S E D A R
Southeast Data, Assessment, and Review

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

SEDAR 1 – SEDAR 50

December 2016

SEDAR is a Cooperative Initiative of:

The Caribbean Fishery Management Council
The Gulf of Mexico Fishery Management Council
The South Atlantic Fishery Management Council
NOAA Fisheries Southeast Regional Office
NOAA Fisheries Southeast Fisheries Science Center
The Atlantic States Marine Fisheries Commission
The Gulf States Marine Fisheries Commission
NOAA Fisheries Highly Migratory Species Division

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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.

SEDAR 1: South Atlantic Red Porgy

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.

Review Workshop

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 affects 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.
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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.

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.

SEDAR 2: South Atlantic Black Sea Bass and Vermillion Snapper

Black Sea Bass

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.

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.

Vermillion Snapper

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 having 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. 5. An 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.

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.

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.

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.

SEDAR 3: South Atlantic/Gulf of Mexico Yellowtail Snapper and ASMFC Atlantic Croaker and Menhaden

South Atlantic/Gulf of Mexico Yellowtail Snapper

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.

Review Workshop

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.

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.

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).

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.

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.

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.

Atlantic Croaker

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

Recommendations to correct initial model

- Commercial landings did not include all removals from the population.

* Evaluate North Carolina unculled bait ("scrap") fishery data and include in the commercial landings.

* Evaluate the potential of applying the North Carolina unculled 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.

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.

SEDAR 4: South Atlantic Snowy Grouper and Tilefish Caribbean Deepwater Snapper Grouper

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").

South Atlantic Snowy Grouper and Tilefish

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 having 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).

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 having 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.

Review Workshop

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.

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.

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.

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.

Landings Statistics

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.

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.

Trip Interview Program (TIP)

General Recommendations

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

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.

U.S. Virgin Islands TIP

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?

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.

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.

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.

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.

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.

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.

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.

SEDAR 5: Atlantic and Gulf of Mexico King Mackerel Assessment Workshop

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.

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.

Review Workshop

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.

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.

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.

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.

Goliath Grouper

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.

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.

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.

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.

SEDAR 7: Gulf of Mexico Red Snapper

Data Workshop

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.

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.

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.

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).

Recommendations of the CIE Contractors

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.

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).

SEDAR 8: Southeastern Spiny Lobster, Caribbean Spiny Lobster, & Caribbean Yellowtail Snapper

Southeastern Atlantic Spiny Lobster

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.

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

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.

Caribbean Spiny Lobster

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.

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.

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)

Caribbean Yellowtail Snapper

Data Workshop

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

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.

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.

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.

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 sand Puerto Rico.
- Work towards identifying the primary information needs regarding improving the ongoing fishery independent sampling initiatives for yellowtail snapper populations in the Caribbean.

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.

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.

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.

SEDAR 9: Gulf of Mexico Gray Triggerfish, Greater Amberjack, & Vermilion Snapper

Gray Triggerfish

Data Workshop

No research recommendations were provided.

Assessment Workshop

No research recommendations were provided.

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.

Greater Amberjack

Data Workshop

No research recommendations provided.

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

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.

Vermilion Snapper

Data Workshop

No research recommendations provided.

Assessment Workshop

No research recommendations provided.

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.

General SEDAR Process Recommendations

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.

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 :

- Data screening, to check assumptions in 1 and 2.
- Model screening, to see if broadly similar conclusions are drawn from different models, including sensitivity to constraints etc.
- Residual pattern screening: Does the model replicate the trends in the data?
- Credibility check: are the estimated model parameters reasonable (e.g. selection pattern, r, B0/Bmsy , trends in F etc. in the context of biological knowledge about the stock and the fishery ?
- 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 :

- Data used to fit the assessment model.
- Structural model equations, including process-error model if applicable
- Observation-error model
- Description of estimating algorithm
- List of final parameter estimates and their sd.s
- Computational validation, including simulation testing
- Source code (and ideally documentation) of the programs used should be made available.

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.

SEDAR 10: Gulf of Mexico and South Atlantic Gag Grouper Gulf of Mexico Gag Grouper

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.

Assessment Workshop

No research recommendations provided.

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.

South Atlantic Gag Grouper

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.

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.

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

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.

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.

CIE Contractor Recommendations

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.

SEDAR Process Recommendations

- Like the SAW process, the SEDAR Review Workshop is now reliant solely upon panelists 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.

SEDAR 11: Highly Migratory Species - Large Coastal Sharks

Data Workshop

Life History

- Whereas previous assessments have defined maximum sustainable yield (MSY) as 0.5 of carrying capacity, recent life history analysis and peer-reviewed literature has suggested this level is risk-prone, particularly for K-selected species (Musick et al. 2000). The life history group recommends a more conservative definition of MSY be adopted (i.e. 60-70% MSY or 40% of spawning stock biomass) for this assessment.
- Develop more empirical estimates of natural mortality for large coastal species.
- Research into further refining the separation of Gulf of Mexico stock of blacktip sharks using a combination of genetics, demography/life history and conventional and advance tagging technology (i.e. satellite archival tags).
- Updates on demographics using revised life history information.
- Continue research on life history characteristics of prohibited species.
- Research on stock-recruitment function for sharks.
- Accrue data necessary for ecosystem-based management: trophic relationships, bioenergetics, and diet.

Catch Statistics

- Biological data should be collected on the illegal Mexican shark catch confiscated in U.S. waters, including species, sex, and length.
- Gear-related information, including effort and gear used for each species should be collected on the interdicted Mexican vessels.
- One central electronic database for biological and gear data should be created to keep information regarding the confiscated sharks and vessels.
- Scientists should help the Coast Guard create the database and teach the agents how to identify the species and collect gear information.
- The Atlantic menhaden fishery data should be examined to determine shark bycatch estimates, if available.
- Historical data should be re-examined to determine if the “unreported catch” from Mr. Brannon is or is not already included in the commercial landings.
- Better landings information on number of species, by weight, from the dealers should be sought
- Dockside sampling information would be helpful to verify landings information such as species composition.
- Determine whether port sampler information for large coastal sharks is available and if so, how to access it.

Indices of Relative Abundance

- The working group recommended inverse weighting based upon CVs as the default weighting scheme whenever indices are not given equal weighting.

Assessment Workshop

The Assessment Workshop Panel identified the following Research Recommendations which will aid in future assessments.

- Data Workshop participants need to bring raw data to workshop to enable additional analysis to be conducted and reviewed during the workshop when practical
- Length frequency data should be provided when available, with particular reference to the VA LL dataset.
- Examination and analysis of the Pelagic Longline Observer data should be included.
- Identify nursery areas for sandbars in the northern Gulf of Mexico
- Additional life history studies for all complex species to allow for additional species-specific assessments.
- Additional life history research into sandbar sharks to supplement or replace the available data from the mid 1990s
- Incorporation of the University of North Carolina dataset collected by Dr. Frank Schwartz in the next LCS assessment, with recognition that it may also contain valuable information useful for the Small Coastal Shark assessment to be conducted in 2007.
- Examination of methods to incorporate tagging data information into the assessment
- Attempt to recover and quantify information on historic catch, with special emphasis prior to the 1993 FMP.
- Management to force contrast would improve the blacktip assessments.
- Additional length sampling and age composition collection to improve information for developing selectivities
- Initiation or expansion of dock side sampling for sharks
- Ensure that existing independent sampling programs be continued
- Ensure funding for the recently initiated (2002) pelagic survey being conducted by the Pascagoula laboratory- SEFSC

Review Workshop

Issue: Lack of species-specific data, and the inability to identify carcasses/logs/ fins to species level.

- Improve dockside monitoring of catches
- Increase observer coverage of the commercial fleet
- Use biochemical and/or genetic testing of products (carcasses/logs/fins) to produce reliable species identifications

Issue: Lack of life history data for some species within the large coastal shark species complex, which results in no meaningful estimate of intrinsic rate of increase (*r*) for use in assessments.

- Conduct research on the life history of all species in the complex, including regular sampling and analysis of the main species
- Use life tables (or other similar approaches) to estimate population parameters such as *r*

Issue: Limited numbers of longer term abundance (catch rate) data.

- Utilize all appropriate abundance series available, e.g. the Schwartz data from North Carolina

Issue: Geographic range of abundance surveys is variable, and those with limited geographic coverage are more likely to reflect localized changes than stock-wide changes.

- Evaluate alternative weighting schemes or modelling approaches for abundance data that take account of the geographic range of the surveys

Issue: Lack of species and size composition and effort data for abundance surveys.

- Provide information on species and size composition
- Obtain trends in deployed fishing effort at least for the catch-rate index series in Data Workshops and present them in the Assessment Workshop report, together with corresponding trends in catches and catch rate.

Issue: Information on the type and quality of the standardization used for abundance indices was not always available.

- Document the method of standardization used for all catch-rate indices
- Where possible, use the same standardization methods for all indices

Issue: Assessment of the Large Coastal Shark (LCS) complex does not represent the status of the stocks, or any particular component of the stocks.

- Develop species-specific assessments for the main components of the LCS complex, where possible. Continuing with the current approach will only result in confusion with regards to the status of these resources
- As an interim step, an improvement may be achieved if the complex can be split into smaller groups based on species with similar life history characteristics, or which occur within the same regions (e.g. the Gulf of Mexico or the Atlantic).

SEDAR 12: Gulf of Mexico Red Grouper

Data Workshop Recommendations

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.

Commercial

- No research or monitoring recommendations provided.

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.

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.

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.

Review Workshop Recommendations

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).

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.

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.

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.

SEDAR 13: Small Coastal Sharks, Finetooth Shark, Blacknose Shark, Atlantic Sharpnose Shark, and Bonnethead Shark

Data Workshop Research Recommendations

Life History Working Group

- Bonnethead life history in Atlantic Ocean, spanning the range of the stock.
- Re-evaluate finetooth life history in the Atlantic Ocean in order to validate fecundity and reproductive periodicity.
- Determine reproduction for finetooth in the Gulf of Mexico.
- Re-evaluate blacknose life history in Atlantic Ocean, spanning the range of the stock.
- Expand research efforts directed towards tagging of individuals in south Florida and Texas/Mexico border to get better data discerning potential stock mixing.
- Develop empirically based estimates of natural mortality.
- Coordinate a biological study for Atlantic sharpnose so that samples are made at least monthly, and within each month samples would be made consistently at distinct geographic locations. For example, sampling locations would be defined in the northern Gulf, west coast of Florida, the Florida Keys (where temperature is expected to be fairly constant over all seasons), and also several locations in the South Atlantic, including the east coast of Florida, South Carolina, and North Carolina. This same sampling design could be applied to all small coastal sharks.
- Population level genetic studies are needed that could lend support to arguments for stock discriminations using new loci and/or methodology that has increased levels of sensitivity.

Catch Histories Working Group

No research recommendations provided

Indices Working Group

The following recommendations provided in no particular order, deal with the collection of catch rate series data.

- Continuation of the fishery-independent surveys reviewed is encouraged. Some series that were not useful at this time may prove useful in the future with the inclusion of more data and series that were recommended for use at this time may improve with the additional information.

- If significant methodological changes are planned, it would be wise to have an overlap period between the gear, design, or vessel changes to all for calibration and quantification of those changes. This will allow for the time series to be maintained as one entity.

Assessment Workshop Research Recommendations

No research recommendations provided

Review Workshop Research Recommendations

The Review Panel chose to separate its report into several sections, starting with comments which pertained to all assessments, followed by discussion and recommendations for the small coastal shark complex and individual species assessed.

General research recommendations from the Data Workshop Report relevant to all species include the following

1. Re-evaluate life history in Atlantic Ocean, spanning the range of the stock.
2. Expand research efforts directed towards tagging of individuals in south Florida and Texas/Mexico border to get better data discerning potential stock mixing.
3. Develop empirically based estimates of natural mortality

Additionally, the following recommendations provided in no particular order, deal with the collection of catch rate series data.

The Review Panel encourages the continuation of the fishery-independent surveys reviewed. Some series that were not useful at this time may prove useful in the future with the inclusion of more data and series that were recommended for use at this time may improve with the additional information.

Small Coastal Shark Complex

With the development of species-specific data bases, SEDAR 13 used species-specific models for analysis. Nevertheless, for continuity purposes the species aggregated assessments were continued. However, it is the Review Panel's view that the aggregate analysis of the complex is unlikely to accurately reflect the status of every individual species in the complex and therefore it should not be viewed in isolation from the species-specific assessments. The aggregated results were not inconsistent with the assessment results on bonnethead and Atlantic sharpnose sharks, in particular. Therefore, the results of alternative forms of analysis were examined for differences and similarities in their structure and results, leading to advice on those species. This does not preclude that management of small coastal sharks as a complex may continue into the future; however, the scientific advice now focuses on the individual species within that complex. The Review Panel supports the Assessment Workshop decisions to provide assessment and advice on a species by species basis, rather than on the complex.

Finetooth Shark

Research recommendations from the Data Workshop Report are given above.

Additionally, the Review Panel has two more recommendations for finetooth shark. The first is to resolve the issue of negative r by targeted research on the life history of this species for both the Atlantic Ocean and the Gulf of Mexico. The second is to use an alternate model that is more appropriate to such a data-poor species. This class of model includes length- and stage-based density dependent matrix models or a delay-difference model. The assessment team is to be commended for endeavoring to apply more data-demanding models. However, the Review Panel is concerned that these models may give a misleading sense of confidence that isn't warranted.

Blacknose Shark

Research recommendations from the Data Workshop Report relevant to blacknose are given above.

Atlantic Sharpnose Shark

Recommendations are only made by the Data Workshop. Those of relevance to Atlantic sharpnose are as follows:

a) Coordinate a biological study for Atlantic sharpnose so that samples are made *at least* monthly, and within each month samples would be made consistently at distinct geographic locations. For example, sampling locations would be defined in the northern Gulf, west coast of Florida, the Florida Keys (where temperature is expected to be fairly constant over all seasons), and also several locations in the South Atlantic, including the east coast of Florida, South Carolina, and North Carolina. This same sampling design could be applied to all small coastal sharks.

b) Population level genetic studies are needed that could lend support to arguments for stock discriminations using new loci and/or methodology that has increased levels of sensitivity.

c) Continuation of the fishery-independent surveys reviewed is encouraged. Some series that were not useful at this time may prove useful in the future with the inclusion of more data and series that were recommended for use at this time may improve with the additional information.

All three recommendations have merit but need to be judged on the basis of resources available and the priority/value of the fishery concerned. If the stock can be evaluated as not overfished and where no overfishing is occurring it is doubtful that increasing the level of sampling and research will change the effectiveness of management. It is also necessary to consider the opportunity costs of allocating resources to this species at the expense of other priorities. Recommendation (b) is only worthwhile if there is a capability to manage the two regions as separate stocks and that the fisheries operating in the two areas are sufficiently separate for this to make sense. For example, if vessels can transfer between areas, separate management may not be effective. A desk study using simulation models could be carried out to explore if a two stock approach is desirable, and if so, the more costly genetic study could be initiated.

With regard to (c), such surveys are often extremely costly and before an open ended commitment is made it would be desirable analyse the value of existing surveys and consider whether a more parsimonious approach might serve the purpose of the assessment without the need to support numerous surveys.

Bonnethead Shark
Research recommendations from the Data Workshop Report relevant to bonnethead sharks are given above in the general research recommendation section.

Comments Received Regarding the SEDAR Process

1. Evaluate the SEDAR Process. Identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops; identify any additional information or assistance which will improve Review Workshops; suggest improvements or identify aspects requiring clarification.

The SEDAR process is a well thought out transparent consensus building process. Given the diversity of data and information sources, particularly for indices of stock size and biological parameters, putting the data together is a major task and it is appropriate to do so through a data workshop where all interested parties can participate. Similarly, analyzing the data through an Assessment Workshop whose tasks are to provide estimates of population parameters and trends as well as estimates of management benchmarks is appropriate. The Review Workshop, whose tasks are to evaluate the assessment methods and results and to provide the status declaration, with support from the assessment teams, provide an independent neutral evaluation of the methods, results and status determination.

The Data Workshop appears to have met the large majority of its terms of reference completely. Term of reference 3 was almost completely met, but the evaluation of how well the indices of stock size represented fishery and population conditions was not complete. For most stocks, at least some indices indicate conflicting trends over time, some increasing and some decreasing, while other indices were variable over time but showed no trends. The three conditions cannot adequately represent the conditions of the stock, assuming that the stock unit is appropriately defined, unless various geographical components of a stock complex behave differently over time. It is not clear if the selection of indices could be further refined at the Data Workshop or whether it would be more appropriately done at the Assessment Workshop, but it is clear that the selection of indices to be used in the modeling has to be further refined.

The Assessment Workshop appears to have successfully and completely met all its relevant terms of reference except that it did not provide research recommendations.

The process as implemented in SEDAR 13 could be improved by structuring the reports and the presentations more explicitly according to the terms of reference. It would also help to provide

more details of the exploratory runs, perhaps in a working paper so that the choice of final run can be better understood.

The review of finetooth shark assessment could have benefited by seeing the exploratory analyses of the life tables that were conducted by the assessment team who were very thorough. It would have given the Review Panel more confidence in the results from the input data.

Recommendations for future SEDAR assessments

Participants and the Review Panel commented throughout the week on the SEDAR assessment process. What follows is a non-prioritized list of the points made:

Sensitivity runs in the assessments should examine the robustness of stock status relative to the biological parameters that determine MSY. These include values for M, growth fecundity selectivity and the form of the stock recruitment curve.

Projection software tools should be developed that can incorporate uncertainty in the initial conditions and capture process error more comprehensively for the forecast period.

The Review workshop identified process error, especially in F, as a problem in determining stock status relative to MSY reference points. Further consideration needs to be given to a more robust means of interpreting stock status than the procedure of simply using the most recent data year. It is also important for managers to know the probability of exceeding reference points in the medium term, even if present stock status is judged satisfactory.

A more detailed and comprehensive analysis of the CPUE series would be desirable to evaluate the utility of many series available. A rigorous and objective scientific protocol should be developed against which CPUE series are evaluated as a basis for inclusion in assessments. This should include, *inter alia*, statistical design, spatial coverage and relevance to target species. The Review Panel envisioned a set of standards that delineated a weighted scoring depending on the attributes of the time series. For example, if the time series was based on a statistically valid sampling design targeted at the specific species, then it would achieve a high score for that standard. If the time series was properly designed for another species and largely covered the distribution in space and time, it would achieve an intermediate score against this standard, and so on. This would avoid vulnerability to personal preference and ad hoc choice of time series to include.

Differences between successive assessments, particularly when different data series or different assessment models are used, should be systematically investigated to assess whether differences are due to changes in data, changes in models, or changes in assumptions.

SEDAR 14: Caribbean Yellowfin Grouper, Mutton Snapper, and Queen Conch

Caribbean Yellowfin Grouper

Data Workshop

Life History

The life history subgroup made several research recommendations pertaining to yellowfin grouper. These are prioritized below.

Early life History

1) Conduct studies on temporal (intra- and inter-annual) variability of oceanographic processes in relation to larval dispersal to quantify the degree of connectivity between platforms of the currently managed stock units.

2) Examine early larval dispersal patterns (post fertilization to pre-flexion) using genetic markers.

3) Identify essential habitats according to life history stage, including critical recruitment and post-settlement (nursery) habitats.

Adult Populations

4) Identify additional past and present spawning aggregation sites and characterize migration corridors.

5) Define the spatial scale of migrations by individuals participating in spawning aggregations through tag and release studies.

6) Evaluate the potential to use visual census data obtained from spawning aggregations as fisheries independent data for assessing stock status (i.e. sex ratio, average size, density) and for monitoring populations.

Stock Identification

7) Investigate population genetic structure of yellowfin grouper "stocks" within the US Caribbean and in relation to the wider Caribbean.

8) Examine ontogenetic shifts in habitat usage and diel foraging patterns

Commercial

1. Continuous biological sampling in the Virgin Islands at sufficient levels to adequately characterize size and age composition.

2. Link biostatistical data for a fishing trip from Puerto Rico to all of the landings records for that trip.

3. Ensure that the catch and effort data of individual fishers in Puerto Rico can be identified over time.

4. Eliminate the need for expansion factors by obtaining information on all landings.

Recreational

1. Conduct surveys to estimate the magnitude of the U. S. Virgin Islands recreational landings for all species including conch and lobster. It is possible that using a Virgin Islands contractor would improve the likelihood of success of the survey.

2. Include conch and lobster in the MRFSS for Puerto Rico.

3. To adequately characterize catch rates and sizes of mutton snapper caught by recreational anglers in Puerto Rico, very substantial increases in dockside sampling will be needed.

Indicators of Population Abundance

1. Fisheries-independent survey efforts currently rarely include stations in deep water, the preferred habitat of adult mutton snapper and adult yellowfin grouper. In addition, large aggregations of queen conch have been reported in deep water by commercial fishers. The group highly recommends the initiation and continued funding of such surveys. As trends can be regional in nature, the group highly recommends that such surveys be conducted throughout Puerto Rico and the US Virgin Islands.

2. The commercial landings data from Puerto Rico and the US Virgin Islands have been incompletely entered and a variety of problems are known to exist in those data. The group strongly recommends that every effort be made to resolve the problems with those data. This should include extensive meetings with port samplers and others familiar with the US Caribbean fisheries.

3. The group recommends that tag-recapture studies of mutton snapper, yellowfin grouper, and queen conch be conducted in Puerto Rico and the US Virgin Islands to determine habitat utilization and movement of those species.

4. Ongoing long-term monitoring studies should be expanded spatially and include data useful for stock assessment, e.g. size-frequency and density information.

5. It is suggested that areas exploited by fishermen be compared to those areas where monitoring has been ongoing to further knowledge of essential habitat for these species and improve the design of monitoring efforts (i.e., ensure that monitoring is reflective of fished conditions).

6. The group recommends that efforts be made to monitor spawning aggregations of finfish to improve measures of population abundance. Collection of historical indicators of spawner abundance (e.g., directed visual census, analysis of catch statistics for spawning peaks, etc).

7. The group encourages the collection and documentation, for this and future Caribbean assessments, of historical information for qualitative and/or quantitative comparisons of current conditions.

Assessment Workshop

The AWP recommends collecting species level information on commercial and recreational harvest in the US Virgin Islands.

The AWP recommends collecting biological samples to characterize commercial and recreational catches in the US Virgin Islands and Puerto Rico.

The AWP recommends continuation of the survey efforts directed at the Grammanik Bank spawning aggregation as a potential source of yellowfin grouper trends that reflect a potentially important population component.

The AWP recommends developing specific surveys to evaluate species such as yellowfin grouper which rarely occur in general surveys but are known to seasonally aggregate.

The AWP recommends developing research and monitoring programs that enable quantitatively evaluating management actions such as seasonal and area closures, especially as such actions can significantly alter fishery operations and limit traditional data collection approaches.

The AWP recommends pursuing alternative assessment methods for evaluating the status of stocks such as yellowfin grouper that are not commonly encountered by either fishery-dependent or fishery-independent sampling and monitoring programs.

The AWP recommends devoting effort to characterizing basic catch, biological, and survey data availability before recommending SEDAR assessments of stocks that have never been quantitatively assessed. Such work should be considered between scheduled SEDAR assessment projects or perhaps in lieu of a project dedicated to a particular species.

The AWP recommends a complete review of the potential data collection programs, including commercial and recreational catch, biostatistical sampling and fishery-independent surveys for Puerto Rico and US Virgin Islands with the purpose of identifying what relevant information could be obtained and modifying sampling procedures accordingly, including the identification of key economic and ecological indicator species.

The efforts to analyze the available data were greatly enhanced by the presence of local fishers and agency representatives. However, there was no local representative from the USVI Division

of Fish and Wildlife assigned to the AWP and the sole Puerto Rico representative could not attend the full term of the meeting. There must be greater buy-in from the local agencies such that knowledgeable representatives are present for the full term of the meeting. Furthermore, greater efforts should be made to attract and secure participation of local fishers.

Review Workshop

The Review panel replied to Term of Reference 9.

> 9. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment and indicate whether a benchmark or update assessment should be considered.

The Review Panel agrees with the points put forward by the Data Workshop and Assessment Workshop.

In addition it was the opinion of the RP that:

1. Tagging data should also be considered in relation to obtaining information on growth rates of yellowfin grouper. In addition to be of general life history interest this will also be of importance in relation to validation of otolith age determination.

Because yellowfin grouper is a quite rare species it might be considered to use some kind of Data Storage Tags in order to obtain as much information from each individual fish tagged as possible. If sufficient number of yellowfin grouper can be caught and tagged (with ordinary tags), annual tagging programs to reveal stock size and fishing mortality could be considered for yellowfin grouper. Because yellowfin grouper is quite rare to catch it might be practical to tag several species (with similar lack of life history knowledge for which tagging studies are potential appropriate) at the same time.

2. An internet setup could be explored, where anglers and maybe divers report their catches of yellowfin grouper (and other relevant species) as well as additional information directly on forms on the internet. Such internet systems are used with success in other places in the world to report fish catches, especially for large and rare species like yellowfin grouper. Such an approach should be accompanied with various test and checks to estimate reporting rates by segments of anglers and divers, etc., so that total catches from relevant segments of the fishers can be estimated in a proper way. The internet is also an effective tool for communicating with the data suppliers, for instance about how to report, the results of the reports and ongoing tagging experiments.

Of all these recommendations including those of Data Workshop and Assessment Workshop, the Panel regards the following to be of the highest priority:

• the improvements of sampling from the fishery (both commercial and recreational) including biological measurement;

• tagging studies to reveal stock structure, population size, annual fishing mortality and life history parameters;

• improving fisheries-independent surveys;

• resolving the problems in the commercial landings data base.

Recommendations for Future SEDAR Assessments

The Review Panel recommends that the assessment and management of inshore and reef fish in the Caribbean should follow a multi-species, mixed fishery approach appropriate to the conditions of coastal tropical fisheries. It is therefore recommended that the scope and timing of the next Assessment Workshop is established following an inter-sessional workshop within the next 12 - 18 months to evaluate the information available to support such an approach. Specifically, the workshop should identify the relative abundance, potential vulnerability to exploitation and type and quality of data available for each species, potential indicator species for which it may be possible to provide reliable single-species assessments and benchmarks, and procedures and data-needs for deriving indicators and benchmarks at the fish community level.

Mutton Snapper

Data Workshop

Early Life History

1. Conduct studies on temporal (intra- and inter-annual) variability of oceanographic processes in relation to larval dispersal to quantify the degree of connectivity between platforms of the currently managed stock units.

2. Examine early larval dispersal patterns (post fertilization to pre-flexion) using genetic markers and otolith microchemistry where possible.

3. Identify essential habitats according to life history stage, including critical recruitment and post-settlement (nursery) habitats.

Adult Populations

4. Identify additional past and present spawning aggregation sites and characterize migration corridors.

5. Define the spatial scale of migrations by individuals participating in spawning aggregations through tag and release studies.

6. Evaluate the potential to use census data obtained from spawning aggregations as fisheries independent data for assessing stock status (i.e. sex ratio, average size, density) and for monitoring populations.

7. Investigate population genetic structure of mutton snapper "stocks" within the U.S. Caribbean and in relation to the wider Caribbean.

8. Examine ontogenetic shifts in habitat usage and diel foraging patterns.

Commercial

5. Continuous biological sampling in the Virgin Islands at sufficient levels to adequately characterize size and age composition.

