abundance should be developed for deeper water.
- The aging assumptions and the plus-group assumptions in the age structured model should be evaluated.
- Alternative assumptions about M should be evaluated.

- Sampling of catch by sex from commercial vessels should be initiated.
- Analyses to develop indices of abundance should consider the effects of unsuccessful effort.

## B. Review Workshop

### 1) RESEARCH RECOMMENDATIONS

- Sampling for sex ratio is needed where protogeny is a concern; models and evaluations should incorporate this feature. Stock assessment scientists should discuss and develop methods to deal with these species. The implications of alternative assumptions about spawning stock definitions should be investigated.
- At-sea observers should be considered for monitoring discard and developing CPUE indices.
- Red porgy switch sex from females to males. The analytical tools and biological reference points do not take this into consideration. Implications of this are unknown and could have important effects on reference points and estimates of recovery.
- Concern was expressed that important information on the status of larger red porgy derived from deeper waters was not available as a separate index for inclusion in the assessment. It is recommended that further consideration be given to developing such indices from commercial and fishery independent data.
- Effective monitoring of stock recovery, especially under further fishing mortality reductions, will require information on discards.

### 2) PROCESS RECOMMENDATIONS

- The three step process (DW, SAW & SARC) proved to be very useful. It is recommended that more time be allocated between each of these steps. It would be helpful to have this incorporated into the Terms of Reference.
- If more than one stock is to be assessed per year, substantial additional resources must be provided. Additional funding will be necessary for NMFS and state participants.
- Participation of industry was a very important part at each step of the process. This practice should be continued.
- Priorities as to the stocks to be assessed need to be set.
- Having both NMFS and state scientists participating in the decision process for input data and assumptions for the model was very useful.
- Input from SARC participants other than on the panel was very useful. This will facilitate exchanges between the SAW and SARC participants.
- As well as peer review, the SARC was a useful forum for the exchange of technology and ideas.
- In future, the SARC will draft the Consensus Report at the meeting with a subsequent review.
- Improved technical support is required; printers, copiers, hard copy of drafts, LAN and other support.

### C. CIE Consultant Recommendations

- Future SARCs should be larger; there was no buffer.
- More emphasis should be placed on systematic and structured comparison (figures and tables) with earlier assessments.
- The Chair was required to fill two roles; steering the meeting and as a technical reviewer.



## II. SEDAR 2: South Atlantic Black Sea Bass and Vermillion Snapper

### A. Black Sea Bass

#### 1) ASSESSMENT WORKSHOP

- Representative age sampling is needed (proportional); also commercial age sampling.
- Increased fishery independent sampling.
- Development of logbook indices is recommended.
- Information about fecundity is needed (batch fecundity and frequency at age and/or size).
- Further consideration of implications of change in sex for fishery management.
- Further development of analytical models to incorporate historical catch information.
- Future research should be conducted to further develop age-structured models that could account for historic landings. Specifically, methods that allow scaling of uncertainty in landings records over time are needed. We need to include more historical records which are more uncertain than current records, this may be done by changing CVs over time as opposed to constant CV for a data series.

#### 2) REVIEW WORKSHOP

Recommendations are listed in priority order as identified by the workshop panel.

1. The Panel requested that SC DNR expand their MARMAP efforts to conduct a synoptic study of their gear to provide a basis for comparing relative gear efficiencies and thus connecting the several short MARMAP indices available for this assessment.
2. Commercial fisheries data, including logbooks, should be analyzed to determine whether it is possible to develop a reliable fishery-dependent index of abundance from these data.
3. The monitoring program should be expanded to collect data on the magnitude, release mortality, and the size/age composition of the black sea bass that are discarded by each fishing sector and from each fishing gear and depth.
4. Age samples need to be increased and collected appropriately for use in aging the catches of the various fishery sectors. Furthermore, the possibility of determining reliable age compositions from the historical MARMAP age samples needs to be evaluated.
5. The Panel suggested that a comprehensive study and documentation of the abundance index derived from the headboat data would be useful. For example, consideration might be given to whether changes in fishing operations, including species composition of landings, might reflect changes in catchability of black sea bass that have not been taken into account by the GLM.

6. The Panel considered that, through more detailed examination, it might be possible to develop an acceptable abundance index from the MRFSS data and suggested that this should be investigated.
7. An index of recruitment for the stock should be developed.
8. Research should be initiated to estimate fecundity by female size and age.
9. The Panel considered the possibility that fish from the assemblages of black sea bass located north and south of Cape Hatteras, NC, might mix and suggested that a research study should be initiated to investigate its magnitude, geographic extent, direction, timing and management implications.
10. The Panel recommended that the issue of whether it is more appropriate to use total mature biomass, mature female biomass or some other measure of spawning potential for a protogynous hermaphrodite should be investigated.
11. The Panel concluded that the application of a production model should be investigated as to its appropriateness for a protogynous species.
12. The behavioral dynamics associated with reproduction in this protogynous species should be investigated with respect to the effects of size selective harvesting.

## B. Vermillion Snapper

### 1) ASSESSMENT WORKSHOP

- The statistical weights assigned various data sources in the assessment model can influence the results. At present, weights are determined heuristically to provide a balance of fit to all data sources. The group recommends further research to investigate methods of weighting data sources, e. g., based on their apparent significance, relevance, or reliability.
- Fishery-independent data collected by the MARMAP program are used in many stock assessments in this region, and the National Research Council has recommended that fishery-independent data play a more important role in stock assessment generally. However, the MARMAP sampling programs do not have ideal extent, either in area coverage or in sampling intensity, for vermilion snapper. The group recommends that the MARMAP program expand its coverage, particularly into deeper water, as needed.
- Under many forms of management, considerable discarding of vermilion snapper could be expected to occur. The group recommends that sampling programs be strengthened to quantify discard rates, especially in the commercial fishery, where the discard mortality rate is believed higher, and to estimate discard mortality rates better. The group recommends that research be instituted on management strategies that could reduce discard mortality.
- Data have been recorded from commercial catch logbooks since 1993. However, logbook data have not been incorporated into stock assessments in the South Atlantic because of apparent difficulties in analyzing the data. The DW and AW both recommended that an investigation be undertaken to determine the feasibility of and best methodology for using commercial logbooks to develop an abundance index for the commercial fishery for vermilion snapper.

important data element for stock assessment, including vermilion snapper, is routinely collected age-composition data for major fisheries. The DW and AW recommend that regular statistical sampling and analysis of vermilion snapper for aging is needed, in both the commercial hook-and-line and headboat fisheries. A minimum sample size of 500 ages per year is recommended from each fishery.

- Abundance indices for vermilion snapper indicate only minor fluctuations in population abundance during the model time period. This low population contrast is partly responsible for the large uncertainty in estimates derived from the model. The AW recommends that alternative age-structured models be investigated for vermilion snapper and other low contrast populations to determine whether more robust population estimates might be achieved.
- Recreational landings estimates for vermilion snapper (and other species) in the MRFSS database are often highly variable, resulting in large year-to-year swings in the estimates. Those swings apparently reflect sampling error, rather than true fluctuations in fishery landings. Such large year-to-year changes can influence assessment models in undesirable ways. The AW recommends that smoothing techniques be investigated to potentially reduce some of those large year-to-year changes. This will be particularly important for other species, many of which are taken in larger fractions by the recreational fisheries sampled by MRFSS.
- Although an age-structured model was ultimately not used in this assessment of vermilion snapper, it was noticed when developing this model that fecundity estimates were available only by length and not by age. The AW recommends that fecundity estimates at age be developed for future use in age-structured models.

## 2) REVIEW WORKSHOP

- The panel proposed that MARMAP conduct a synoptic study of their gear to provide a basis for comparing relative gear efficiencies. This would allow a more comprehensive fishery-independent index to be developed.
- Age samples from the various fishery sectors need to be increased and collected appropriately for use in stock assessment.
- Commercial fisheries data (including logbooks) should be analyzed to determine whether it is possible to develop a reliable fishery-dependent index of abundance from these data.
- MARMAP should be expanded into deeper water to assure greater representation of the spatial range of the stock.
- A monitoring program should be developed to collect data on the magnitude and the size/age composition of the vermilion snapper that are discarded by each fishing sector and from each fishing gear.
- An index of recruitment representative of the entire stock should be developed for vermilion snapper.
- The Panel recommended that, as an alternative model that could be applied in parallel with the existing model, consideration might be given to combining the indices of abundance externally and using the resultant combined index in the length-structured model rather than including the separate indices within the model. This suggestion was also made with respect to the black sea bass

assessment. The external analysis might provide better understanding of the input data and make the weighting more transparent.

- The Panel suggested that, in future assessments, consideration should be given to calculating and presenting estimates of the abundance-at-age weighted fishing mortality to supplement the information that is presented on the fishing mortality for fully-recruited fish.
- The estimated abundance indices used in the assessment of this stock are based on a limited spatial coverage that does not fully reflect the entire stock. In the short-term, information from the commercial fishery on the abundance of larger vermilion snapper should be examined. Over the long-term, fishery independent sampling should be expanded.
- Attention should also be given to developing a recruitment index.
- Effective monitoring of stock status will require more and improved data on discards. It is recommended that the bycatch logbook be continued and expanded estimates provided.

### C. Review Workshop Recommendations applicable to both assessments

- The descriptions in the assessment reports of the methods, which were used to collect and to analyze the data used in the assessments, were not sufficiently complete for a thorough and comprehensive review. Similarly, technical descriptions of the model structure, which were provided in the assessment reports, were sketchy and insufficiently complete. Accordingly, members of the Review Panel were obliged to base much of their assessment on the information provided in the verbal presentations. It is possible that the detailed descriptions that were sought by members of the Review Panel may be presented in the reports of the Data or Assessment workshops. However, if not, it is recommended that the assessment reports for future stock assessments should include more detailed descriptions of the methods of data collection, analysis, and the use of these data for stock assessment. Generic descriptions of these methods should be developed, that are broadly applicable to this and future assessments.
- For future stock assessments, sufficient details of the methods of data collection should be provided to allow the Review Panel to assess the extent to which catches from different spatial or temporal zones or from different fishing sectors have been representatively sampled, how the various samples are combined, and the sampling intensity that has been applied to the different sectors. Standard errors of estimates of landings and of the various abundance indices should be calculated whenever possible, and potential sources of bias should be identified and adjusted for when feasible. It is acknowledged that the data will be adjusted in the model for gear selectivity. In the current assessment, the Review Panel was not able to assess whether samples were representative and, if not, the likely magnitude of bias that would result.
- The Review Panel considered that minimum levels of sampling intensity and spatio-temporal coverage to achieve acceptable precision for key population parameters should be specified by the assessment team and that sample sizes should be increased if the sampling intensity should fall below this minimum

level. The sampling designs of the various data collection methods should be reviewed for statistical adequacy (sampling intensity and spatio-temporal coverage).

- Data should be reported in tabular as well of graphical format, to allow the Review Panel to explore miscellaneous aspects of the data.
- For future SEDAR reviews, the biological evidence and scientific motivation that led to the selection of the base parameter case as well as alternate parameter choices that are considered for sensitivity runs should be documented in the Assessment Report. Such selection will most likely take place at the Data Workshop, but any modifications that are made at the Assessment Workshop should also be recorded.

#### D. CIE Consultant Recommendations

- I strongly recommended that the assessment reports for future stock assessments include more detailed descriptions of the methods of data collection, analysis, and the use of these data for stock assessment.
- Minimum levels of sampling intensity and spatio-temporal coverage to achieve acceptable precision for key population parameters should be specified by during the Data and Assessment Workshops, and those sample sizes should be increased if the sampling intensity should fall below this minimum level.
- Over time, it is strongly recommended that the assessment assign more weight to fisheries-independent survey indices from the MARMAP program. MARMAP should also be expanded into deeper water to improve the spatial coverage of the stock.
- it is recommended that commercial logbook data be evaluated for inclusion as auxiliary information in stock assessments.
- I recommend that the variability in assessments caused by sampling variability in estimated landings in number by age be evaluated, for example by applying bootstrapping to port sampling data in connection with the model runs.
- The current stock assessment models for vermilion snapper and black sea bass apply a large number of parameters that are difficult to track. The external analysis of multiple survey indices of abundance might provide a better understanding of the input data, make the weighting more transparent, and result in a more parsimonious stock assessment model.
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### III. SEDAR 3: South Atlantic/Gulf of Mexico Yellowtail Snapper

#### A. Assessment Workshop

- As with other fisheries, we need data on all removals from the fishery.
- We need to collect annual discard information from all sectors of the fishery.
- An improvement for the assessment would be to develop a probabilistic aging procedure that accounts for selectivity and mortality that uses the catch-at-length and fishery-independent and fishery-dependent ages and lengths.
- We need to investigate the inclusion of interaction terms in the calculation of standardized catch rates.
- We also need to investigate whether the increases in the commercial catch rates reflects improvements in fishing methods such that the increase does not reflect the underlying population.
- We also need to review the methodology of the Reef Visual Census and its use as a fishery independent index of population trends.
- Another catch rate issue is whether the change in contractors for MRFSS was responsible for the patterns in the recreational catch rates.
- Stock assessments in the Southeastern U. S. would benefit from a workshop addressing natural mortality and steepness and how the stock status conclusions depend on the chosen values.
- The performance of the assessment models could be evaluated for retrospective bias by running the models with simulated data.

#### B. Review Workshop

##### 1) YELLOWTAIL SNAPPER SPECIFIC RECOMMENDATIONS

- Determine the release mortality rate for fish in the commercial, charterboat, headboat, and private/rental boat fisheries.
- Collect discard data (quantity, size, condition, etc.) from the headboat fishery. This could include modification to the current logbook used by headboats or employing observers; if observers are used, they could also collect biological data. Collection of discard data from the commercial fishery should continue. It is critical that a total (accurate) estimate of discards by sector (commercial, headboat, charter boat and private/rental boat) be available for the next assessment.
- Thoroughly evaluate the reef visual census CPUE index prior to use in future assessments.
- Examine alternative methods to incorporate recent increases in catching efficiency (“power-chumming”, smaller hooks, fluorocarbon leaders, GPS, etc.) into the commercial and recreational CPUE indices. This effort should lead to alternative methods to refine CPUE indices (electronic logbooks, observers, etc.), or alternative indices.
- Continue the use of annual age/length keys, and move to direct age estimation where possible. Cognizance should also be taken of the temporal and geographic effects on such collections.

- Seek better validation of age estimates.
- Continue research into stock structure, e.g. genetics.

## 2) GENERAL ASSESSMENT & RESEARCH

- Thoroughly examine estimates of natural mortality (M) and steepness (h) in a workshop setting. Such a workshop should not be limited to yellowtail snapper, but should make comparisons with other species.
- Examine the following issues with the MRFSS program:
  - \* The contractor changed in the mid-1990s. Whether or not this affected CPUE trends should be examined.
  - \* The level of intercepts increased after 1992, and from 1998/99 onwards, representatives of the State of Florida conducted the intercepts. What impact did this have on estimates and how should this CPUE index be incorporated into future assessments (as a continuous time-series or subdivided into one or more separate time series)?
  - \* Private vessel owners leaving from their own private facilities are not currently sampled adequately. Is an adjustment factor used to account for this sector? Is this an important issue in Keys fisheries, given the large number of canals and private docks?
  - \* Given the concerns about the MRFSS data, potential new methodologies to collect these data should be evaluated.
- Examine predator/prey interactions (and other ecosystem considerations).
- Develop methods to incorporate the effects of spatial variability into assessments.
- Put effort into developing better fishery-independent survey indices to assess fish stock status.