6. Link biostatistical data for a fishing trip from Puerto Rico to all of the landings records for that trip.

7. Ensure that the catch and effort data of individual fishers in Puerto Rico can be identified over time.

8. Eliminate the need for expansion factors by obtaining information on all landings.

Recreational

4. Conduct surveys to estimate the magnitude of the U. S. Virgin Islands recreational landings for all species including conch and lobster. It is possible that using a Virgin Islands contractor would improve the likelihood of success of the survey.

5. Include conch and lobster in the MRFSS for Puerto Rico.

6. To adequately characterize catch rates and sizes of mutton snapper caught by recreational anglers in Puerto Rico, very substantial increases in dockside sampling will be needed.

Indicators of Population Abundance

1. Fisheries-independent survey efforts currently rarely include stations in deep water, the preferred habitat of adult mutton snapper and adult yellowfin grouper. In addition, large aggregations of queen conch have been reported in deep water by commercial fishers. The group highly recommends the initiation and continued funding of such surveys. As trends can be regional in nature, the group highly recommends that such surveys be conducted throughout Puerto Rico and the US Virgin Islands.

2. The commercial landings data from Puerto Rico and the US Virgin Islands have been incompletely entered and a variety of problems are known to exist in those data. The group strongly recommends that every effort be made to resolve the problems with those

data. This should include extensive meetings with port samplers and others familiar with the US Caribbean fisheries.

3. The group recommends that tag-recapture studies of mutton snapper, yellowfin grouper, and queen conch be conducted in Puerto Rico and the US Virgin Islands to determine habitat utilization and movement of those species.

4. Ongoing long-term monitoring studies should be expanded spatially and include data useful for stock assessment, e.g. size-frequency and density information.

5. It is suggested that areas exploited by fishermen be compared to those areas where monitoring has been ongoing to further knowledge of essential habitat for these species and improve the design of monitoring efforts (i.e., ensure that monitoring is reflective of fished conditions).

6. The group recommends that efforts be made to monitor spawning aggregations of finfish to improve measures of population abundance. Collection of historical indicators of spawner abundance (e.g., directed visual census, analysis of catch statistics for spawning peaks, etc).

7. The group encourages the collection and documentation, for this and future Caribbean assessments, of historical information for qualitative and/or quantitative comparisons of current conditions.

Assessment Workshop

Table 12 provides a comprehensive overview of the availability of information for U.S. Caribbean mutton snapper populations, This table in addition to the following discussion provides a synthesis of the groups thoughts regarding sufficiency and quality of the data available for use in evaluating the stock status of the mutton snapper population in this region. Due to the current categorization of mutton snapper as undergoing overfishing, this species should be prioritized in all data collection efforts in the US Caribbean both in dependent and fishery independent programs. Obtaining information required to assess the impact of regulations on management measures is needed. Targeted research efforts are needed to determine relative abundance, CPUE, length and age structure of catch for all commercial and recreational gears used to harvest mutton snapper. The group noted the need to monitor population densities at seasonal closed areas to open areas to determine effects of management and to monitor compliance. The only area closure for mutton snapper is off St. Croix and the closure has been in place since 1993. There has been no monitoring in this area since the closure took effect. In addition there is no current mechanism of enforcing the spawning seasonal closure.

Review Workshop

The Review panel replied to Term of Reference 9.

9. Review the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment.

The RP reviewed the wide range of research recommendations provided by the DW and AW in relation to immediate and longer-term needs for improving the assessment of the stocks and the provision of management advice. The RP provided additional recommendations where appropriate. The research recommendations are reviewed in a separate section of this report.

The RP recommends that the assessment and management of inshore and reef fish in the Caribbean should follow a multi-species, mixed fishery approach appropriate to the conditions of coastal tropical fisheries. It is therefore recommended that the scope and timing of the next AW is established following an intersessional workshop within the next 12 – 18 months to evaluate the information available to support such an approach. Specifically, the workshop should identify the relative abundance, potential vulnerability to exploitation and type and quality of data available for each species, potential indicator species for which it may be possible to provide reliable single-species assessments and benchmarks, and procedures

Review Panel research recommendations

The DW and AW reports provided a wide range of research recommendations related to biology, fishery data, fishery-independent data and assessment methods for mutton snapper. The recommendations were scattered throughout the reports, but without any prioritization according to short-term and longer-term needs or any indication of the extent to which the results could improve the assessment and management of the stocks. The RP recommends that future DW and AW reports provide a single section collating all recommendations, with priorities and expected contribution of the results clearly identified.

The following sections give the combined DW and AW recommendations for different research areas. In each case these are followed by RP evaluations and consolidated recommendations for data collection and research that is needed to address the deficiencies in data and understanding that are impeding the evaluation of stock status and development of appropriate management measures. In some cases similar recommendations appear in different guises in different parts of the DW and AW reports and the RP has taken the liberty of merging and rewording these as appropriate, and summarizing some of the other recommendations.

DW & AW Workshop recommendations on fishery-dependent data

- Biological sampling at USVI to characterize size and age composition.
- Ensure that the catch and effort data of individual fishers in Puerto Rico can be identified over time.
- Eliminate the need for expansion factors by obtaining information on all landings; resolve other problems with data through extensive meetings with port samplers and others familiar with US Caribbean fisheries.

- Targeted research efforts to determine relative abundance, CPUE, length and age structure of catch for all commercial and recreational gears;
- Collection of species landings data at resolution to allow CPUE data for each gear; need to identify each individual fisher, location/date of catch, and depth where possible.
- Estimate CPUE in terms of numbers and biomass; estimate effort as hook-hours and trap soak times;
- Where appropriate, collection of discards data and fate (dead or alive) of discards;
- Review of field methods and protocols for fishery data collection throughout Caribbean;
- Review catch sampling intensity protocols;
- Evaluate impacts of management measures, particularly closed areas

The RP considers the improvement in the accuracy and coverage of fishery data to be of very high priority for the fisheries of Puerto Rico and the U.S. Virgin Islands, and endorses the DW and AW recommendations. The RP makes the following consolidated recommendations:

i) Ensure accurate recording of data by species in all areas.

ii) Development of a random fishery sampling scheme, stratified by appropriate areas/gears/seasons, to provide valid statistical estimates of catches and size compositions by species, and fishing effort, with high spatial and temporal resolution.

iii) Continued improvement of log-book reporting schemes and improvements in methods for expanding reported landings to the total fishery, for example by stratifying by port.

iv) Evaluation of the representativeness of the reported fishery data, for example by interviewing fishermen who have submitted log sheets in recent years but did not before.

v) Identification of fishing effort units (e.g. soak time for traps; hook-hours) that are most likely to provide a linear relationship between CPUE and population abundance, and the capturing of historical TIP data on landing weight per trip for trips with soak time or other effort data

vi) Collection of covariates (e.g. depth) to help explain variability in CPUE data

vii) Accurate documentation of changes over time in fishing effort, fishing gears and their deployment, species targeting and fish-location technology (e.g. GPS), to help interpret CPUE data and identify periods when catchability may have changed.

viii) The Panel agrees that standardized sampling protocols and systems for Quality Assurance / Quality Control of data are needed for data collection throughout the Caribbean.

ix) Involvement of fishers in data collection schemes, including investigating the potential for web-based systems for capturing fisher's data and other information.

DW & AW Workshop recommendations on the recreational fishery

- Conduct surveys to estimate magnitude of USVI recreational landings for all species (use a USVI contractor) (To adequately characterize catch rates and sizes of mutton snapper caught by recreational anglers in Puerto Rico, very substantial increases in dockside sampling will be required.)

- MRFSS program should add additional survey attributes to draw out information on mutton snapper throughout US Caribbean; increase MRFSS intercepts to improve sample sizes.
The RP endorses recommendations to collect relevant data on recreational fishing. Data on recreational fishery catches of mutton snapper are limited to the recent period of the MRFSS survey (2000 onwards for Puerto Rico, 2000 only for USVI). Although the precision of estimates of fish catches is quite low (CV's = 30-50%), recreational fishing appears to be an important source of mortality (6,000 – 25,000 fish killed per year off Puerto Rico), and shore fishermen appear to target mainly juvenile mutton snapper. Improvements in the coverage and intensity of the Puerto Rico sampling scheme and restarting the USVI scheme would contribute significantly to the accuracy of removals estimates from the stocks. Shore-angling catch rates may indicate recruitment trends. As with the commercial fishery, involvement of the angling community in data collection schemes would be beneficial, potentially making use of web-based systems.

DW & AW Workshop recommendations on fishery independent data

- Initiate surveys in deeper water, the preferred habitat of adult mutton snapper.
- Identify essential habitats according to life history stage, including critical recruitment and post-settlement (nursery) habitats.
- Monitor spawning aggregations for density (abundance indices), and collection of population parameters such as sex ratio and size of fish.
- Collection and documentation of historical information for qualitative and/or quantitative comparisons of current conditions; collation of historical indicators of spawner abundance
- Continue and enhance fishery independent programs including spawning aggregations and collection of data on size of individuals, depth, time of day, habitat; use of visual counts or directed gear sampling;

The RP encourages the development of fishery independent surveys using fishing gears or direct observation, provided the surveys adequately cover the range of the target species and are capable of providing abundance indices or raised abundance estimates with acceptable accuracy. The RP recognizes that such surveys require substantial investment to achieve the necessary spatial coverage, and will benefit from existing studies and fisher's knowledge to identify strata for visual or fishing surveys of spawning fish.

The DW listed 14 different sources of fishery independent data from different areas around Puerto Rico and the U.S. Virgin Islands, but only five appear to provide data on mutton snapper, mainly in the U.S. Virgin Islands. In general the surveys tend to be localized and observations of mutton snapper can be low. Diver surveys using volunteer divers on the REEF program indicate (other than in 2006) an increase in abundance of mutton snappers at inshore sites off the U.S. Virgin Islands, showing a similar general pattern to the Puerto Rico commercial trap fishery CPUE. The existing surveys should be reviewed to establish areas that could be targeted for

systematic dive surveys, and to determine the survey effort required to achieve specified precision levels. Discussions at the Review meeting indicated that surveys at times of year when the fish are more dispersed may provide more precise abundance indices than surveys of spawning aggregations. Occupancy of spawning sites will also be strongly affected by spawning behavior and the environmental triggers for spawning.
On the other hand, surveys designed to collect data on parameters such as relative size composition of mature fish, may benefit from taking place on known spawning sites at spawning time. The design of surveys therefore needs to be linked clearly to their objectives.

The RP recommends investigation of other methods for fishery-independent stock monitoring, for example beach-seine surveys to provide recruitment indices for mutton snapper and other species and tag-release programs to estimate mortality rates as well as fish movements. Desk studies are however required to establish the requirements for design, intensity and sampling to deliver the required accuracy of estimates from any such surveys.

DW & AW Workshop recommendations on biological studies

- Collect life history information (growth, maturity, fecundity etc.); coordinate between key agencies;

- Tag recapture studies to determine habitat utilization and movement.

- Identify additional past and present spawning aggregation sites and characterize migration corridors;

- Define the spatial scale of migrations by individuals participating in spawning aggregations through tag and release studies;

- Conduct studies on temporal variability of oceanographic processes in relation to larval dispersal and connectivity of platforms of currently managed stock units;

- Examine early larval dispersal patterns using genetic markers and otolith microchemistry;

- Investigate population genetic structure of mutton snapper “stocks” within US Caribbean and in relation to the wider Caribbean.

- Examine ontogenetic shifts in habitat usage and diel foraging patterns.

The RP endorses the need for estimates of biological parameters determining productivity (growth, maturity, fecundity). Growth estimates by sex are needed for length-based models, and growth and maturity data are needed for development of biological reference points for exploitation.

The RP endorses the need for better information on distribution and seasonal/ontogenetic migrations and dispersal of mutton snapper. Whilst such information may not necessarily feed directly into stock assessment models, it is important for interpreting CPUE data, evaluating the impact of effort redistribution during closures, and establishing the possibility for over-fishing of

localized populations with limited dispersal and mixing. Modeling of egg and larval drift provides further information on connections between spawning and recruitment sites and the linkages between mutton snapper populations around Puerto Rico and the US Virgin Islands, and is an important long-term area of research rather than for assessing local stock status.

Queen Conch

Data Workshop

Commercial

1. Continuous biological sampling in the Virgin Islands at sufficient levels to adequately characterize size and age composition
2. Link biostatistical data for a fishing trip from Puerto Rico to all of the landings records for that trip.

3. Ensure that the catch and effort data of individual fishers in Puerto Rico can be identified over time.

4. Eliminate the need for expansion factors by obtaining information on all landings.

Recreational

1. Conduct surveys to estimate the magnitude of the U. S. Virgin Islands recreational landings for all species including conch and lobster. It is possible that using a Virgin Islands contractor would improve the likelihood of success of the survey.

2. Include conch and lobster in the MRFSS for Puerto Rico.

3. To adequately characterize catch rates and sizes of mutton snapper caught by recreational anglers in Puerto Rico, very substantial increases in dockside sampling will be needed.

Indices of Abundance

1) Fisheries-independent survey efforts currently rarely include stations in deep water, the preferred habitat of adult mutton snapper and adult yellowfin grouper. In addition, large aggregations of queen conch have been reported in deep water by commercial fishers. The group highly recommends the initiation and continued funding of such surveys. As trends can be regional in nature, the group highly recommends that such surveys be conducted throughout Puerto Rico and the US Virgin Islands.

2) The commercial landings data from Puerto Rico and the US Virgin Islands have been incompletely entered and a variety of problems are known to exist in those data. The group strongly recommends that every effort be made to resolve the problems with those data. This should include extensive meetings with port samplers and others familiar with the US Caribbean fisheries.

3) The group recommends that tag-recapture studies of mutton snapper, yellowfin grouper, and queen conch be conducted in Puerto Rico and the US Virgin Islands to determine habitat utilization and movement of those species.

4) Ongoing long-term monitoring studies should be expanded spatially and include data useful for stock assessment, e.g. size-frequency and density information.

5) It is suggested that areas exploited by fishermen be compared to those areas where monitoring has been ongoing to further knowledge of essential habitat for these species and improve the design of monitoring efforts (i.e., ensure that monitoring is reflective of fished conditions).

6) The group recommends that efforts be made to monitor spawning aggregations of finfish to improve measures of population abundance. Collection of historical indicators of spawner abundance (e.g., directed visual census, analysis of catch statistics for spawning peaks, etc).

7) The group encourages the collection and documentation, for this and future Caribbean assessments, of historical information for qualitative and/or quantitative comparisons of current conditions.

Assessment Workshop

1. The efforts to analyze the available data were greatly enhanced by the presence of local fishers and agency representatives. However, there was no local representative from the USVI Division of Fish and Wildlife assigned to the meeting, while the Puerto Rico representative could not attend the full term of the meeting. There must be greater buy-in from the local agencies such that knowledgeable representatives are present for the full term of the meeting.
Greater efforts should be made to attract the participation of local fishers.

2. Data from past density surveys should be re-analyzed so that values can be expanded on the basis of both habitat and depth, including confidence limits. Habitats should be matched to those available for existing/planned habitat maps. As a subportion of this, the data for the Puerto Rico 1986 survey should be entered into electronic and GIS formats. This could be done using NOAA's Data Rescue funds.

3. Expansion factors for both Puerto Rico and the USVI should be calculated for conch fishers only.

4. Assessment of the spatial and temporal variations and dynamics of the resource, fishery, habitat and species interactions would be greatly enhanced if traditional ecological knowledge were obtained from fishers. Efforts should be made to incorporate fishers into the process, particularly using NOAA's CRP funds.

5. The impact of the recreational fishery is unknown and must be quantified.

6. Considering the established and potential value of resource surveys, mechanisms should be identified to increase their aerial coverage.

7. More detailed spatial expansions of survey densities should be planned in preparation of the 2010 Conch Update. For this, significant improvements in available data and analyses are required, including but not limited to the following:

A. Detailed bathymetry data for PR and USVI
B. Analysis of the impact of closed areas
C. Inclusion of more detailed habitat maps for the PR western platform currently in progress
D. Quantified size/age structure of the exploitable stock.

8. The only estimate to date of fishing mortality came from a tagging study in the 1980's. New tagging studies should be initiated to quantify rates of exploitation. This would allow existing SPR models for conch to be used in assessments.

9. Another issue remaining is to investigate the potential impact of very old conch in deep refuges, especially with respect to reproduction, coupled with studies to age very old conch. Such refuges may be substation off St. Thomas/St. John, in patches in Puerto Rico and potentially in protected areas on all three platforms.

10. Intersessional data evaluation workshops for CFMC managed species or species complexes should be conducted by the Council so that SEDAR level analyses are limited to those where data are sufficient to warrant such an analysis.

11. There needs to be a complete review of the potential data collection programs, including commercial and recreational catch, biostatistical sampling and fishery independent surveys for Puerto Rico and US Virgin Islands with the purpose of identifying what relevant information could be obtained and modifying sampling procedures accordingly, including the identification of key economic and ecological indicator species.

Review Workshop

The Review panel replied to Term of reference 9.

> 9) Review the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment.

The RP reviewed the wide range of research recommendations provided by the DW and AW in relation to immediate and longer-term needs for improving the assessment of the stocks and the provision of management advice. The RP provided additional recommendations where appropriate. The research recommendations are reviewed in a separate section of this report (see below under Additional Comments).

It is recommended that the next assessment be deferred until an inter-sessional data evaluation workshop can demonstrate significant progress in the improvement of resource survey and landings data. An interval of 3 years would be appropriate for an inter-sessional workshop.

Additional Comments of the Review Panel

The conclusion that the available data on queen conch fisheries and stock abundance around Puerto Rico and USVI are inadequate to allow a stock assessment or calculation of benchmark statistics was strongly endorsed by the RP. A commitment to long-term research and data collection to address these deficiencies in data and knowledge is essential for effective management supported by robust assessments, and adequate resources need to be provided to collect essential data to support scientifically based management of queen conch in the region. The RP however recognizes the significant effort that has been put into data collection in the region and emphasizes that these have provided a valuable framework for identifying the priorities for future data collection to support stock assessment and fishery management. The DW and AW have made a number of recommendations for future research and monitoring which are reviewed below alongside further recommendations of the RP.

Recommendations of the Data Workshop

Life History

The DW made no recommendations for future research into queen conch life history. Biological parameters for queen conch are generally well characterized from the literature, although variations in growth and maturation over small spatial scales mean that there is uncertainty about area-specific parameters. This is not presently a limiting factor for stock assessment, principally because there are neither data nor model structures available for analytical assessment of conch stocks, but use of yield or spawner per recruit analyses to develop biological reference points would need to account for this fine scale variation. In common with many other species, empirical information is lacking on natural mortality after early life stages, but assumed values and their relationship with age appear to be adequate at present.

The RP made no specific recommendations for high priority research into conch life history parameters, but there was a general view that more information is needed on stock identity and the spatial scale of population processes at each life stage. Genetic studies indicate population connectivity between different areas of the Caribbean, but this does not preclude the existence of stock units that are effectively self-contained at time scales relevant to stock assessment and fishery management. Modeling of conch larvae dispersal by surface currents may shed some light on this issue.

Commercial Statistics

The DW recommended that Puerto Rico conch landings for recent years should be corrected for the change from reporting uncleaned to reporting cleaned meat weights and that this should be done on a port-by-port basis. Landings included in the DW report were not corrected, but approximate corrections at the scale of the entire Puerto Rico fishery were applied in figures

presented in the AW report and during the RW meeting. The RP agreed that it was a high priority to apply such corrections in presenting time-series of conch landings data.

The DW also made the following recommendations regarding the collection of statistics on the commercial fisheries for the three species considered by SEDAR 14:

DW1) Continuous biological sampling in the Virgin Islands at sufficient levels to adequately characterize size and age composition.

DW2) Link biostatistical data for a fishing trip from Puerto Rico to all of the landings records for that trip.

DW3) Ensure that the catch and effort data of individual fishers in Puerto Rico can be identified over time.

DW4) Eliminate the need for expansion factors by obtaining information on all landings.

The first recommendation relates mostly to finfish, but it is also true that future assessments may benefit from more information on the composition of conch catches. Ideally, continuous sampling should be maintained at sufficient levels to allow calculation of required indicator statistics, but occasional intensive sampling may provide a viable alternative. The definitions of 'sufficient' and 'occasional' can only be judged in a risk assessment context, the relevant question being what precision around indicator statistics is required for management purposes. In the absence of information on which indicator statistics might be desirable the RP is unable to provide more specific recommendations on sampling of conch catch composition.

Recommendations DW2-4 reflect the urgent need for accurate gear-specific total landings and effort data across the whole of the assessed area, and for comprehensive qualifying data to be matched with individual catch records such that meaningful and properly standardized CPUE estimates can be calculated. The RP regards these recommendations as being of the highest possible priority. Future progress in developing stock assessments and population benchmarks for queen conch depends critically on the availability of comprehensive, quantitative information on fishery removals and the associated fishing effort. This will remain true even if, as seems likely, fishery independent indices are used as the primary source of information on stock abundance. ABCs and related statistics will always need to be calculated with reference to complete landings data. The RP further recommends investigation of uncertainty around estimated expansion factors and hence around estimated total landings. This might be achieved by bootstrap sampling of the reported landings data, preferably on a species-specific basis. There also needs to be some evaluation of the assumption that available landings declarations are representative of all license holders. One possible approach would be to examine fishery returns from long-term license holders who have only recently submitted logbook records. If this subset of records is representative of the whole it would be reasonable to suppose that the calculated expansion factors are not biased.

The RP also recommends exploration of alternative approaches to estimating total landings and fishing effort directed at queen conch. These might include randomized sampling of catches at

landing sites, aimed at statistical estimation of landings quantities that might circumvent the possible biases involved in expanding incomplete log-book records. Another approach that could be considered is the use of internet forms to allow fishers to enter catch and effort data directly. In this context it is worth emphasizing the desirability of developing partnerships with local fishers to collect data and to conduct research.

Recreational Fishing

In common with other species, the recreational catch of queen conch may be considerable. Recreational fish catch estimates for Puerto Rico are available for 2000 onwards, but unfortunately conch and other invertebrates were not included in the MRFSS. Based on a one-off survey in 2000, recreational catches of conch were estimated to be at a level of about a third of the commercial landings by Puerto Rico in 2000-20011, i.e. around a quarter of the total landings. Clearly, the recreational catch of queen conch is an important omission from the Puerto Rico total landings data for other years and from the USVI total landings data in all years2. Furthermore, it is difficult to interpret even relative trends without more information on the variability of recreational effort between years3. The DW made the following recommendations relevant to recreational fishing for queen conch:

DW5) Conduct surveys to estimate the magnitude of the U. S. Virgin Islands recreational landings for all species including conch and lobster. It is possible that using a Virgin Islands contractor would improve the likelihood of success of the survey.

DW6) Include conch and lobster in the MRFSS for Puerto Rico.

The RP strongly endorses these two recommendations for both Puerto Rico and USVI and considers that they should be given high priority in the immediate term. Information on total landings is crucial for calculation of ABCs and associated benchmark statistics. The RP further recommends that, in common with the expansion factors for commercial landings statistics (see above), the uncertainty around the current and future recreational landings estimates be investigated. The current figures for Puerto Rico can be regarded as indicative rather than definitive estimates, and the application of the same expansion factor to USVI is somewhat tenuous. Unlike the commercial landings, it would be unrealistic to suppose that 100% coverage of recreational landings could ever be achieved. This makes it important to characterize the uncertainty around all recreational landings estimates.

1 The figures appear to be derived from the observation that recreational catches during a 3 month period were at around 50% of the reported landings over the same period. No adjustment seems to have been made for differences in commercial reporting rates between years.
2 Tentative estimates for the USVI have been made for the same years, assuming that the same relationship exists with commercial landings (SFA Amendment, 2005).
3 The AW report also mentions a similar proportion of recreational landings (35% of commercial landings) for Puerto Rico in 1986, but this would be a slender basis from which to infer a constant proportional contribution over time.

Indices of Abundance

Both fishery-dependent and fishery-independent indices were examined by the DW. A number of recommendations were made on the analysis of CPUE, mainly concerning filtering of trip records and adjustment for reporting cleaned or uncleaned meat weights.

These recommendations were taken on board by the AW, but owing to the lack of relationship between conch density and the ability of commercial divers to catch their daily quotas the resulting indices were considered not to be informative of stock abundance. The RP agrees that under current fishing practices it is unlikely to be feasible to measure diver effort in any way that would allow calculation of CPUE values that are responsive to abundance changes. The RP considers that low priority should be given to further analyses of queen conch CPUE data, given the likelihood that fishery-independent stock indices will be used as the main source of information on stock status in the near future, but the situation might change if alternative effort measures could be devised and recorded. This does not, of course, mean that reduced emphasis should be placed on collecting reliable records on fishing effort. Examination of effort trends is an important component of monitoring for overall fishery 'health', and trends in effort directed at queen conch may in themselves be indicative of changes in abundance.

The DW provided additional recommendations on indices of abundance for species considered by SEDAR 14, of which the following are relevant to queen conch:

DW7) Fisheries-independent survey efforts currently rarely include stations in deep water, the preferred habitat of adult mutton snapper and adult yellowfin grouper. In addition, large aggregations of queen conch have been reported in deep water by commercial fishers. The group highly recommends the initiation and continued funding of such surveys. As trends can be regional in nature, the group highly recommends that such surveys be conducted throughout Puerto Rico and the US Virgin Islands.

DW8) The commercial landings data from Puerto Rico and the US Virgin Islands have been incompletely entered and a variety of problems are known to exist in those data. The group strongly recommends that every effort be made to resolve the problems with those data. This should include extensive meetings with port samplers and others familiar with the US Caribbean fisheries

DW9) The group recommends that tag-recapture studies of mutton snapper, yellowfin grouper, and queen conch be conducted in Puerto Rico and the US Virgin Islands to determine habitat utilization and movement of those species.

DW10) Ongoing long-term monitoring studies should be expanded spatially and include data useful for stock assessment, e.g. size-frequency and density information.

DW11) It is suggested that areas exploited by fishermen be compared to those areas where monitoring has been ongoing to further knowledge of essential habitat for these species and improve the design of monitoring efforts (i.e., ensure that monitoring is reflective of fished conditions).

DW12) The group encourages the collection and documentation, for this and future Caribbean assessments, of historical information for qualitative and/or quantitative comparisons of current conditions.

The RP agreed that all of these recommendations are valid for queen conch, with varying degrees of urgency, but more specific information is required on precisely what is needed and on the proposed methods of addressing them. Recommendation DW8 regarding commercial landings data should be clarified. The high priority that should be given to attempts to improve compliance with reporting requirements has already been noted above. However, the completeness of commercial fishing records is less of an issue in the context of abundance indices, principally because commercial CPUE is not informative as an index. It is nonetheless desirable to ensure that qualifying data for landings records are as comprehensive as possible, for example allowing the efforts of individual fishers to be followed. Significant progress with identifying improved measures of effort may change the priority of this recommendation.

Recommendations DW7, DW10 and DW11 are relevant to fishery-independent surveys, specifically visual surveys that generate habitat-specific queen conch density estimates that can be expanded to domain-wide stock abundance estimates. This assessment method is the most promising for queen conch stock assessments in the near future; the RP took the view that high priority should be given to expanding the spatial coverage and habitat coverage of the fishery-independent surveys with a view to improving the precision of stock abundance estimates. This type of assessment might also benefit from the inclusion of information on how fishing effort is distributed between areas of similar habitat, so that, for example, fishing intensity as well as habitat classification could be used to stratify the density estimates.

The RP agreed that tagging studies of queen conch should be conducted in both Puerto Rico and USVI. Recommendation DW9 relates to the use of tagging to determine patterns of movement and habitat utilization. The RP endorses this recommendation as a medium- to long-term priority, and further recommends that serious consideration should be given to tagging sufficient numbers of conch to allow conclusions to be drawn about population dynamics as well as movement patterns. Modeling of recaptures potentially allows estimation of, among other parameters, rates of both fishing and natural mortality. Even if large-scale, long-term tagging studies prove not to be feasible, short-term, intensive tagging experiments conducted alongside the fishery can be extremely informative, particularly if both commercial and experimental operations are used to generate recaptures and recoveries.

Recommendation DW12 relates to the collation of conch density estimates from different areas of the Caribbean experiencing varying levels of exploitation. Preliminary results of such an exercise constructed by the AW show considerable promise as an innovative approach to placing survey findings in the context of potential population benchmarks. The RP considered that progress with this approach is a high, short-term priority, and recommended that further attention be paid to the influence of habitat type and stock structure (juveniles and adults) on the comparisons. The RP also took the view that the establishment of Marine Protected Areas in the waters of Puerto Rico and USVI holds potential for shedding light on unfished conch densities in the area. This might provide an improved basis for calculating a Bmsy proxy than comparisons with quasi-unexploited densities in other areas of the Caribbean. The AW suggested that conch

densities measured around Puerto Rico are below the 'Allee effect limit', this being the threshold below which reduced reproductive output may be expected based on studies in the Bahamas. The RP recommends examination of whether the mean conch densities reported are representative of effective local densities that may exist in patches, hence whether Puerto Rico conch stocks are in fact reproductively compromised to the extent shown. This would need to be addressed before precautionary advice could be offered on the basis of such evidence.

Recommendations of the Assessment Workshop

The AW rejected the use of production (biomass dynamic) models for assessing Puerto Rico queen conch stocks, on the grounds that landings data are incomplete, lacking particularly the recreational component, and that CPUE data do not effectively index stock abundance. Similarly, for reasons stated above, diver CPUE data alone cannot be used to infer trends in stock abundance. The RP agreed with these conclusions and with the decision of the AW to concentrate primarily on fishery-independent surveys. The RP further recommended that stock assessments based on primarily on fishery-dependent data should not be attempted until it can be demonstrated that landings data are complete and that there are informative indices of stock abundance.

The AW compiled the following list of research recommendations for queen conch:

AW1) The efforts to analyze the available data were greatly enhanced by the presence of local fishers and agency representatives. However, there was no local representative from the USVI Division of Fish and Wildlife assigned to the meeting, while the Puerto Rico representative could not attend the full term of the meeting. There must be greater buy-in from the local agencies such that knowledgeable representatives are present for the full term of the meeting. Greater efforts should be made to attract the participation of local fishers.

AW2) Data from past density surveys should be re-analyzed so that values can be expanded on the basis of both habitat and depth, including confidence limits. Habitats should be matched to those available for existing/planned habitat maps. As a sub-portion of this, the data for the Puerto Rico 1986 survey should be entered into electronic and GIS formats. This could be done using NOAA's Data Rescue funds.

AW3) Expansion factors for both Puerto Rico and the USVI should be calculated for conch fishers only.

AW4) Assessment of the spatial and temporal variations and dynamics of the resource, fishery, habitat and species interactions would be greatly enhanced if traditional ecological knowledge were obtained from fishers. Efforts should be made to incorporate fishers into the process, particularly using NOAA's CRP funds.

AW5) The impact of the recreational fishery is unknown and must be quantified.

AW6) Considering the established and potential value of resource surveys, mechanisms should be identified to increase their aerial coverage.

AW7) More detailed spatial expansions of survey densities should be planned in preparation of the 2010 Conch Update. For this, significant improvements in available data and analyses are required, including but not limited to the following:

A Detailed bathymetry data for PR and USVI
B Analysis of the impact of closed areas
C Inclusion of more detailed habitat maps for the PR western platform currently in progress
D Quantified size/age structure of the exploitable stock.

AW8) The only estimate to date of fishing mortality came from a tagging study in the 1980s. New tagging studies should be initiated to quantify rates of exploitation. This would allow existing SPR models for conch to be used in assessments.

AW9) Another issue remaining is to investigate the potential impact of very old conch in deep refuges, especially with respect to reproduction, coupled with studies to age very old conch. Such refuges may be substation off St. Thomas/St. John, in patches in Puerto Rico and potentially in protected areas on all three platforms.

AW10) Inter-sessional data evaluation workshops for CFMC managed species or species complexes should be conducted by the Council so that SEDAR level analyses are limited to those where data are sufficient to warrant such an analysis.

AW11) There needs to be a complete review of the potential data collection programs, including commercial and recreational catch, bio-statistical sampling and fishery independent surveys for Puerto Rico and US Virgin Islands with the purpose of identifying what relevant information could be obtained and modifying sampling procedures accordingly, including the identification of key economic and ecological indicator species.

The RP was supportive of all recommendations in this comprehensive list, several of which re-iterate suggestions by the DW. The RP draws particular attention to recommendations AW2, AW6 and AW7 which provide specific comments on improving and extending the existing fishery-independent surveys and their analyses. Recommendations AW3, AW5 and AW11 relate to improved collection of commercial and recreational fishery statistics, the importance of which has already been emphasized above. The DW suggested tagging studies to examine patterns of movement and habitat utilization; recommendation AW8 suggests extending tagging studies to examine exploitation rates. The RP endorses this recommendation as a priority for the medium-to long-term, with the suggestion that the feasibility of small-scale intensive tagging experiments be examined in addition to more extensive experiments.

Recommendation AW9 is for investigation of the reproductive contribution of very old conch in deep water refuges. Given the implications for spatial management of the resource, and the context this would supply for interpretation of assessment outcomes in relation to potential population benchmarks, this recommendation should be prioritized for the medium term.

The AW made two recommendations (AW1 and AW10) relevant to future queen conch stock assessment meetings. The RP notes recommendation AW10 to conduct inter-sessional data

evaluation workshops. Given the current lack of a definitive stock assessment for conch the RP considers data evaluation workshops to be a high priority and recommends that the next workshop be held within the next 3 years to maintain impetus particularly on improvements to fishery monitoring and resource surveys. The time-scale for future stock assessments would be dictated by the progress demonstrated at these inter-sessional workshops.

SEDAR 15: South Atlantic Red Snapper, South Atlantic Greater Amberjack, and Florida Mutton Snapper Review

South Atlantic Red Snapper

Data Workshop

Life History Workgroup

1) Use new technology such as recent advances in genetics techniques (microsatellite multiplex panels; see Saillant and Gold (2006)) to reinvestigate the stock structure and estimate the effective population size of red snapper in the Gulf of Mexico and along the Atlantic coast.

2) Obtain better estimates of red snapper natural mortality and release mortality in commercial and recreational fisheries.

3) Investigate life history of larval/juvenile (age 0 and 1) red snapper, as little is known.

4) All future age assessments (any species) should include assessment of otolith edge type. Classification schemes for edge type and quality of the otolith/section have been developed by the MARMAP program (Table 2.1). These classifications are currently used by MARMAP and NMFS Beaufort.

5) Continue to conduct inter-lab comparison of age readings from test sets of otoliths in preparation for any future stock assessments.

6) Obtain adequate data for gutted to whole weight conversions a priori (before stock assessment data workshop).

7) Strategies for collection of ageing parts vary for estimations of age composition and von Bertalanffy growth parameters. Typically, small specimens from fishery independent sampling are needed to produce good estimates of von Bertalanffy parameters.

Commercial Workgroup

The following research recommendations were developed by the Working Group:

- Still need observer coverage for the snapper-grouper fishery
  - 5-10% allocated by strata within states
  - possible to use exemption to bring in everything with no sale
  - get maximum information from fish
- Expand TIP sampling to better cover all statistical strata
  - Predominantly from Florida and by H&L gear
  - In that sense, we have decent coverage for lengths
- Trade off with lengths versus ages, need for more ages (i.e., hard parts)

• Workshop to resolve historical commercial landings for a suite of snapper grouper species

– Monroe County (SA-GoM division)

– Species identification (not an issue with red snapper)

Recreational Workgroup

Six years of concurrent RDD and FHS effort estimates for east Florida need to be compared for adjusting effort estimates in for-hire mode for future assessments. This has been done in the Gulf for six years of concurrent data and resulted in significant changes to landings estimates for red snapper in the Gulf of Mexico assessment (SEDAR 7).

The PSE's for MRFSS estimates for reef-fish species continue to be high in the south Atlantic region, in spite of increased sample sizes implemented in recent years. The workgroup recommends evaluating recreational fishery survey data to study the relationship between sample size (both angler intercepts and effort interviews) and precision of annual catch estimates of reef-fish species at the sub-region and state levels to determine what sample sizes are needed to obtain minimum PSE levels of 20% or less.

Better geographic definition for estimated effort and catch are needed for red snapper in the south Atlantic. Red snapper are considered rare north of Cape Hatteras, NC. In Florida, red snapper are abundant in northeast Florida and less common in southeast Florida; however, private boat mode estimates are for the entire Florida east coast. The FHS stratifies east Florida into two subregions for better precision. Monroe County is a separate sub-region in the for-hire survey, but for private boat mode, MRFSS estimates effort and landings for the entire Gulf Coast of Florida, which included Monroe County. There is currently no way to separate Monroe County landings by Atlantic and Gulf waters in either the MRFSS or FHS. In addition to finer geographic scales, more detailed information on location of catch are needed from angler interviews. Currently, the MRFSS and FHS only delineate if fishing occurred in inland, state, or federal waters with no further detail on area fished or depth.

These issues come up repeatedly in data work shops and stock assessments for other species, and a finer scale stratification for data collection and sample distribution with more detailed area fished information should be pursued in efforts to refine and improve recreational data collections at the national level, which are currently underway.

Indices Workgroup

1. Develop a method to correct for red snapper that are misclassified or unclassified on a trip-by-trip basis.
2. Expand existing fishery independent sampling and/or development new fishery independent sampling of red snapper population so off the southeastern U.S. Two ideas discussed were the following:

   − Adding gears to MARMAP that are more effective at catching red snapper

   − Developing coast-wide sampling of larval and juvenile abundance

3. Examine how catchability has changed over time with increases in technology and potential changes in fishing practices. This is of particular importance when considering fishery dependent indices.
4. Investigate potential density-dependent changes in catchability.
5. Examine possible temporal changes in species assemblages. Such changes could influence how the Stephens and MacCall method is applied when determining effective effort.
6. Continue and expand the "Headboat at Sea Observer Survey". This survey collects discard information, which would provide for a more accurate index of abundance.

Assessment Workshop

No research recommendations were reported for the Assessment Workshop

Review Workshop

The Review panel responded to Term of Reference 9:

> 9. Review the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment.

The RP supports the recommendations of data workshop. Of the recommendations provided in the report, the most critical priority for stock assessment is establishment of a fishery independent index. This could best be accomplished by adding gears to the MARMAP survey that are more effective at catching red snapper.

Other important recommendations are:

- Quantifying release mortality and length/age structure of discards, for instance by expanding the "Headboat at Sea Observer Survey."
- Using consistent otolith ageing assumptions.
- Assessing the degree to which catchability has changed over time.
- Improving data collection protocols.

The recommendation to analyze stock structure using microsatellite genetic techniques, while good science, is probably less important to improving the current assessment.

The panel felt that the procedure for choosing the weights in the likelihood function might be improved and recommends that a more rigorous protocol be investigated to avoid criticism of subjectivity.

Bayesian methods should be considered for inference on uncertainty. These methods would allow priors on steepness, natural mortality, and other parameters to be chosen in order to quantify uncertainty in stock status and benchmarks. These additional procedures will require adequate time being afforded to assessment scientists to develop the appropriate tools.

In order to be able to measure an improvement in the stock, the next assessment would need to be conducted some years (5 perhaps) after any new management measures are introduced. This

implies an interval of about 6-7 years before the next assessment. If managers are particularly concerned about the status of the stock, then a shorter interval of 3 years might be considered to check whether any further deterioration has occurred, but this would not be a sufficiently long time interval to be able to detect the efficacy of management measures.

South Atlantic Greater Amberjack

Data Workshop

Life History Workgroup

1) Use new technology such as satellite pop-up archival tags and recent advances in genetics techniques to reinvestigate the mixing rate between greater amberjack in the Gulf of Mexico and those in the waters along the Atlantic coast of the southeastern U.S. Such research will also provide insight into post-release survivorship, migratory patterns, and spawning locations.

2) All future age assessments (any species) should include assessment of otolith edge type. Classification schemes for edge type and quality of the otolith/section have been developed by the MARMAP program at SCDNR (Table 2.3). These classifications are currently used by MARMAP and NMFS Beaufort.

3) Conduct inter-lab comparison of age readings from test sets of otoliths in preparation for any future stock assessments.

4) Obtain adequate data for gutted to whole weight conversions a priori (before stock assessment data workshop).

5) Obtain better estimates of greater amberjack natural mortality and release mortality in commercial and recreational fisheries.

6) Strategies for collection of ageing parts vary for estimations of age composition and von Bertalanffy (VB) growth parameters. Typically, small specimens from fishery independent sampling are needed to produce good estimates of VB parameters.

7) Investigate life history of larval/juvenile (age 0 and 1) greater amberjack, as little is known.

Commercial Workgroup

The following research recommendations were developed by the Working Group:

- Still need observer coverage for the snapper-grouper fishery
  - 5-10% allocated by strata within states
  - possible to use exemption to bring in everything with no sale
  - get maximum information from fish
- Expand TIP sampling to better cover all statistical strata
  - Predominantly from Florida and by handline gear
  - In that sense, we have decent coverage for lengths

• Trade off with lengths versus ages, need for more ages (i.e., hard parts)
• Workshop to resolve historical commercial landings for a suite of snapper-grouper species
  – Monroe County (SA-GoM division)
  – Species identification is a major issue with amberjack

Recreational Workgroup

Six years of concurrent RDD and FHS effort estimates for east Florida need to be compared for adjusting effort estimates in for-hire mode for future assessments. This has been done in the Gulf for six years of concurrent data and resulted in significant changes to landings estimates for red snapper in the Gulf of Mexico assessment (SEDAR 7).

The PSE's for MRFSS estimates for reef-fish species continue to be high in the south Atlantic region, in spite of increased sample sizes implemented in recent years. The workgroup recommends evaluating recreational fishery survey data to study the relationship between sample size (both angler intercepts and effort interviews) and precision of annual catch estimates of reef-fish species at the sub-region and state levels to determine what sample sizes are needed to obtain minimum PSE levels of 20% or less.

Better geographic definition for estimated effort and catch are needed for greater amberjack in the south Atlantic. There is currently no way to separate Monroe County landings by Atlantic and Gulf waters in either the MRFSS or FHS. Private boat estimates for Monroe County must be post-stratified from west Florida estimates. In addition to finer geographic scales, more detailed information on location of catch are needed from angler interviews. Currently, the MRFSS and FHS only delineate if fishing occurred in inland, state, or federal waters with no further detail on area fished or depth. These issues come up repeatedly in data work shops and stock assessments for other species, and a finer scale stratification for data collection and sample distribution with more detailed area fished information should be pursued in efforts to refine and improve recreational data collections at the national level, which are currently underway.

Indices Workgroup

1. Develop a method to correct for greater amberjack that are misclassified or unclassified on a trip-by-trip basis.

2. Expand existing fishery independent sampling and/or development new fishery independent sampling of greater amberjack population so off the southeastern U.S. Two ideas discussed were the following:
  − Adding gears to MARMAP that are more effective at catching greater amberjack
  − Developing coast-wide sampling of larval and juvenile abundance

3. Examine how catchability has changed over time with increases in technology and potential changes in fishing practices. This is of particular importance when considering fishery dependent indices.

4. Investigate potential density-dependent changes in catchability.

5. Examine possible temporal changes in species assemblages. Such changes could influence how the Stephens and MacCall method is applied when determining effective effort.

6. Continue and expand the "Headboat at Sea Observer Survey". This survey collects discard information, which would provide for a more accurate index of abundance.

Assessment Workshop

No research recommendations were reported for the Assessment Workshop

Review Workshop

The Review panel responded to Term of Reference 9:

9. Review the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment.

The DW and AW made numerous recommendations regarding further research that might improve future assessments of mutton snapper. The review panel supports those recommendations, and in particular endorses the following:

- Collection of specimens for maturity analysis. After selection criteria had been applied to select an appropriate subset of potential samples, only 32 specimens were available to estimate the maturation schedule for the current assessment,
- Continued monitoring of discards in the commercial and recreational (headboat) fisheries to estimate magnitude and size frequency of discards is endorsed.
- Continuation of the various fishery independent surveys was recommended by the DW. The panel endorses this recommendation, but notes that the current surveys generally encompass only a portion of the habitats and regions of the mutton snapper stock, which may limit their utility for stock assessment. A fishery independent survey that encompasses the range of the stock would have greater value for stock assessment than a multitude of surveys that each are limited in geographic range.

The review panel noted the limited flexibility of the age-structured model (ASAP) used for the mutton snapper assessment and recommends that a more flexible age-based model be used in

future assessments. Particular functionality that was missing from the ASAP model includes: ability to model both asymptotic and dome-shaped selectivity; ability to fit length frequency data directly; ability to fit longer time series of data; and, ability to initialize the population assuming a constant historical exploitation rate. The RP encouraged the continued development of ASAP as it provides an accessible software platform that can be used by a wide range of users.

Florida Mutton Snapper (SEDAR 15A)

Data Workshop Research Recommendations

Life History Workgroup

The biology of Lutjanus analis during reproduction remains perhaps the greatest unknown in the life-history of this species. Despite its relatively large body size, exploited status, and gregarious nature during reproduction, the behaviors, location, and sources of individuals of spawning aggregations in Florida and the greater Caribbean remains elusive. Seasonal migration patterns are completely unknown and based on speculation. Primary habitats used by this species during various stages of its ontogeny are undefined. This information would reveal the dependence of the Florida population on various habitats and locations, e.g., a given spawning location; critical information since models have revealed that contributions to the Florida population of L. analis in the form of larvae from outside southern sources is minimal (Paris et al. 2005), and that the Florida population is biologically "on its own". Because of the aforementioned difficulties and differences in staging criteria, we recommend further review of the maturity data from Tequesta and the Florida Keys, and Puerto Rico before accepting the size- and age- at-maturity values from the regressions reported here.

Commercial Workgroup

Increasing the dockside sampling of commercial catches, particularly for the longline and bandit rig fisheries will be important to monitoring the size of fish, areas and depths fished, and fishing effort for this species and other reef fish. The scarcity of otoliths in the earlier portions of the sampling time series restricts the amount of age information that could be used for assessments, and we suggest placing more emphasis on sampling otoliths for this and other reef species to aid future age-structured stock assessments. There is also a need for increasing the amount of discard information (either at-sea or from logbooks) and discard mortality data in modern stock assessments, including this species. Few discards of mutton snapper were actually noted in commercial fishermen‟s logbooks, and perhaps the number of fish discarded by commercial fishermen is really low. However, the relatively low frequency of discard logbooks assigned to fishermen may have also been a factor in the low number of discard records provided. Mutton snapper tend to be caught in low numbers with other reef fish species, and relatively few commercial fishing trips actually appear to target this species.

An examination of the conversion factors used to convert landed weight to whole weight should be undertaken. A comparison of the regressions in Life History Section II (Table 2.12) for gutted weight and whole weight would appear to suggest a lower percentage difference between gutted weight and whole weight at comparable sizes, perhaps as low as 2-5% rather than the 11%

currently used for all snappers. However, at this time, there is not enough data to allow a direct comparison of gutted weight to whole weight and derive a suitable conversion factor and the differences suggested would be small and perhaps negligible for the stock assessment.

Ultimately, if allocation between the various sectors of the fishery for mutton snapper and other reef fish are contemplated, conversion factors may become more of an issue.

There were differences noted in the commercial fisheries landings data between the ALS system, the General Canvass data, and the FWC trip ticket data. These differences should be reconciled so that each system will provide comparable numbers where appropriate.

Recreational Workgroup

Biological sampling of recreational landings in Florida has been funded on the West Coast of Florida, including Monroe County, since 2000, but continues to remain unfunded on the East Coast of Florida. Improved biological data collections are essential for making use of the best stock assessment models currently available, and the Recreational Data Working Group recommends funding and implementation of biological data collections in the shore, private boat, and for-hire modes on the east coast of Florida. The Recreational Data Working Group recommends continued funding for discard data collection and improved data collections on depth and area fished in the Headboat At-Sea Survey in Florida. Data on discarded catch is particularly important for size and bag regulate species, such as mutton snapper. The Working Group also recommends better data collection for area and depth fished in the MRFSS. Depth and area fished are particularly important for calculating depth and area-dependent discard mortality rates for reef fish species, such as mutton snapper, that are found in progressively deeper habitats throughout their life history.

Indices Workgroup

GENERAL recommendations: Explore night fish data! No data taken at night by anyone!

Assessment Workshop Research Recommendations

Life History

The maturity analysis used in this assessment was based on only 32 fish. A study should be designed to collect mutton snapper for age and gonad samples at spawning sites during the spawning season. This would entail a multi-year study to identify the diurnal usage patterns at spawning sites during year and to collect gonad samples for histological examination. To maintain quality and ensure consistency among readers, a set of training histological slides should be developed.

Dependent Data Collections

It is essential that adequate numbers of aging structures be collected from all sectors of the fishery from all regions. A weakness of the assessment was the paucity of age samples in the 1980s and early 1990s.

Review Workshop Research Recommendations

The Review Panel replied to Term of Reference 9.

> 9. Review the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment.

The DW and AW made numerous recommendations regarding further research that might improve future assessments of mutton snapper. The review panel supports those recommendations, and in particular endorses the following:

- Collection of specimens for maturity analysis. After selection criteria had been applied to select an appropriate subset of potential samples, only 32 specimens were available to estimate the maturation schedule for the current assessment,

- Continued monitoring of discards in the commercial and recreational (headboat) fisheries to estimate magnitude and size frequency of discards is endorsed.

- Continuation of the various fishery independent surveys was recommended by the DW. The panel endorses this recommendation, but notes that the current surveys generally encompass only a portion of the habitats and regions of the mutton snapper stock, which may limit their utility for stock assessment. A fishery independent survey that encompasses the range of the stock would have greater value for stock assessment than a multitude of surveys that each are limited in geographic range.

The review panel noted the limited flexibility of the age-structured model (ASAP) used for the mutton snapper assessment and recommends that a more flexible age-based model be used in future assessments. Particular functionality that was missing from the ASAP model includes: ability to model both asymptotic and dome-shaped selectivity; ability to fit length frequency data directly; ability to fit longer time series of data; and, ability to initialize the population assuming a constant historical exploitation rate. The RP encouraged the continued development of ASAP as it provides an accessible software platform that can be used by a wide range of users.

SEDAR 16: South Atlantic and Gulf Of Mexico King Mackerel

Data Workshop Research Recommendations

Life History Working Group

1) Examine population connectivity throughout the Gulf and S. Atlantic using otolith elemental and stable isotope signatures of age-0 fish as natural tags of various regions. Otolith signatures of juvenile king mackerel collected in various resource surveys should first be examined to determine if population- or region-specific differences exist in otolith signatures, although success seems likely given the degree of classification success seen in adult mackerel whose otolith chemical signatures are integrated over several years of life, thus adding greater variance to their signatures. Once signatures are determined, the chemistry of adult cores could be sampled to examine interregional mixing between purported migratory groups (populations) in the Atlantic, eastern Gulf, western Gulf, and even Mexico.

2) Investigate and quantify mixing between eastern Gulf and western Gulf populations. The magnitude of the Mexican landings in comparison to U.S. landings from the GOM unit indicate clarification of this issue should be a priority for future assessments (see SEDAR16-DW-31).

3) Investigate / estimate the vulnerability of western Gulf fish to overfished Mexican fisheries in winter (Chavez and Arreguin-Sanchez 1995).

4) Conduct studies and monitoring that will allow estimation of natural mortality.

5) Review sampling procedures for age, length, and weight of king mackerel for both commercial and recreational fisheries to identify possible sampling biases.

6) Determine the impact of the quota sampling methodology, typically used for king mackerel in the TIP program, on growth parameter and age composition estimates; and explore methodologies for removing this potential bias.

7) Investigate the feasibility of switching from the current quota sampling design to random sampling of major strata.

8) Establish uniform, clear, consistent age and size sampling protocols.

9) Continue holding ageing workshops and training to standardize techniques and increase the ageing precision among laboratories.

10) Increase age sampling in South Carolina and Georgia and length sampling north of Florida in the Atlantic.

11) Increase sampling effort in the western Gulf (Louisiana, Texas, and Mexico) for otoliths and lengths of landed catch. Currently, there are very few samples being collected for this important component of the fishery, thus there are few data to parameterize the king mackerel population and fishery in the western Gulf.

12) Try to recover and include age and size data from Collins et al. (1989) Atlantic age and growth study in the next stock assessment of Atlantic king mackerel.

13) For the sake of standardization, request the Texas Parks and Wildlife Department to measure fork length on king mackerel in the future.

14) Establish clear priorities for added reproductive information as expanded work would involve considerable costs for a long-term sampling program.

15) If made a priority, more precisely determine 1) the extent of hydration that can be determined via routine observations in the field and 2) the timing of this phase relative to final oocyte maturation and spawning and 3) calibration of the degeneration of post-ovulatory follicles. This is needed to account for and correct a likely bias in spawning frequency estimates.

16) If made a priority, design and implement a reproductive sampling program (in concert with age sampling) on an annual basis that expands and intensifies spatial and temporal coverage (particularly adding the western Gulf of Mexico). A goal would be to provide annual estimates of spawning frequency. This would include regular training of port agents and scientific observers in macroscopic methods and additionally include a quality control component of random sub-sampling for histological comparisons.

Commercial Statistics Working Group

Consistent and sufficient levels of observers are needed aboard shrimp vessels in both the Gulf of Mexico and the South Atlantic. The South Atlantic shrimp fishery has been woefully under sampled.

The Mackerel Stock Assessment Panel reports should be reviewed for information on the Mexican fishery.

Cooperative research with Mexican scientists is needed to understand the relationships between king mackerel exploited in Mexican and U. S. waters. Additionally participation of Mexican scientists is needed in the assessment process (both accumulation and interpretation of data as well as assessment) to better understand the linkages and the Mexican fisheries.

Recreational Statistics Working Group

There is a need to characterize and quantify tournament effort and catch. It is recommended that tournaments be required to register and provide at least basic information (similar to that provided for the billfish survey). This basic information should include all catch (including releases and kept fish, whether or not they are submitted for weighout). The preferred approach would be to develop a program by which detailed trip information is collected from participating fishermen.

Future recreational fishery surveys should collect information about tournament participation in both effort and intercept components. These surveys should also include Texas fisheries in the geographic coverage, as the existing separate surveys are not comparable (which is problematic for the assessments).

Observer surveys should collect information on the initial condition of released fish. Research on post-release mortality should be encouraged. The Headboat Observer program provides useful information and should be continued.