## 3) COMMENTS REGARDING GOLIATH GROUPEr

Goliath Grouper were initially considered during the data workshop but further assessment effort was not pursued due to a lack of data. The Review Workshop identified some potential assessment methods and overlooked datasets that ultimately led to an assessment of Goliath Grouper that was reviewed through SEDAR 6.

- Estimation of population size. Estimates of population size were considered to be crucial for future management. It was noted that, because of the apparently narrow home ranges and site fidelity, sampling throughout the geographic range would probably be important. Tag/recapture research and studies with data storage tags were mentioned as potential monitoring tools.
- Demographics. Monitoring the demographics of the population, particularly age composition, could provide valuable information. Noting that age determination of the species was difficult, the Panel suggested that effort be channeled into improving it.
- Reproductive biology. Developing further understanding of the reproductive biology of goliath grouper was considered important. Identifying spawning locations, duration and periodicity, and identifying whether there were spawning migrations, could be useful in identifying sites to conduct population surveys. Further, there would be value in obtaining more information on early life history

(eggs and larvae). It appeared that the survival rate of juveniles in mangroves and estuaries was good.

- Historical abundance. Obtaining information on historical abundance, perhaps via old logbooks, was considered a possibility as such information could enhance assessments.
- Other research material and topics considered as of less immediate importance or of questionable feasibility (in terms of collection of data) were:
  - estimating unrecorded mortality from accidental or intentional sources;
  - information on stock structure;
  - bioenergetics and trophic relationships (though note the comment above on the need for ecosystem management);
  - information identifying changes in mangrove abundance and distribution, and hence changing available nursery habitat (goliath grouper spend their first 6-7 years in mangrove areas, sometimes attaining as much as 50 lbs).

#### 4) PROCESS AND PROCEDURE RECOMMENDATIONS

- Provide hard copies of materials for participants. Not everyone can access material via the Internet and download/print large quantities of material.
- The category “recreational catch” should include charterboat catches, private/rental boat catches, headboat catches and shore-mode catches (if appropriate).
- Review and evaluation of data during Data Workshops should be much more rigorous. All data should be plotted and the trends examined, and detailed recommendations should be documented and provided on the use of the various datasets. Assessment scientists should attend along with representatives of all major data collection programs (MRFSS, commercial logbook, TIP, etc.). Consensus needs to be reached on the use of specific datasets or estimates for incorporation in the assessments.
- The next assessments should use simple stock assessment techniques in addition to relatively complex stock assessment models, because simple techniques are easier to understand and describe, as well as being useful in confirming the results from the more complicated models. In particular, simple exploitation indices (total catch divided by abundance indices) should be examined to detect trends in fishing mortality. The simple trends in survey, CPUE, and catch data should be examined and described, and trends in survey and CPUE data compared. Trends in mean length or mean weight also provide information on exploitation and recruitment levels, and are worthy of presentation.

#### C. CIE Consultant Recommendations

- That consideration be given in future assessments to:
  - \* the issues of year interactions, polynomial terms, and model selection in the standardization of CPUE ;
  - \* the use of less arbitrary data weightings;
  - \* further validation of yellowtail snapper ageing, an examination of the “representativeness” of age-length keys, and more work on direct age estimation;

- \* better documentation of the rationale for the assumed values of natural mortality and recruitment steepness;
- That consideration be given, in writing of terms of reference for future SEDAR Assessment Review Panels, to
  - \* either removing the phrase “including management recommendations” or giving clear guidance as to what sort of management recommendations are appropriate;
  - \* clarifying what is to be reviewed — the assessment or the assessment report — and, if the latter (not recommended), providing clear guidelines as to what is required in an assessment report.

## IV.SEDAR 3: ASMFC Atlantic Croaker and Menhaden

### A. Atlantic Menhaden

- There is no adult abundance index to tune the population model.
  - \* Evaluate commercial purse seine fishery effort (vessel/weeks) series as a possible tuning
  - \* index in the model. Evaluate any measure of effort contained in this or other data series.
  - \* Evaluate the data collected in the Captain's Daily Fishing reports for an adult abundance
  - \* index. If these data are not useful, explore the utility of a commercial fishery-based adult
  - \* index, developed jointly with the fishermen, for future assessments.
- Recent relative productivities of menhaden nursery areas coast wide are unknown.
  - \* Investigate if there are any existing studies that could assist in evaluating current productivity.
  - \* Develop protocols to quantify contribution of different nursery areas to the adult stock.
- M-at-age is an improvement over constant M assumption. However, there is concern that not all key sources of mortality have been accounted for and little is known about the temporal patterns of mortality.
  - \* Identify key sources of non-fishing mortality for menhaden.
  - \* Enhance the coverage of the MSVPA to more predator and prey species.
  - \* Determine if there are temporal patterns in these sources.
  - \* Validate assumptions about applying results from MSVPA to the 1955-1980 period.
- There have been large changes in size-at-age over the 1955-2002 period. These trends are not a problem for the model but could have an impact on forecasts.
  - \* Evaluate historical change in size (weight and length) at age using existing data (e.g., scale incremental widths).
- There are patterns in residuals of numbers at age for commercial catch estimated by the model.
  - \* Investigate if the selectivity model is causing this pattern.
  - \* Look at spatial changes in fishing pattern as well as fish distribution.
- Current fecundity estimates are from studies in the 1980's and earlier.
  - \* Update the fecundity-at-size estimates and maturity ogives.
- Cannot address local depletion questions with the current model.
  - \* Investigate methods to determine the proportion of the stock that may reside in a particular area in any one season and whether regional reference points can be developed to address local depletion.
  - \* Extend these methods to track changes in distribution over time.
- Control plot determination of overfishing/overfished is based on point estimates only.
  - \* Develop uncertainty measures or risk analysis for control plots.

- It is difficult to distinguish between results of different models and model assumptions.
  - \* Develop measures (goodness of fit/complexity) to screen multiple models.
- The assessment model assumes a unit stock.
  - \* Test this assumption using otolith microchemistry and/or genetic markers.

## B. Atlantic Croaker

The Review Panel rejected the initial Atlantic Croaker stock assessment due to critical data and model deficiencies. Specific steps necessary to correct the assessment were outlined as well as long term research and monitoring needs.

### 1) RECOMMENDATIONS TO CORRECT INITIAL MODEL

- Commercial landings did not include all removals from the population.
  - \* Evaluate North Carolina uncultured bait (“scrap”) fishery data and include in the commercial landings.
  - \* Evaluate the potential of applying the North Carolina uncultured bait fishery data to other states.
  - \* Consider at-sea observer data for discards and bycatch.
- The model used catch data from 1973 to the present but tuning indices were only used from 1981 to the present.
  - \* Extend the NMFS NEFSC bottom trawl survey data to 1973 for inclusion in the model.
  - \* Evaluate the difference between the Delta lognormal and stratified mean estimates from NMFS NEFSC bottom trawl survey.
  - \* Evaluate the VIMS survey data for possible inclusion in the model.
- The base model assumed that the SSB in 1973 was equal to 0.75 SSB (virgin biomass) from the Beverton-Holt analysis.
  - \* Re-evaluate after inclusion of the full time series of NMFS NEFSC and VIMS trawl survey data.
- The model assumes that the fisheries-independent survey indices are more precise than the fisheries-dependent data and model recruitment estimates and, therefore, provided higher weights to these surveys.
  - \* Evaluate the consequences of alternative weighting schemes.
  - \* Provide detailed justification for the final choice of weighting scheme.
- Separate models were developed for the mid-Atlantic (North Carolina and north) and South Atlantic (South Carolina to Florida).
  - \* Investigate the distribution and movement of croaker by age and season.
  - \* Compare life history parameters over the full distribution of croaker.
- The assessment included an age structured production model only. This required development of an algorithm to generate an age structure for the population.
  - \* Compare non-age assessment models, such as the Collie-Sissenwine catch-survey and a delay difference model, to understand the implications of this age structure on derived reference points and stock advice.
- Determination of overfishing/overfished were based on point estimates only.
  - \* Estimate the error distribution for current estimates of F, and reference points.

- \* Determine whether, given error distributions determined above, target F and threshold F could be distinguished from estimates derived from the assessment model.
- \* Consider revising F target reference point relative to the previous bullet.

## 2) RESEARCH RECOMMENDATIONS

- Separate models were developed for the mid-Atlantic (North Carolina and north) and South Atlantic (South Carolina to Florida).
  - \* Conduct tagging and otolith microchemistry studies to address the justification for regional assessments.
- Difficult to understand what component of the population the surveys were tracking.
  - \* Include maps of fishery and survey areas in future reports.
- A single growth curve based on data from North Carolina was applied over all years and for whole area.
  - \* Evaluate the applicability of the North Carolina growth curve to all areas (spatial variability).
  - \* Investigate inter-annual variability in growth.
- A single natural mortality estimate was used for all ages and years.
  - \* Develop age-specific M for inclusion in the model.
- Trends in the recruitment deviations may indicate temporal bias in the recruitment model.
  - \* Assess whether changes in potential population reproductive capacities have changed by quantifying patterns in the maturity ogive and size- and age-dependent fecundity.
  - \* Assess whether density dependent shifts in age- or condition-dependent timing of age at maturity have occurred as in other sciaenids.
  - \* Assess whether temporal patterns in recruitment slope or asymptote have occurred.
- There are no standard protocols for ageing of Atlantic croaker.
  - \* Conduct a workshop to develop and approve ageing standards for Atlantic croaker.
  - \* Continue collection of coast-wide age samples from fisheries-independent surveys and length samples from the MRFSS.
- Selectivity curves were used for both commercial and fisheries-independent indices.
  - \* Evaluate culling of the larger fish out of the survey indices to better match the assumed selectivity.



## V. SEDAR 4: South Atlantic Snowy Grouper and Tilefish

The SEDAR 4 Data Workshop considered numerous Caribbean and South Atlantic deepwater snapper-grouper species. Data were tabulated for all assigned species, and assessments prepared for the two judged to have adequate data for quantitative assessment – South Atlantic snowy grouper and tilefish (“golden tilefish”).

### A. Tilefish Assessment Workshop

- Ageing discrepancies between laboratories should be resolved. State and Federal investigators should continue efforts to standardize techniques and resolve the systematic discrepancies in age determinations. Additional research should be undertaken to verify and validate age determinations.
- Sampling programs are required to quantify discard rates. Research should also be initiated to identify management strategies that could reduce discard mortality. Discarding may become an increasingly important concern as the stock recovers and compliance with measures such as trip limits become more difficult.
- Fishery-independent data collected by the MARMAP program are important to understanding the dynamics of this population, and the National Research Council has recommended that fishery-independent data play a more important role in stock assessment. However, it has been noted that the MARMAP sampling programs do not have ideal extent, both in area coverage and in sampling intensity, for many important species in the South Atlantic snapper-grouper complex. It would be highly desirable for the MARMAP program to receive sufficient funding to expand its coverage and thus provide improved measures of stock abundance.
- Recent West Coast stock assessments were criticized by the U.S. General Accounting Office (GAO 2004) for not including at least one NMFS (i.e., fishery-independent) data source of sufficient scope and accuracy collected from an unbiased, statistical, and scientifically designed program. Effort should be devoted toward developing an independent data source for the South Atlantic snapper-grouper complex that meets the requirements outlined in the Stock Assessment Improvement Plan and the 1998 National Research Council report on improving stock assessment. This could be done through the MARMAP program or otherwise.
- Representative age, length, and sex composition data are needed for all fisheries, seasons, and areas. Sampling should be distributed according to the pattern of landings. Initial sampling targets are suggested as 20 age structure samples per age and 5 length samples per age sample. This provides approximate tilefish sampling targets of 1000 age structures and 5,000 lengths.
- Additional life history and biological research is needed, especially that which covers the full geographic range of the species. Among other items, fecundity and reproductive research is needed (batch fecundity and frequency at age and/or size).

## B. Snowy Grouper Assessment Workshop

- Ageing discrepancies between laboratories should be resolved. State and Federal investigators should continue efforts to standardize techniques and resolve the systematic discrepancies in age determinations. Additional research should be undertaken to verify and validate age determinations.
- Sampling programs are required to quantify discard rates. Research should also be initiated to identify management strategies that could reduce discard mortality. Discarding may become an increasingly important concern as the stock recovers and compliance with measures such as trip limits become more difficult.
- Fishery-independent data collected by the MARMAP program are important to understanding the dynamics of this population, and the National Research Council has recommended that fishery-independent data play a more important role in stock assessment. However, it has been noted that the MARMAP sampling programs do not have ideal extent, both in area coverage and in sampling intensity, for many important species in the South Atlantic snapper–grouper complex. It would be highly desirable for the MARMAP program to receive sufficient funding to expand its coverage and thus provide improved measures of stock abundance.
- Recent West Coast stock assessments were criticized by the U.S. General Accounting Office (GAO 2004) for not including at least one NMFS (i.e., fishery-independent) data source of sufficient scope and accuracy collected from an unbiased, statistical, and scientifically designed program. Effort should be devoted toward developing an independent data source for the South Atlantic snapper-grouper complex that meets the requirements outlined in the Stock Assessment Improvement Plan and the 1998 National Research Council report on improving stock assessment. This could be done through the MARMAP program or otherwise.
- Representative age, length, and sex composition data are needed for all fisheries, seasons, and areas. Sampling should be distributed according to the pattern of landings. Initial sampling targets are suggested as 20 age structure samples per age and 5 length samples per age sample. This provides approximate snowy grouper sampling targets of 700 age structures and 3500 lengths.
- Additional life history and biological research is needed, especially that which covers the full geographic range of the species. Among other items, fecundity and reproductive research is needed (batch fecundity and frequency at age and/or size).
- Further research is needed into the implications of sex change for fishery management.

## C. Review Workshop

### 1) PROCESS AND PROCEDURE

- Several members of the Panel found the complete documentation of equations and the inclusion of model code particularly informative, and recommend that such information become a standard component of SEDAR assessment reports.

Further, it is recommended that model input data files also be included in future reports.

- The Review Panel suggests that two additional pieces of information be provided in future reports: 1) a table of model parameter estimates, and 2) a thorough documentation of the process that led to the initial model configuration.
- The Review Workshop also recommends that future data workshop reports provide greater evaluation of input data. In many instances data are provided with little consideration of the ‘evaluation of quality and reliability’ as required in the Terms of Reference.
- The Review Panel suggests for future SEDAR's that confusion may be reduced by providing a brief description of the process that leads to assessing only a subset of those species addressed in the Data Workshop.

## 2) RESEARCH

- Regarding ageing methods, the Review Panel recommends that ageing validation should be accomplished prior to addressing concerns over differences in age determinations between the various labs.
- Regarding age sampling, the Panel recommends that the suggested initial sampling rate for age structures be clarified to avoid the suggestion of age as a sampling strata. The intent is to establish an initial age sample of 20 times the number of ages in the population. The Review Workshop also recommends that stratification by length and development of appropriate age-length keys be considered as a possibly more effective and economical approach to inferring age composition than attempting random age sampling. Regardless of the method ultimately chosen, it is most important to provide adequate age and length sampling through a rigorous and statistically valid sampling program.
- The Panel recommends exploring the relative importance of age sampling in models of the type used here to assess snowy grouper and tilefish. Such analysis could help identify the best allocation of limited monitoring resources.
- The Panel supports the snowy grouper recommendation regarding research into the implication of sex change. The Review Workshop adds that future assessment models addressing species which undergo sex change should provide model results that incorporate sex-specific information.

## D. Comments of CIE contractors

- The Panel's, and that of subsequent readers', ability to review the Workshop Reports was compromised in that details of analysis and discussion were lost through the multi-step process.
- The acceptance criteria for LFs and AFs could be improved. Acceptance criteria should be based on whether each LF or AF is representative of the catch.
- The way landings were modeled in these assessments could be improved.
- It would be better to estimate selectivities as functions of length, rather than of age.
- Statistical models, like those used here, provide a powerful tool for dealing with uncertainty. They allow us to assign appropriate weights to different sources of information and they tell us how certain we can be about our inferences. In

practice it is impossible to gain the full power of these models because we are unable to correctly specify all the statistical components of the model and so are often forced to add arbitrary non-statistical components. I suggest that our aim should be to minimize these non-statistical components.

- There is clearly a need for validation of the ageing of both species so that we can have more confidence in the AFs and the age-length conversion matrix.
- The MCB analyses are a good way to replace one type of sensitivity analysis whose aim is to quantify uncertainty. Another type of sensitivity analysis which could have been useful in the Workshop would have been to rerun the initial run several times, each time dropping one type of data, thus showing the extent to which the assessments depended on each data type.
- There were several small problems in both assessments, mostly in the documentation.
- It should be made clear that the calculation of generation time involves only female fish
- In fitting the von Bertalanffy equation the assumption used was clearly that the standard deviation of length at age was proportional to the mean length (not the variance, as stated).
- In the formula for the age-length conversion matrix the superscript 2 is misplaced.
- Equations should be given for the per-recruit calculations.
- It might be worth checking the method of fitting the maturity ogives for both species because the fitted curve is to the right of all data points for which the proportion mature is not near 0 or 1
- In the tables documenting the model it might avoid confusion if a clear distinction were made between fixed parameters (e.g., growth parameters, LF sample sizes), estimated parameters (e.g., selectivity parameters, fishing mortalities), derived quantities (e.g., length at age, selectivity at age) and observations (which are characterized by having an associated likelihood component, e.g., CPUE, LFs).
- Snowy Grouper : It might be useful to try some more sophisticated techniques (e.g., GAMs or tree-based regression) to seek an explanation of the unrealistic MCB runs. This may be informative. It might be worth dropping the Chevron trap CPUE index (for reasons given above). It seems a matter of some concern that more than half the catch is of immature fish. It is worth considering explicitly modeling the three categories of fish: immature, mature female, mature male (i.e., keeping track of numbers of fish by age and category)
- Tilefish: It would be worthwhile to explicitly model sex (i.e., to keep track of numbers by sex, as well as by age — the assessment report stated that this was not possible because the landings and LFs were not sex-specific, but I don't see why). As females are smaller at age than males they probably do not have the same selectivity at age as males do, so modeling selectivity as length-based would be better.

## VI. SEDAR 4: Caribbean Deepwater Snapper Grouper

Data were compiled for several Caribbean Deepwater snapper grouper species during the SEDAR 4 data workshop. Significant data deficiencies were noted, leading to an extensive list of recommendations.

### A. Landings Statistics

#### 1) PUERTO RICO

- In Puerto Rico it is important to determine the feasibility of expansion factors to estimate total catch. The information used to calculate expansion factors by year needs to be verified. Reporting of single trips, rather than multiple-trips per record in the catch report forms should be encouraged. This would greatly facilitate the estimation of effort and CPUE.

#### 2) U.S. VIRGIN ISLANDS

- The collection of landings statistics in the U.S.V.I. should also aim at breaking down the reported catch into species, since analysis of the current species-groupings is not straightforward without additional information on species composition from TIP or alternative sampling programs.
- The information used to calculate expansion factors by year (number of fishermen registered, reporting, etc.) needs to be corroborated, and the feasibility of these expansion factors for estimation of total catch needs to be determined.
- Further examination and analysis of the data sets available to date would require an improved collaboration between local and SEFSC biologists. In particular, it is important to determine what species were commonly grouped within each gear-type classification in the 'Old Report Forms'. This information would help to break up the aggregated catch from years prior to the implementation of the Trip Interview Program.
- Landings files for most years for the period 1974-2002 have now been compiled and provided to the SEFSC. However, some coding, typing and other errors, duplicates, as well as gaps in the time series still persist. Action is required to verify, correct the errors and edit those data for future use.
- Significant effort should be geared toward the standardization of the landings series.
- Finally, it would be important to encourage fishermen to submit all the monthly catch reports, to submit reports for months when they do not fish, and to complete all the fields in the reports, since critical information such as effort, gear, and location fished are often missing or incomplete.

### B. Trip Interview Program (TIP)

#### 1) GENERAL RECOMMENDATIONS

- Encourage the development of length-weight equations from the existing information in TIP

## 2) PUERTO RICO TIP

- Record the total weight landed by species for each trip.
- Record the sampled fractions.
- Coding errors in length and weight units must be corrected.

## 3) U.S. VIRGIN ISLANDS TIP

### 4) ENCOURAGE/ AID THE DEVELOPMENT OF A COMMERCIAL LOGBOOK SYSTEM TO ENABLE ESTIMATION OF REPORTING FRACTIONS.

- Increasing the fraction of interviewed trips (the sampling fraction needed to achieve specific objectives will depend on the objective and the variability of the observed species composition) to properly determine the species composition., which is needed to break out the aggregated catches.
- Conduct regular interviews in St. Thomas and St. John, with the goal of increasing the sampling fraction.
- Encourage port samplers to complete all the fields in the sampling form. Often the trip effort information is missing, which is essential for the estimation of catch rates or relative indices of abundance.
- Continued and enhanced collaboration between the NMFS SEFSC scientists and the local USVI biologists and data collection agents.
- Correct coding errors, particularly in length and weight units.
- Some questions that could be posed to local USVI biologists to improve the analyses of TIP data are:
  - \* How is the species in question landed, gutted or whole, etc.? How are length and weight typically recorded?
  - \* Is the species in question targeted or by-catch of another target species?
  - \* What species are often landed in association with a given species?
  - \* Is the species ever reported under a different name? For example, another species id, or a genus or family designation?
  - \* Are there environmental factors that might influence the abundance or catch rates of a given species?
  - \* Have management efforts, economic impacts, weather events, or other factors influenced fishing effort, catch rates or targeting?
  - \* Have fishery attributes changed (gear, boat type, technology, species targeted, skill of fishers etc.) changed during the period of monitoring. If so how?
  - \* Are interviewed trips chosen randomly? If not, what potential biases might exist in the dataset?

## C. Catch Rates

- In Puerto Rico the total catch by species for each trip in the TIP data is required. It has to be determined whether assumptions can be made regarding sampling fractions in TIP data to allow construction of Puerto Rico's CPUEs.
- The SEDAR Committee recommended that CPUEs for the U.S.V.I. be recalculated for a truncated time series (1984-1991), given that sample sizes for subsequent years are very limited.

- It is important to explore the availability of other fisheries-independent CPUE series.
- Standardization approaches for data-poor species, different from the delta-lognormal, need to be evaluated.
- The use of bootstrapping to estimate confidence intervals of the CPUE series should be investigated.
- The use of multivariate statistical analysis is recommended to identify the appropriate pool of gears to use when measuring effort.

#### D. Species Composition

- In Puerto Rico, it is important to recommend increased interviews with an emphasis on representative sampling, and to record the sampling fraction.
- Eventually, if Puerto Rico moves toward reporting landings by species, it will be advisable to compare TIP and landings species composition.
- In the U.S.V.I., it is important to examine the species composition on handline and trolling trips separately, and to evaluate whether sampling is representative.

#### E. SEAMAP Survey

- Encourage continued annual surveys throughout the area.
- Determine the spatial/temporal coverage in fine detail.
- Data analysis and interpretation must address the temporal patterns observed in the size frequency distributions.
- Regarding the shallow reef fish monitoring fishery-independent survey in Puerto Rico:
  - \* Coordinate with NMFS to make this data readily available.
  - \* Explore the CPUE and size-frequency data available from this data set.
  - \* Compare with the other SEAMAP data set.

#### F. General Recommendations

- Continue and improve collaboration with scientists from Puerto Rico and the U.S. Virgin Islands. Advice is needed in terms of handling the data, interpreting it, correcting coding errors, duplicates, and other problems in the data collection, recording, and editing systems. Local scientists and staff can help to understand the sampling protocols, documenting the observed trends, and filling out persisting gaps in the time-series.
- Continued data exploration must be made with consultation of the local laboratories/agencies, including the biologists, field agents, and data-entry staff.
- There is a possibility that the data will have limited value for assessment in the near future; however, continued analysis and improved data collection may greatly increase the utility of the information. The fishery-dependent data from Puerto Rico in particular has a good potential for use in stock assessment.
- Emphasis should be placed on the improvement of the TIP sampling program, as catch rate standardization, catch composition and size-frequency analyses will continue to rely upon this information. However, fishery-independent surveys and the collection of other biological data are extremely important to develop alternative indices of abundance.

- It is recommended that early biological or biostatistical sample data for the U.S. V.I., from the early to mid 1970's be computerized and made available for future data workshops. It is strongly recommended that formal discussions between NMFS, SEFSC TIP program coordinator and the USVI DFW are held to ascertain what steps/procedures, etc. are needed to improve sampling in the U.S.V.I. fisheries. Similarly, discussions should be initiated between Puerto Rican biologists and NMFS assessment staff to identify any remaining historical data sets not yet available. It is noted that an effort to computerize Puerto Rico biostatistical samples from the mid 1980's is ongoing (N. Cummings personal communication).
- It is recommended that analytical efforts expended by the recent working group members be continued. First, some attention should be given towards identifying or selecting which species should be assessed more quantitatively. The Caribbean reef fish fisheries are complicated comprising a mix of many species that are harvested by a number of gears.
- It is recommended that additional workshops such as this one be implemented to further develop the information for assessment, especially for those species and fisheries for which extensive information exist.
- It is noted that that strong cooperation of all agencies and local scientists involved would be beneficial.

#### G. Availability of Data for Stock Assessments

The workshop participants reviewed summaries of the information presented by the Caribbean group which might be used to assess the status of silk, queen and blackfin snapper and sand tilefish on each platform (Table 64). For the Puerto Rican platform the availability of information was examined for three data sources: Puerto Rico, the United States Virgin Islands and the British Virgin Islands.

##### 1) PUERTO RICAN PLATFORM

- For Puerto Rico, reported commercial landings are available in electronic form only since 1983 although the local fisheries were exploited since the early 1900's. Efforts are underway to obtain previously computerized data files of landings for 1963-1982 (N. Cummings personal communication). These early landings statistics could better characterize fishing mortality levels on this multi-gear/multi-species fisheries complex and efforts should be made to extract these data. Snapper landings in the Puerto Rico database are apparently aggregated for multiple species within the 'silk snapper group' in the Puerto Rico database before 1997 (after 1996 silk snapper is apparently not aggregated with other species) (Aida Rosario personal communication). Estimates of the landings of those snappers probably can be made given some assumptions about the species composition information from dockside sampling after considerable additional effort and consultation with Puerto Rican biologists who are familiar with the data collections and fisheries. It is strongly recommended that cooperative analyses be initiated between scientists from Puerto Rico and NMFS to accurately quantify species composition from these data. Analyses should take into account the highly variable operations of the local fisheries.

- For sand tilefish annual landings are less than 1,000 lb and in most years less than 50 lb. The dockside sampling (TIP) data which might be used for species composition had very few sand tilefish recorded) so that if sand tilefish landings had been included in the various unclassified categories, it would not be possible to estimate the amount of sand tilefish in such landings.
- For Puerto Rico the recreational harvest of the three snapper species are thought to be relatively low compared to the commercial landings. Because they are thought to be low, the absence of recreational harvest estimates prior to 2000, was thought not to be a major problem for assessment of these stocks, given the other uncertainties in the data sets.
- The landings in the United States Virgin Islands have not been recorded by species; therefore species composition information would be needed for St. John and St. Thomas to estimate catches by species. Only limited species composition samples have been collected from those islands, therefore estimates of the landings by species have not been made. Additionally there is no information on possible recreational harvests of these species around those islands. Also there was no information available at the workshop on the British Virgin Island fisheries. It is noted that an effort is ongoing to obtain historical information on landings and biostatistics samples for the British Virgin Island (BVI) fisheries for use in future data workshops regarding the Puerto Rico platform. It is also recommended that biologists from the BVI fisheries department be included in future data-workshops that involve the appropriateness of the use of data from the BVI in characterizing reef fish stocks on the Puerto Rican platform.
- Information on size composition is available for the three snappers from the Puerto Rican commercial fishery and a limited amount of information is available for silk snapper from the recreational fishery. Additionally, there are ample observations on the size of sand tilefish taken in the fishery-independent sampling near Puerto Rico, and there possibly are sufficient samples for silk and blackfin snappers from those surveys. For St. Thomas and St. John there are few or no size samples from the commercial and recreational fisheries. The workshop participants have not determined whether there were fishery independent samples from that area.
- It is expected that crude information on commercial catch rates could be obtained for the three snappers from expanded annual landings and estimated deep water effort for Puerto Rico; it seems unlikely however that the TIP data could provide reliable indices of abundance for those species, because it does not appear that the total landed weight for a species was recorded and it appears that in general not all fish were measured. It is likely that the fishery independent sampling could be used to develop an index of abundance for sand tilefish, and probably also for silk and blackfin snapper. There do not seem to be sufficient data for calculating fishery dependent catch rates from St. John and St. Thomas.
- In summary for the Puerto Rican platform:
  - \* For the Puerto Rican platform it seems that multiple years of commercial landings might be developed for the three snapper species from reported catches and species composition data. However it would best if these tasks were done in consultation with scientists familiar with the fisheries and the

specific datasets. Those catches would however represent only a part of the total removals.

- \* Some information can probably be obtained from the TIP collected size frequency of the commercial catch for the three snappers. It is recommended that analytical effort focus on further review of the available size frequency samples. Of all of the available data sets, the fishery independent sampling on the Puerto Rican platform conducted by the NMFS, SEFSC and by the PR, DNER, FRL FSP may be most likely to provide indications of the abundance trends of at least silk and blackfin snapper and sand tilefish on the Puerto Rican platform. It is recommended that analytical efforts focus on aggregating those data sets and developing abundance indices.

## 2) ST. CROIX PLATFORM

- The landings data from St. Croix probably can be disaggregated into species-specific data sets, but is restricted to a limited number of years when species composition is available and the landings are categorized by species-groups. However, the generally low sampling fractions indicate that there would be very great uncertainty about the estimated landings by species. Disaggregating the catch from the earlier years, when no species composition is available and landings were recorded by gear category may be cumbersome. Added to these issues is the possible imprecision in the estimation of the total catch based on expansion factors. These will be more reliable once compliance reports are reviewed and reanalyzed for the full time-series. Given these uncertainties, the overall utility of the catch for use in stock assessment is questionable at the moment, particularly for years prior to the implementation of the TIP program.
- The decrease in the mean size and the size of the larger (80th percentile) of both silk and queen snapper landed in St Croix between 1983-1996 could have been an indication of over harvesting. Additionally that the majority of silk snapper are below the estimated size at maturity would have been of substantial concern if fishing mortality rates were high. The standardized commercial catch rates calculated from the TIP samples from St. Croix were based on relatively few observations and the time series ends in 1991 (too few observations in subsequent years). Thus, they do not provide information on the current status of the resource. It is recommended that cooperative efforts be initiated by NMFS, SEFSC and the USVI DFW to address improvements in sampling the near-shore reef fish fisheries off these islands. It is possible that the fishery independent sampling (1992-1994, 1999, 2002) conducted by the NMFS, SEFSC Pascagoula Laboratory off the Virgin Islands could provide useful information, but it was not clear to the workshop participants what portion of that sampling occurred on the St. Croix platform. Once again it is recommended that examination of the fishery independent data be given high priority in terms of expending analytical time.
- Participants at the workshop understood that additional fishery independent data sets may exist for both the Puerto Rican and the St. Croix platforms particularly from in situ observations. It was recommended that efforts be made to obtain that information for possible use in developing additional indications of population status.