Expand existing efforts to collect length-age samples to more completely cover the geographic range of the stocks.

Indices Of Abundance Working Group

The index working group recommends that:

1) Fisheries Independent sampling efforts should continued and be expanded, with increased emphasis on created fisheries-independent surveys in the South Atlantic.

2) Current fisheries independent surveys sample mostly Ages 0 and 1. Programs should be developed or expanded to obtain fisheries independent abundance estimates for older king mackerel (Ages 2+) more commonly landed by the directed fisheries. These programs should not impact current fisheries-independent survey methodologies.

3) An effort should be made to estimate changes in catchability. Previous SEDAR assessments of other species have used a linear increase in catchability. Assessment model results are likely to be sensitive to the functional shape and magnitude of the change in catchability. However, these functions are not well understood.

4) Research into methods to directly accommodate regulatory changes (i.e. bag limits and trip limits) within index standardization procedures is greatly needed. A possible technique to address changes in bag/trip limits is the truncated negative binomial distribution. This technique will be examined in the future to determine its applicability to fisheries dependent indices of abundance.

5) Research to incorporate environmental variables into CPUE indices is also of potential importance.

Assessment Workshop Research Recommendations

1. Increase observer coverage in the South Atlantic shrimp fishery to get a more accurate representation of king mackerel discard rates.

2. Increase commercial sampling of king mackerel in North Carolina, especially for the gill net fishery in the northeast region.

3. Determine whether separate stocks exist in the eastern and western portions of the GOM.

4. Determine the relationship of king mackerel off the coast of Mexico with U.S. king mackerel stocks. Given the magnitude of king mackerel landings off the coast of Mexico, this could have a large impact on the Gulf of Mexico king mackerel fishery in US waters. It could also provide a more complete evaluation of parameters such as stock size, for some or all migratory groups. Other fisheries may also be significant, such as any Cuban fisheries on the stocks.

5. Obtain detailed commercial and recreational landings information, discard information, and biological samples (age, length, weight, sex, fecundity, etc.) from king mackerel off the coast of Mexico if US king mackerel stocks are found to intermix with Mexican stocks.

6. Continue or begin research programs that conduct tagging studies, otolith microchemistry and shape analysis studies, and gather microsatellite genetic marker data to determine mixing rates of king mackerel off of south Florida during the winter months. A longer time series documenting stock composition data in the mixing zone is needed to increase the accuracy of the SS3 model.

7. Continued evaluation of tag data, ongoing otolith microchemistry and shape analysis studies, and microsatellite genetic marker data to improve estimation of stock structure and mixing proportions.

8. Investigate a method for correcting the reporting bias associated with the commercial logbook index for the South Atlantic.

9. Improve the SS3 model so that it allows for uncertainty in the landings and does not require that estimated landings match the input landings data exactly (e.g., incorporate CV estimates from MRFSS landings), the Hessian can be inverted, estimates of uncertainty can be provided, and stock-specific management benchmarks can be produced.

10. Investigate differences in total headrope lengths of nets, along with other possible estimates of fishing power per vessel, in the function used to estimate shrimp bycatch and consider these in the GLM analysis.

Review Panel Research Recommendations

The assessment and data workshops have identified the most important research required to improve the assessment. Those areas of research requiring highest priority as well as some additional research are outlined below, based on the need to appreciably improve the reliability of future assessments. Where possible, this research should be completed for the next assessment.

The RW emphasized the importance of the Mexican catches. This was addressed by the AW's recommended research, to determine whether separate stocks exist in the eastern and western portions of the GOM and the relationship of king mackerel off the coast of Mexico with U.S. king mackerel stocks (DW 2 & 3; AW 3, 4 & 5). The RW considered these a priority.

An objective procedure to justify the choice of steepness value used for king mackerel modeling is required. This may be either from best fits to available data, or choice of appropriate values for similar species from a meta-analysis. It should also be investigated whether improved behavior at lower steepness values could be achieved by fitting the SR curve through an equilibrium point, rather than by limiting maximum recruitment. This applies both to reference point calculation and projections.

The RW was concerned with the accuracy of the available abundance indices. With the exception of the research to remove the suspected bias in the log-book data (AW 8), no recommendations on improving the abundance indices were made by either the DW or AW. Given the problems with the indices, research should include identifying methods which might improve collection and standardization of data used for this purpose. In particular, the RW believed that improved stock-wide fishery independent indices may be required to carry out control to the level of precision implied by management. It is also important that the commercial logbook index constructed for the Atlantic stock unit is used if possible in future assessments.

The RP recommended that the behavior of the current control rules that use per recruit $F_{30\%SPR}$ values be investigated using simulation, to ensure that they achieve management objectives as expected. A useful framework for this form of testing is known as management strategy evaluation that includes an operating model of fish population dynamics (using various plausible scenarios), fisheries scientific sampling from the population with error, fishing fleet operations and catch, stock assessment and management action as simulation components (e.g. see ICES Marine Science Symposia, 1999).

The RP endorses the AW recommendation that the discrepancy between the two programming codes R and SAS that were used in SEDAR5 and SEDAR16, respectively for estimating shrimp trawl bycatch be resolved.

If the development of the SS3 model is to continue, research programs are required that improve monitoring of the stock mixing. These include tagging studies, otolith microchemistry and shape analysis studies, and the collection of microsatellite genetic marker data to determine mixing rates (DW 1; AW 6 & 7).

Otoliths from the mixing zone need to be evaluated with shape or elemental analyses in order to assign them to one of the two stocks for use in future assessments.

The size and age maturity functions should be updated as the most recent estimates are over 20 years old.

Either the intensity of sampling for fecundity should be greatly increased, or else weight-at-age of mature fish should be used as a proxy for spawning potential.

Procedures should be investigated for incorporating uncertainty and assign utility across model structures into ABC and stock condition calculations. Most of the uncertainty in assessment outcomes is between alternative plausible model structures.

An important uncertainty for the GOM stock is whether a series of recent good recruitments that appear in some indices will contribute in the medium term to increase stock biomass of fish of a size targeted by the commercial and recreational sectors. It will take two to three years for these fish to enter the fishery and for a stock assessment to determine what the impact of those recruitments really is. Therefore, the RP recommends that an update assessment be conducted in two to three years.

The SEDAR Steering Committee should investigate the methodology currently used by the National Hurricane Center to develop consensus forecast models from varied different forecast models to determine if a similar approach is suitable for in improving estimates of stock status and medium term management forecasts with more realistic estimates of uncertainty than can be gained from an examination of internal variability within a single model.

Comments Received Regarding the SEDAR Process

The Panel strongly recommends that a serious effort be made to fill data gaps (e.g., better designed larval surveys, data to improve stock identification, etc.) and notably to ensure a full coverage of the stock in time and space using methods suited to measuring pelagic fish abundance, such as larval, egg production or acoustic surveys. At present levels of survey effort, the assessment results are unlikely to be precise enough to allow the Management Councils to

implement the management procedures currently under discussion (such as setting ABCs for several years in the future on the basis of medium-term projections).

The RP recommended that the behavior of the current control rules be investigated using simulation, to explore whether (and if so, how) the management objectives can be attained using the information available.

The RP had concerns as to the appropriateness of assessing a resource that is apparently migratory and trans-boundary in nature in a national assessment and management structure. This is relevant as the absence of Mexican catch data is a critical source of uncertainty in terms of stock levels and selectivity; better information of the Mexican catch is needed.

The evaluation of the SEDAR workshops in addressing their terms of reference are in Tables 8.1 and 8.2. Overall, the workshops have conducted their work very conscientiously. They have clearly been professional and addressed almost all of the ToRs as well as might be expected. However, not all terms of reference were fully addressed.

The data workshop is required to "Evaluate the degree to which available indices adequately represent fishery and population conditions." (ToR 3) This was certainly done at a sampling / statistical level, but guidance was limited on how well these different indices reflect abundance.

The data workshop is required to "Provide maps of fishery effort and harvest." (ToR 4) These maps were not provided, although information on the spatial distribution of catch and effort was provided.

The assessment workshop ToR "Evaluate the results of past management actions and, if appropriate, probable impacts of current management actions with emphasis on determining progress toward stated management goals" was not met due to time constraints. However, the RP understand that the complexity of this task is very great and it is not feasible to be conducted in the time available.

Several data workshop ToRs (DW ToR 2, 3, 4) refer to "adequacy" of input information. The focus of the workshop was to provide the best information available, which is succeeded in doing. However, "adequacy" requires subjective judgment and is suitable for developing a base case assessment. What is also of interest to the assessment and review panels should be measures of uncertainty. Information helping identify the least reliable source of information among the catches, indices of abundance and size/age compositions or alternative inputs where "data" are estimated, might be used to develop alternative models to test for sensitivity. It should be noted that alternative models were suggested by the DW to test stock structure.

In the opinion of the RP, the AW TORs 6 and 8 contained inappropriate references to stock structure. Stock structure should be determined on scientific grounds, and is the prerogative of the DW and AW, based on the scientific evidence and expert opinion only. Other mechanisms should exist for determining how these resources are shared among stakeholders.

The RP recommended that SEDAR attempts to evaluate the effectiveness of past management actions, as this provides feedback control important to this sort of process. The management actions have been listed, but there have not been evaluations except in the sense of the impact on monitoring indices. SEDAR should also develop standardized procedures to guide AW on methodology and especially on the presentation of results. This should include for example:

- Standard residual plots including QQ plots;
- Fish stock parameters presented in a standard way, e.g. arithmetic mean across ages as recommended here;
- Results of plausible alternative model fits in the form of a decision table

SEDAR 17: South Atlantic Spanish mackerel and Vermilion Snapper

South Atlantic Spanish Mackerel

Data Workshop

Recommendations of the Life History Work Group

1. Ages provided for future assessments should be advanced when appropriate (i.e., during months when annuli are being formed) so fish can be assigned to the correct year class. If advanced ages cannot be provided, data should include assessment of otolith edge type. Classification schemes for edge type and quality of the otolith/section have been developed by the MARMAP program at SCDNR and are currently used by MARMAP and NMFS Beaufort.

2. Conduct inter-lab comparisons of age readings from test sets of otoliths in preparation for any future stock assessments.

3. Obtain adequate data to determine gutted to whole weight relationships.

4. Investigate the discard mortality of Spanish mackerel in the commercial and recreational trolling fishery, commercial gillnet fishery, and the shrimp trawl fishery.

5. To ensure more accurate estimates of t0, increase efforts to collect age 0 specimens for use in estimating von Bertalanffy (VB) growth parameters.

Recommendations of the Commercial Work Group

1. Need observer coverage for the fisheries for Spanish mackerel (gillnets, castnets

2. (FL), handlines, poundnets and shrimp trawls for bycatch):
   - 5-10% allocated by strata within states
   - possible to use exemption to bring in everything with no sale
   - get maximum information from fish

3. Expand TIP sampling to better cover all statistical strata
   - Predominantly from Florida and by gillnet & castnet gears
   - In that sense, we have decent coverage for lengths

4. Trade off with lengths versus ages, need for more ages (i.e.,hard parts)

5. Need to address issue of fish retained for bait (undersized) or used for food by crew.(how to capture in landings)

Recommendations of the Recreational Work Group

There was insufficient time for this topic to be addressed by the workgroup during the data workshop.

Recommendations of the Indices Work Group

1. Expand existing fishery independent sampling and/or develop new fishery independent sampling of the Spanish mackerel population off the southeastern U.S.

Two ideas discussed were the following:

- Collect age samples from SEAMAP
- Fishery independent sampling of adults

2. Investigate whether catchability varies as a function of fish density and/or environmental conditions.

3. Investigate how temporal changes in migratory patterns may influence indices of abundance (for fishery dependent and fishery independent indices).

4. Investigate the possibility of using models that allow catchability to follow a random walk.

Assessment Workshop

Recommendations of the Assessment Panel

Comprehensive Data and Assessment Archive: A goal of the SEDAR process, as stated in several workshop Terms of Reference, is to properly document all aspects of the data employed in the assessments, the assessments themselves, and the peer review of assessment details and results. While the various workshop reports and data workbooks compile much of the information, concern has been expressed that a full compilation of data manipulations, and programs used to generate the final data used in the assessment is not available following a SEDAR cycle. The concept of a SEDAR Comprehensive Data and Assessment Workshops Archive was proposed by the SEDAR 17 Data Compiler during preparations for the DW. Though the idea was not advanced from the DW as a formal recommendation it was generally taken favorably. An archive could serve as: a single reference for anyone wishing to dig deeper into how data were processed, a reference for future assessments, a backup of final data processing programs or spreadsheets for those who develop them, and continuity in cases of personnel changes for future assessments and updates. When discussed at the AW it was recognized implementation of an archive could have benefits and costs, but that it would require more attention than SEDAR 17 AW participants could give it, and all SEDAR cooperators were not present. The AW recommends that a SEDAR-wide workgroup be convened to identify the pros and cons of a Comprehensive Data and Assessment Archive for each future SEDAR.

Independent Expert on Assessment Panel: The assessment panel recommends that for future SEDAR assessment workshops, a scientist experienced in assessment methods and

modeling (such as a CIE reviewer, or a NMFS or state person from outside the region) be provided as a workshop panelist. An independent expert can participate in discussing technical details of the methods used for SEDAR assessments, and assist in decisions related to model configuration during the workshop. In particular, the analysts believe that an independent analyst could contribute fresh information to improve the assessments.

Review and Qualification of Historic Recreational Angler Survey Reports: Pre-MRFSS catch and related effort data from south Atlantic recreational fisheries are very scarce, but are considered valuable to stock assessments, where available. Two reports of the U. S. Fish and Wildlife Service (SEDAR 17-RD13 and SEDAR 17-RD14) and one of the NMFS (SEDAR 17-RD15) characterize south Atlantic salt-water angling effort and success based on recall surveys conducted in 1960, 1965, and 1970, respectively. These references have been viewed in various ways in previous stock assessments performed through the SEDAR process. In SEDAR 2 for South Atlantic black sea bass, these data were not used explicitly in the age-structured modeling, however, with assumptions, were used to extend the time frame for application of the production modeling approach. In SEDAR 15 for South Atlantic red snapper these data were employed by the assessment panel at face value for the three survey years and to interpolate recreational landings before, between, and after survey years. In SEDAR 15 for South Atlantic greater amberjack the review panel agreed with the assessment panel that the survey estimates of recreational landings of "jacks" not be included in the assessment due in part to species identification concerns. For the present assessment the assessment panel has employed the survey data for both stocks under assessment, but considers recall bias on the part of persons surveyed to be a significant factor. Thus they chose to reduce the weight of the estimates in its base runs and explore the effect on the model through sensitivity runs.

A guiding principal of the SEDAR process is consistency in the identification and utilization of data that characterize fishery stocks under assessment and the fisheries that affect the stocks. Because the three pre-MRFSS saltwater angling survey reports have proven of value, and likely will be referenced in future stock assessments, the AW recommends they be reviewed by a group of fishery professionals. The group should include persons knowledgeable in survey design, data collection, and application of survey data to fishery stock assessments. The group's function would be to qualify the three surveys, and others which the group may identify, and provide guidelines that further consistency in their utilization in future stock assessment conducted under the SEDAR process. The review of these reports could be coupled with a review and qualification of commercial and other data to standardize their use in stock assessments, as recommended in the SEDAR 17 data workshop reports.

Avoid Brief Workshop Interims: The panel made a recommendation against scheduling abbreviated SEDAR stock assessments. AW participants felt that an abbreviated schedule could compromise the quality of the assessment.

Review Workshop

Research Recommendations of the Review Panel

In its review of DW research recommendations the RW noted the recommendation to increase samples should be accompanied by information on the methodology to determine adequate sample sizes for both length frequency and age samples. Some recommendations for future research related to indicators of population abundance were outlined; however, for those to be useful, a clear statement of the problem, research objectives, methodology and identification of groups and/or projects that could undertake such research should be specified. The RW noted that the DW provided useful recommendations regarding life history, commercial, and indices. However, some of these recommendations need to be more specific and deadlines and personnel assignments identified. The need of a fishery independent index of the adult population was mentioned but ways forward were not spelled clearly enough.

In its review of pre-AW changes in data, the RW noted estimation of shrimp bycatch data resulted in a highly variable time-series, which was not fully justified. Lack of consistency with historical data requires clarification. Better documentation of the shrimp bycatch estimation procedure would be useful. Pre-MRFSS catch estimates are not available, and data for the period 1950 – 1980 was extrapolated from 3 data points, which raised some concern. Research into estimating historical recreational catch should continue.

As to estimation of uncertainty in the SCA model, the RW states research into better methods to include the uncertainty in landings history is recommended.

South Atlantic Vermilion Snapper

Data Workshop

Recommendations of the Life History Work Group

1. Ages provided for future assessments should be advanced when appropriate (i.e., during months when annuli are being formed) so fish can be assigned to the correct year class. If advanced ages cannot be provided, data should include assessment of otolith edge type. Classification schemes for edge type and quality of the otolith/section have been developed by the MARMAP program at SCDNR and are currently used by MARMAP and NMFS Beaufort.

2. Conduct inter-lab comparisons of age readings from test sets of otoliths in preparation for any future stock assessments.

3. Obtain adequate data to determine gutted to whole weight relationships.

4. To ensure more accurate estimates of t0, increase efforts to collect age 0 specimens for use in estimating von Bertalanffy (VB) growth parameters.

Recommendations of the Commercial Work Group

1. Expand TIP sampling to better cover all statistical strata
   - Predominantly from Florida and by gillnet & castnet gears
   - In that sense, we have decent coverage for lengths

2. Trade off with lengths versus ages, need for more ages (i.e.,hard parts)

3. Need to address issue of fish retained for bait (undersized) or used for food by crew.(how to capture in landings)

Recommendations of the Recreational Work Group

There was insufficient time for this topic to be addressed by the workgroup during the data workshop.

Recommendations of the Indices Work Group

1. Investigate whether catchability varies as a function of fish density and/or environmental conditions.

2. Investigate how temporal changes in migratory patterns may influence indices of abundance (for fishery dependent and fishery independent indices).

3. Investigate the possibility of using models that allow catchability to follow a random walk.

Assessment Workshop

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A guiding principal of the SEDAR process is consistency in the identification and utilization of data that characterize fishery stocks under assessment and the fisheries that affect the stocks. Because the three pre-MRFSS saltwater angling survey reports have proven of value, and likely will be referenced in future stock assessments, the AW recommends they be reviewed by a group of fishery professionals. The group should include persons knowledgeable in survey design, data collection, and application of survey data to fishery stock assessments. The group's function would be to qualify the three surveys, and others which the group may identify, and provide guidelines that further consistency in their utilization in future stock assessment conducted under the SEDAR process. The review of these reports could be coupled with a review and qualification of commercial and other data to standardize their use in stock assessments, as recommended in the SEDAR 17 data workshop reports.

Avoid Brief Workshop Interims: The panel made a recommendation against scheduling abbreviated SEDAR stock assessments. AW participants felt that an abbreviated schedule could compromise the quality of the assessment.

Review Workshop

Research Recommendations of the Review Panel

The numerous research recommendations from the DW and AW were not explicitly discussed at the RW. Individual panelists reviewed the recommendations and were in broad agreement with the suggestions. However, there is a clear need for the recommendations to be prioritized. Also, the Panel recommended that a proper statistical framework be used for the catch-at-age models. This would allow alternative parameterizations to be evaluated in terms of AIC or some other statistical criteria, and the calculation of standardized residuals (which allows the appropriateness of relative data weightings to be judged).

The AW base model estimates that over-fishing is occurring and that stock size is close to the over-fished threshold. This suggests that the next assessment should be sooner than the normal timeframe for assessment updates.

SEDAR 18: ASMFC Red Drum

Data workshop

Recommendations of the Life History Work Group

The ASMFC-approved multi-state sampling program of adult Atlantic red drum from Florida to Virginia represents a unique opportunity to obtain critical comprehensive data. Specifically relevant to the genetic population structure evaluation is the concurrent aging of the fish which will allow for the determination if any detected genetic structure is the result of differential age composition of the reproductive stock, particularly in light of the proposed temporal genetic heterogeneity (Chapman et al. 2002) and suspected age structure differences from the GoM. The combined age-specific life history and genetic knowledge will allow for greater interpretive capabilities of the genetic data as well as provide the needed life history information necessary for an accurate estimate of effective population sizes for Atlantic red drum.

Updated maturity schedules and fecundity information for adult Atlantic red drum from Florida to Virginia is lacking. Just as there are suspected age structure differences between the Atlantic and GoM stocks, maturity schedules and fecundity estimates are also suspected to be different in the Atlantic stock.

Further study is needed to determine discard mortality estimates for the Atlantic coast, both for recreational and commercial gears. Additionally, discard estimates should examine the impact of slot-size limit management and explore regulatory discard impacts due to high-grading.

Dedicated northern and southern region larval and juvenile recruitment indices, as well as a Virginia adult recruitment index are recommended to provide more informative trends for future assessment processes.

Continued cooperation between state ageing labs, such as the October 2008 red drum ageing workshop, to provide consistent age verification between labs. Additionally, otolith microchemistry should be approached to look at state differences between regions for stock differentiation.

Identification of juvenile and adult habitat requirements and loss rates would provide more informative information for future management planning

Recommendations of the Commercial Work Group

- Continued and expanded observer coverage for the NC and VA gill net fisheries (5-10% coverage).
- Expand observer coverage to include other gears of concern (i.e. haul seine, pound net, trawls).
- Expand biostatistical sampling (ages and lengths) to better cover all statistical strata (gears/states - principally NC and VA) – more ages proportional to lengths, preferably otoliths.

Recommendations of the Recreational Work Group

Review of Historical Data: Have experts in survey design and implementation review historical data.

Marine Recreational Information Program (MRIP): The recreational statistics workgroup supports ongoing efforts to improve recreational and for-hire data collection through the Marine Recreational Information Program (MRIP).

Volunteer Logbook: We support inclusion of volunteer logbook data for length.

Recommendations of the Indices Work Group

Adult sampling with the goal of small population estimates or density estimates through tag-recapture methods to evaluate trends in abundance over time. Secondarily, this would help with delineate the stock distribution and mixing rates.

Suggests a workshop on adaptive sampling techniques as applied to wildlife populations as well as other techniques that can be applied to aggregated species.

Encourage that states continue on with current surveys, and with current methodologies. If sampling methodologies change, the workgroup suggests some consistency exist between the original and new methodologies.

Age structure established for surveys internally rather through external age-length keys.

Assessment workshop

The assessment panel reviewed the research recommendations from the data workshop report. Additional research recommendations developed at the Assessment Workshop are:

- Determine batch fecundity estimates of red drum.
- Conduct experiments using logbooks etc. to develop estimates of the B2 catch in both the North and South regions.
- Further identify the selectivity of age classes of the B2 catch in both regions.
- Determine if existing and historic recreational tagging programs can be used to evaluate better B2 selectivities.

Review workshop

In reply to RW Term of Reference 8 the Review Panel reviewed the research recommendation of the Data Workshop and the Assessment Workshop and provided research recommendations of its own.

Review of Data Workshop Recommendations

Life History Workgroup

The ASMFC-approved multi-state sampling program of adult Atlantic red drum from Florida to Virginia

The Review Panel considers this project low priority for leading to improvements to the assessment of red drum stock status. The Review Panel considers that further investigation into population structure is important. However, genetic analyses are only one of the tools available to address this question and may be of limited utility if there are low levels of gene flow among populations or if population divergence has been recent. It was not clear to the Review Panel how knowledge of the effective population size would be expected to improve the assessment.

Updated adult maturity schedules and fecundity information from Florida to Virginia

The Review Panel supports research to better characterize maturity schedules of red drum for the northern and southern stocks, given the observed differences in growth in these resources. This study would require a specially designed sampling plan given the potential bias due to age- and possible maturity-dependent processes.

Further study to determine discard mortality estimates for recreational and commercial gears; impact of slot-size limit management; regulatory discard impacts due to high-grading

The Review Panel recommends the establishment of programs to provide on-going estimates of commercial discard and recreational live release mortality using appropriate statistical methods. While specifically targeted studies are useful, it is through time series of these data that patterns emerge and insight is gained on both mortality rates and influential processes.

Dedicated northern and southern region larval and juvenile recruitment indices; Virginia adult recruitment index

The Review Panel does not support the establishment of larval surveys to provide indices of spawning biomass. Larval surveys can only provide general indications of spawning biomass. There are more direct sampling approaches to assess spawning biomass. Further, the Review Panel recommends evaluation of the broader survey program needs (see section 2.1.8.3).

Continued cooperation between state ageing labs to provide consistent age verification; otolith microchemistry should be approached for stock differentiation

On-going cooperation between state ageing labs should be standard best practice; the Review Panel notes its concern if this is not occurring. It is thus highly supportive of this recommendation.

In relation to the recommendation on otolith microchemistry, the Review Panel considers that this project would be of value if the life stage linkage between estuarine and offshore red drum were incorporated into the study. There is uncertainty on the origins of offshore adult red drum in relation to the early life history stages in the estuarine habitat which could be resolved by this study.

Identification of juvenile and adult habitat requirements and loss rates

As this recommendation does not directly pertain to improvements in the stock assessment but rather to management, the Review Panel defers comment.

Commercial Work Group

Continued and expanded observer coverage for the NC and VA gill net fisheries (5-10% coverage)

The Review Panel notes that observer coverage in the NC fishery during 2004-06 was adequate but didn't provide an indication of annual variability in discard rates. The Panel thus supports expanded observer coverage in State and Federal fisheries as appropriate to allow better on-going characterization of discards in directed and non-directed fisheries. As noted earlier, while specifically targeted studies are useful, it is through time series of these data that patterns emerge and insight is gained on both mortality rates and influential processes. Specifically, it is important that this program identify the main factors that cause both high vulnerability of red drum to fishing gear (e.g. salinity, temperature) and high post – release mortality (e.g. hook type).

Expand observer coverage to include other gears of concern (i.e. haul seine, pound net, trawls)

As with the previous recommendation, the Review Panel supports expanded observer coverage in State and Federal fisheries as appropriate to allow better on-going characterization of discards in directed and non-directed fisheries.

Expand biostatistical sampling (ages and lengths) to better cover all statistical strata (gears/states - principally NC and VA) – more ages proportional to lengths, preferably otoliths

The Review Panel recommends that this project only be undertaken based upon a statistical analysis which would specify the details of a sampling program required to comprehensively characterize the age/size composition of removals.

Recreational Work Group

Have experts in survey design and implementation review historical data

Sampling design is fundamental to any survey activity but it is unclear what is being proposed. Thus, the Review Panel cannot comment on this recommendation.

Improve recreational and for-hire data collection through the Marine Recreational Information Program (MRIP)

The Review Panel supports this recommendation to the degree that it informs the stock assessment of red drum.

Inclusion of volunteer logbook data for length

The Review Panel supports this recommendation to the degree it informs stock assessment of red drum. Further, the statistical methods used to analyze the collected data require careful consideration given that there does not currently appear to be an experimental design for the volunteer program.

Indices Work Group

Adult sampling with the goal of small population estimates or density estimates through tag-recapture methods to evaluate trends in abundance over time. Secondarily, this would help delineate stock distribution and mixing rates.

This recommendation is unclear. Thus, the Review Panel cannot comment.

Workshop on adaptive sampling techniques as applied to wildlife populations and other techniques that can be applied to aggregated species.