## VII. SEDAR 5: Atlantic and Gulf of Mexico King Mackerel

### A. Assessment Workshop

#### 1) ASSESSMENT DATA

- Available growth data needs to be evaluated for improved application to historical catch at age.
- Available sex ratio at size data needs to be evaluated to determine how sex ratios vary by size.
- Methods that allow for including error estimates in the catch at age matrix need to be developed.
- Continued evaluation of tag data, ongoing otolith microchemistry and shape analysis studies, and micro-satellite genetic marker data to improve estimation of stock structure and mixing proportions.
- Field studies are needed to develop or improve batch fecundity, spawning frequency, and age specific fecundity estimates, including size and age at maturity.
- Western Gulf king mackerel catches need to be aged for use in age length key analyses.

#### 2) ASSESSMENT MODELING

- Currently, it is only possible to model two stocks using tagging data to model mixing rates (Porch 2003). In the long term the Data Workshop and Assessment Panels recommend that assessment models be developed which can model multiple stocks and/or areas and which can use multiple types of data that enable mixing rate estimations (including tagging data and biological tags including elemental and isotopic composition, genetic information and morphological information).
- Sensitivity of CAA and management benchmarks to changes in the growth model used in the stochastic ageing procedure need to be evaluated.
- A three-area age structured model with forward projection formulation may result in better estimation of the impact on stock status of mixing zone dynamics using existing tagging data and most recent recruitment estimates.
- Sensitivity runs considered in this assessment indicate two areas where additional research is critically needed to improve stock status evaluation. The Assessment Workshop Panel advises that stock assessment uncertainty will not be reduced until these issues are resolved. These two areas are:
- Methods used to allocate catches to age class when samples are inadequate for constructing age-length keys. Sensitivity runs based on alternative growth models suggest that estimates of stock status are sensitive to differences in growth models when they are used to estimate age from size in the absence of an ALK. The raw data used to develop the historical growth models (Manooch et al. 1987; Collins et al. 1988) are no longer available, and thus it may not be possible to provide the type of identical analyses of current and historic data that are necessary to evaluate whether growth model differences are simply due to analytical technique or whether the differences truly reflect changes in growth over time. The Panel

recommends that current growth data (1987 onward) be modeled with increased resolution to refine growth model parameters. Specifically, decimal rather than integer ages should be modeled, and attention should be paid to collection date, birth date, and annulus formation date.

- Sensitivity analyses of stock mixing impacts on stock status determination. Results suggest that the assumed degree of stock mixing has relatively equivalent impacts on the perceived productivity of each migratory units, but divergent impacts on stock status determination. The estimated status of the Gulf of Mexico Migratory Unit is strongly influenced by mixing assumptions, while status determination of the Atlantic Migratory Unit varies minimally. Both the Data and Assessment Workshop Panels devoted significant discussion and effort toward resolving stock allocation within the mixing zone. Based on Data Workshop recommendations, the SEFSC reconsidered mixing rates through updated analyses of tag data, developed an alternative assessment framework to incorporate tag-based stock mixing estimates into a VPA framework, and developed stock estimates with the base assessment configuration for a variety of mixing rates within the mixing zone. However, none of these efforts have led to a consensus recommendation on the actual level of stock mixing.
- The Assessment Workshop Panel believes that analyses of otolith shape and microchemistry, as presented in the progress reports discussed at the Data Workshop, offer a promising approach to resolving stock mixing. The Assessment Workshop Panel strongly recommends that this work be continued for several additional years to increase sample size, continually improve the resolution of the method, and better account for potential annual variation in mixing. The Panel also recommends increased sampling intensity within the mixing zone, with sample allocation that is representative of the fine-scale geographic distribution of the catch within the mixing zone. Also an effective tagging program designed specifically to address the mixing issue could increase the quality and quantity of available data.

## B. Review Workshop

### 1) RESEARCH RECOMMENDATIONS

- The RW Panel noted that major concerns remain about the growth curves used to age the catch in some years and areas, the fecundity-length relationship used to estimate spawning stock, and the degree of mixing of the Gulf and Atlantic migratory groups in the winter fishery mixing zone. The RW Panel also expressed concern about the limited number of fishery independent indices of abundance available for VPA calibration.
- The RW Panel recommends enhancing ongoing research programs and implementing new research programs to collect fishery independent data (e.g., length measurements, age structures, fecundity measurements) to improve the accuracy and precision of current estimates of growth, fecundity, and stock mixing. Spatial variability in size at maturity and fecundity at age should be evaluated among regions/migratory groups.

- The data collection program should also be designed to provide fisheries independent indices of abundance for the full age range in the stock. This consideration should have a strong influence on the design aspects [gear, season] of the recommended research programs. These programs might include research sampling targeting spawning aggregations, research sampling targeting juveniles, tagging studies specifically designed to provide information on mixing rates, and hydro-acoustic sampling. Scientists should seek the advice of members of the commercial and recreational fishing communities in the design of these programs.
- The RW Panel suggested that the MRFSS indices of abundance could be recompiled to address two issues: 1) consider incorporation of the January-June intercept data in addition to the current July-December data, and 2) consider restriction of the sample data to the age classes most likely to contribute to the respective catch types (i.e., recompile the indices including only Catch Types A, and restrict the corresponding length composition to legally landed fish).
- The RW Panel also recommended the future application of different assessment models to provide alternative perspectives on the status of king mackerel stocks (e.g., those including estimation of the likely degree of error in the fishery catch-at-age, and/or those which employ forward-projecting computation approaches).
- One growth model should be developed for the splitting of catch at length data into catch at age data and another one that can be used for stock related data like weight at age in the stock, maturity at age in the stock and the like.
- Available sex ratio at size data needs to be evaluated to determine how sex ratios vary by size.
- Western Gulf king mackerel catches need to be aged for use in age length key analysis.
- The commercial fishery tuning indices should be further developed and it seems important that this is done in cooperation with fishers with an intimate knowledge of the way the fishery is prosecuted.
- Age composition of commercial and recreational discards is needed.
- Discard mortality rates are needed.
- Tuning indices should be weighted according to their internal variability, the part of the stock covered by the index, correlation with other indices etc. For instance it is realized that using their individual degree of correlation to the VPA stock abundance estimates could be problematic due to the circular logic feature of this approach.
- Data from Mexican catches need to be obtained, probably via initiatives for closer cooperation with Mexico. In this connection there is a need to look into whether the eastern and western Gulf King Mackerel are separate stock components.
- Tagging programs specifically designed to examine the mixing should be developed. Otolith shape and microchemistry and maybe micro-satellite DNA analysis are promising methods that should be pursued.
- Mixing of the stocks in the mixing zone should be investigated also the during summer period.

## 2) PROCESS AND PROCEDURE RECOMMENDATIONS

- The amount of documentation and issues to be dealt with are significant. Some of the documentation could have been sent out earlier to the RW Panel, for instance background material and the data workshop material. That would have eased the task of getting deeply into the substance of the material, especially for the external reviewers, who (almost by definition) were not beforehand familiar with the assessment.

### C. Comments from the CIE Contractors

(These are excerpted comments intended to highlight suggestions and areas of concern; readers are encouraged to consult the full report for additional details)

- The amount of reports and other material to read before the meeting was extensive. There was only little time to do this, about two weeks. It would be useful if some of the material were sent out as early as possible. It should be possible to send out previous assessment reports, background articles, and the Data Workshop report, several weeks earlier.
- A complete description of the assessment with all the input data files and the precise settings of the model would be nice to have in one document. It was a bit difficult to find precisely in which document to look for the various details. The level of details and data files should allow for an exact and easy repeat of the calculations.
- Fishers (and nongovernmental organizations (NGOs)) contributed during the meeting some information on CPUE series, the fishery and the management regulations effects on this, and the like. It is, however, important that political issues do not enter the discussions. It might, however, be important for the entire process that fishers participate, or at least get the opportunity to observe what is done, in order to secure transparency and trust in the system. However, extra time would need to be spent on explaining things to non-scientists and in balancing the statements put forward so that fishers and NGOs correctly understand the issues.
- My task as Chair for the meeting was a bit difficult because most panel members were more familiar with the process than I was. Maybe a bit more information about the duties of the Chair would be useful. Alternatively, another member of the Panel could be the Chair, and one of the CIE Experts could be appointed as the lead expert and perhaps still be responsible for the reporting.
- Maybe the reviewers (and other Panel members) could, to the extent possible, state before the start of the meeting what sensitivity runs they want to see in addition to what has been presented in the documents sent to the Panel. This will allow SEFSC staff more time to prepare the runs, and it will make mistakes less likely.
- The timing of the whole process from the last data sampled in 2001/02 and until now (start of 2004) with the aim of giving advice for 2005/2006 could be improved. It is a very long time span, and there is a large risk for the things in the fishery and the stock to have changed in between meeting processes. It should be

3possible to shorten this time span so that the advice for 2005/2006 can be based on data from 2003/2004.

- It is important that estimates of age-composition of commercial and recreational discards, and of discard mortality be obtained. It is strongly recommended that fisheries-independent surveys be expanded, and eventually assigned more weight in the tuning process.
- Fisheries-independent surveys should be designed to provide indices of abundance for the full age range in the stock. This would likely require multi-seasonal sampling and the combined use of multiple sampling gears and hydro-acoustics.
- Data from Mexican catches need to be obtained to improve the accuracy of Gulf king mackerel assessments.
- If feasible, I recommend that the uncertainty in assessments caused by sampling variability in estimated landings in number by age be further evaluated.
- The use of multiple survey indices for “tuning” can introduce a bias of unknown magnitude in the assessments of Atlantic and Gulf king mackerel. One way to reduce such bias is to combine overlapping survey estimates by using a composite estimator with weights determined by coverage and precision of each abundance series, and then apply the combined series in tuning the model. Additional post-stratification might be appropriate when surveys overlap only in a sub-area or during a limited time.



## VIII. SEDAR 6: Goliath Grouper and Hogfish

A SEDAR Review Workshop convened to review assessments of Goliath grouper and hogfish snapper. The Goliath grouper assessment was prepared in response to recommendations from the SEDAR 3 (Atlantic Yellowtail snapper) review workshop. The hogfish snapper assessment was prepared by contract with the State of Florida and reviewed by request.

### A. Goliath Grouper

#### 1) DATA WORKSHOP (SEDAR 4)

- The top four prioritized research topics:
  - \* Estimation of population size - Estimates of population size were considered to be of highest importance for future management. It was noted that because of the apparent restricted home ranges and high site fidelity, sampling throughout the geographic range would probably be important. Tag/recapture studies were mentioned as a potential monitoring tool.
  - \* Demographics - Monitoring the demographics of the population, particularly age composition, could provide valuable information (as it has for red drum in the Gulf of Mexico).
  - \* Reproductive Biology - Developing further understanding of the reproductive biology of goliath grouper was considered quite important. Identifying spawning locations, duration and periodicity could be very useful for identifying sites to conduct population surveys.
  - \* Historical Abundance - Obtaining information on historical abundance, perhaps via old logbooks, was also considered important.
- Other Research Topics:
  - \* It could be very useful to have estimates of unrecorded mortality from accidental or intentional sources, but obtaining such information would be very difficult.
  - \* Additional information on stock structure was considered important.
  - \* Some thought that it would be useful to have a greater understanding of goliath grouper bioenergetics and trophic relationships. Others asked how that information would assist in a stock assessment.
  - \* Information identifying the changes in mangrove abundance and distribution, thereby changing available nursery habitat, could assist in developing predictions of future abundance.

#### 2) REVIEW WORKSHOP

- Estimation of population size: Estimates of population size were considered to be of highest importance for future management. It was noted that because of the apparently restricted home range and high site fidelity characteristic of adults, sampling throughout the geographic range would be important. Tag/recapture studies were mentioned as a potential monitoring tool.
- Estimates of on-going mortality: The issue of ongoing mortality was of critical concern to the Review Panel. Anecdotal information with regard to various

sources of this mortality was presented. These sources included longline by-catch, post-release mortality, and illegal harvest. It is extremely important that these sources of ongoing mortality be identified and the magnitude of this mortality estimated.

- Investigations of stock structure: This question was repeatedly raised. The assessment reviewed by the Panel was of necessity limited to south Florida owing to the geographic coverage of the data and the absence of data concerning the stock structure.
- Demographics: Monitoring the demographics of the population, particularly age composition, could provide valuable information.
- Reproductive biology: Developing further understanding of the reproductive biology of Goliath Grouper was considered important.
- Historical abundance and exploitation: Obtaining information on historical abundance was also considered important.
- Survey data. While the Review Panel considered it in the highest degree important to continue the current surveys, it recommended that data collection could be improved by extending survey efforts to better cover the full historical range of the stock.
- The review would have been facilitated if the assessment had been examined by an assessment workshop. It would have been helpful to have the authors of all the relevant documents available to make presentations and answer questions.

## B. Hogfish

- Due to the relatively short time series and relatively low contrasts of CPUE for the available fishery data, the absolute historical limits of stock size and productivity are still somewhat unclear. This would suggest the need for further assessment analyses using other classes of modeling procedures like stock reduction analyses (Kimura et al. 1984), that could allow the merging of quantitative data time series with observations and opinions about historical states of the fishery.
- Reef-fish commercial log-books should be considered as an additional source of data on commercial catch and effort.
- Weight data, as well as length, should be collected in the head-boat survey;
- Using data from spearfishing tournaments could reinforce length-weight relationships, especially at the right-hand end of the distribution where data are rare.
- The Review Panel considers it important to maintain the current data-collection programs.
- The Review Panel observed that both it, and the presenters, had been handicapped in this review in that neither a data workshop, which would have verified the data sources, nor an assessment workshop had previously been held.

## C. Comments from CIE contractors

(These are excerpted comments intended to highlight suggestions and areas of concern; readers are encouraged to consult the full report for additional details)

- Some guiding documents that would have been useful were not provided. Notable among those were a) brief histories of the assessments, i.e. how they came into being, when, why, and at whose request they were written, and what the prospects would be of having changes made to them; and b) templates for reports—it transpired that the Advisory Report has a fairly specific format that is preferred, and a template or example would have been useful to clarify for the Chairman before the meeting how the information to be derived from the assessments was to be presented in final reports and therefore, to some extent, to define the set of information to be sought.
- A little more information on the meeting format would also have been helpful. The Chairman was not aware before the meeting that the public would be present, and when he was aware of it, he wasn't quite clearly informed what they were doing there and to what degree they were entitled to participate in the process. These questions got sorted out at the meeting, and in the end public participation was in high degree both orderly and helpful.
- Facilities for presenters were minimal and unsatisfactory: they needed more space to put their papers.
- It is a mistake to try to compress such meetings into too few days. Long days put unacceptable pressure on the report-drafting which ideally takes place at the meeting. We had a fairly uncomplicated and trouble-free meeting, but even so did not have much time to spare.
- The delayed response by some Panel members to reports has been a problem; when objections to decisions that were clearly nailed down at the meeting are first voiced two weeks later when the final report is about to be sent, an impossible situation arises in respect of completing and distributing the reports.
- The fact that the (hogfish) assessment had been conducted under contract also proved to be troublesome. The Review Panel was uncertain if the authors could be asked to conduct sensitivity analyses given that they were no longer under contract. It was also unclear who would conduct any subsequent re-assessment.
- For both assessments, the stock area to be assessed was not clearly defined.
- In the report from the Goliath Grouper Data Workshop, distribution was discussed, but more in terms of distribution of the data rather than the species. This was a major issue of discussion for the Review Panel and the lack of a stock definition severely restricted the interpretation of results. For future assessments, this issue should be more closely examined at the Data workshop stage.
- The Peer Review Panel Reports included a section for Stakeholder Comments. This section, independent of and unedited by the Review Panel, provided meeting participants (other than the Review Panel) with a venue to express their views. Given the active participation of certain stakeholders during the workshop, I consider this to be an important and positive feature of these reports.



## IX. SEDAR 7, Gulf of Mexico Red Snapper

### A. Data Workshop

#### 1) LIFE HISTORY GROUP

- More movement information via tagging is needed from the western Gulf. There was discussion that a recreational tagging data base from the Coastal Conservation Association (CCA) may be available for this purpose. The sub-group recommended every effort be made to access and analyze this data base (by LSU researchers).
- The results from the otolith micro-chemical analysis were compelling in providing estimates of mixing rates for the north-central, northwest, and southwestern Gulf. The sub-group recommends continued work to also derive mixing rates from the eastern Gulf (west Florida shelf). It was of great interest to determine if there was evidence for localized recruitment in the east or whether recruits were derived from other areas as suggested by tagging results.
- Much more otolith microchemistry needs to be conducted on snapper off Texas, especially age 0 & 1 cohorts to aid in our understanding of the recruitment dynamics there.
- There needs to be an examination of whether regional stock recruitment functions can be developed. It was recognized that trawl surveys, which have been previously relied upon for recruitment estimates, are conducted from Texas to the Florida/Alabama border and may not capture any localized recruitment which may occur on the west Florida Shelf. The sub-group recommended that other survey methods be examined for recruitment determination and the red snapper larval index was recognized as a candidate for this purpose.

#### 2) SHRIMP FISHERY BYCATCH GROUP

- Future recommendations for improved data collection methods related to shrimp effort estimation include implementation of the Electronic Logbook Program (ELB) for 3-5 years (SEDAR7-REF-1; SEDAR7-REF-2) in conjunction with the current (or some form of) port agent interview system. Amendment 13 to the Shrimp Fishery Management Plan will address vessel monitoring systems (VMS) or ELB approaches for the shrimp fishery to obtain better effort data. Considerations of who will pay and own units (VMS or ELB) were discussed. VMS units are approximately \$1200 (+ monthly fee + maintenance) vs. ELB (\$500).
- The group strongly recommended a fully-funded shrimp trawl observer program to collect bycatch data as related to bycatch reporting requirements. This program would cost approximately \$2.5 KK annually.
- Work will continue on the new BRD designs using infrared observation technology (SEDAR7-DW-30). With this approach, we must encourage industry innovation by providing information to fishers for cooperative research to solve operational problems and maximize shrimp retention. The key to development of effective designs is getting new designs into the fleet, but this will result in innovation only if the industry has incentive to develop new technology.

Consideration must also be given to the present certification protocol. BRD performance requirements will have to be re-examined based on performance projections of current BRD designs. BRD development should be focused on BRD designs which induce continuous and consistent bycatch escapement during variable environmental and commercial applications.

#### B. Assessment Workshop

- direct measurement of current fishing mortality rates,
- experiments to determine the magnitude and timing of density dependent compensation in juveniles,
- information on the effects on shrimp trawling on red snapper through community effects including nutrient cycling and changes in predation pressure,
- continuation and expansion of the fishery-independent survey for adult red snapper,
- more information on release mortality and discard rate by depth, season, and fishery,
- additional alternatives for reducing bycatch such as closed areas etc.,
- additional research such as simulation testing on the estimation properties of stock assessment methods and models,
- distribution and mixing between the East and West.

#### C. Review Workshop

Some of the following research recommendations are marked [D] or [A] or both. The symbol indicates that all or part of the corresponding recommendation was adapted from recommendations of the SEDAR 7 Data Workshop or Assessment Workshop.

- Data on shrimp fishery. The RW recognized the importance of obtaining better estimates of fishing effort in the shrimp fishery, which might be done through vessel monitoring systems, electronic logbooks, or otherwise [A]. Also, the RW recommends that the statistical design and extent of the shrimp-trawl observer program be reviewed to ensure that the bycatch data collected are appropriate and sufficient for stock assessment.
- Independent estimates of mortality rates. Direct estimation of mortality rates through tagging would reduce uncertainty in future assessments [A].
- Fishing power. Research is recommended to estimate (independently of any stock assessment) changes in catchability  $q$  by gear over time. The RW believes that the introduction of GPS and marine chart-plotting equipment is likely to have increased fishing power substantially for some modes of fishing. Independent collection of data on fishing effort would provide valuable data for assessment and relieve the need to estimate catchability changes.
- Stock structure. Research (e.g., tagging, otolith analysis) is recommended to better describe stock structure and mixing rates. Research should include a review of oceanographic data to see whether transport from the Campeche Banks could reasonably be supplying important numbers of larvae to the western Gulf stock [A].

- Spawning-stock index. Given the many factors that can mask relationship of larvae to spawners, the value of the larval indices should be reviewed.
- Spatial distribution at age. The RW recommends study of the age structure observed from longlines (survey and fishery), to clarify geographic distribution of fish as they age.
- Density dependence. Research could clarify the magnitude and timing of density dependent compensation in juveniles by estimating survival (from age-0 to age-1 year) at different densities of juvenile abundance [A].
- Ecosystem concerns. The RW recommends that the management objectives for the fishery complex (shrimp, red snapper, vermilion snapper, etc.) be formalized. Simulation studies could usefully identify and evaluate appropriate management strategies (including use of various reference points) and corresponding assessment modeling approaches. Research could also test the hypothesis that red snapper production is enhanced in some way by increased shrimp trawling [A].
- Assessment modeling. The RW's recommendations for assessment modeling are made while recognizing that technology is currently limiting (the power of current small computers is marginal for the given model complexity). (a) Future assessments should include interval estimates on parameters and status indicators. (b) More diagnostic and output information should be provided in future assessment reports (e.g., plots or tables of  $F$  at age and plots of standardized residuals). (c) Extensive simulation tests of assessment models are recommended to examine accuracy, precision, and robustness [A].
- Age sampling. The RW recommends that representative sampling of age- and length-composition of red snapper be conducted consistently across area, time, and gear.
- Fecundity at age. The RW noted that few fecundity samples were available from older fish, and recommends that more such samples be collected.
- Model implementation. The RW recommends that the assessment model's recruitment sub-model be generalized to allow various options on the timing of bycatch mortality relative to density dependent compensation (see AW-8).

#### D. Recommendations of the CIE Contractors

##### 1) CIE CHAIR

- Provide more clarity with regard to the exact role of the RW and the authority of the RW
- There needs to be a process for addressing potential disagreements between the RW and the AW and it must be made clear who has ownership of the Advisory Report.
- Supply all documents electronically with only essential reading provided as hardcopy.
- The red snapper assessment had not been updated since 1999. The DW, AWs, and RW to update the assessment have spanned more than a year. The whole process was delayed because of problems encountered with the previous assessment method when new data were added. Had a "simple" update been possible there would not have been the need for two AW's, and the full results would have been

presented to an AW, rather than only becoming available at the RW. There is perhaps a lesson here. A simple update was not the objective of the first AW given the ambitions of the DW to produce and use an ultra-historical catch history. Simple updates can be done in a timely manner to provide appropriate advice to fisheries managers. However, with such a large gap between assessments, it was unlikely that a simple update would eventuate.

- In terms of providing timely scientific advice to fisheries managers, I have long advocated that there should be two asynchronous processes. Management advice should be provided by “simple” updates of stock assessments as required. The development of assessment methods and the substantial modification of data sets should be done in a separate process – it is harder and the timelines cannot be guaranteed. Scientific disagreements can also be dealt with outside of the management process.

## 2) CIE REVIEWER

- Adequacy and appropriateness of data
  - \* Perform sensitivity analyses to examine the effect of different historical catch divisions between east and west areas of the Gulf on the assessment.
  - \* Perform sensitivity analyses to examine the impact of potential changes in biological parameters over time on the assessment.
  - \* Examine the implications of the different potential distributions of larvae and adults for the assessment. Are there areas offshore suitable for juvenile settlement? Is the offshore age structure consistent with recruitment directly to deeper waters, or ontogenetic migration? Does oceanographic information suggest that larval movements of this type are realistic? Consider tagging programmes to examine the movement of juveniles and adults offshore/onshore and between east and west regions of the Gulf.
  - \* Consider the examination of available information on fishing position through logbooks (if sufficiently accurate) or observer programmes (if available) for serial depletion. Recommendations by the RW to examine the feasibility of VMS may need to be initiated before this can be investigated further.
  - \* Examine the sensitivity of assessment results to different values of release mortality rate (within the bounds indicated by the existing research). Investigate the interaction between natural mortality values and release mortality rates at younger ages.
- Adequacy, appropriateness and application of assessment methods
  - \* The model represents a change from that applied during the 1999 assessment. Recommendations arise as result of this change, settings within the assessment, and particular assessment results:
  - \* Examine the fishing mortality levels output from ASAP and CATCHEM for the short time period run to identify any differences and trends in this metric.
  - \* Perform projections based upon the CATCHEM outputs from the short time period run to identify whether there are quantitative differences in expected recovery period. This will also require consideration of the management benchmarks resulting from changes in the estimated stock recruitment relationship, which may result in more significant differences.

- \* Consider the inclusion of migration between east and west areas of the Gulf in the model. Parameterization might be based upon available information (if sufficient) or through new tagging studies (if feasible).
- \* Examine the issue of density dependence and its effect on stock status and recovery further. Consider results in terms of risk to the population.
- \* Present confidence limits on the recent recruitment levels estimated by the model, so that statistical differences between recruitments in the recent past and the ultra-historical period can be identified.
- \* Develop further diagnostic approaches to assess the performance of the model. Present interval estimates for output parameters, or examine posterior distributions, as many of the estimates may be against their bounds (a count of the number of parameters against their bounds could be another diagnostic). Examine the shape of the response surface to assess whether local maxima are being identified. Perform retrospective analyses to assess model stability.
- Adequacy, appropriateness and application of population benchmark estimation methods
  - \* Management benchmarks for these projections were highly sensitive to management decisions and biological assumptions. Recommendations are:
  - \* Identify benchmarks that are more robust to changes in management levels and the stock-recruitment relationship, through management strategy evaluation simulations.
  - \* Consider whether there is a need specifically to examine the red grouper/vermillion snapper fisheries (closed-season bycatch) along with the shrimp bycatch fishery and the targeted fisheries in assessments and management. Evaluate multispecies benchmarks.
  - \* While the RW was not tasked to look at management issues, the division of the stock between east and west areas of the Gulf within the assessment allows separate management to be applied within these areas, rather than the current strategy of producing Gulf-wide management (TACs). Indeed, given that the eastern stock appears to be less productive than the western stock, Gulf-wide management has the potential to reduce the eastern stock to very low levels. This needs to be presented to managers for consideration.
- Adequacy, appropriateness and application of projection methods
  - \* Consider performing stochastic projections and providing management with suitable diagnostics for recovery (e.g. the likelihood of recovery within particular time periods).



## X. SEDAR 8:

### A. Southeastern Atlantic Spiny Lobster

#### 1) DATA WORKSHOP

- Work to develop an active program for a juvenile tuning index
- Develop a greater understanding of the interaction between lobsters and traps
- Develop research partnerships with the fishery
- Try to reestablish an onboard fishing vessel monitoring program
- Increase understanding of lobster disease
- Continue to understand growth
- Develop future assessments that take into account the role males play in determining fecundity.

#### 2) ASSESSMENT WORKSHOP

- Tuning Indices: geographically robust adult and juvenile monitoring programs that could provide tuning indices that can be connected to each other and the fishery.
- Growth: lack of growth data from larger (>100 mm CL) lobsters

#### 3) REVIEW WORKSHOP

- Data from the commercial fishery
  - \* Re-establish a commercial fishery observer program (described above). Fishery-independent indices of abundance
  - \* Standardize existing data sets that may be used for juvenile and legal-sized indices of abundance
  - \* Design new monitoring programs to collect systematic, consistent, and statistically rigorous data.
- Improved growth information
  - \* Tagging projects should be initiated to obtain growth-rate data from larger (CL >100 mm) lobsters
  - \* Activity may need to be focused in areas of reduced exploitation (such as the Tortugas) to allow capture of these larger individuals in appreciable numbers
  - \* Reconcile growth information from Lipofuscin and tagging data
- Modeling
  - \* Conduct Monte Carlo simulations to test F20% and F30% threshold and target reference points against various performance criteria. The stock assessment workshop for the stock should develop various scenarios covering a range of hypotheses concerning recruitment and changes in gear selectivity, as well as suitable performance indicators, including catch and measures of SSB. Risks in the performance indicators associated with applying the threshold and target should be generated in future assessments.
- Fishing pressure has decreased in the Keys because (i) there are less traps as a result of the Trap Certificate Program, (ii) recent efforts to curtail a rapidly expanding illegal dive fishery, (iii) the loss of dock space and subsequent selling

out as gentrification continues at an increasing rate, (iv) the loss of suitable crew as a direct consequence of the increasing cost of living in the Keys.

- Fishermen are very willing to sit down with scientists to devise long-term observer/sampling programs that enmesh with operational activity and satisfy crucial needs for data.

## B. Caribbean Spiny Lobster

### 1) DATA WORKSHOP

- Commercial Statistics
  - \* Estimate landings based on complete catch report database after corrections to landings database are made and after reporting years 1986/1987 to 1992/1993 are entered.
  - \* Recalculate expanded landings based on new lists of licensed fishers.
  - \* Table final analyses of commercial bio-statistical data (size-frequency, catch composition, CPUE) until all the field sampling data has been completely entered and checked for errors and both US, Virgin Island and NMFS, SEFSC staff have signed off on corrections.
  - \* Avoid repetitive analyses on incomplete information. Use only complete data sets in stock assessment analysis. A solid foundation will then be established for the analysis of other species to be included in future assessments.
  - \* Immediate changes in the catch report forms are not recommended. The fishing community in the U.S. Virgin Island is reluctant to provide any additional information, unless they see their data of approximately 30 years reflected in the management decisions.
- If the assessment proceeds, assumptions about the data should be clearly identified.
- Provide feedback to the fishing community after stock assessment analyses are performed, in order to reassure them that the information they provide is valuable and necessary to manage their resources.
- Caribbean Fishery Management Council staff present at the SEDAR8 Data workshop, recommended to conduct stock assessments with the information available at the moment to support management decisions. Proper consideration of uncertainty and acknowledgment of missing data was recommended.