See the Review Panel's recommendation on surveys (RW Report Section 2.1.8.3). There, the need for the study of the broader survey program needs is identified.

Encourage States continue current surveys with current methodologies. If sampling methodologies change, maintain consistency between original and new methodologies.

As with the previous recommendation, see the Review Panel's recommendation on surveys (RW Report Section 2.1.8.3). There, the need for the study of the broader survey program needs is identified.

Age structure established for surveys internally rather through external age-length keys

Best practice is that survey-specific age/length keys are developed and applied to that survey's size frequency information to provide age-based estimates of abundance. Thus, the Review Panel endorses this recommendation.

Recommendations of Assessment Workshop (1 – 5 June 2009)

Determine batch fecundity estimates of red drum

The Review Panel does not support this recommendation as it will not significantly improve the red drum stock assessments. While more precise estimates of fecundity could be provided, it is unclear how these would be used given the uncertainties in the estimation of age 4^+ female abundance.

Conduct experiments using logbooks etc. to develop estimates of the B2 catch in both the North and South regions

See the Review Panel's response to the Data Workshop's recommendation on volunteer logbook data (section 2.1.8.1), where the need for careful consideration of the statistical analyses to be employed on these datasets was noted.

Further identify selectivity of age classes of the B2 catch in both regions

Assuming that adequate size frequency information is collected for the B2 catch, the Review Panel supports explorations of assessment model formulations that fit modeled size frequencies to the observations (see section 2.1.8.3).

Determine if existing and historic recreational tagging programs can be used to evaluate better B2 selectivities

See previous recommendation.

Recommendations of Review Workshop

Needs of Current Assessments

The Review Panel considered the needs of the two red drum assessments that were additional to those noted in the Data and Assessment workshops. These covered issues spanning input data, assessment model and benchmarks.

Current Surveys

The Review Panel recommends study of the broader survey program to better identify gaps in current activities and potential expansion / refocusing of current surveys. At present, it is difficult to discern where improvements to the overall survey program could be made. This study could be undertaken through simulation work to evaluate how proposed new survey activities would better inform stock assessment and management.

Adult Survey

The Review Panel notes the gap in synoptic indices of adult abundance and age composition which are critical to improvements in the red drum stock assessments. It recommends that a survey to provide indices of abundance for ages 4 and older be established but in the context of the previous recommendation. During the Review Workshop, mention was made of apparent gaps in the size frequencies (i.e., red drum present in these distributions at smaller sizes and again at larger sizes but with few observations in between). The Review Panel recommends development of testable hypotheses on the biological basis of this apparent missing size frequency information. Survey activity could then be designed to challenge these hypotheses.

Existing Tagging Data

The Review Panel recommends that a comprehensive analysis of existing tagging data for use in the assessment models be undertaken and, based upon this, there be consideration of additional tagging activities (based upon a statistical design for both the northern and southern stocks to provide age-based estimates of population abundance and fishing mortality). This activity could also provide estimates of movement which can confound estimation of stock parameters. It would be worthwhile to consider State- Space methods as has been recently employed to estimate fishing mortality and migration rates of some New England groundfish stocks (Miller and Andersen, 2008).

Tagging Data Model Integration

Further on the tagging data, the Review Panel strongly recommends integration of the tagging analysis into the assessment models, thereby ensuring that parameters and error estimates derived in the model are appropriately treated throughout the analysis. This would ensure that the tagging data are appropriately weighted in the assessment model and are not afforded undue weighting compared to other information.

Data Set Weighting

The Review Panel recommends exploration of iterative re-weighting to better define weightings for the contribution of each data set. The contribution of the survey indices to the negative log-likelihood calculated by the assessment model should be modified to allow for both the variance associated with sampling, i.e. related to the CVs calculated for the surveys, and an additional variance component due to "fluctuations in ... the fraction of the population present in the sites being surveyed" (Punt et al., 2002). An example is presented by DeOliveira et al. (2007), who cite Butterworth et al. (1993). Essentially, the inclusion of this additional variance provides an iterative re-weighting of the survey indices and avoids the need for including an arbitrary, subjective, external weighting, such as that currently employed in the assessment model. A similar approach may need to be adopted for other components of the objective function if the observations are derived from samples that are not fully representative.

Proportion-at-Age Sample Size

The effective sample size that is currently employed when calculating the negative log-likelihood of the proportion-at-age data, i.e., the square root of the number of fish in the age-length key for the year or two if no age-length key was available for the year, should be compared with the value that is currently calculated in the ADMB implementation of the model using the method described by McAllister and Ianelli (1997, Appendix 2, Equation 2.5). Such a comparison might indicate whether the effective sample size currently used is appropriate.

Size Frequency

The Review Panel recommends exploration of assessment model formulations that fit modeled size frequencies, based upon age-based population dynamics to the size frequency observations. This would facilitate use of size frequency data when data for age / length keys are too sparse to reliably derive age composition.

Effects of Age 4+ Abundance Constraints

The Review Panel recommends exploration of imposing constraints on the size of the age 4^{+} abundance to determine whether or not model fits are improved.

Effects of Data Inconsistency on Uncertainty

Possible inconsistencies among the various data sets that contribute to the objective function of the assessment model should be explored by plotting the likelihood profiles for each component across the ranges of feasible values for the parameters that represent the major axes of uncertainty. By examining the resulting plots, it is possible to identify the values of the parameters that minimize the negative log-likelihood of the different components, and thereby identify those parameters that most influence the values of the parameter estimates. Identification

of inconsistencies among the data sets provides a focus for re-assessing the extent to which inconsistent data sets are representative of the variables that they are intended to measure.

Confirmation of Convergence

Convergence of the assessment models for the base, sensitivity and retrospective runs should be confirmed by "jittering" the initial parameter values and re-fitting the model a number of times, e.g. 100, then comparing the resulting parameter estimates and values of the objective function (e.g., Methot, 2007). Exploration of the consequences of "jittering" may also reveal whether the model converges to a region of parameter space in which the Hessian is positive definite, noting that, in several of the retrospective runs, the Hessian was found to be non-positive definite.

Over-Parameterization

Highly-correlated parameters indicate that the parameter estimates to which the model has converged are likely not to be unique, and that the model may be over-parameterized. In future stock assessments, the Review Panel recommends that the parameter correlation matrix should be explored.

Fishing Mortality Estimates Based on Tagging Data

The Review Panel recommends exploration of use of estimates of fishing mortality directly from the tagging data (i.e. northern stock) as the basis for stock assessment and guidance for fisheries management. Current stock assessments are undertaken every five years or so and involve the collection and synthesis of a wide array of data. The tagging program, as long as it is designed appropriately, can directly provide estimates of fishing mortality at a higher frequency than the current statistical catch-at-age (SCA) formulations. It also has the benefit of having wide fishery visibility and support. Through a simulation exercise, such as Management Strategy Evaluation (MSE), the efficacy of using the tagging-derived fishing mortality estimates between applications of the SCA assessment could be explored. The use of the tagging information directly to inform management decision rules could also be investigated.

Recommend an appropriate interval for the next assessment

Key issues which influence the appropriate interval until the next red drum assessments are significant advances on the research agenda and the nature of management actions. It is evident that until progress on many of the research recommendations outlined in this report is made, future assessments will suffer many of the same uncertainties that have influenced the current assessments. It would be inappropriate to undertake assessments before the key ones are addressed. If management requires more immediate assessment input, then consideration should be given to more immediate addressing of the tagging-related recommendations as these may provide improvements in the relatively short-term. The last Review Panel recommendation on MSE-style simulations is of particular note in this regard. This approach would allow evaluation of the assessment approach (e.g. SCA, tagging analysis) in the context of the management tools in use.

Under these conditions, it is likely that the next assessment should not be undertaken within at least five years.

SEDAR 19: South Atlantic and Gulf of Mexico Black Grouper and South Atlantic Red Grouper

Data Workshop

Life History Work Group

- The DW LH WG recognized the value of continuing the age workshops and exchange of otoliths in preparation of SEDAR data workshops. This will be especially important for species that have been recognized as relatively difficult to age.
- The DW LH WG also recognizes the value of similar workshops to discuss the interpretation of reproductive samples, and the possible exchange of histological sections between labs in preparation of SEDAR Data Workshops. This will be especially important for species that have been recognized as relatively difficult to stage.
- Since fecundity information is only available from the GOM and does not include estimates for ages less than 5 years, the DW LH WG recommends initiating a study to estimate fecundity and further identify spawning locations for all age classes in both the GOM and Atlantic populations.
- The data presented at the DW suggest a possible disjunct distribution in the Atlantic stock (NC-FL). The DW LH WG recommends a study to further investigate this by use of genetic, tagging, and other techniques.
- Improved collection and collection strategy for hard parts, in particular from the recreational sector.
- Increase of Fishery Independent data to include the entire area of red grouper distribution in the Atlantic.
- Virtually no information on the life history and distribution of juvenile red grouper (i.e. ages 0-2) is available. The DW LH WG recommends a study to gather information on these early stages.

Procedural recommendation:

- The DW recommends that the report of the natural mortality workshop organized by NMFS (Seattle, WA, August 2009) be a made available to the DW LHW before the next SEDAR as a guide in the discussions concerning natural mortality.

Commercial Work Group

• Still need observer coverage for the snapper-grouper fishery
– 5-10% allocated by strata within states
– get maximum information from fish

• Expand TIP sampling to better cover all statistical strata
– Predominantly by H&L gear
– In that sense, we have decent coverage for lengths

• Trade off with lengths versus ages, need for more ages (i.e., hard parts)
• Workshop to resolve historical commercial landings for a suite of snapper-grouper species
– Monroe County (SA-GoM division)
– Historical species identification (mis-identification and unclassified)

Recreational Work Group

-Need more detailed information about where the fish are caught (depth, spatial, etc.)

-More detailed information on recreational discards, such as hooking location, depth fished, etc. that are likely to impact discard mortality and discard size/age.

- Additional information on sector (mode) differences.

Measures of Abundance Work Group

1. Expand fishery independent sampling to provide indices of abundance. The DW Panel noted that this recommendation has been the first on the list for virtually all previous SEDAR's in the south Atlantic.

2. Examine variability in catchability
    - Environmental effects
    - Changes over time associated with increases in technology and potential changes in fishing practices. This is of particular importance when considering fishery dependent indices.
    - Potential density-dependent changes in catchability. This is of particular importance for schooling fishes.

3. Conduct studies to examine how the behavior of fisherman changes over time and how these changes relate to factors such as gas prices and economic trends

4. Consider optimal sample allocation for species of interest when designing surveys to increase sample sizes.

5. Examine possible temporal changes in species assemblages. Such changes could influence how the Stephens and MacCall method is applied when determining effective effort.

6. Continue to expand fishery dependent at-sea-observer surveys. Such surveys collects discard information, which would provide for a more accurate index of abundance.

Assessment Workshop

1. Expanded fishery independent surveys of reef fishes in the Southeast, including red grouper, would greatly improve stock assessments.
2. More information on age/length composition of discards from various fleets would improve stock assessment of reef fishes in the Southeast, including red grouper.
3. More information on discard mortality rates would improve stock assessment of reef fishes in the Southeast, including red grouper.
4. The apparent stock separation of red grouper deserves further consideration. It may be desirable to develop appropriate spatial assessment models, if corresponding data requirements could be met. It may be desirable to research methods of spatial management (whether or not the assessment is spatially explicit).
5. More detailed spatial resolution of fishing effort would likely improve assessments.
6. Information on historical landings of reef fishes in the Southeast could lead to improved understanding of stock productivity and dynamics of stock assemblages.
7. Methods to characterize uncertainty in assessment results deserve further consideration. For avoiding overfishing, characterizing uncertainty is more than an academic exercise, particularly when relying on probabilistic methods to set catch levels.
8. Effects of new management measures (Amendment 16, seasonal closure) should be monitored.

Review Workshop

Members of the Data and Assessment workshops identified a number of shortcomings in the data available for red grouper, and the Review Panel (RP) felt that future research efforts should be focused on obtaining more precise estimates for parameters that displayed a strong potential effect and high uncertainty on the output of the assessment models. This opinion was reinforced by the fact that red grouper are not abundant, nor do they represent substantial fisheries; hence data acquisition efforts are hampered by both low abundances and low availability of samples from fishery sources. Many of the research recommendations have a reasonable biological basis, but a number are not directly linked to the assessment models used in the stock assessment. The RP felt that future research should focus on discard mortality, especially from the recreational fishery, acquiring better fishery-independent abundance estimates, improved methods for estimating catch by recreational anglers, improved age and growth data, and efforts to quantify linkages (i.e., recruitment effects) between western Caribbean and US stocks of red grouper. Given that fecundity data are not currently used in the stock assessment models, nor are histological gonadal stages utilized other than to distinguish mature from immature specimens, we suggest that these studies have lower priority than the research needs identified above. Studies directed towards identifying locations of spawning aggregations may be difficult to conduct for a species with low abundance, although such studies would be useful if spatially-based fisheries closures were to be employed for red grouper.

The RP recommends a strategic approach should be taken towards research for the snapper-grouper complex. The criteria which would be used to evaluate the strategy should be:

- Efficiency: for example sampling for sex ratio, length, and age could cover a range of species simultaneously.
- Impact: the resulting information should have clear implications for decision making.

To achieve this, managers and scientists will both need to be involved in developing a strategic research plan.

The RP recommends future research to determine which F metric behaves best under this management system.

SEDAR 20: South Atlantic Croaker and Menhaden Review

South Atlantic Croaker

Short-Term Research Priorities ***(for next benchmark assessment, in order of importance)***

1. Continue fisheries-independent surveys throughout the species range and subsample for individual weights and ages, particularly in the southern range.

2. Encourage fishery-dependent biological sampling of Atlantic croaker from the southern region. Collect age samples from the recreational fishery when the length distribution of the recreational fishery samples is not adequately represented by the fisheries from which the age-length keys are developed.

3. Maintain SEAMAP funding.

4. Increased observer coverage for commercial discards.

5. Hybrid random sampling of commercial catch: sample catch for ageing at random, and mark those samples as selected randomly, then supplement underrepresented length bins with additional samples—this will avoid the necessity of weighting length-at-age estimates by the fisheries length frequencies.

6. Conduct studies of discard mortality for recreational and commercial fisheries.

7. Conduct study on fecundity in the south Atlantic and continue to develop estimates of length-at-maturity and year-round reproductive dynamics.

8. Investigate environmental covariates in stock assessment models.

9. Historical summaries of landings data from NOAA indicate landings are available at a finer scale (e.g., landings by water body, month) for the earliest years than are currently reported. We encourage efforts to recover these data and make them available for stock assessments.

10. Re-examine historical ichthyoplankton studies of the Chesapeake Bay for an indication of the magnitude of estuarine spawning.

Long-Term Research Priorities ***(in order of importance)***

1. Collect data on fishing attributes necessary to develop gear-type-specific fishing effort estimates.

2. Develop and implement sampling programs for state-specific commercial scrap fisheries in order to monitor the relative importance of Atlantic croaker in the scrap landings.

3. Develop a coast-wide tagging program for Atlantic croaker to evaluate migration and movement and continue any coast-wide studies (e.g., genetics, otolith microchemistry) designed to improve understanding of stock definition.

4. Examine socioeconomic aspects of the fishery.

Atlantic Menhaden

Research recommendations are broken down into two categories: data and modeling. While all recommendations are high priority, the first recommendation is the highest priority. Each category is further broken down into recommendations that can be completed in the short term and recommendations that will require long term commitment.

Annual Data Collection

Long term:

1. [Highest Priority] Develop a coastwide fishery independent index of adult abundance at age to replace or augment the existing Potomac River pound net index in the model.
2. Work with industry to collect age structure data outside the range of the fishery.

Short term:

1. Continue current level of sampling from bait fisheries, particularly in the mid-Atlantic and New England, and continue recovery of historical tagging data from paper data sheets.
2. Request annual samples of menhaden from the PRFC pound net fishery to better characterize age and size structure of catch.

Assessment Methodology

Long term:

1. Develop multispecies statistical catch-at-age model to estimate menhaden natural mortality at age.
2. Develop spatially-explicit model, once sufficient age-specific data on movement rates of menhaden is available.

Short term:

1. Re-evaluate menhaden natural mortality-at-age and population response to changing predator populations by updating and augmenting the MSVPA (e.g. add additional predator, prey, and diet data when available).
2. Incorporate maturity at age variability in the assessment model.

Future Research

1. Evaluate productivity of different estuaries (e.g., replicate similar methodology to Ahrenholz et al. 1987).
2. Collect age-specific data on movement rates of menhaden to develop regional abundance trends.
3. Determine selectivity of PRFC pound nets.
4. Update information on maturity, fecundity, spatial and temporal patterns of spawning, and larval survivorship.
5. Investigate the effects of global climate change on distribution, movement, and behavior of menhaden.

SEDAR 21: HMS Dusky, Sandbar, and Blacknose Sharks

Dusky Shark

Data Workshop

LIFE HISTORY WORKING GROUP

- Increase research on post-release survivorship of all shark species by gear type
- Update age and growth and reproductive studies of dusky sharks.
- Develop empirically based estimates of natural mortality
- Continue tagging efforts

COMMERCIAL STATISTICS WORKING GROUP

No research recommendations were provided.

RECREATIONAL STATISTICS WORKING GROUP

No research recommendations were provided.

INDICES OF ABUNDANCE WORKING GROUP

No general research recommendations were provided. Recommendations specific to each index can be found in the workshop text and on the appropriate index scorecard.

CIE REVIEW RECOMMENDATIONS - DATA WORKSHOP

Conclusions and Recommendations

The Data Workshop provides a productive environment in which stakeholders and scientists can share knowledge to optimize the information available for assessment. It also serves as a mechanism where differences of opinion can be resolved before assessments are completed. The quality of science was high and appropriate for the purpose of stock assessment.

Compared with many stocks the availability of data are comparatively limited, especially in relation to catches, whether landings or discards. Although there is a large quantity of abundance index information the quality of these data is limited by the amount of fishery independent information or spatial coverage of the survey. Preliminary inspection of the indices at the meeting suggested that there was very little similarity of trends suggesting they have high uncertainty. There is a danger that the assessment might be driven arbitrarily by one of the time series if it happened to have low estimated CVs. I would **recommend that more exploratory analyses are done with the CPUE indices to try to identify those which contribute the most information on stock trends over the area of the assessment.** One possible line of analysis would be to use factor analysis to see if a common annual signal could be extracted from the suite of indices.

During the meeting some time was devoted to filling out a 'report card' for each series. In order to save time I **would recommend that the report card is completed by the author and that more time**

at the meeting is devoted to assessing the value of each time series for the assessment. The latter should include participation by assessment analysts.

The catch data suffer from a high degree of uncertainty. As much of the uncertainty relates to historical records there is not much that can be done to improve them. However, I would **recommend that an analysis is performed to try to quantify the uncertainty in the time series of catch data.** This would help in characterizing the overall uncertainty in the assessment.

The frequency of spawning by female sharks may be an important factor in estimating the spawning potential of the stock. Biological examination of female sharks appears to be able to determine that some species spawn less often that annually but the actual frequency cannot yet be established. In the absence of definitive information on spawning frequency I would **recommend that female sharks are examined in the spawning period to determine the proportion of spawning females**. While this will not provide an estimate of spawning frequency, it may provide sufficient information to estimate annual spawning biomass.

Estimates of discard survival proved an area of disagreement between scientists and fishing industry representatives. This was in part a result of differing perceptions of the meaning of discard survival. It is important that such disagreements don't lead to negotiated values that have no scientific basis. It might be worth investing in further discussion with the industry to reach a common understanding of the parameter in question. It might also help if **a desk study was undertaken to examine whether the choice of discard survival has a significant bearing on the estimated status of the stock in relation to MSY reference points.** If the sensitivity of the assessments to this quantity is low, it might defuse some of the polarization over the chosen values.

There may be a case for assessment analysts at the workshop to be more active in commenting whether certain biological effects can usefully be incorporated into assessments. This might be because some biological phenomena that are statically significant in their own right have little importance in determining the assessment outcome or where added biological realism in an assessment model is negated by the added uncertainty in input parameter values.

Assessment Workshop

The greatest source of uncertainty about dusky sharks is clearly the amount of human induced removals (e.g., discards) that are occurring. However, it is difficult to recommend a single course of action to improve this situation, as uncertainty in removals stems from a number of sources (species misidentification, non-reporting, etc.). Nevertheless, improving the reliability of removal data would help assessment modeling immensely.

Another suggestion for improving the reliability of assessment advice is the development of a stock-wide fishery independent monitoring program. The present assessment is based on a combination of spatially-restricted fishery independent surveys and several fishery dependent surveys. The former are not ideal in that observed trends may better represent localized dynamics than stock wide trends; the latter are deficient in that observed trends may often reflect changes in catchability (for instance, due to differences among vessels, captains, and changes in targeting) rather than absolute abundance.

Finally, further assessment work would benefit from a consistent life history sampling program that gathers annual samples of length and age-frequencies. The current hodgepodge of length-at-age samples is not sufficient to implement catch-age or catch-length models, and is only marginally useful for constructing selectivity curves because temporal changes in age-frequencies are confounded with

selectivity. Although an attempt was made to use existing age-length data to produce selectivity curves for the present assessment, this approach is clearly not ideal.

Review Workshop

The Assessment Team provided several research recommendations in the data workshop and AW reports, and these are endorsed by the Review Panel (RP) to the extent that they will improve the assessment. The RP considers research leading to an improved understanding of landings and removals, that improves consistency among indices, that reduces variability within the individual indices, and that leads to development or application of a model that more fully takes advantage of the length and age data including integration of the selectivity estimation into the assessment to be priorities.

With respect to further life history research, the RP considers the following to be priorities:

- Research on post-release survival by fishing sector and gear type should lead to improved landings and removals time series

- Research on fecundity and reproductive frequency should lead to an improved understanding of population productivity. As shown in assessment, status with respect to benchmarks is relatively robust to assumptions about overall productivity; however abundance and fishing mortality rate estimates are sensitive to this information. Research about natural mortality would also lead to a better understanding of productivity but traditionally has been difficult for most species.

- As noted throughout this report, the lack of age data was a limiting factor in this assessment and collection of sex-specific age and length data would aid the assessment. Regular collection of age data will help in the construction of improved age-length keys, in the interpretation of indices particularly in cases where populations have spatially structured with respect to age, and significantly aid in fitting the selectivity within the models. Additionally, if the abundance indices are age-structured, population responses to management actions should be detectable earlier than if the indices only provide information on total abundance.

- Although information about stock structure is important, as noted under ToR 1, genetic studies may not necessarily be informative about structure. Tagging studies to determine stock structure need to take into account that populations may be discrete during reproduction, but otherwise mixed most of the time. Increased international collaboration (e.g. Mexico) could help ensure wider distribution and returns of tags.

With respect to the abundance indices, the RP recommends:

- Evaluation of the individual indices via power analyses to determine whether they are informative about abundance trends. The majority of indices used in these assessments exhibited greater inter-annual variability than would be expected given the life history of these species, and given this variability, may only be able to detect large changes in abundance which are not expected to occur rapidly. A power analysis would help to determine how much abundance would have to change in order for the change to be detected with the survey, and additionally, if the survey effort needs to be

increased or re-distributed in order to be able to evaluate the effectiveness of rebuilding strategies given the relatively low population grow rates for these species.

- A small study on how to make the best use of the knowledge of the data workshop participants for developing index rankings.

- Ensuring that, to the extent possible, information about sex, length and age is collected for the reasons provided above.

With respect to the landings and removals, the RP recommends:

- Research that improves the understanding of historical landings, both in the modern and historical period and to support the assumptions about when stocks are at virgin biomass if this assumption is carried forward in future assessments. This is particularly important for GoM blacknose sharks given the difficulties reconciling the abundance indices, landings and life history information.

- As recommended by the AT, improved observer coverage particularly during periods of regulatory or gear changes (e.g. TEDs).

- Ensuring that, to the extent possible, information about sex, length and age is collected for each fishery in order that selectivity can be estimated in the model.

With respect to the assessment models, the RP recommends further model development using both simpler and more complex models taking the following into consideration:

- The RP noted that the models used in this assessment were reasonably suited to shark life history. However, other models (e.g. SS3) could also be adapted. If reproduction is modeled as a function of the number of mature females, uncertainty in the reproductive frequency, fecundity and pup-survival can be integrated into a single parameter (the slope at the origin of the SR function), and information about these traits can be incorporated via priors on the parameter. The RP recommends consideration of this approach if information on reproduction remains uncertain.

- Estimating the fishery and survey selectivities within the assessment model.

- Development of a two sex model for more direct estimation of the spawning stock

- Fitting the model to either length or age data. In addition to being necessary in order to estimate selectivities, these data can be informative about changes in age-specific abundance.

- Exploration of models that do not require an assumption that the population is at virgin levels at some point in time.

- If external age-length keys are used in future assessments, development of a key based on a growth model to better assign proportions-at-age in each length class.

- Simulation tests (management strategy evaluation) can be used to test the performance of alternative assessment methods (including the catch-free model, ASPM, ASPIC, SS3, or stock specific models), recruitment parameterizations, harvest control rules, assessment frequency and data collection. Simulation studies may have a particular use in these assessments because of the particular biology of sharks and the data poor nature of these stocks.

In the case of GoM blacknose shark, the appropriate interval of the next assessment depends on progress made towards reconciling the issues raised during this assessment process. For Atlantic blacknose shark, dusky shark and sandbar shark, the RP recognizes that population growth is expected to be relatively slow, but that modifications to the model may result in a different assessment of status. Benchmark assessments are recommended once the modifications are made. Additionally, for dusky shark, given the retrospective patterns in the present analysis and the resulting uncertainties in the assessment, updates using the existing model in the shorter term are also recommended. In the longer-term, development of a set of indicators (age-structure, total mortality estimates from catch curves, changes in abundance indices values) that could be used to determine whether status has changed sufficiently to warrant a full assessment, is recommended.

Sandbar Shark

Data Workshop

LIFE HISTORY WORKING GROUP

- Increase research on post-release survivorship of all shark species by gear type
- Continue to investigate reproductive periodicity for sandbar sharks
- Continue to collect vertebral samples from the sandbar shark research fishery to develop an ageing material archive and to keep track of the age distribution of the catch, and continue monitoring juvenile sandbar shark ages through the collection of fishery-independent samples
- Develop empirically based estimates of natural mortality
- Continue tagging efforts

COMMERCIAL STATISTICS WORKING GROUP

- Expand observer coverage to obtain 5% coverage of total trips or 20 to 30% PSE (percent standard error).
- Conduct more studies to better estimate post-release mortality
- Review bycatch estimation models
- Discard rates of sandbar sharks in the current directed and non-directed bottom longline fishery should be calculated and extrapolated using BLLOP data.
- Continue to develop better methods to quantify discards and effort from logbook programs and observer programs

RECREATIONAL STATISTICS WORKING GROUP

No recommendations were provided.

INDICES OF ABUNDANCE WORKING GROUP

No general research recommendations were provided. Recommendations specific to each index can be found in the workshop text and on the appropriate index scorecard.

CIE REVIEW RECOMMENDATIONS - DATA WORKSHOP

Conclusions and Recommendations

The Data Workshop provides a productive environment in which stakeholders and scientists can share knowledge to optimize the information available for assessment. It also serves as a mechanism where differences of opinion can be resolved before assessments are completed. The quality of science was high and appropriate for the purpose of stock assessment.