### 2) ASSESSMENT WORKSHOP

- Fishery-Independent Sampling:
  - \* Increase the fishery independent sampling effort in the US Caribbean.; diversify regions sampled; cooperative sampling design and implementation between the fishermen and scientists; those species deemed important to the local fishing economy should be given sampling priority.
  - \* Relatively good knowledge of habitat distributions and of habitat usage by various species/life stages provides a valuable opportunity to explore the power of habitat-based spatial models in this region.
- Fishery-Independent Monitoring of Spiny Lobster:

- \* Develop fishery independent sampling program specific to Caribbean spiny lobster.
- \* Visual surveys could be used in the Virgin Islands and in Puerto Rico to collect additional size and abundance information on the spiny lobster resource.
- \* Mark recapture techniques could be attempted to estimate abundance and learn more about the movements and habitat preferences of spiny lobster.

### 3) REVIEW WORKSHOP

- Improve and complete historical data on relative abundance indices and catch
- Fishery-independent monitoring
  - \* The Panel identified an apparent inconsistency between the assessment model assumptions of recruitment as a direct function of spawning stock. This appeared important enough to warrant two recommendations:
    - 1) build additional flexibility into the models to allow time-varying recruitment (or at least recruitment dynamics);
    - and,
    - 2) seek to establish a fishery-independent index of recruitment, which is deemed to be crucial.
  - \* The panel recommends considering the method used for the SA-GOM lobster assessment: placing a series of post-larval collectors in appropriate areas and consistent sampling their catch.
  - \* It is necessary to develop and implement sampling program(s) specific to both pre-recruit and adult Caribbean spiny lobsters
  - \* It is crucial to increase sampling effort in the US Caribbean.
  - \* There will be benefit in further diversifying the regions sampled to include equal coverage of areas frequently fished
  - \* Visual surveys for size structure, abundance, and YPR could provide useful time-series of data
- Revise the trip interview program (TIP) database exhaustively
  - \* Completing the historical data set would be valuable
  - \* Revitalizing TIP sampling in the US Virgin Islands would have many benefits, not just for the Caribbean spiny lobster stock
  - \* Effort should be directed at key species, generating trip-target information, and obtaining needed detail
  - \* Length distribution of the catch
- Commercial: Complete incorporation of non-digitized data for the US Virgin Islands (TIP). Recover historical length data for Puerto Rico and the US Virgin Islands from other studies prior to the TIP.
- Recreational: Determine length distributions
- Conduct studies to understand the ecology of early juveniles (25 mm carapace length)
  - \* Habitat use needs to be understood better
  - \* More needs to be known about settlement habitat
  - \* Information on movements and migrations needs to be sought
  - \* Clarity of the mortality rates needs to be sought

- Spatially explicit studies
  - \* Identify spawning areas and sources of recruits
  - \* Build/acquire habitat maps to identify stratification for research designs
  - \* Combine habitat maps with density counts and habitat models to provide population estimates
  - \* Develop a GIS map of spiny lobster landings throughout the geographic range of the stock, producing catch distributions
- Mark-recapture techniques
  - \* Such studies could hone knowledge of abundance
  - \* The techniques could provide additional information on movements and migrations
  - \* Habitat preferences would be better understood
- Stock structure
  - \* Stock structure is important in assessments, and genetics offers hope to improve knowledge
- Future assessments
  - \* These should explore further use of length structure and density from closed areas as reference points
  - \* Assessments need to be repeated when significant quantities of previously unavailable historical data have become available
  - \* Alternative stock assumptions need to be considered during assessment: That of a wider Caribbean stock, That of the stock of the US Caribbean and neighboring islands
  - \* The use of nominal CPUE should be considered in future assessments
  - \* The modeling approach needs to be modified to produce a model that would support the observed data. Within the model, the recruitment parameter  $r$  should be allowed to increase over the second part of the time-series, perhaps moving beyond the standard modeling software currently used. Of the above, the Panel places the highest priority on the following, understanding the need to maximize the likelihood of generating an acceptable assessment of the stock in the near future:
    - \* Develop/strengthen fishery-independent data collection
    - \* Incorporate historical data into existing data sets
    - \* Utilize refined models (better to identify viable hypotheses)

### C. Caribbean Yellowtail Snapper

#### 1) DATA WORKSHOP

#### 2) LIFE HISTORY

- tagging studies of adult yellowtail snapper to obtain data on large-scale movements.
- evaluate maturation (size and spatial variation) and growth and fecundity
- preparation of general regional-wide GIS maps of landings

### 3) COMMERCIAL STATISTICS

- Complete data entry and clean-up task of fisher landings reports for reporting years 1986/1987 through reporting years 1992/1993) within 2-3 months, prior to the SEDAR8- Assessment Workshop. This task is currently being carried out by the US Virgin Islands, DFW;
- Estimate landings based on complete catch report database after corrections to landings database are made and after reporting years 1986/1987 through 1992/1993 are entered;
- Recalculate expanded landings based on new lists of licensed fishers;
- Staff of the US Virgin Islands, DFW suggested that analyses of commercial bio-statistical data (size-frequency, catch-composition, CPUE) should be put on hold until all the field sampling data has been completely entered and checked for errors and both US, Virgin Island and NMFS, SEFSC staff have signed off on corrections;
- Avoid repetitive analyses on incomplete information. Use only complete data sets in stock assessment analysis. A solid foundation will then be established for the analysis of other species to be included in future assessments;
- If assessments proceed with incomplete databases, assumptions about the data should be clearly identified and formally documented;
- Immediate changes in the fisher landings report forms are not recommended. The fishing community in the U.S. Virgin Islands is reluctant to provide any additional information, unless they see their data of approximately 30 years reflected in the management decisions;
- Provide feedback to the fishing community after stock assessment analyses are performed, in order to reassure them that the information they provide is valuable and necessary to manage their resources; and
- CFMC and NMFS, SEFSC staff present at the SEDAR8 Data workshop, recommended to conduct stock assessments with the information currently available to support management decisions. Proper consideration of uncertainty and documentation of missing or possibly inaccurate data was emphasized.

### 4) OVERALL WORKSHOP RECOMMENDATIONS

- Continue the updating and data correction checks ongoing for the US Virgin Islands commercial landings and Biostatistical data bases.
- Continue the data correction checks ongoing with the Puerto Rico commercial landings and bio-statistical data bases.
- Continue the analyses related to partitioning of US Virgin Islands bulk landings data into species groupings after the missing bio-statistical samples have been entered, proofed and agreed on by both US Virgin Islands DFW staff and NMFS, TIP staff.
- Work toward developing a species specific commercial landings sales ticket in the US Virgin Islands commercial fisheries.
- Work towards research to obtain bio-statistical samples in the US Virgin Islands and especially to improve much needed sampling in St. Thomas/St. John. Fisheries.

- Implement hard part biological sampling in US Virgin Island and Puerto Rico.
- Work towards identifying the primary information needs regarding improving
- the ongoing fishery independent sampling initiatives for yellowtail snapper populations in the Caribbean.

#### 5) ASSESSMENT WORKSHOP

- Increase the fishery independent sampling effort in the U.S. Caribbean. Cooperative sampling design and implementation between the fishermen and scientists is strongly encouraged. If every species captured cannot be completely sampled, then those species deemed to be important to the local fishing economy or those species considered representative of relevant habitat types should be given sampling priority. A list of commercially important species to the region can be obtained from the Caribbean Fishery Management Council.
- The ideal survey would utilize hook and line and traps as the primary sampling gears in order to maintain consistency with those surveys that have been completed in the past.
- Visual surveys could be used in the Virgin Islands and in Puerto Rico to collect additional size and abundance information on the reef fish resource.
- Mark recapture techniques could be used to estimate abundance and learn more about the movements and habitat preferences of yellowtail snapper.
- The relatively good knowledge of habitat distributions and of habitat usage by various species/life stages provides a valuable opportunity to explore the power of habitat based spatial models in this region.

#### 6) REVIEW WORKSHOP

- Fishery-independent data
  - \* A new independent sampling regime to target yellowtail snapper more effectively should be created, because current methods do not allow temporal or spatial coverage.
  - \* Visual surveys can provide useful fishery-independent data. The methods would, however, vary, based on the depth of the insular shelf.
  - \* The output of other existing studies (NOAA and non-NOAA) should be examined to see if alternative fishery-independent sampling already exists.
- Life history data
  - \* Fecundity data should be collected
  - \* Maturity data should be collected
  - \* Growth information should be collected
  - \* The parameter natural mortality needs investigation on the basis of better data
- Catch data
  - \* Recreational catches need to be sampled and quantified better
  - \* Information on trip species targeting is needed
  - \* Information on the location of catches is sometimes not good, and should be improved
  - \* Identification of species in the snapper complex in the US Virgin Islands is crucial to future assessments

- \* Historical data from the US Virgin Islands need to be collected from fishermen, if they exist
- \* Port samplers need to modify their schedules to target yellowtail snapper landings, and to sample sizes of the species need to increase
- \* TIP sampling in the US Virgin Islands needs to be revitalized
- Age and length frequency data
  - \* These are needed from all commercial catches
  - \* These are urgently required from recreational catches
  - \* Fishery-independent surveys can provide these crucial data
- Genetic / otolith microchemistry studies
  - \* Stock structure is important in assessments, and genetics and otolith microchemistry offer hope to unravel it in future
- Spatially explicit studies
  - \* Identification of spawning areas and the source of recruits is important
  - \* Construction of habitat maps will help identify stratification for research designs
  - \* Combination of habitat maps with fish counts and habitat models will aid in providing population estimates
  - \* Development of a GIS map of yellowtail snapper landings throughout the species' geographical range could help in the production of a distribution map of catches
- Mark-recapture studies
  - \* This could help identify movements and migrations
  - \* Fishing mortality estimates could be derived
  - \* Population estimates would be enhanced with such studies
  - \* Such studies could help solve the perplexing question of stock structure

Of the above, the Panel places the highest priority on the following, understanding the need to maximize the likelihood of generating an acceptable assessment of the stock in the near future:

  - \* The carrying out of fishery-independent surveys
- Collection of more catch data, including specifically the recreational fishery
- The collection of age and length data from commercial and recreational catches and from fishery-independent surveys
- Continue the updating and data correction checks ongoing for the US Virgin Islands commercial landings and Biostatistical data bases.
- Continue the data correction checks ongoing with the Puerto Rico commercial landings and bio-statistical data bases.
- Continue the analyses related to partitioning of US Virgin Islands bulk landings data into species groupings after the missing bio-statistical samples have been entered, proofed and agreed on by both US Virgin Islands DFW staff and NMFS, TIP staff.
- Work toward developing a species specific commercial landings sales ticket in the US Virgin Islands commercial fisheries.
- Work towards research to obtain bio-statistical samples in the US Virgin Islands and especially to improve much needed sampling in St. Thomas/St. John. Fisheries.

- Implement hard part biological sampling in US Virgin Island and Puerto Rico.
- Work towards identifying the primary information needs regarding improving the ongoing fishery independent sampling initiatives for yellowtail snapper populations in the Caribbean.

#### D. Review Workshop Procedural Suggestions for SEDAR

- There is a strong need for enhanced communication, specifically to stakeholders, about what SEDAR is trying to achieve in terms of management.
- To date, there has not been full acceptance from all, and this is put down at least partially to the lack of education and training of certain key parties about the process. Their cooperation is essential if SEDAR is to succeed in its objectives.
- An advanced plan of what species is to be handled when is essential for all those who need and wish to be involved in the process.
- There is need for a (web-based) Glossary of Terms used.
- Continuity of personnel in the workshops is crucial to ensuring both acceptance and enhanced understanding.
- Dissemination of the information created and the results in terms of management action are not always perceived by stakeholders to have been achieved, so it was felt that Councils should make greater effort in this regard, at all levels of the process.
- Several participants, both technical and representing fishermen, felt that greater effort should be made to maximize the time for preparation of data series, assessments, and review material. The Panel shied away from suggesting a deadline for receipt of material prior to each workshop, realizing that the very nature of some data would always make collection to the last possible moment necessary, but stressed that late receipt could easily lead to delayed or less informative assessments of stock status.
- As mentioned several times elsewhere in this report, strong cases were made for incorporating fishermen's knowledge better into the assessment and management process.
- The Review Panel requires the presence of scientists who have not been involved in the Data and/or Assessment Workshops. This may not be a preferred requirement for the participating stakeholders. Stakeholders would clearly benefit and be better able to participate fully in the review process if they had been present throughout all meetings. The Councils could maximize meeting this recommendation by considering paying stipends to participating stakeholders to compensate them for lost earnings.
- There was strong feeling that the anticipated changed representation on the Review Panel may not be most appropriate for the SEDAR area. While understanding and wholeheartedly endorsing the need for independent peer review, a strong case could be made for Panel representation to include stakeholders, biologists knowledgeable about the species, and stock assessment scientists who were not involved in the immediate assessment. It was felt unlikely that such people would be able to participate in the discussions at the current enthusiastic level unless they were formally accepted as members of the Panel.

- Allied to the above and notwithstanding what was ultimately decided on the make-up of the Panel, there was unanimity that the independence of the Review Panel chair (currently appointed by the CIE) was paramount and matched well the objective of independence.
- Given the volume of documentation associated with such reviews and the shortage of time often available to assimilate it, the Review Panel and other participants stressed the need for a clear executive summary to be provided for all substantive documents being addressed. Further, there was a call for a succinct table of model parameters (estimated and observed) to be provided for each assessment along with, if appropriate, a table of management options (e.g. a decision table) and the risks associated with them.

#### E. Review Workshop Stakeholder recommendations

- The need for robust education of fishermen and other stakeholders is acknowledged. Such education should be of a two-way nature and would potentially lead to an enhancement of their trust in the assessment and management process, especially if they were to become involved in research program design.
- The fact that most of the product in the yellowtail snapper fishery is sold retail and that there are no fish houses (at least in the US Virgin Islands) makes any meaningful future stock assessment in the region extremely dependent on cooperation with the local fishermen.
- A paucity of recent socio-economic information continues to hinder the development of integrated biological, economic, and social assessments.
- Partnerships with organizations such as NGOs, which are often staffed by highly qualified people and are perhaps also less constrained by political influence, can mobilize extra resources in meeting some of the research objectives.
- Biological and habitat/ecosystem research information is as important in the assessment process as catch data.
- Over the past 35+ years of fishing, yellowtail snapper abundance has remained stable.
- Detailed data (information) on yellowtail snapper catch are lacking for US Virgin Islands commercial landings. The lack of this type of data has introduced uncertainty into the determination of stock status. Therefore, collection of detailed catch information there is suggested as a top research priority.

#### F. Recommendations of the CIE contractors

- ensure the provision of a large-scale locator map in the meeting room (for those not familiar with the geography or sampling areas).
- ensure that membership of Panels for future SEDAR Review Workshops preserves independence of any involvement in assessment of the stocks being addressed, in terms of both Chair and Panel (the latter to retain participation if possible by several US scientists not involved in the assessment).
- Yellowtail Snapper: In terms of future research and monitoring, much needs to be done, but to maximize the likelihood of generating an acceptable assessment of the stock in the near future, the highest priority should be on:

- carrying out fishery-independent surveys;
- collecting more catch data, including specifically the recreational fishery; and
- collecting age and length data from commercial and recreational catches and from fishery-independent surveys
- Caribbean Spiny Lobster: priority for future research and monitoring was given to
  - developing/strengthening fishery-independent data collection;
  - incorporating historical data into existing data sets; and
  - utilizing refined models (better to identify viable hypotheses).
- Generally, the standardization procedure for the Caribbean yellowtail and spiny lobster abundance indices was well conducted and, based upon what was presented, the analyses appear to be sound. However, some improvements in the approach were recommended.
- Statistical criteria should not be the sole basis for determining terms in the GLM, but terms need to refer to some theoretical justification.
- Year interaction terms to remove random effects should be avoided if possible, as they could make the standardized index worse.
- Some factors would be better treated as covariates rather than factors, thereby reducing the number of parameters.
- The analysis needs to explore alternative treatments for missing data, rather than having a missing data category.

## XI.SEDAR 9. Gulf of Mexico Gray Triggerfish, Greater Amberjack, & Vermilion Snapper

### A. Gray Triggerfish

#### 1) DATA WORKSHOP

No research recommendations were provided.

#### 2) ASSESSMENT WORKSHOP

No research recommendations were provided.

#### 3) REVIEW WORKSHOP

- The Review Panel should be provided an executive summary for substantive documents from Data and Assessment Workshops, a succinct table of model structural equation and parameters, and if appropriate a table of management options. A glossary of all the acronyms used in the assessments should be provided as an appendix in every assessment report.
- All of the data used for the assessment should be included in the Reports as well as the model formulations for the assessment. Some of the data in gray Triggerfish (such as age composition data) used in the assessment were missing from the Assessment Report, which could preclude further independent evaluation of the assessment results. The Addendum to the gray triggerfish Assessment Report includes these data now.
- An observer program should be implemented to estimate levels of shrimp bycatch and appropriate age composition with some well-designed, systematic research programs, which are essential to provide the data necessary for effective management. Shrimp by catches for gray triggerfish are the dominant removals for this species and it is scientifically important for better estimates for an accurate stock assessment. Catch in numbers of fish is dominated by shrimp bycatch which mainly consists of age-0 and age-1 fish (Table 1 and Fig 1 in the Addendum). The shrimp bycatch fishery annually removes roughly 1 million fish age-1 equivalent and peaked at 5 million fish at year 2002. However the recreational and commercial fisheries' combined take was roughly 1 million pounds in recent years but had past peaks reaching 3 million pounds annually.
- A comprehensive age-reading programme should be established in the major sectors. This will allow a more accurate age distribution and therefore a more accurate and precise assessment. This is more important for this species since the assessment method has changed from ASPIC model to SSASPM using catch at age data.
- MRFSS programme should be strengthened so that more precise estimations of total catches are available for the assessment.
- A mark-recapture study should be initiated. Such a study will help:
  - \* Identifying movements and migrations between east and west regions;
  - \* Estimating fishing mortality;
  - \* Enhancing the population estimates; and
  - \* Identifying the stock structure;

- \* Better understanding habitat preferences.
- The methods should be more thoroughly documented, including the structural model equations, the observation-error models, process-error models (if appropriate), values of constants, constraints and priors, and description of the fitting algorithm including the uncertainty-estimation method.
- The panel should be provided more detailed model diagnostics, such as complete lists of estimated parameters together with their estimated standard errors, the most important investigation of model sensitivity runs.
- The model residuals diagnostics should be included to test whether there is still time-series autocorrelation for lack of goodness of fit in the assessment.
- The resources available to the assessment data collection, processing and modeling teams should be significantly increased. This increase in resources would be required in order to allow the foregoing recommendations to be implemented realistically.
- The panel's internally-adopted guidelines for assessing assessments developed during the SEDAR 9 Review Workshop (see Appendix 1) should be followed.

## B. Greater Amberjack

### 1) DATA WORKSHOP

No research recommendations provided.

### 2) ASSESSMENT WORKSHOP

- age-length keys representative of all sectors and regions of the fishery in the U.S. Gulf of Mexico (in part being addressed by current MARFIN NA05NMF4331071).
- reproductive parameters, such as age of sexual maturity and fecundity at age for the Gulf of Mexico stock of amberjack (age at maturity being addressed by current MARFIN NA05NMF4331071).
- fishery-specific release mortality

### 3) REVIEW WORKSHOP

- collect information on the species composition and total catch of shore based landings of Greater Amberjack and other species.
- Within the greater amberjack assessment, because of the uncertainty caused by the final year of data, an update assessment should be conducted within a few years (outside the usual benchmark assessment process) to elucidate the most likely trajectory being followed by the stock and enable the provision of remedial management measures should these be necessary.
- A yield-per-recruit analysis should be made for the greater amberjack as an addition to future assessments to act as a check against growth overfishing and to determine whether the legal minimum length is appropriate.

## C. Vermilion Snapper

### 1) DATA WORKSHOP

No research recommendations provided.

## 2) ASSESSMENT WORKSHOP

No research recommendations provided.

## 3) REVIEW WORKSHOP

- Establish an obligatory, randomised observer scheme to estimate levels of shrimp by-catches.
- Establish a comprehensive age-reading programme for vermilion snapper in the major sectors, especially the shrimp by-catches.
- Consider further reinforcing the MRFSS programme so that more precise and accurate estimations of recreational catches can be obtained.
- Methods should preferably be simulation-tested prior to their use in an advisory context.
- Methods should be documented more fully, including the structural model equations, the observation-error models, process-error models (if appropriate), values of constants, constraints and priors, and description of the fitting algorithm including the uncertainty-estimation method. This documentation, together with the input data, should be included in the stock assessment reports.
- More detailed model diagnostics should be provided, such as complete lists of estimated parameters together with their estimated standard errors.
- Significant increases in the resources available to the data collection, processing and modeling teams would be required in order to allow the foregoing recommendations to be implemented.
- The benchmarks should be updated when new life history parameters become available.
- In future assessments the SSASPM should be modified to take account of bias-correction in the length-weight prediction.

## D. General SEDAR Process Recommendations

### 1) SPECIFIC RECOMMENDATIONS OF THE REVIEW WORKSHOP PANEL.

- There were some concerns expressed in the Review Workshop that pressure may have been brought to participants at some of those workshops to progress management further than was possible within the available time frame and with available time series data.
- Incorporation of fishermen's knowledge into the data and assessment process.
- Whenever a major data stream (effort, catches or catch rates) is to be modified the details of any modifications should be stated explicitly and documented completely.
- To avoid overloading the scientific staff, sufficient resources and time should always be provided to prepare the materials to normal scientific standards and allowance be made for any major un-avoidable disruption to this process (such as Hurricane Katrina).
- A summary table for each assessment should be provided stating each data stream to be used with its constraints and any treatments or modifications made. Included in this table should be an indication of the reliability of each data stream. It could be included in either the Data Workshop or Assessment Workshop reports.

- Each assessment document should, preferably, contain appendices detailing the structure and likelihood estimator for at least the base case model, or alternatively refer to a readily available document containing these details.
- The various model outputs and management benchmarks (e.g. MSY, Fmsy, Bmsy, MSST, MFMT) for the accepted base case model should be defined in one place within the stock assessment report along with how they were defined mathematically.
- A glossary of all the acronyms used in the assessments should be provided as an appendix in every assessment report.
- If the data available are adequate for conducting an assessment, then the 5th and 6th Terms of Reference in the Data Workshop should be removed from consideration by the Data Workshop and shifted instead to the Assessment Workshop.
- There was large volume of documentation associated with this Review Workshop. The Review Panel recommended the need for a clear executive summary for all substantive Data and Assessment Documents. It could be more informative to distribute a succinct table of model equations and parameters (estimated and observed) to be provided for each assessment along with, if appropriate, a table of management options (e.g. a decision table) and the risks associated with them.
- The SEDAR process appears to be remarkably thorough and detailed, with many opportunities for clarification and communication of the stock assessment processes. The whole idea of such detailed reviews is to be applauded as demonstrating a willingness to be open and to provide the best defensible assessments possible with available data.
- The process itself is relatively intensive and after observing the difficulties involved in review three species at the same time it is recommended that future SEDAR events only consider two species at the most. With three fisheries there are greater opportunities for confusion between species and the time available for detailed discussion could be compromised. If there were to be multiple species considered in future SEDAR workshops it would be beneficial to allocate species among reviewers prior to arrival at the workshop so they could begin the detailed and focused examination of the very many reports from the Data and Assessment Workshops before arriving at the review venue.
- The final review workshop report appears to be asking for the review panelists to produce an independent assessment summary and while the review panel may have possibly provided significant input to the assessment development the work is still mostly all that of the assessment scientists. As such it feels contrary to general practice to not have their names associated with the final consensus report.
- Some of the review reporting, such as the advisory report, appears to be primarily an editorial effort which could be produced by anyone rather than the review panelist. The chances for errors of omission would be significantly lower if the advisory report were produced by the assessment scientists concerned and merely edited and agreed to by the review panelists.

## 2) RECOMMEND APPROACH TO ASSESSMENT REVIEW

- The review panel considered the characteristics that would ideally be desirable in a stock assessment process used for advisory purposes.
  1. All relevant data should be used, unless there is an *a priori* reason to exclude a data series, or a sound *a posteriori* reason can be identified. Data should be real observations, not “filled-in” using assumptions or other criteria, to the extent possible. Fish stock assessment depends on having reasonably long time-series of catch, effort and fishery-independent abundance estimates.
  2. Conclusions about stock status with respect to reference points should be robust to underlying assumptions about data and structural model, e.g. reliance on filling-in assumptions, dependence on most contested parts of the data sets.
  3. Assessments should include the following :
    - 3.1 Data screening, to check assumptions in 1 and 2.
    - 3.2 Model screening, to see if broadly similar conclusions are drawn from different models, including sensitivity to constraints etc.
    - 3.3 Residual pattern screening: Does the model replicate the trends in the data?
    - 3.4 Credibility check: are the estimated model parameters reasonable (e.g. selection pattern,  $r$ ,  $B_0/B_{msy}$ , trends in  $F$  etc. in the context of biological knowledge about the stock and the fishery ?
    - 3.5 Variance estimates (or posteriors) for the estimated interest parameters, and a priori model testing, using simulated data, which should demonstrate that the model has useful precision in predicting interest parameters when presented with data.
  4. Assessment documentation should include :
    - 4.1. Data used to fit the assessment model.
    - 4.2. Structural model equations, including process-error model if applicable
    - 4.3. Observation-error model
    - 4.4. Description of estimating algorithm
    - 4.5. List of final parameter estimates and their sd.s
    - 4.6. Computational validation, including simulation testing
    - 4.7. Source code (and ideally documentation) of the programs used should be made available.

### E. Recommendations of the CIE Contractors

- Whenever a major data stream (effort, catches or catch rates) is to be modified the details of any modifications should be stated explicitly and documented completely.
- To avoid overloading the scientific staff, sufficient resources and time should always be provided to prepare the materials to normal scientific standards and allowance be made for any major un-avoidable disruption to this process (such as Hurricane Katrina).
- A summary table for each assessment should be provided stating each data stream to be used with its constraints and any treatments or modifications made. Included

in this table should be an indication of the reliability of each data stream. It could be included in either the Data Workshop or Assessment Workshop reports.

- Each assessment document should, preferably, contain appendices detailing the structure and likelihood estimator for at least the base case model, or alternatively refer to a readily available document containing these details.
- The various model outputs and management benchmarks (e.g. MSY, Fmsy, Bmsy, MSST, MFMT) for the accepted base case model should be defined in one place within the stock assessment report along with how they were defined mathematically.
- A glossary of all the acronyms used in the assessments should be provided as an appendix in every assessment report.
- The SEDAR process is impressive in its thoroughness, its transparency, and in the consensus perception of stock development that it builds. This consensus-building is however achieved at considerable cost in terms of scientific manpower. The three-stage process of data evaluation, stock assessment and review is laudable in principle, but each stage involves a large number of participants, many of which are to some extent repeating work that has been done elsewhere. A symptom of this is that the technical elements of the assessments are spread out through a large number of working documents and workshop reports which refer to each other, creating a “thicket” of documentation that is difficult for an outsider to this process to penetrate. The task of repeating text from one report to another detracts significantly from the time available to address new substance.
- The consensus-building is achieved at cost of considerable inefficiency in the use of scientific resources, to an extent that may not be sustainable.
- I would suggest that SEDAR consider some of the following options, in order of priority:
  1. Recruiting more assessment scientists to the process;
  2. Reducing and simplifying the terms of reference to workshops - in particular, it is unrealistic to expect experts in fish stock modelling to address terms of reference concerning control and enforcement issues;
  3. Reducing and simplifying the number of reports to be produced – for example, there is considerable redundancy and repetition in the six reports generated by the review process;
  4. Merging some meetings in the process, e.g. either merge the “data” and “assessment” workshops into one, or else merge “data” workshops for several species (because many data issues are not species specific), or incorporate external experts into the assessment workshops and cease holding separate “review” meetings;
  5. Introducing a “lighter” procedure for assessing species of minor importance, with perhaps all three steps addressed in a single meeting.
- With respect to the SEDAR Review process in particular, I would make the following points:
  - \* The workload for the reviewers to address the terms of reference thoroughly is very challenging to meet within the allocated 12 working days – this could be alleviated with some pre-meeting task allocation and possibly a stronger focus by each reviewer to a particular stock;

- \* If an agreement could be reached on the desirable elements of an assessment (e.g. as Section 2) this could assist a better coordination of the assessment and review activities.



## **XII. SEDAR 10. Gulf of Mexico and South Atlantic Gag Grouper**

### **A. Gulf of Mexico Gag Grouper**

#### **1) DATA WORKSHOP**

- **Life History**
  - \* Conduct further review of current sampling methodologies by sector, including detailed comparison of length data from otolith samples and from more expansive port-based length sampling (via TIP; see SEDAR10-DW24).
  - \* Bring increased attention to the need for strategies to improve port sampling (representation of fishery sectors and random sampling)
  - \* Increase the sampling of the recreational sector for biological samples throughout the docks and ports of Florida's west coast.
  - \* Continue support of fishery-independent surveys including all gears (hand-line, long-line, and trap) throughout the west Florida shelf.
  - \* Recognize that gag landings may be increasing elsewhere in the Gulf and bring increased attention to sampling the northern and western Gulf regions.
  - \* Continue exchanges of calibration otoliths sets and age workshops among state and federal agencies, and universities to continue improvements of data comparability and quality control.
  - \* The DW recommends continued research on the use of otolith chemistry to evaluate the population structure of gag.
  - \* Continue genetics research to determine connectivity among different regions. The DW further highly recommends every opportunity be taken to add Mexican (Campeche) samples to this analysis as these methods can be most informative in divining patterns of gene flow and population connectivity.
  - \* The DW suggests that it may be particularly valuable to convene a workshop to address the potential non-random and non-representative sampling that hampers collection of small numbers of biological samples (relative to numbers of fish landed) which in turn are used for parameter estimates.
  - \* The DW recommends that age structure sampling continue on an annual basis in the Gulf.
  - \* The DW recommends that larval transport and modeling efforts associated with development of an Integrated Coastal Ocean Observing System (ICOOS) is further supported.
  - \* Tagging studies are needed to: 1) clarify the extent of movement between the Gulf and SA regions and within region, and 2) aid further development of age-specific estimates of depth-related mortality in the Gulf region. In the Gulf region, we recommend that tagging effort be extended to the middle and outer shelf, perhaps with the assistance of cooperating commercial fishers, for the purpose of tagging adult gag. The DW recommends that future tagging studies should be done in a more coordinated manner between researchers in the Gulf and SA regions, particularly with respect to gear, fish size, and depth.
- **Commercial Statistics**
  - \* Increase sampling for otoliths for aging
  - \* Improve at-sea observation for discards

- Recreational Statistics
  - \* Recommended a closer examination of reported headboat fishing locations, with respect to the GMFMC-SAFMC dividing line.
  - \* Explore surrogates for recreational fishing effort, for example numbers of recreational boat licenses or numbers of operating headboats.
  - \* MRFSS shore mode be explored further to elucidate whether it provides a useful annual signal of catches.
- Indices of Abundance
  - \* Develop a suitable method to correct species misidentification between black and gag grouper on a trip by trip basis.
  - \* The group strongly recommends increased adequate funding for both developing new and maintaining existing fishery-independent sampling programs, and stresses that quality indices require continuous funding over meaningful time periods (ideally decades).
  - \* When possible, environmental factors should be considered in future index standardization procedures.
  - \* The group recognized the need to quantify changes in catchability over time.
  - \* Recommend the use of an assessment model structure that can accommodate a nonlinear relationship between CPUE indices and stock size. Since data are often lacking, the group recommends sensitivity analyses that fix the nonlinear parameter(s) at plausible values.