Compared with many stocks the availability of data are comparatively limited, especially in relation to catches, whether landings or discards. Although there is a large quantity of abundance index information the quality of these data is limited by the amount of fishery independent information or spatial coverage of the survey. Preliminary inspection of the indices at the meeting suggested that there was very little similarity of trends suggesting they have high uncertainty. There is a danger that the assessment might be driven arbitrarily by one of the time series if it happened to have low estimated CVs. I would **recommend that more exploratory analyses are done with the CPUE indices to try to identify those which contribute the most information on stock trends over the area of the assessment.** One possible line of analysis would be to use factor analysis to see if a common annual signal could be extracted from the suite of indices.

During the meeting some time was devoted to filling out a 'report card' for each series. In order to save time I **would recommend that the report card is completed by the author and that more time at the meeting is devoted to assessing the value of each time series for the assessment.** The latter should include participation by assessment analysts.

The catch data suffer from a high degree of uncertainty. As much of the uncertainty relates to historical records there is not much that can be done to improve them. However, I would **recommend that an analysis is performed to try to quantify the uncertainty in the time series of catch data.** This would help in characterizing the overall uncertainty in the assessment.

The frequency of spawning by female sharks may be an important factor in estimating the spawning potential of the stock. Biological examination of female sharks appears to be able to determine that some species spawn less often that annually but the actual frequency cannot yet be established. In the absence of definitive information on spawning frequency I would **recommend that female sharks are examined in the spawning period to determine the proportion of spawning females**. While this will not provide an estimate of spawning frequency, it may provide sufficient information to estimate annual spawning biomass.

Estimates of discard survival proved an area of disagreement between scientists and fishing industry representatives. This was in part a result of differing perceptions of the meaning of discard

survival. It is important that such disagreements don't lead to negotiated values that have no scientific basis. It might be worth investing in further discussion with the industry to reach a common understanding of the parameter in question. It might also help if **a desk study was undertaken to examine whether the choice of discard survival has a significant bearing on the estimated status of the stock in relation to MSY reference points.** If the sensitivity of the assessments to this quantity is low, it might defuse some of the polarization over the chosen values.

There may be a case for assessment analysts at the workshop to be more active in commenting whether certain biological effects can usefully be incorporated into assessments. This might be because some biological phenomena that are statically significant in their own right have little importance in determining the assessment outcome or where added biological realism in an assessment model is negated by the added uncertainty in input parameter values.

Assessment Workshop

- Investigate alternative approaches to age-length keys for estimating age from length

Review Workshop

The Assessment Team provided several research recommendations in the data workshop and AW reports, and these are endorsed by the Review Panel (RP) to the extent that they will improve the assessment. The RP considers research leading to an improved understanding of landings and removals, that improves consistency among indices, that reduces variability within the individual indices, and that leads to development or application of a model that more fully takes advantage of the length and age data including integration of the selectivity estimation into the assessment to be priorities.

With respect to further life history research, the RP considers the following to be priorities:

- Research on post-release survival by fishing sector and gear type should lead to improved landings and removals time series

- Research on fecundity and reproductive frequency should lead to an improved understanding of population productivity. As shown in assessment, status with respect to benchmarks is relatively robust to assumptions about overall productivity; however abundance and fishing mortality rate estimates are sensitive to this information. Research about natural mortality would also lead to a better understanding of productivity but traditionally has been difficult for most species.

- As noted throughout this report, the lack of age data was a limiting factor in this assessment and collection of sex-specific age and length data would aid the assessment. Regular collection of age data will help in the construction of improved age-length keys, in the interpretation of indices particularly in cases where populations have spatially structured with respect to age, and significantly aid in fitting the selectivity within the models. Additionally, if the abundance indices are age-structured, population responses to management actions should be detectable earlier than if the indices only provide information on total abundance.

- Although information about stock structure is important, as noted under ToR 1, genetic studies may not necessarily be informative about structure. Tagging studies to determine stock structure need to take into account that populations may be discrete during reproduction, but otherwise mixed most of the time. Increased international collaboration (e.g. Mexico) could help ensure wider distribution and returns of tags.

With respect to the abundance indices, the RP recommends:

- Evaluation of the individual indices via power analyses to determine whether they are informative about abundance trends. The majority of indices used in these assessments exhibited greater inter-annual variability than would be expected given the life history of these species, and given this variability, may only be able to detect large changes in abundance which are not expected to occur rapidly. A power analysis would help to determine how much abundance would have to change in order for the change to be detected with the survey, and additionally, if the survey effort needs to be increased or re-distributed in order to be able to evaluate the effectiveness of rebuilding strategies given the relatively low population grow rates for these species.
- A small study on how to make the best use of the knowledge of the data workshop participants for developing index rankings.
- Ensuring that, to the extent possible, information about sex, length and age is collected for the reasons provided above.

With respect to the landings and removals, the RP recommends:

- Research that improves the understanding of historical landings, both in the modern and historical period and to support the assumptions about when stocks are at virgin biomass if this assumption is carried forward in future assessments. This is particularly important for GoM blacknose sharks given the difficulties reconciling the abundance indices, landings and life history information.
- As recommended by the AT, improved observer coverage particularly during periods of regulatory or gear changes (e.g. TEDs).
- Ensuring that, to the extent possible, information about sex, length and age is collected for each fishery in order that selectivity can be estimated in the model.

With respect to the assessment models, the RP recommends further model development using both simpler and more complex models taking the following into consideration:

- The RP noted that the models used in this assessment were reasonably suited to shark life history. However, other models (e.g. SS3) could also be adapted. If reproduction is modeled as a function of the number of mature females, uncertainty in the reproductive frequency, fecundity and pup-survival can be integrated into a single parameter (the slope at the origin of the SR function), and information about these traits can be incorporated via priors on the parameter. The RP recommends consideration of this approach if information on reproduction remains uncertain.
- Estimating the fishery and survey selectivities within the assessment model.

- Development of a two sex model for more direct estimation of the spawning stock
- Fitting the model to either length or age data. In addition to being necessary in order to estimate selectivities, these data can be informative about changes in age-specific abundance.
- Exploration of models that do not require an assumption that the population is at virgin levels at some point in time.
- If external age-length keys are used in future assessments, development of a key based on a growth model to better assign proportions-at-age in each length class.
- Simulation tests (management strategy evaluation) can be used to test the performance of alternative assessment methods (including the catch-free model, ASPM, ASPIC, SS3, or stock specific models), recruitment parameterizations, harvest control rules, assessment frequency and data collection. Simulation studies may have a particular use in these assessments because of the particular biology of sharks and the data poor nature of these stocks.

Atlantic Blacknose Shark

Data Workshop

LIFE HISTORY WORKING GROUP

- Increase research on post-release survivorship of all shark species by gear type
- Update age and growth and reproductive studies of blacknose sharks, with emphasis on smaller individuals in the Atlantic and larger individuals in the Gulf of Mexico. Additionally, more information on litter size and reproductive periodicity is needed for blacknose sharks.
- Population level genetic studies on blacknose for stock discrimination(s).
- Develop empirically based estimates of natural mortality
- Continue tagging efforts

COMMERCIAL STATISTICS WORKING GROUP

The current level of shrimp trawl observer coverage is inadequate to model shrimp bycatch and catch rates with reasonable levels of uncertainty. The bycatch in the shrimp fishery also contains protected species and species of concern. With the current level of coverage, it is very difficult to statistically estimate bycatch of those rare species. More coverage would allow for better estimates of rare species, both protected and otherwise. We recommend the expansion of the observer program towards a goal of 2 to 5 % of the total effort. The recommended coverage levels are common in other observer programs, and have proved adequate for multiple types of statistical analysis. We recommend the program strive for even spatial coverage (particularly adding more south Atlantic coverage), randomness in vessel selection, and full identification to species of elasmobranchs (continuing on from the 2009 Bycatch Characterization Protocol).

RECREATIONAL STATISTICS WORKING GROUP

No specific research recommendations were provided.

INDICES OF ABUNDANCE WORKING GROUP

Specific research recommendations, if provided, were given for each index.

CIE REVIEW RECOMMENDATIONS - DATA WORKSHOP

Conclusions and Recommendations

The Data Workshop provides a productive environment in which stakeholders and scientists can share knowledge to optimize the information available for assessment. It also serves as a mechanism where differences of opinion can be resolved before assessments are completed. The quality of science was high and appropriate for the purpose of stock assessment.

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understanding of the parameter in question. It might also help if **a desk study was undertaken to examine whether the choice of discard survival has a significant bearing on the estimated status of the stock in relation to MSY reference points.** If the sensitivity of the assessments to this quantity is low, it might defuse some of the polarization over the chosen values.

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Assessment Workshop

- Investigate alternative approaches to age-length keys for estimating age from length
- Improve observer coverage, particularly during regulatory or gear changes in the fishery.
- Longer time series for surveys will always aid the assessment process. However, it is equally important to maintain the sampling methods and document them well for the most appropriate statistical analyses to be applied to the data.
- More time was necessary to complete the data vetting process for this many species, and in the future we strongly recommend that no more than probably two stocks be assessed simultaneously with the same number of participants.

Review Workshop

The Assessment Team provided several research recommendations in the data workshop and AW reports, and these are endorsed by the Review Panel (RP) to the extent that they will improve the assessment. The RP considers research leading to an improved understanding of landings and removals, that improves consistency among indices, that reduces variability within the individual indices, and that leads to development or application of a model that more fully takes advantage of the length and age data including integration of the selectivity estimation into the assessment to be priorities.

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- A small study on how to make the best use of the knowledge of the data workshop participants for developing index rankings.

- Ensuring that, to the extent possible, information about sex, length and age is collected for the reasons provided above.

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- As recommended by the AT, improved observer coverage particularly during periods of regulatory or gear changes (e.g. TEDs).

- Ensuring that, to the extent possible, information about sex, length and age is collected for each fishery in order that selectivity can be estimated in the model.

With respect to the assessment models, the RP recommends further model development using both simpler and more complex models taking the following into consideration:

- The RP noted that the models used in this assessment were reasonably suited to shark life history. However, other models (e.g. SS3) could also be adapted. If reproduction is modeled as a function of the number of mature females, uncertainty in the reproductive frequency, fecundity and pup-survival can be integrated into a single parameter (the slope at the origin of the SR function), and information about

these traits can be incorporated via priors on the parameter. The RP recommends consideration of this approach if information on reproduction remains uncertain.

- Estimating the fishery and survey selectivities within the assessment model.
- Development of a two sex model for more direct estimation of the spawning stock
- Fitting the model to either length or age data. In addition to being necessary in order to estimate selectivities, these data can be informative about changes in age-specific abundance.
- Exploration of models that do not require an assumption that the population is at virgin levels at some point in time.
- If external age-length keys are used in future assessments, development of a key based on a growth model to better assign proportions-at-age in each length class.
- Simulation tests (management strategy evaluation) can be used to test the performance of alternative assessment methods (including the catch-free model, ASPM, ASPIC, SS3, or stock specific models), recruitment parameterizations, harvest control rules, assessment frequency and data collection. Simulation studies may have a particular use in these assessments because of the particular biology of sharks and the data poor nature of these stocks.

Gulf of Mexico Blacknose Shark

Data Workshop

LIFE HISTORY WORKING GROUP

- Increase research on post-release survivorship of all shark species by gear type
- Update age and growth and reproductive studies of blacknose sharks, with emphasis on smaller individuals in the Atlantic and larger individuals in the Gulf of Mexico. Additionally, more information on litter size and reproductive periodicity is needed for blacknose sharks.
- Population level genetic studies on blacknose for stock discrimination(s).
- Develop empirically based estimates of natural mortality
- Continue tagging efforts

COMMERCIAL STATISTICS WORKING GROUP

The current level of shrimp trawl observer coverage is inadequate to model shrimp bycatch and catch rates with reasonable levels of uncertainty. The bycatch in the shrimp fishery also contains protected species and species of concern. With the current level of coverage, it is very difficult to statistically estimate bycatch of those rare species. More coverage would allow for better estimates of rare species, both protected and otherwise. We recommend the expansion of the observer program towards a goal of 2 to 5 % of the total effort. The recommended coverage levels are common in other observer programs, and have proved adequate for multiple types of statistical analysis. We recommend the program strive for even spatial coverage (particularly adding more south Atlantic coverage), randomness

in vessel selection, and full identification to species of elasmobranchs (continuing on from the 2009 Bycatch Characterization Protocol).

RECREATIONAL STATISTICS WORKING GROUP

No specific research recommendations were provided.

INDICES OF ABUNDANCE WORKING GROUP

Specific research recommendations, if provided, were given for each index.

CIE REVIEW RECOMMENDATIONS - DATA WORKSHOP

Conclusions and Recommendations

The Data Workshop provides a productive environment in which stakeholders and scientists can share knowledge to optimize the information available for assessment. It also serves as a mechanism where differences of opinion can be resolved before assessments are completed. The quality of science was high and appropriate for the purpose of stock assessment.

Compared with many stocks the availability of data are comparatively limited, especially in relation to catches, whether landings or discards. Although there is a large quantity of abundance index information the quality of these data is limited by the amount of fishery independent information or spatial coverage of the survey. Preliminary inspection of the indices at the meeting suggested that there was very little similarity of trends suggesting they have high uncertainty. There is a danger that the assessment might be driven arbitrarily by one of the time series if it happened to have low estimated CVs. I would **recommend that more exploratory analyses are done with the CPUE indices to try to identify those which contribute the most information on stock trends over the area of the assessment.** One possible line of analysis would be to use factor analysis to see if a common annual signal could be extracted from the suite of indices.

During the meeting some time was devoted to filling out a 'report card' for each series. In order to save time I **would recommend that the report card is completed by the author and that more time at the meeting is devoted to assessing the value of each time series for the assessment.** The latter should include participation by assessment analysts.

The catch data suffer from a high degree of uncertainty. As much of the uncertainty relates to historical records there is not much that can be done to improve them. However, I would **recommend that an analysis is performed to try to quantify the uncertainty in the time series of catch data.** This would help in characterizing the overall uncertainty in the assessment.

The frequency of spawning by female sharks may be an important factor in estimating the spawning potential of the stock. Biological examination of female sharks appears to be able to determine that some species spawn less often that annually but the actual frequency cannot yet be established. In the absence of definitive information on spawning frequency I would **recommend that female sharks are examined in the spawning period to determine the proportion of spawning females**. While this will not provide an estimate of spawning frequency, it may provide sufficient information to estimate annual spawning biomass.

Estimates of discard survival proved an area of disagreement between scientists and fishing industry representatives. This was in part a result of differing perceptions of the meaning of discard

survival. It is important that such disagreements don't lead to negotiated values that have no scientific basis. It might be worth investing in further discussion with the industry to reach a common understanding of the parameter in question. It might also help if **a desk study was undertaken to examine whether the choice of discard survival has a significant bearing on the estimated status of the stock in relation to MSY reference points.** If the sensitivity of the assessments to this quantity is low, it might defuse some of the polarization over the chosen values.

There may be a case for assessment analysts at the workshop to be more active in commenting whether certain biological effects can usefully be incorporated into assessments. This might be because some biological phenomena that are statically significant in their own right have little importance in determining the assessment outcome or where added biological realism in an assessment model is negated by the added uncertainty in input parameter values.

Assessment Workshop

- Investigate alternative approaches to age-length keys for estimating age from length
- Improve observer coverage, particularly during regulatory or gear changes in the fishery.
- Longer time series for surveys will always aid the assessment process. However, it is equally important to maintain the sampling methods and document them well for the most appropriate statistical analyses to be applied to the data.
- More time was necessary to complete the data vetting process for this many species, and in the future we strongly recommend that no more than probably two stocks be assessed simultaneously with the same number of participants.

Review Workshop

The Assessment Team provided several research recommendations in the data workshop and AW reports, and these are endorsed by the Review Panel (RP) to the extent that they will improve the assessment. The RP considers research leading to an improved understanding of landings and removals, that improves consistency among indices, that reduces variability within the individual indices, and that leads to development or application of a model that more fully takes advantage of the length and age data including integration of the selectivity estimation into the assessment to be priorities.

With respect to further life history research, the RP considers the following to be priorities:

- Research on post-release survival by fishing sector and gear type should lead to improved landings and removals time series

- Research on fecundity and reproductive frequency should lead to an improved understanding of population productivity. As shown in assessment, status with respect to benchmarks is relatively robust to assumptions about overall productivity; however abundance and fishing mortality rate estimates are sensitive to this information. Research about natural mortality would also lead to a better understanding of productivity but traditionally has been difficult for most species.

- As noted throughout this report, the lack of age data was a limiting factor in this assessment and collection of sex-specific age and length data would aid the assessment. Regular collection of age data will help in the construction of improved age-length keys, in the interpretation of indices particularly in

cases where populations have spatially structured with respect to age, and significantly aid in fitting the selectivity within the models. Additionally, if the abundance indices are age-structured, population responses to management actions should be detectable earlier than if the indices only provide information on total abundance.

- Although information about stock structure is important, as noted under ToR 1, genetic studies may not necessarily be informative about structure. Tagging studies to determine stock structure need to take into account that populations may be discrete during reproduction, but otherwise mixed most of the time. Increased international collaboration (e.g. Mexico) could help ensure wider distribution and returns of tags.

With respect to the abundance indices, the RP recommends:

- Evaluation of the individual indices via power analyses to determine whether they are informative about abundance trends. The majority of indices used in these assessments exhibited greater inter-annual variability than would be expected given the life history of these species, and given this variability, may only be able to detect large changes in abundance which are not expected to occur rapidly. A power analysis would help to determine how much abundance would have to change in order for the change to be detected with the survey, and additionally, if the survey effort needs to be increased or re-distributed in order to be able to evaluate the effectiveness of rebuilding strategies given the relatively low population grow rates for these species.

- A small study on how to make the best use of the knowledge of the data workshop participants for developing index rankings.

- Ensuring that, to the extent possible, information about sex, length and age is collected for the reasons provided above.

With respect to the landings and removals, the RP recommends:

- Research that improves the understanding of historical landings, both in the modern and historical period and to support the assumptions about when stocks are at virgin biomass if this assumption is carried forward in future assessments. This is particularly important for GoM blacknose sharks given the difficulties reconciling the abundance indices, landings and life history information.

- As recommended by the AT, improved observer coverage particularly during periods of regulatory or gear changes (e.g. TEDs).

- Ensuring that, to the extent possible, information about sex, length and age is collected for each fishery in order that selectivity can be estimated in the model.

With respect to the assessment models, the RP recommends further model development using both simpler and more complex models taking the following into consideration:

- The RP noted that the models used in this assessment were reasonably suited to shark life history. However, other models (e.g. SS3) could also be adapted. If reproduction is modeled as a function of the number of mature females, uncertainty in the reproductive frequency, fecundity and pup-survival can

be integrated into a single parameter (the slope at the origin of the SR function), and information about these traits can be incorporated via priors on the parameter. The RP recommends consideration of this approach if information on reproduction remains uncertain.

- Estimating the fishery and survey selectivities within the assessment model.
- Development of a two sex model for more direct estimation of the spawning stock
- Fitting the model to either length or age data. In addition to being necessary in order to estimate selectivities, these data can be informative about changes in age-specific abundance.
- Exploration of models that do not require an assumption that the population is at virgin levels at some point in time.
- If external age-length keys are used in future assessments, development of a key based on a growth model to better assign proportions-at-age in each length class.
- Simulation tests (management strategy evaluation) can be used to test the performance of alternative assessment methods (including the catch-free model, ASPM, ASPIC, SS3, or stock specific models), recruitment parameterizations, harvest control rules, assessment frequency and data collection. Simulation studies may have a particular use in these assessments because of the particular biology of sharks and the data poor nature of these stocks.

SEDAR 22: Gulf of Mexico Yellowedge Grouper and Tilefish

Yellowedge Grouper

Data Workshop

LIFE HISTORY WORKING GROUP

- The LH DW recommends directed studies for better estimation of onset of maturity, batch fecundity by age, spawning frequency by age, and spawning duration by age.
- Recommend the fishery-independent longline survey enhance collection of sediment/habitat data to allow post-stratification. Increased resolution of spatial population structure is important given the demographic differences (east and western GOM) noted. There is the potential for over-exploitation of sub-populations within the larger GOM stock.
- Monitor for possibility of increased discards/high-grading as ITQs (catch shares) is undertaken as management approach.
- Since preliminary genetic research and demographic comparisons by Cook (2007) found differences between regions in the GOM the LH DW recommends additional genetic research on population genetics throughout the GOM be conducted.
- Improve information on stock structure/rates of possible exchange between Gulf and Atlantic, including pathways for larval transport.
- Age Johnson historical otoliths collected off Florida during 1982-1983. Use otolith age results to support ages determined using otolith weight to predict age.

COMMERCIAL STATISTICS WORKING GROUP

No recommendations were provided.

RECREATIONAL STATISTICS WORKING GROUP

No recommendations were provided.

INDICES OF ABUNDANCE WORKING GROUP

In both the fishery-independent surveys presented above, precision in abundance indices could be improved by increasing the number of samples at least two- to three-fold.

<u>Research recommendations for fishery dependent data:</u>

1.) Expand observer coverage to provide a subsample adequate to construct indices of abundance (Pelagic Longline Observer Progam has 5-8% coverage). Observer data provides finer spacial resolution and a more accurate measure of CPUE. It also provides size frequency and discard information that is currently unavailable in the self-reported dataset. Current observer coverage is inadequate for the construction of indices of abundance.

2.) Self logbook data should be restructured to collect data on a per set basis rather than per trip. This would allow for a more accurate calculation of CPUE. Data subsetting (determining targeting) would be vastly improved with set-based data.

CIE REVIEWER RECOMMENDATIONS - DATA WORKSHOP

Conclusions and recommendations

I would like to commend the great efforts of all the participating scientists, managers and fishermen in the SEDAR 22 DW in the identification, evaluation and compilation of the information on life history, fishery-dependent and fishery-independent abundance indices, and landings in the commercial and recreational fisheries for YG, tilefish (i.e., golden tilefish), and blueline tilefish in the GOM. I was impressed by the breadth of expertise and experience of the panelists, openness of discussion for considering alternative approaches/suggestions, and constructive dialogs in each working group and at the plenary meetings throughout the workshop. All the comments, whether they were from scientists, managers, or fishermen, were fully considered and discussed. In particular, I commend the inclusion in the Data Workshop of fishermen, who provided insights on the quality of the fishery data, in particular for historical fisheries data. I observed on many occasions constructive interactions and dialogs between scientists/mangers and representatives of the industry in the Workshop.

In general, I consider the information identified and compiled in the DW represents the best efforts given all the limitations associated with data quality and quantity. I consider the approaches used in developing life history parameters, fisheries landings, and abundance indices sound.

Having said that, I believe that there are large uncertainties associated with data identified and compiled in the DW, and that there is room for further improvement. I have made the following general comments and specific recommendations.

General comments

Although the SoW states that all the working papers and reference/background information for the workshop will be available two weeks before the workshop, only a few working papers (less than 25% of all the working papers promised) were available before the start of the workshop (not mention two weeks before the start of the workshop). Many working papers were still not ready in the middle of the workshop, which made my work difficult. The three separate working groups worked concurrently every day, making it impossible for me, as the only CIE reviewer, to be fully involved in each group's discussions.

I was told at the DW that Stock Synthesis 3 (SS3) will be used for the assessment of YG and tilefish. This choice of stock assessment model has direct impacts on the quality and quantity of the data that need to be evaluated and compiled in the Workshop. However, I observed that most DW panelists did not know exactly the data requirements, key assumptions, and options of the SS3 program. I recommend that future data workshop start with the introduction of the stock assessment model that will be used in the assessment so that data workshop participants understand the information needs of the stock assessment model.

I noticed that the time period that the SEDAR 22 assessment covers had not been defined prior to the DW. I suggest that a stock assessment time period be defined prior to the DW so that working

groups can focus on the defined time period, and not waste time discussing data falling outside the target stock assessment. The DW may also be a good place to discuss and make a decision about the time period the stock assessment should cover.

There is a need to include scientific names for all species covered in the TORs and SoW. The tilefish is the official name of golden tilefish in the American Fisheries Society list of fish species. However, both golden tilefish and blueline tilefish were discussed at the Workshop. This creates some confusion. It is clear from all the discussions at this Workshop that the information for blueline tilefish is not sufficient for a formal stock assessment using an assessment model like SS3.

Specific recommendations

Although I have provided detailed comments and recommendations under each TOR, I re-iterate the following recommendations.

- Possible existence of local stocks for both species needs to be evaluated;
- More comparative studies need to be done to evaluate differences in data collected from different monitoring programs;
- More comparative studies need to be done to evaluate differences in parameters estimated using different methods to improve our understanding of the degree of uncertainty associated with these parameters;
- More comparative studies need to be done to evaluate spatial and temporal variability in key life history parameters, abundance indices and landings;
- More habitat variables need to be included in CPUE and abundance index standardization;
- General additive models need to be considered in standardizing abundance index and CPUE;
- Instead of using a point estimate as a bias correction factor in correcting potential biases in landings data, a range of correction factors can be used so that large uncertainty in landings data can be incorporated into the stock assessment;
- The quality of catch data (landings, catch size/age composition, catch sex ratio etc.) is probably the most questionable of the data available to the stock assessment for both fish species, and the stock assessment model should have an ability to incorporate uncertainty in catch data;
- A critical evaluation of fishery-independent monitoring programs should be done to identify problems associated with the current program design in quantifying population dynamics;
- A systematic mail survey/interview of fishermen who have been involved in the GOM YG and tilefish needs to be done to have a better understanding of the degree of misreporting/underreporting and to identify if there is spatial and temporal variability in underreporting;
- It appears that outliers may exist in the assessment and given the data quality concerns, I suggest that robust estimation methods be used in the assessment (although this may be the choice of the modelers, but I believe that the Data Workshop is a place to make the recommendation because this is the place to deal with data quality issues);
- Uncertainty should be considered in all life history modeling, and confidence intervals should be estimated for the key life history parameters for the GOM YG and tilefish;

- Because of the extremely small YG catch in the SEAMAP bottom trawl survey, caution should be used in applying the derived abundance index, and the change in survey protocol in 1987 calls for a separate analysis of the two time periods and two different catchabilities in population modeling;
- Different measures for SSB should be considered for both tilefish and YG in stock assessment modeling; and
- I recommend conducting a systematic evaluation of current sampling programs for quantifying size composition and age composition of commercial catch. Factors such as adequate spatial and temporal coverage and sampling intensity to have high effective sample sizes should be considered. I recommend developing alternative sampling designs, developing a simulated fishery that mimics temporal and spatial variability in size and age compositions in commercial landings, applying current and alternative sampling programs to the simulated fishery, comparing the performance of the sampling programs with respect to their replications of built-in size and age compositions in the simulated fishery, and identifying a cost-effective port sampling program for quantifying size and age compositions of commercial landings.

Finally, I strongly concur with the recommendations made by the LHG in their draft DW report regarding life history work for the GOM YG and tilefish, and I think all the issues raised in the report are critical to improve the life history data quality. The draft reports of the other two groups (IG and LDG) were not available when I prepared this report so I cannot make any comments regarding the recommendations they will list in the DW reports.

Assessment Workshop

No specific research recommendations were provided.

CIE REVIEW RECOMMENDATIONS – ASSESSMENT PROCESS

The research recommendations in the yellowedge grouper assessment report were all identifying appropriate areas for further investigation but a number of them were rather short on proposed investigative methodologies.