## 2) ASSESSMENT WORKSHOP

No research recommendations provided.

## 3) REVIEW WORKSHOP

- Age determination: The Review Panel noted the importance of age reading comparisons and recommended that exchange of otoliths between labs continue in the future.
- Stock structure: The Review Panel recommended a further examination of stock structure before the next assessment, including a detailed analysis of existing tagging data and the initiation of new tagging experiments.
- The Panel recommends that a special workshop be convened to estimate and quantify changes in catchability over the last 25 to 30 years.

## B. South Atlantic Gag Grouper

### 1) DATA WORKSHOP

- Life History
  - \* Continue annual sampling for age structure with increased attention to representative sampling.
  - \* Continue exchanges of calibration otoliths sets and age workshops among state and federal agencies, and universities to continue improvements of data comparability and quality control.
  - \* The DW recommends continued research on the use of otolith chemistry to evaluate the population structure of gag.

- \* Continue genetics research to determine connectivity among different regions. The DW further highly recommends every opportunity be taken to add Mexican (Campeche) samples to this analysis as these methods can be most informative in divining patterns of gene flow and population connectivity.
- \* The DW suggests that it may be particularly valuable to convene a workshop to address the potential non-random and non-representative sampling that hampers collection of small numbers of biological samples (relative to numbers of fish landed) which in turn are used for parameter estimates.
- \* The DW recommends that long-term continuous monitoring of age structure be undertaken in the South Atlantic to test this hypothesis that strong year classes are reflected in both the South Atlantic and Gulf of Mexico.
- \* The DW recommends that larval transport and modeling efforts associated with development of an Integrated Coastal Ocean Observing System (ICOOS) is further supported.
- \* Tagging studies are needed to: 1) clarify the extent of movement between the Gulf and SA regions and within region, and 2) aid further development of age-specific estimates of depth-related mortality in the Gulf region. In the SA region, most of the tagging effort has been off South Carolina. Therefore, we recommend that additional tagging be completed off the east coast of Florida to examine the extent of northerly and southerly movements. The DW recommends that future tagging studies should be done in a more coordinated manner between researchers in the Gulf and SA regions, particularly with respect to gear, fish size, and depth.
- Commercial Statistics
  - \* Increase sampling for otoliths for aging
  - \* Improve at-sea observation for discards
  - \* Continued education of samplers for species identification
  - \* Conversions needed for different market categories (gutted, headed, filleted, whole weight).
- Recreational Statistics  
No research or monitoring recommendations provided.
- Indices of Abundance
  - \* Investigate further the issue of misidentification between black grouper and gag. Develop a suitable method to correct misidentifications on a trip by trip basis. This issue will also be of concern when assessing black grouper. The catches of gag grouper misidentified as black is likely a substantial proportion of reported black grouper landings.
  - \* We recognize that many valuable and well designed fishery-independent sampling programs have been underfunded or discontinuously funded, resulting in low sample sizes, variable sampling effort (in time and space), discontinuous time series, and poorly stratified designs. The group strongly recommends increased funding toward developing and maintaining fishery-independent sampling programs, and stresses that quality indices require continuous funding over meaningful time periods (ideally decades).
  - \* It was proposed that the index working group examine the possibility of including environmental variables in computation of indices. Variables

discussed included wave height, sea surface temperature, surface currents and hurricane impact. The group considered that other model parameters, particularly the spawner-recruit relationship, might be a meaningful way to include environment variables in assessment models.

- \* Examine methods to account for changes in catchability over time of abundance. This is of particular importance when considering fisheries-dependent indices.
- \* Develop coast-wide sampling of larval and juvenile abundance.

## 2) ASSESSMENT WORKSHOP

- The AW recommends that spatial information, including the depth related mortality functions suggested by the DW, continue to receive research attention.
- Improved spatial information on gag grouper to be used for depth related mortality functions (DW suggestion that could not be implemented for the south Atlantic assessment), and to monitor for potential changes in range that may affect assessment results.
- The AW also recommends that data be collected in the South Atlantic on effort and discards by depth.
- The AW recommends a fishery independent index of abundance be developed. A major missing component is the availability of a fishery independent index, as all three available indices were fishery dependent and therefore subject to shifts in efficiency and regulations.
- The AW recommends that the gag grouper mature sex ratio needs to be observed, from which it may also be possible to infer information about male fertility and the number of sperm required for successful fertilization. The potential results of shifts in sex ratio in a protogynous species like gag are not entirely known.
- The AW recommends further examination and reconstruction of the catch and total removals history (prior to 1962) from data sources not currently contributing the assessment history.
- The AW suggests that methods like DNA tagging may prove useful as a means for gaining an independent snapshot of total mortality. Estimates of mortality may be difficult to attain or determine if current estimates are on the correct scale.
- The AW recommends that effectiveness of effort from technological changes (e.g., electronics, GPS) be examined. The assessment ran alternate base runs that both assumed increasing catchability from improvements in technology and no increases in catchability. The AW agreed that this increase in technology had occurred, though any level had to be heavily inferred from studies in other fisheries. Research should be conducted in the major grouper fisheries to determine a more appropriate level and degree of increasing catchability.

## 3) REVIEW WORKSHOP

- The Panel recommends that a special workshop be convened to estimate and quantify changes in catchability over the last 25 to 30 years.
- Strengthen the MRFSS program to provide more precise estimations of the age/length composition.

- Provide more detailed model diagnostics, such as complete lists of estimated parameters together with their estimated standard errors, in model sensitivity runs.
- Explore the model residuals diagnostics to test for time series autocorrelation contributions to the lack of goodness of fit in the assessment.
- Analyze the existing mark-recapture data and initiate new mark-recapture studies, which will help identify movements and migrations between two stocks, estimate fishing mortality, enhance population estimates; and better identify the stock structure and habitat preferences.
- Bias on estimating weight from the log-log length-weight relationship
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#### C. General Assessment Advice From the Assessment Workshop

- Never rely on any one assessment procedure.
- Include retrospective analyses showing how estimates change with time.
- Beware of complex size-age and temporally changing vulnerability schedules.
- Beware of confounding between stock-recruitment and recruitment anomaly (environmental) effects.
- Examine implications of relative abundance time series that give contradictory indications of time trends.
- Provide time series estimates of fishing mortality rates.
- Run assessments on the longest possible catch data series, to give the best possible long term perspective on stock status.
- Carefully examine any available spatial data for evidence of range collapse or expansion.

#### D. Review Workshop Recommendations for both Stocks

- There was large volume of documentation associated with this RW. The Review Panel recommends a clear executive summary for all substantive Data and Assessment Documents.
- It could be more informative to distribute a succinct table of model equations and parameters (estimated and observed) to be provided for each assessment along with, if appropriate, a table of management options (e.g. a decision table) and the risks associated with them.

#### E. CIE Contractor Recommendations

##### 1) RESEARCH AND ASSESSMENT RECOMMENDATIONS

- Information on the number, location and persistence of spawning aggregations should be obtained and presented in future assessments in order to identify essential habitat (if this information is not already available).
- A further examination of stock structure should be completed before the next assessment, including a detailed analysis of existing tagging data and, possibly, the initiation of new tagging experiments to estimate mixing rates and the associated fishing mortality independent of the commercial fishing. This would necessitate an effective design for estimating tagging mortality, tagging shedding, reporting rates to increase confidence in the stock assessments.

- Standard fisheries methods based on yield per recruit analyses may not be appropriate for species that change gender during their lifetime. Spawner recruit analyses should consider males and females reproductive biomasses separately. In the case of gag grouper, male biomass may become limiting before female biomass does. In this context, projections of future population status should be provided by gender in the next assessment.

## 2) SEDAR PROCESS RECOMMENDATIONS

- Like the SAW process, the SEDAR Review Workshop is now reliant solely upon panellists provided by the Center for Independent Experts. In my opinion, this poses some concerns. Under the former model (e.g.: SEDAR6), the Review Panel consisted of scientific experts from the CIE, from the NMFS, and from academia. This provided for a broader expertise in the review process. The current model is designed to assess scientific credibility only and not to provide management advice. This is a positive step as it provides a buffer between the science of stock assessment and the potential politics of management. This buffer or barrier should be maintained and the revised model attempts to address this. However, the assessment of scientific credibility should not preclude additional panellists besides those provided by the CIE.
- The assessment of each of the stocks was conducted by separate teams, using similar but somewhat different assessment models. It was therefore more difficult for the Review Panel to make direct comparisons between assessment results. Recognizing that this was the first time that either of these stocks was assessed under the SEDAR process, the assessment teams did an excellent job. However, in future, a more thorough review could be facilitated if the assessment teams worked cooperatively using a single model for both stocks.

### **XIII. SEDAR 12 Gulf of Mexico Red Grouper**

#### **A. Data Workshop Recommendations**

##### **1) LIFE HISTORY GROUP**

- Studies performed with larger sample sizes for pre- and post-release mortality.
- All observer studies collect predation data and record release condition of fish.
- Future experimental studies to relate “sink or swim” observations to post-release mortality and suggests that controls are needed for all cage studies, such that control fish are captured and caged at depth (without bringing to the surface at all).
- Burns’ tag data be recoded to incorporate the comments regarding “sink or swim” into a standardized data field and used to estimate pre-release and predation mortality by sector.
- More research dedicated to determine methodologies to decrease release mortality (see Bartholomew and Bohnsack 2005).
- South Atlantic and Gulf Councils coordinate with CRP and MARFIN officers to provide all grant reports dealing with discards to be available at SEDARs and that all PI’s on grants dealing with said species are invited to SEDAR.
- All documents (including old assessments and references within) that were used in previous stock assessments for said species are more readily available to SEDAR participants.
- Conduct further review of current sampling methodologies by sector, including detailed comparison of length data from otolith samples and from more expansive port-based length sampling (via TIP; see SEDAR 12-DW-10).
- Bring increased attention to the need for strategies improving port sampling (representation of fishery sectors and random sampling)
- Increase the sampling of the recreational sector for biological samples throughout the docks and ports of Florida’s west coast.
- Continue support of fishery-independent surveys including all gears (hand-line, long-line, and trap) throughout the west Florida shelf.
- Continue exchanges of calibration otolith sets and age workshops among state and federal agencies and universities to continue improvements of data comparability and quality control.
- Continue use and development of a reference collection as a means to monitor precision between readers.
- Continue age structure sampling on an annual basis.
- Continue search for original samples and raw data on age and growth collected during the 1960s.
- Undertake more systematic collection of maturity data (e.g. to characterize the inshore and younger aged fish as well as the adults in mid and outer- shelf depths).
- Continue work on fecundity and spawning frequency and incorporate a spatial-temporal design to improve estimates of reproductive potential by age. Statistically test for regional effect. Continue work on spawning pattern to better

understand and discriminate between annual asynchrony in spawning (skipped spawning) and seasonal asynchrony in spawning. Explore model sensitivities to reproductive parameters.

## 2) COMMERCIAL

- No research or monitoring recommendations provided.

## 3) RECREATIONAL

- Interviews/data on catch rates are needed from recreational fisheries prior to 1981, in order to improve estimates of historical catches.
- Study of discard mortality rates, preferably linked to factors that can be obtained from available recreational data.
- Discards undoubtedly have length/age frequency distributions which differ greatly from the landed catch, however there is little length or age information on these fish. Efforts should be made to collect such data. Collections methods could include length measurements of discarded fish obtained from anglers, at-sea observer programs, and/or the granting of special research permits allowing anglers to retain undersized fish as samples for researchers.

## 4) INDICES OF ABUNDANCE

- The initiation and continued funding of such surveys, including, but not limited to the NE GULF INNER SHELF TRAP SURVEY. As trends can be regional in nature, the group highly recommends that recruitment trends be examined gulf-wide.
- Research be conducted to assess the possible impacts of hurricanes on the catch per unit effort of snapper/grouper complex members.
- Research be conducted to assess the possible impacts of red tide on the catch per unit effort of snapper/grouper complex members.

## B. Assessment Workshop Recommendations

- Refine sampling for age determination to provide sufficient spatial and temporal coverage across all fisheries. Ensure some fisheries are not sampled excessively, necessitating subsampling for age determination.
- Quantify temporal and spatial changes in catchability rate
- Develop methods to evaluate the impact of natural events such as red tide in modeling M and the overall assessment.
- Develop and expand fishery-independent indices for tuning assessment models and evaluation of management measures
- Increase at-sea observation of discards by fishery to provide numbers of discards, fate of discards, and size/age composition of discards.
- Quantify release mortality rates by fishery by depth
- Improved the MRFSS survey and estimates of recreational fishing effort, especially to improve spatial resolution. Develop methods to obtain age samples from the recreational fishery and improve estimation of fish weight from recreational sampling.

- Support research to better describe and understand dolphin predation of red grouper.

## C. Review Workshop Recommendations

### 1) LIFE HISTORY

- Investigate a two-gender growth model that explicitly addresses maturation and protogynous hermaphroditic gender change;
- Use tagging to further evaluate north-south connectivity;
- Explore temporal and/or density-dependent changes in growth and reproduction, including investigation of possible abiotic effects such as temperature;
- Publish a technical document about the application of Lorenzen method to convert conventional constant M to age-dependent M (avoid problem with the maximum age over which average has been developed).

### 2) FISHERY

- Support ongoing work to evaluate and reduce possible bias and precision of recreational catch estimates;
- Evaluate sampling design for fishery length and age composition sampling for optimum cost, precision, analytical flexibility;
- Include more documentation of patterns in the fishery (seasonal, geographic, quota attainments, etc.) in the next assessment report.

### 3) INDICES

- Evaluate the mix of surveys (longline, trap, SEAMAP video survey) to achieve best coverage of recruits and pre-recruits across relevant habitats and geographic and depth ranges.

### 4) MODEL

- Consider extending the model over different time periods. One sensitivity option would limit the assessment to the period after 1990 when the new 20 inch minimum size came into affect. Prior to 1990, data are different due to the size limit change so consider discarding pre-1990 data and fit the model to this shorter time series. Another option would be to complete the investigation of model performance and inference when the entire time series since 1880 is included. Such a long time series would have uncertainties due to assumptions about fishery characteristics in the early years, but could provide a check on the consistency between estimates of stock productivity and the cumulative removals over the entire time period.