One proposal was to look at genetics. The application of genetics to fisheries management has had mixed success but here is a need to address stock structure and a regional genetics program may be able to address this issue, not only for this species but for others in the same position.

The fishery dependent research recommendations were both good but it is probably worth defining how much observer coverage would be required to provide adequate data from which to construct alternative indices. The additional fishery information obtained from an expanded observer program (on such things as discards) would, however, also be very welcome.

Direct aging of the Johnson otoliths from 1982 and 1983 is a low cost and worthwhile study that will directly feed into future assessments and specifically help to correct the paucity of data in the earlier years of the fishery.

Additional research recommendations have been identified by the reviewer and are presented below in priority order.

Reviewer Recommendations

• In a fishery with multiple data deficiencies, one of the objects of modeling is to identify those data sets that, by their inadequacy or absence, have a disproportionate impact on the outcome of the assessment. This then provides an independent assessment of the prioritization of future research effort aimed at improving the assessment most effectively. More could probably be made of this in defining immediate future research focus.

• Analyze existing data, or collect and analyze new data to confirm that the yellowedge grouper is composed of only a single stock. This could focus on a genetics program aimed at a number of species in the region, as this appears to be a shared problem amongst a number of species.

• Selection bias has occurred in yellowedge grouper age samples, with many more samples in recent years and more from some fishery areas than others (e.g. Florida). Some attempts to obtain a balance of samples from the different areas of (i) the fishery and (ii) the wider stock distribution should be developed and implemented

• While the recreational landings represent a small proportion of the landings it could be worth reviewing the biological data available as recreational fisheries often either target or catch different age or length components of the stock compared to other fisheries. This can be seen in differences between the handline and longline fisheries here. If this is the case then this small part of the fishery may contain useful information about length or age. A basic analysis of length and possibly otolith weight (as a proxy for age) would advise whether this merits further consideration.

• The core input data are in imperial units (lbs) while model processed data (e.g. weight at length or age) are presented in metric units. More importantly the landings/catch data are in lbs and model outputs are in kgs making comparison somewhat difficult. Input and output data should be presented in consistent units.

Review Workshop

The review panel was in agreement with the research recommendations from the Data and Assessment Workshop reports. These identify the main shortcomings in the data and assessment which might be improved by research. However, the recommendations are extensive and some priority may be placed so that research having the greatest impact on the assessment might be given priority.

Based on the observations made during the review, the RP suggested priority might be determined for the following research topics:

1. Research to improve abundance indices and their development from fishery-dependent and fishery-independent data sources would appear to have relatively high priority as they would have a great impact on the assessment. Topics could include, but not be limited to:
    - Improve precision in fishery-independent survey abundance indices by increasing the number of samples, including expansion into deeper water.

- Improve precision in fishery-independent survey abundance indices by expanding observer coverage to at least 5% of the area to provide additional accurate information adequate to construct indices of abundance. Observer data should provide finer spatial resolution, a more accurate measure of CPUE, size frequency and discard information that is currently unavailable in the self-reported dataset. Current observer coverage is inadequate for this purpose.
- Improve fishery-independent survey abundance indices by using logbooks to collect data on a set-by-set basis rather than per trip. This would allow for a much more accurate calculation of CPUE.
- Re-examination of the standardization of CPUE indices, both the models and the covariates (habitat, sediment, depth etc.).

2. For yellowedge grouper, ageing could be improved. There are historical otoliths collected off Florida during 1982-1983 which could be used if partitioned between species (e.g. using discriminant analysis). More age data might become available if the relationship between age and otolith weight could be developed. This could have a significant impact the stock assessment.
3. Research to improve stock definition and structure. For the stock assessment, the biggest impact of this sort of research is on the way data are broken down into areas to try to improve coherence within sub-sets of data. This suggests that priority for this sort of research should depend upon demonstrating that the data can support alternative stock structures and that there would be greater coherence within these subsets of data. There were no apparent cohorts identifiable in the age composition data from the two areas used in this assessment, but insufficient data to support break down into three areas. Improving the basic data through, for example, re-examination of the sampling design for size and age composition from the commercial fishery might have higher priority.
4. Research on life history is high priority, but should first and foremost be reflected in data collection before assessment model structure. While model structure might be seen as improved in representing real biological processes, such as protogynous hermaphroditism, unless there is sufficient monitoring and other data, the model will effectively be unable to incorporate the process in the assessment. One of the research recommendations which could prove important is to determine a more appropriate way to model spawning stock size for protogynous species.

In addition to research identified in the DW and AW, the RP recommends further work on the stock assessment modelling. The RP found results depended on how different sources of information were weighted, and alternative weighting schemes could be considered in developing future stock assessments. The age and length composition likelihood models appear appropriate, so research may be more focused on the abundance index standardization and ensuring their likelihood model and scale parameters are compatible with the age and length composition likelihood.

The RP also suggested some additional methods which would improve the absolute stock size estimate. These methods would help determine the shape of the selection curve, the value of M, and therefore would improve the MSY estimation. Even though M has been reasonably well estimated, the assessment is still very uncertain, because F and M are low, so further improvements in the estimate of M would be beneficial. Absolute stock estimates might be obtained from 1) underwater video surveys to count fish burrows; 2) deep water tagging, as done for redfish in the Irminger Sea; or 3) depletion fishing experiments within a small area (e.g. 1 x 1 km) combined with NMFS survey type long line fishing to estimate survey catchability, like that done in the REX project for cod and other species in the north-eastern North Sea.

Tilefish

Data Workshop

LIFE HISTORY WORKING GROUP

- In addition to the tilefish reproductive data needs (above), the WG recommends examination of the size frequency of commercial catch by month to examine potential inference concerning the sex ratio of the catch.
- Improve information on stock structure/rates of possible exchange between Gulf and Atlantic, including pathways for larval transport.
- Expand the fishery-independent long-line survey to deeper depths. In addition, increase collection of sediment/habitat data to allow post-stratification of survey results. Increased resolution of spatial population structure is important given the spatially divergent landings and demographic differences (east and western Gulf) and given the potential for localized over-exploitation within the larger Gulf of Mexico stock.
- Last, the WG recommends monitoring the possibility of increased discards/highgrading as ITQs (catch shares) is undertaken as a management approach.

Procedural Recommendation:

At points during the SEDAR 22 process, WG and DW panel members noted some confusion about "tilefish" as a species and as a species complex during discussions. Given the lack of clarity about common names for several species and their associated complexes, The WG recommends that scientific names be added to future SEDAR schedules and announcements.

COMMERCIAL STATISTICS WORKING GROUP

No recommendations were provided.

RECREATIONAL STATISTICS WORKING GROUP

No recommendations were provided.

INDICES OF ABUNDANCE WORKING GROUP

In the fishery-independent survey presented above, precision in abundance indices could be improved by increasing the number of samples at least two- to three-fold.

Research recommendations for fishery dependent data:
1.) Expand observer coverage to provide a subsample adequate to construct indices of abundance (Pelagic Longline Observer Progam has 5-8% coverage). Observer data provides finer spacial resolution and a more accurate measure of CPUE. It also provides size frequency and discard information that is currently unavailable in the self-reported dataset. Current observer coverage is inadequate for the construction of indices of abundance.

2.) Self logbook data should be restructured to collect data on a per set basis rather than per trip. This would allow for a more accurate calculation of CPUE. Data subsetting (determining targeting) would be vastly improved with set-based data.

CIE REVIEWER RECOMMENDATIONS - DATA WORKSHOP

Conclusions and recommendations

I would like to commend the great efforts of all the participating scientists, managers and fishermen in the SEDAR 22 DW in the identification, evaluation and compilation of the information on life history, fishery-dependent and fishery-independent abundance indices, and landings in the commercial and recreational fisheries for YG, tilefish (i.e., golden tilefish), and blueline tilefish in the GOM. I was impressed by the breadth of expertise and experience of the panelists, openness of discussion for considering alternative approaches/suggestions, and constructive dialogs in each working group and at the plenary meetings throughout the workshop. All the comments, whether they were from scientists, managers, or fishermen, were fully considered and discussed. In particular, I commend the inclusion in the Data Workshop of fishermen, who provided insights on the quality of the fishery data, in particular for historical fisheries data. I observed on many occasions constructive interactions and dialogs between scientists/mangers and representatives of the industry in the Workshop.

In general, I consider the information identified and compiled in the DW represents the best efforts given all the limitations associated with data quality and quantity. I consider the approaches used in developing life history parameters, fisheries landings, and abundance indices sound.

Having said that, I believe that there are large uncertainties associated with data identified and compiled in the DW, and that there is room for further improvement. I have made the following general comments and specific recommendations.

General comments

Although the SoW states that all the working papers and reference/background information for the workshop will be available two weeks before the workshop, only a few working papers (less than 25% of all the working papers promised) were available before the start of the workshop (not mention two weeks before the start of the workshop). Many working papers were still not ready in the middle of the workshop, which made my work difficult. The three separate working groups worked concurrently every day, making it impossible for me, as the only CIE reviewer, to be fully involved in each group's discussions.

I was told at the DW that Stock Synthesis 3 (SS3) will be used for the assessment of YG and tilefish. This choice of stock assessment model has direct impacts on the quality and quantity of the data that need to be evaluated and compiled in the Workshop. However, I observed that most DW panelists did not know exactly the data requirements, key assumptions, and options of the SS3 program. I recommend that future data workshop start with the introduction of the stock assessment model that will be used in the assessment so that data workshop participants understand the information needs of the stock assessment model.

I noticed that the time period that the SEDAR 22 assessment covers had not been defined prior to the DW. I suggest that a stock assessment time period be defined prior to the DW so that working groups can focus on the defined time period, and not waste time discussing data falling outside the target stock assessment. The DW may also be a good place to discuss and make a decision about the time period the stock assessment should cover.

There is a need to include scientific names for all species covered in the TORs and SoW. The tilefish is the official name of golden tilefish in the American Fisheries Society list of fish species. However, both golden tilefish and blueline tilefish were discussed at the Workshop. This creates some confusion. It is clear from all the discussions at this Workshop that the information for blueline tilefish is not sufficient for a formal stock assessment using an assessment model like SS3.

Specific recommendations

Although I have provided detailed comments and recommendations under each TOR, I re-iterate the following recommendations.

- Possible existence of local stocks for both species needs to be evaluated;
- More comparative studies need to be done to evaluate differences in data collected from different monitoring programs;
- More comparative studies need to be done to evaluate differences in parameters estimated using different methods to improve our understanding of the degree of uncertainty associated with these parameters;
- More comparative studies need to be done to evaluate spatial and temporal variability in key life history parameters, abundance indices and landings;
- More habitat variables need to be included in CPUE and abundance index standardization;
- General additive models need to be considered in standardizing abundance index and CPUE;
- Instead of using a point estimate as a bias correction factor in correcting potential biases in landings data, a range of correction factors can be used so that large uncertainty in landings data can be incorporated into the stock assessment;
- The quality of catch data (landings, catch size/age composition, catch sex ratio etc.) is probably the most questionable of the data available to the stock assessment for both fish species, and the stock assessment model should have an ability to incorporate uncertainty in catch data;
- A critical evaluation of fishery-independent monitoring programs should be done to identify problems associated with the current program design in quantifying population dynamics;
- A systematic mail survey/interview of fishermen who have been involved in the GOM YG and tilefish needs to be done to have a better understanding of the degree of

misreporting/underreporting and to identify if there is spatial and temporal variability in underreporting;

- It appears that outliers may exist in the assessment and given the data quality concerns, I suggest that robust estimation methods be used in the assessment (although this may be the choice of the modelers, but I believe that the Data Workshop is a place to make the recommendation because this is the place to deal with data quality issues);
- Uncertainty should be considered in all life history modeling, and confidence intervals should be estimated for the key life history parameters for the GOM YG and tilefish;
- Because of the extremely small YG catch in the SEAMAP bottom trawl survey, caution should be used in applying the derived abundance index, and the change in survey protocol in 1987 calls for a separate analysis of the two time periods and two different catchabilities in population modeling;
- Different measures for SSB should be considered for both tilefish and YG in stock assessment modeling; and
- I recommend conducting a systematic evaluation of current sampling programs for quantifying size composition and age composition of commercial catch. Factors such as adequate spatial and temporal coverage and sampling intensity to have high effective sample sizes should be considered. I recommend developing alternative sampling designs, developing a simulated fishery that mimics temporal and spatial variability in size and age compositions in commercial landings, applying current and alternative sampling programs to the simulated fishery, comparing the performance of the sampling programs with respect to their replications of built-in size and age compositions in the simulated fishery, and identifying a cost-effective port sampling program for quantifying size and age compositions of commercial landings.

Finally, I strongly concur with the recommendations made by the LHG in their draft DW report regarding life history work for the GOM YG and tilefish, and I think all the issues raised in the report are critical to improve the life history data quality. The draft reports of the other two groups (IG and LDG) were not available when I prepared this report so I cannot make any comments regarding the recommendations they will list in the DW reports.

Assessment Workshop

In addition to the recommendations made in the SEDAR 22 Data Workshop Report, the AP makes the following recommendations for research and data collection.

- In a fishery with multiple data deficiencies, one of the objects of modeling is to identify those data sets that, by their inadequacy or absence, have a disproportionate impact on the outcome of the assessment. This then provides an independent assessment of the prioritization of future research effort aimed at improving the assessment most effectively. More could probably be made of this in defining immediate future research focus.

- Analyze existing data, or collect and analyze new data to confirm that the tilefish is composed of only a single stock. This could focus on a genetics program aimed at a number of species in the region, as this appears to be a shared problem amongst a number of species.

- Review the information about distribution of tilefish age in time and geographical area with a view to obtain better quality data going forward (i.e. attempts to obtain a balance of samples from the different areas of (i) the fishery and (ii) the wider stock distribution should be developed and implemented).

- Evaluating whether the amount of remaining quota influences how landings are reported by species should be considered.

- While the recreational landings represent a small proportion of the landings it could be worth reviewing the biological data available as recreational fisheries often either target or catch different age or length components of the stock compared to other fisheries. If this is the case then this small part of the fishery may contain useful information about length or age. A basic analysis of length and possibly otolith weight (as a proxy for age) would advise whether this merits further consideration.

CIE REVIEW RECOMMENDATIONS – ASSESSMENT PROCESS

The research recommendations in the tilefish assessment report were all identifying appropriate areas for further investigation but a number of them were rather short on proposed investigative methodologies.

One proposal to look at stock structure should be part of a larger, probably genetics program to look at regional stock structure in a number of similar species.

The fishery dependent research recommendations were both good but it is probably worth defining how much observer coverage would be required to provide adequate data from which to construct alternative indices. The additional fishery information obtained from an expanded observer program (on such things as discards) would, however, also be welcome.

Additional research recommendations have been identified by the reviewer and are presented below in priority order.

Reviewer Recommendations

• In a fishery with multiple data deficiencies, one of the objects of modeling is to identify those data sets that, by their inadequacy or absence, have a disproportionate impact on the outcome of the assessment. This then provides an independent assessment of the prioritization of future research effort aimed at improving the assessment most effectively. More could probably be made of this in defining immediate future research focus.
• Analyze existing data, or collect and analyze new data to confirm that the tilefish is composed of only a single stock. This could focus on a genetics program aimed at a number of species in the region, as this appears to be a shared problem amongst a number of species.
• Review the information about distribution of tilefish age in time and geographical area with a view to obtain better quality data going forward (i.e. attempts to obtain a balance of samples from the different areas of (i) the fishery and (ii) the wider stock distribution should be developed and implemented).
• Evaluating whether the amount of remaining quota influences how landings are reported by species should be considered.
• While the recreational landings represent a small proportion of the landings it could be worth reviewing the biological data available as recreational fisheries often either target or catch different age

or length components of the stock compared to other fisheries. If this is the case then this small part of the fishery may contain useful information about length or age. A basic analysis of length and possibly otolith weight (as a proxy for age) would advise whether this merits further consideration.
• The core input data are in imperial units (lbs) while processes data (e.g. weight at length or age) are presented in metric units. More importantly the landings/catch data are in lbs and model outputs are in kgs making comparison somewhat difficult. Input and output data should be presented in consistent units.

Review Workshop

The review panel was in agreement with the research recommendations from the Data Workshop and Assessment Workshop reports. These identify the main shortcomings in the data and assessment which might be improved by research. However, the recommendations are extensive and some priority may be placed so that research having the greatest impact on the assessment might be given priority.

The RP noted that the AP suggested using the models to identify the most important data deficiencies to prioritize research and that more work on this could be undertaken. Based on the observations made during the review, the RP suggested priority might be determined for the following research topics:

5. Research to improve abundance indices and their development from fishery-dependent and fishery-independent data sources would appear to have relatively high priority as they would have a great impact on the assessment. Topics could include, but not be limited to:

- Improve precision in fishery-independent survey abundance indices by increasing the number of samples, including expansion into deeper water.
- Improve precision in fishery-independent survey abundance indices by expanding observer coverage to at least 5% coverage to provide additional accurate information adequate to construct indices of abundance. Observer data should provide finer spatial resolution, a more accurate measure of CPUE, size frequency and discard information that is currently unavailable in the self-reported dataset. Current observer coverage is inadequate for this purpose.
- Improve fishery-independent survey abundance indices by using logbooks to collect data on a set-by-set basis rather than per trip. This would allow for a much more accurate calculation of CPUE.
- Re-examination of the standardisation of CPUE indices, both the models and the covariates (habitat, sediment, depth etc.).

6. Research to improve stock definition and structure. For the stock assessment, the biggest impact of this sort of research is on the way data are broken down into areas to try to improve coherence within sub-sets of data. This suggests that priority for this sort of research should depend upon demonstrating that the data can support alternative stock structures and that there would be greater coherence within these subsets of data. There were no apparent cohorts identifiable in the age composition data from the two areas used in this assessment, but insufficient data to support break down into three areas. Improving the basic data through, for example, re-examination of the

sampling design for size and age composition from the commercial fishery, might have higher priority.

7. Research on life history is high priority, but should first and foremost be reflected in data collection before assessment model structure. While model structure might be seen as improved in representing real biological processes, such as protogynous hermaphroditism, unless there are sufficient monitoring and other data, the model will effectively be unable to incorporate the process in the assessment.

In addition to research identified in the DW and AW, the RP recommends further work on the stock assessment modelling. The RP found results depended on how different sources of information were weighted, and alternative weighting schemes could be considered in developing future stock assessments. The age and length composition likelihood models appear appropriate, so research may be more focused on the abundance index standardisation and ensuring their likelihood model and scale parameters are compatible with the age and length composition likelihood.

The RP also suggested some additional methods which would improve the absolute stock size estimate. These methods would help determine the shape of the selection curve, the value of M, and therefore would improve the MSY estimation. Even though M has been reasonable well estimated, the assessment is still very uncertain, because F and M are low, so further improvements in the estimate of M would be beneficial. Absolute stock estimates might be obtained from 1) underwater video surveys to count fish burrows; 2) deep water tagging, as done for redfish in the Irminger Sea; or 3) depletion fishing experiments within a small area (e.g. 1 x 1 km) combined with NMFS survey type long line fishing to estimate survey catchability, like that done in the REX project for cod and other species in the north-eastern North Sea. This last method may be particularly suitable for tilefish, which is a sedentary species.

SEDAR 23: FWC Goliath Grouper

Data Workshop

LIFE HISTORY WORKING GROUP

Stock Definition:

- D. Jones has new MARFIN funding to use otolith microchemistry (laser ablation) to determine if there are distinct subpopulations based on geographic differences in chemical signatures. Juvenile habitat would be represented at the origin of otolith, adult habitat at the margins (SA and/or Gulf) ***goliath grouper were not originally considered in this MARFIN proposal, but could easily be added with availability of otoliths and moderate time resources.*
- Koenig referenced the availability of goliath grouper eggs from the SA and GOM which could be used for genetic population structure analysis. Eggs will be sampled for Dr Matthew Craig (U Puerto Rico) who has done the most extensive work on goliath grouper population genetics (Craig et al. 2009)
- Description of larval stages of goliath grouper is part of an ongoing MARFIN project by Koenig and Coleman.
- Limited recent drifter studies along the US South Atlantic coast have shown the potential for wide distribution patterns along the coast from Cape Hatteras to the Florida Keys (Lesher and Sedberry, SEDAR 10-DW-06). With location and timing of spawning now known, it would be a good opportunity to initiate additional drifter studies in the SA and GOM.
- Ongoing research (Koenig and Coleman) will verify known SPAGS and suspected SPAGS. It will also determine the size structure of spawning fish, their residency time on the SPAGS, and size-related fecundity. With more known SPAGS, there is the potential to assess the abundance of reproductive adults based on numbers present at SPAGS and knowing the geographical range of the participating spawners.

Age and Growth:

- A directed effort to collect hard parts from large, old fish to validate these methods for old individuals.
- More detailed information on maximum age and size is needed. There are no new data available for maximum age or maximum size since Bullock et al. 1992. There is reason to suspect that maximum age is a low estimate due to the small number of large, old fish sampled. Additionally, there is concern over whether or not the asymptote is fully represented due to the low number of samples represented at the oldest ages (Fig.1). However, this maximum age does fall within the values observed for other epinephelines [i.e., *E. fuscoguttatus* (42 y for females and 40y for males; Pears, 2006), *E. morio* (29 y; Lombardi-Carlson et al., 2006), *E.*), *H. nigitus* (41 y; Manooch, 1987), *E. striatus* (29 y; Sadovy and Ecklund 1999)]. However, the best species for

comparison (due to similar size, tropical/subtropical distribution and ecological role) are the Indo-Pacific *E. lanceolatus* and *E. tukula*; data on maximum size, age and growth rate are still being sought at the time of writing the present report.

- As suggested during the last SEDAR (SEDAR6, 2004): "The panel recommended continued work on ageing. Ages should be standardized to a calendar year, so that information on a year class is treated consistently throughout the year."

Reproduction

- Ongoing research (Koenig and Coleman, MARFIN) will evaluate fecundity, sexual pattern, SPAG distribution, size structure and sex ratio within SPAGS, and mating system using non-lethal methods.

Habitat and Movement:

- We need spatially-explicit models. Due to microhabitat preferences and site attachment in both juvenile and adult goliath groupers, density values (as number of individuals per unit area or length of coastline) should be used with caution in population estimates and modeling; it is essential to contrast densities in high quality habitats versus low quality habitats, and not use a single density value which could results in over-estimates of total population levels. Future modeling efforts should also account for the known (or unknown) statewide spatial distribution of both juveniles and adults.
- We need a state-wide evaluation of habitat quality integrating habitat structure and water quality. Including this knowledge in our goliath grouper assessments will allow us to expand population models into ecosystem-based management.
- What is the extent of high quality mangrove habitat, and where is it located in Florida? There is a need for a state-wide assessment of mangroves as fish habitat, to evaluate potential high quality sites that are the nurseries, not only for juvenile goliath grouper but also for juveniles of a diverse group of other fish and invertebrate species.
- When evaluating high quality habitat (both in mangroves and reefs), in addition to evaluating the structural characteristics, what is the water quality of each habitat? There is a need to quantify, state-wide in real time and 24/7 the water quality (salinity, temperature, dissolved oxygen) of mangroves, and coastal reefs. This research question applies not only to goliath grouper but also to all estuarine and coastal species that use mangroves and reefs (coral reefs, reef ledges) during their life history.
- What are the biological corridors used during the ontogenetic migrations (from juvenile mangrove habitat to reef adult habitat) and the spawning migrations (from resident habitat to spawning aggregation sites)? We don't know if goliath grouper use a specific path or network (=biological corridor) during their two major migratory events (ontogenetic and reproductive).

- What are the maximum distances that can be covered by juveniles in ontogenetic migrations towards the adult habitat, and by adults in their spawning migrations? These data are needed to understand the ontogenetic and spawning connectivity within the goliath grouper population.

COMMERCIAL AND RECREATIONAL STATISTICS WORKING GROUP

The prohibition on any harvest of goliath grouper precludes any fishery dependent research other than that conducted by on-board observers or recorded in fishermen's logbooks. Continued collection of size, frequency in the catches by gear, and observed release condition is important for obtaining release mortality estimates and possibly an estimate of numbers caught by gear, fishing area, and depth. It is expected that as the abundance of this species increases, so too will the frequency of encounter with fishing gears. Brusher and Schull's (2009) study that goliath grouper have a reasonably good chance of surviving the encounter with fishing gear at least in shallower waters. Capture-recapture studies could be designed to examine the effects of releases from the recreational fishery. With the apparent increase in numbers of goliath grouper reported by anglers, it is inevitable that more encounters with fishing gear will occur and this seems to be borne out by reports from angler surveys such as the ENP Angler Creel Survey and the MRFSS. Surveys of spawning aggregations are needed to extend the usefulness of Don DeMaria's earlier surveys and to monitor population trends of adults.

INDICES OF ABUNDANCE WORKING GROUP

No research recommendations were provided by the Working Group.

Assessment Workshop

Recommendations on future research and data collection were provided at the DW. An additional recommendation for a "research fishery" was briefly discussed at the Assessment Workshop (AW), but was never formalized.

Review Workshop

Although results were unsatisfactory for this stock assessment, they did serve to clarify additional research necessary for future assessment efforts. The next benchmark assessment cannot be successfully completed without data from the research recommended by the Data, Assessment, and Review Panels.

<u>Stock Definition:</u>

- Goliath grouper should be genetically sampled from as many areas in the South Atlantic and Gulf of Mexico as possible to allow for a more thorough examination of the current single stock definition.
- Examination of spawning aggregations over the entire distribution range should include seasonality, sex ratios, and individual fidelity.

<u>Long-term monitoring</u>:

- Basic reproductive data are lacking throughout the species distribution, including: size and age at maturity for each sex, sexual sequence with size and age for each sex, and fecundity.
- As described in the above research recommendations by the Life History Working Group, research on age structure, and locations of suitable juvenile and adult habitat, discard and discard mortality rates should be accomplished throughout the species distribution

Economic impact:

- Because of the relatively small size of a potentially reopened consumptive fishery for goliath grouper, a socio-economic evaluation of the relative benefits of consumptive versus non-consumptive uses would be beneficial. There may be greater long-term economic benefit to development of sustainable non-consumptive eco-tourism venues than would be possible from a consumptive fishery.

SEDAR 24: South Atlantic Red Snapper

Data Workshop

Workshop Term of Reference #10 called for the Data Panel to provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment; and to include specific guidance on sampling intensity (number of samples including age and length structures) and appropriate strata and coverage.

Life History Work Group

The life history WG recommended the following:

- Age Reading Comparisons Continuing the age reading comparisons and calibrations between labs on a reference collection of known age fish would be beneficial for determining a more accurate aging error matrix and would provide accuracy to the age composition data.

- Movements and Migrations More research on red snapper movements/migrations in Atlantic waters is needed. Available data and the results of studies in the Gulf of Mexico indicate high site fidelity. Tropical storms may cause greater than normal movement.

Commercial Work Group

The Workgroup reviewed recommendations from SEDAR 15 and offers additional recommendations. The Commercial WG notes that Sea Grant is currently funding a video monitoring program for observing the snapper-grouper fishery using exemption permits with 7 total vessels participating (1 in NC, 2 each in SC, GA, and FL).

The commercial WG recommended the following:

- Electronic Logbooks
- More observers
    - 5-10% allocated by strata within states
    - Possible to use exemption to bring in everything with no sale
    - Get maximum information from fish
- Angler education with regards to recording depths on paper logbooks
- More precise depths by species from port agents (would require data base change)
- Expand TIP sampling
    - Reallocate samplers for at-sea observer trips
    - Improve sampling from Florida's handline and dive gear where most of the effort and landings are from.
- Continue to sample more ages (proportional to effort), although large numbers of ages were sampled in the most recent years, especially 2009.

Recreational Work Group

The recreational WG recommended the following:

- In order to separate PR and CH catch data, more age data are needed, particularly from the PR mode.
- Continued research efforts to incorporate/require logbook reporting from recreational anglers.
- Quantify historical fishing photos for use in future SEDARS.
- MRFSS At-SEA observer program in NC, SC and GA should collect depth fished data. Standardize data elements within this program.
- Headboat Survey logbook should also collect depth information.
- Continued research efforts to collect discard length and age data from the private sector.
- Improve metadata collection in the recreational fishery.

Indices Work Group

The indices Work Group recommended the following:

- More fishery independent data collection
- Exploration of the Stephens and MacCall trip selection method and alternatives methods
    - Explore the use of actual landings rather than presence/absence for other species for trip selection
- Evaluate how fishermen preferences change over time and whether such changes affect CPUE
- Increase observer coverage, including information on area fished and depth
- Examine how catchability has changed over time with increases in technology and potential changes in fishing practices. This is of particular importance when considering fishery dependent indices
- Investigate potential density-dependent changes in catchability

Analytic Approach Work Group

There were no research recommendations from the Analytic Approach working group.

Discards Mortality Work Group

The discards mortality WG recommended the following:

- More hooking, size, and depth related discard mortality studies
- Angler education
- More accurate depths by species from logbooks
- Survey of fishermen and scientists to possibly get information on depth of areas fished and species abundance

More species specific depth information collected by port agents

Assessment Workshop

Assessment Process I Term of Reference #10 called for the Assessment Panel to provide recommendations for future research and data collection.

The assessment panel recommended the following:

- Fishery independent surveys of reef fishes in the Southeast were expanded in 2010 and continued expansion is recommended. These data should be made available for future assessments of red snapper.
- More information on age/length composition of discards from various fleets would improve stock assessment of reef fishes in the Southeast, including red snapper. A recreational discard reporting system would benefit future assessments.
- More information on discard mortality rates would improve stock assessment of reef fishes in the Southeast, including red snapper.
- More detailed spatial and temporal resolution of fishing effort for each fleet would likely improve assessments.
- Methods to characterize uncertainty in assessment results deserve further consideration. For avoiding overfishing, characterizing uncertainty is more than an academic exercise, particularly when relying on probabilistic methods to set catch levels.
- Compared to other fishes, red snapper mature very young relative to their life span. This is consistent with the hypothesis that maturation, as a character trait, is influenced by exploitation. Assessments and management could be improved by better understanding plasticity in life-history traits (such as maturation), as well as evolutionary effects of exploitation.
- Depth appears to be important component of population and fishery dynamics for red snapper. Spatial assessment models might be able to address depth explicitly, if migration rates among strata were better understood.
- Increased fishery independent sampling of larvae and juveniles.
- Increased TIP sampling.
- Increased sampling of recreational sector.
- Examine or develop ways to include anecdotal information in SEDAR assessments.

Review Workshop

The Review Panel suggested some recommendations, categorized as more important (Tier 1) and less important (Tier 2).

Tier 1

• Investigate alternate stock recruitment models, and in particular the robustness of stock status conclusions to reasonable alternative stock-recruit assumptions.

• Consider estimating missing catch (e.g., recreational) within the model to improve consistency. An example of such an approach is the B-ADAPT model applied to North Sea cod.

• Review historical records for determining historical average weights of fish. This is consistent with a DW recommendation.

• The Review Panel agreed with the DW and AW recommendations to improve age sampling. In particular, this should improve the estimation of fishing mortality in BAM.

• The Review Panel agreed with the DW and AW recommendations to continue developing fishery-independent abundance indices, especially because assumed changes in catchability of CPUE indices for red snapper are uncertain.

• Explore changes in catchability in light of other species involved in the mixed species fisheries that catch red snapper. The Review Panel anticipates that changes in catchability may be consistent among some of these species.

Tier 2

• Consistent with the AW recommendation regarding "plasticity in life-history traits", the Review Panel recommends investigating for temporal variation in growth and maturation rates, especially when such characteristics often show a density-dependent response.

• Tagging studies can provide relatively direct estimates of fishing mortality and selectivity, growth rates, and other stock assessment parameters. Where possible, information from tagging studies that are representative of the stock as a whole should be incorporated into the assessment.

SEDAR 25: South Atlantic Black sea bass and golden tilefish

Black sea bass

Data Workshop

Life History

- Investigate the movements and migrations of black sea bass using otolith microchemistry, genetic studies, and expanding tagging studies.
- Investigate the movement and mixing of larval and juvenile black sea bass within the U.S. South Atlantic region.
- Sampling to include the entire Southeast region over a longer time period.
- Analyze size- or age-specific spawning frequency and spawning seasonality.
- Further develop the tagging model described by Rudershausen et al. (2010) to address the assumptions of the model.
- Depth appears to have an effect on the discard mortality rate. Currently depth-specific discard rates and estimates of discard numbers are not available. There is very little depth specific information on the private recreational fleet.
- Temperature and seasonality of discard mortality should be investigated.
- Circle hooks are now required by the SAFMC for fishermen operating in the snapper grouper fishery. The impact of this regulation cannot currently be incorporated into the discard mortality rate.
- Venting is not required in the South Atlantic but it is required in the Gulf of Mexico for snapper grouper fishermen. Research should be conducted on a variety of recompression techniques to determine the most effective method for reducing discard mortality.

Commercial Statistics

- The Commercial Workgroup recommends study of migration patterns, focusing on fish movements around the Cape Hatteras, NC area.
- Additionally, the group would suggest determining the impact/landings of the historical foreign fleet in the South Atlantic.
- Finally, collection of better spatial information in the fishery to determine potential localized depletion effects is recommended.

Recreational Statistics

- Increase sample size of at-sea observers and dockside validation for HB mode.
- Increase proportion of fish with biological data within MRFSS sampling.
- Development of hard part sampling coordinated with intercept surveys.
- Continue development of standardized method for calculating incomplete weight data
- Quantify historical fishing photos for use in future SEDARS.
- Develop method for capturing depth at capture within MRFSS At-Sea observer program and Headboat Survey.
- Conduct study looking at current compliance rates in logbook programs, develop recommendations for improving them, including increased education directed toward effect of not reporting accurately.
- Continued development of electronic reporting of headboat logbook for full implementation

- Continued development of higher degree of information of condition of released fish e.g. FL as the model
- Continued evaluation of methodology for mandatory reporting in the For-hire sector e.g. Gulf MRIP Pilot

Indices
- None submitted.

Assessment Workshop

- The assessment panel recommended increasing the number of age samples collected from the general recreational sector.

- Black sea bass in the southeast U.S. were modeled in this assessment as a unit stock, as recommended by the DW and supported by genetic analysis (SEDAR-25-RD42). For any stock, variation in exploitation and life-history characteristics might be expected at finer geographic scales. Modeling such sub-stock structure would require more data, such as information on the movements and migrations of adults and juveniles, as well as spatial patterns of recruitment. Even when fine-scale spatial structure exists, incorporating it into a model may or may not lead to better assessment results (e.g., greater precision, less bias). Spatial structure in a black sea bass assessment model might range from the very broad (e.g., a single Atlantic stock) to the very narrow (e.g., a connected network of meta-populations living on individual reefs). What is the optimal level of spatial structure to model in an assessment of snappergrouper species such as black sea bass?

- The assessment time period (1978–2010) is short relative to some other assessments of South Atlantic reef fishes. Extending the assessment back in time might provide improved understanding of the stock's potential productivity and therefore sustainable yield, assuming the historic productivity is still relevant. Such an extension would require historic landings estimates from all fleets in operation. Although historic estimates from the commercial sector are available, those from the recreational sector are not. Hindcasting the historic recreational landings might require the development of new methods, or at least analysis of existing methods.

- Protogynous life history: 1) Investigate possible effects of hermaphroditism on the steepness parameter; 2) Investigate the sexual transition for temporal patterns, considering possible mechanistic explanations if any patterns are identified; 3) Investigate methods for incorporating the dynamics of sexual transition in assessment models.

- In this assessment, the number of spawning events per mature female per year assumed a constant value of $X = 31$. That number was computed from the estimated spawning frequency and spawning season duration. If either of those characteristics depends on age or size, X would likely also depend on age or size. For black sea bass, does spawning frequency or spawning season duration (and therefore X) depend on age or size? Such dependence would have implications for estimating spawning potential as it relates to age structure in the stock assessment.

- For this assessment, the age-dependent natural mortality rate was estimated by indirect methods. More direct methods, e.g. tag-recapture, might prove useful. Some tag-recapture studies have demonstrated relatively high tag return rates for black sea bass, at least compared to those of other reef fishes of the southeast U.S.

Review Workshop

The RP was in agreement with the research recommendations from the Data Workshop and Assessment Workshop reports. These identify the main shortcomings in the data and assessment which might be improved by research. It is worth noting that alongside any improvements in methodology and information, allowance should be made for backwards compatibility with existing long time-series. The recommendations are extensive and some priority may be placed so that research having the greatest impact on the assessment might be given the greatest priority.

High Priority

Life history: There are a number of uncertainties over the life history of this species which are critical in setting up reliable age-structured stock assessment models. Any studies that improve understanding of size or age specific spawning frequency, spawning seasonality, and functions modeling sex-change should be given high priority, particularly because they are critical in defining SSB and therefore stock status. This is particularly important in black sea bass because it depends on a calculation of female fecundity where mortality is apparently focused on the males (protogyny with age specific selectivity and low undersize discard mortality).

Ageing: Age data is an important part of the assessment. Where possible, age sampling should be improved in terms of coverage by maximizing the number of trips sampled from both the recreational and commercial landings and discards.

Discards: Discards make up a significant proportion of the catch, but mortality of discards is estimated as low. This mortality estimate is important in the stock assessment, and research to improve its accuracy could have significant impact on the assessment. Studies could improve estimates by relating mortality to temperature and depth and improving the routine collection of temperature and depth data. Also, any improvement on estimates of discards and research that would reduce discard mortality (e.g. hook type, venting) should have high priority.

Recreational Statistics: The RP believed that research recommendations with the objective of improving recreational statistics could have significant impact on the black sea bass stock assessment. Any program to improve recreational fishery data would cover a wide number of other stocks making it efficient. High priority research and data collection should include improvements in the headboat survey, in methods to estimate weight from length, compliance with logbook programs and development of electronic logbooks where appropriate. Also, the improvements would be enhanced with the research on discards, discard mortality and ageing outlined above.

Historical catches: The AW recommended extending the catch history further back than 1978. The RP considers that this is a high priority as it can significantly change the perception of the productivity of the stock. However, it should be noted that any such extension is almost always associated with great uncertainty both in the estimation of historical catch and in the implicit comparison with a historical baseline that might have changed due to climate and other factors.

Medium Priority

Stock structure: A number of research recommendations by the DW and AW indicated possible ways to improve definitions of stock structure (e.g. genetic analyses). The RP found no very significant problem with this issue in this assessment. However, stock structure, including smaller scale spatial structure, movement and resident times could be valuable. The AW also suggested carrying out simulations to look at how spatial data and models might be included in a stock assessment, and the RP agrees that this might be a good start point before more expensive research is undertaken.

Indices: Abundance indices are usually the main information drivers in the stock assessments in these fisheries. The RP recommended improving the fishery independent index if possible, ensuring geographical coverage of the stock is complete. Also, local absolute stock size estimates might be obtained from underwater video surveys, tagging, depletion fishing experiments within a small area, or some combination of these three. Estimating absolute biomass should be done in a way which is informative on catchability and selectivity in the model (could be included as a prior, for example).

Recreational Statistics: Some research on the recreational fishery, while useful, was in the opinion of the RP, less urgent. This included analysis of historical photos to obtain lengths, research to obtain and interpret condition information on discarded fish and the evaluation of some data collection programs.

Life history: The AW recommended looking at estimating age-dependent natural mortality directly. While the RP recognized that natural mortality is an important parameter, estimating this quantity is likely to be very difficult and may not be practical. Similarly, ontogenetic migration and other movement patterns, a possible cause of dome-shaped selectivity and local depletion, could be investigated. If a tagging program was being implemented for other purposes, these issues could and should be included.

Recruitment Patterns: The RP noted that the apparent variance in the recruitment residuals had decreased over time. The recruitments are estimates of the model, so it was not necessarily clear that this was a real change in the stock dynamics, random chance or an artifact of the model. Nevertheless, the RP believed that some simple research to support or discount recruitment change could be undertaken by reviewing recruitment in other stocks or correlating this change with environmental variables where some causal link could be hypothesized.

Low Priority

The Commercial Statistics working group suggested examining the impact of the historical foreign fleet. However, the RP believed that the impact of any activities on black sea bass would be low, obtaining any data would be difficult and could be unsuccessful.

Ultimately the interval between the current and next assessment is a policy decision, requiring scientific input. The RP wants to highlight scientific factors that should be taken into consideration when making this decision. The current black sea bass assessment indicates the stock is not overfished, but not yet rebuilt; and is undergoing overfishing. This indicates the stock is likely in need of regular assessments to track its status, ensure overfishing ends, and the stock is on a trajectory to rebuild. No new data sources are expected to be available, at least in the short term, limiting the utility of conducting a new benchmark assessment in the short term.

If management actions change, conducting a new assessment after their implementation has the potential to identify the impacts of the new management actions on the stock, as well as better identify the stock's dynamics. A new assessment could provide improved information on benchmarks such as MSY or status indicators such as B/B_{MSY}.

The RP recommends that assessment updates be conducted regularly, at the interval of a high risk stock, and more often in response to changes in management regulations. If an update assessment indicates the stock's status is declining or new data become available, the RP recommends moving forward with a full benchmark assessment.

Tilefish

Data Workshop

Life History

- Investigate the movements and migrations of Tilefish using Otolith microchemistry
- Investigate the stock definition through genetic studies to establish if biogeographic boundary exists at Cape Hatteras or if future assessments will use the NC/VA border.
- Fishery-dependent and fishery-independent sampling to include the entire Southeast Region throughout a longer time period.
- Analyze size or age specific spawning frequency and spawning seasonality.

Commercial Statistics

- The Commercial Workgroup recommends exploration of the definition of the stock, particularly with respect to the northern boundary.
- Additionally, the group would suggest examining the impact/landings of the historical foreign fleet in the South Atlantic.
- Finally, collection of better spatial information in the fishery to determine potential localized depletion effects is recommended.

Recreational Statistics

- Continue development of standardized method for calculating incomplete weight data
- Develop method for capturing depth at capture within MRFSS At-Sea observer program and Headboat Survey.
- Conduct study looking at current compliance rates in logbook programs, develop recommendations for improving them, including increased education directed toward effect of not reporting accurately.
- Continued development of electronic reporting of headboat logbook for full implementation
- Continued development of higher degree of information of condition of released fish e.g. FL as the model

Indices

- None provided.

Assessment Workshop

- The assessment panel made the following recommendations.
- Increasing the number of age samples collected from the main part of the species' range
- Investigate reproductive characteristics, particularly regarding whether senescence or hermaphrodism occurs in the species
- Improve the genetic data available by conducting studies of gene similarities by region
- Investigate whether a climate-recruitment link exists
- Investigate whether time varying M may be appropriate for tilefish
- Evaluate patterns in ageing error at the data workshop including development of an ageing error matrix
- Obtain MRIP intercept numbers at the DW for tilefish and other rarely caught species

Review Workshop

The RP was in agreement with the research recommendations from the Data Workshop and Assessment Workshop reports. These identify the main shortcomings in the data and assessment which might be improved by research. However, the recommendations are extensive and some priority may be placed so that research having the greatest impact on the assessment might be given the greatest priority.

High Priority

Life history: There are a number of uncertainties over the life history of this species which are critical in setting up reliable age-structured stock assessment models. Some of this basic information is lacking, such as whether the species exhibits hermaphroditism. For example, in the Gulf of Mexico tilefish assessment (SEDAR 22), protogynous hermaphroditism was included in the model, whereas in this assessment it was not. Any studies that improve understanding of size or age specific spawning frequency, spawning seasonality, and functions modeling sex change should be given high priority, particularly because they are critical in defining SSB and therefore stock status.

Movement: Several recommendations relate to fish movement. The RP recommends research on local population structure related to residence times and local migration, whether by tagging or alternative methods. Understanding fish movement should help understand how catches might cause local depletion and over what area. This could lead to improved data collection and use of spatial data in tractable way within the model.

Indices: Abundance indices are usually the main information drivers in the stock assessments in these fisheries. The RP recommends developing a fishery independent index, which eventually would greatly improve the determination of stock status. Also, local absolute stock size estimates might be obtained from underwater video surveys (e.g. counting fish burrows), tagging, depletion fishing experiments within a small area, or some combination of these three. Estimating absolute biomass should be done in a way which is informative on catchability and selectivity in the model (could be included as a prior, for example). This last method may be particularly suitable for tilefish, which is probably a relatively sedentary species.

Medium Priority

Stock structure: A number of research recommendations by the DW and AW indicate possible ways to improve definitions of stock structure (e.g. genetic analyses). The RP found no very significant problem with this issue in this assessment. However, it may be that tilefish could be included in a wider program looking at stock structure of a variety of species which perhaps could also include Gulf of Mexico as well as the southern North Atlantic.

Recreational Statistics: The RP believed that research recommendations with the objective of improving recreational statistics would most likely have limited impact on the tilefish stock assessment, and hence these only have medium priority. However, any program to improve recreational fishery data is likely to cover a wide number of other stocks where such data may be more critical. Therefore, any such program as a whole may be given high priority.

Low Priority

The Commercial Statistics working group suggested examining the impact of the historical foreign fleet. However, the RP believed that the impact of any activities on tilefish would be low, obtaining data would be difficult and could be unsuccessful.

SEDAR 26: Caribbean Queen Snapper, Silk Snapper, and Redtail Parrotfish

Silk Snapper

Data Workshop

LIFE HISTORY WORKING GROUP

- It will be important to develop regional sampling programs to collect age and growth data for silk snapper, queen snapper, and redtail parrotfish to estimate growth parameters essential to length-based analyses. Estimates of age-growth parameters are currently limited for the three species in question, therefore, it is essential to continue to build upon the existing published research.
- Regional data collection programs should also be designed to evaluate morphological conversion factors for each species. There is a lack of consistency in the units of measure for length among the studies reviewed by the LHWG. An important area of research will be to develop length-length conversion factors for the three species.
- Length-at-full vulnerability is an important input for length-based analyses. Expansion and improvement of the TIP program will be crucial for continued collection of species-specific size information, which be used to estimate length-at full vulnerability.

PUERTO RICO CATCH STATISTICS WORKING GROUP

- Commercial Landings Expansion Factor - all recommendations are in progress. Port samplers are visiting different fishing centers, collecting data of landings by trip, species and effort
- The working group also recommended that the uncertainty in the annual reported landings be characterized by computing the variance of the expansion factors and confidence intervals about the calculated total landings.
- Increasing the dockside sampling of recreational fishing trips in Puerto Rico to reduce the uncertainty in the catch estimates and 2) 20 extending / initiate MRIP's efforts in the US Virgin Islands to quantify the magnitude of recreational catches. In addition, recreational effort.
- The recreational statistics Program recommends increasing the minimum number of trip interviews to 130 for shore fishing, 200 for private boats and 90 for charter boats.
- There is an immediate need to develop sampling efforts to better identify and quantify discards in the commercial fisheries.

USVI CATCH STATISTICS WORKING GROUP

- Initiate MRIP's efforts in the US Virgin Islands to quantify the magnitude of recreational catches.
- It is important to determine the efficacy of expansion factors used to estimate total catch. The information used to calculate expansion factors by year need to be verified.

- The collection of landings statistics in the U.S.V.I. should be species-specific because analysis of the current species-groupings is not informative for stock assessments. Species composition from TIP is not appropriate, given the current sampling methodology, for estimating species-specific landings using ratio estimators.
- It is 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.

FISHERY INDEPENDENT RESEARCH

- Continuation of ongoing, long term research may provide additional information for future assessments.

INDICES OF ABUNDANCE WORKING GROUP

- Well-designed, systematic research programs are essential to providing the data necessary for effective management. Much of the research reviewed lacked the necessary sample sizes and regular (ongoing) data collection needed to construct an adequate time series of catch and abundance indices
- A commitment to long-term research and data collection is essential for effective management. Short-term research and data collection are not the solution to the data problems identified in this assessment. Long-term research and monitoring are necessary in the Caribbean, as in any other managed fishery
- 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. Fishery-independent surveys and the collection of other biological data, however, are extremely important to develop alternative indices of abundance.
- Need to continue efforts to develop partnerships with local fishermen to conduct research and to collect needed data. Partnerships with the fishing community and other stakeholders are a cost effective way to collect components of the data necessary for the assessment process

Assessment Workshop

Research efforts are needed that focus on improved data collection efforts, particularly on better quantification of trip based catch and effort and recording of more detailed geographical data on catch area. Surveys should be considered that will allow validation of fisher reported catch, landings, and trip effort. Surveys are needed that allow characterization of multi- species trips to allow identification of trips that split fishing effort across different gears and species groups. These surveys should be coordinated with fisher groups to enhance support by the industry. The ability to characterizing trip specific CPUE data by life history stage is needed to aid in quantifying size or age specific abundance trends.

Length-frequency data and the corresponding age-growth relationships will likely serve as the primary mechanism to inform assessments in the US Caribbean in the near future. A direct focus on

increasing sampling intensity with a well-designed program (as being developed in the current Caribbean Data Improvement Plan) should be placed as a top priority. This is particularly important in the Virgin Islands where sample size issues alone preclude drawing conclusions from the current TIP data.

Reliable estimates of the von Bertalanffy growth parameters, required inputs for length-based mortality estimators, should be another research priority. For silk snapper, a recent age-growth relationships derived from data from the region would also allow stronger conclusions to be drawn from the TIP data. A well designed age and growth study should be instated to meet this research objective.

Review Workshop

Major priorities

1. There is large degree of uncertainty in the assessment due to the data poor nature of this fishery. In the short to medium terms, the key data set is likely to remain size frequency distributions. The ability to utilize length-frequency data is contingent upon having reliable estimates of life history parameters (von Bertalanffy parameters in particular), therefore the highest priority for future research are:
    a. Studies on basic life history (e.g. age-growth relationships and estimating natural mortality) are essential in the US Caribbean and will greatly enhance the utility of the existing length-frequency data. This information should provide the greatest benefit to providing management advice in the short term. This should be placed as a top priority for key species.
    b. At present, the TIP size frequency data provides the only source of information on stock status and benchmarks and it is therefore essential that this program be at least continued. However, expansion (for example, to USVI) and improvement of the TIP program will be recommended for continued collection of species-specific size information.
    c. Focus should be on developing more complete and accurate data sets into the future, particularly on trip based catch and effort and recording of more geographical data on catch location.
    d. The recreational catch and effort is an important data set and should be continued. Expanding this system to the USVI may also be useful. Furthermore, this source of mortality should be included in the analyses.
    e. Emphasis should be placed on extension, as compliance and unreporting is likely to increase when more data is required of fishers. Given the present low rate of reporting in Puerto Rico, this would be of great concern.
    f. Validation of fisher reported catch, landings and trip effort should be undertaken.
    g. The collection of landings statistics in the USVI should be species-specific because analysis of the current species-groupings is not informative for stock assessments, unless future assessments and management action focus on logical clusters of species.

h. Characterization of multi- species trips to allow identification of trips that split fishing effort across different gears and species groups. This work should be coordinated with fisher groups to enhance buy-in by the industry.

i. It is important to encourage fishermen to submit all the monthly catch reports (USVI), 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.

2. All sources of mortality should be considered in the analyses especially for the recreational fishery catch in Puerto Rico for Silk and Queen Snapper.

3. Given the importance of the SEINE method and that extensions of this method are likely to be used into the near future, the following additional modification are required:

    a. When the full likelihood surface for the SEINE analyses were shown in session, it was clear that unnecessary combinations are sampled and that the surface is reasonably flat near the optimal likelihood, which means more sampling needs to be undertaken within this range.

    b. The SEINE method should be extended to apply a Bayesian hierarchical model that draws on species with more information (Punt *et al.*, 2011, although this method is not Bayesian). This method would integrate across all the different forms of uncertainty and also allow more data rich species' information to be drawn from for the data poor species.

    c. The SEINE method should be extended to include the estimate of M for those species where this information is available. . This directly acknowledged the correlation between growth, maximum length and natural mortality.

    d. The SEINE method should be tested in a simulation study using a simulated population with known parameters, recruitment, and size frequency and including variability in key parameters. Furthermore, these results should then be converted to a guideline on how to apply this information in a data poor situation.

    e. Some preliminary analyses were undertaken during the Review that should be further investigated.

Medium priority

1. For all landings series, a more appropriate method would be to present median estimates of landings with confidence intervals for all regions. All sources of uncertainty should be included in this analysis.

2. The CPUE standardisation methods needs much more extensive investigation, including:

    a. The feasibility of including additional factors or variables either as offsets or ratios of catch to relevant species total catch should be undertaken in the future. An overall Redtailed Parrotfish index from the catch rate standardisation is developed in the future.

    b. Developing an overall Redtailed Parrotfish index from the catch rate standardisation be developed in the future

3. Given the uncertainty in the data, any future FIS should be designed in such a way as to be aligned with the earlier surveys. This would be extremely useful for comparison.

Lower priority

1. There is some question whether changing the commercial catch expansion method during the series produces biases. Therefore, the effect of the two different methods over the time series to develop the expansion factors should be tested.
2. There is a need to develop sampling efforts to better identify and quantify discards in the commercial fisheries.

Queen Snapper

Data Workshop

LIFE HISTORY WORKING GROUP

- It will be important to develop regional sampling programs to collect age and growth data for silk snapper, queen snapper, and redtail parrotfish to estimate growth parameters essential to length-based analyses. Estimates of age-growth parameters are currently limited for the three species in question, therefore, it is essential to continue to build upon the existing published research.
- Regional data collection programs should also be designed to evaluate morphological conversion factors for each species. There is a lack of consistency in the units of measure for length among the studies reviewed by the LHWG. An important area of research will be to develop length-length conversion factors for the three species.
- Length-at-full vulnerability is an important input for length-based analyses. Expansion and improvement of the TIP program will be crucial for continued collection of species-specific size information, which be used to estimate length-at full vulnerability.

PUERTO RICO CATCH STATISTICS WORKING GROUP

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USVI CATCH STATISTICS WORKING GROUP

- Initiate MRIP's efforts in the US Virgin Islands to quantify the magnitude of recreational catches.
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FISHERY INDEPENDENT RESEARCH

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effort across different gears and species groups. These surveys should be coordinated with fisher groups to enhance buy in by the industry.

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Review Workshop

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Redtailed Parrotfish

Data Workshop

LIFE HISTORY WORKING GROUP

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Assessment Workshop

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Reliable estimates of the von Bertalanffy growth parameters, required inputs for length-based mortality estimators, should be another research priority. Deriving age-growth relationships from data collected from the region would also allow stronger conclusions to be drawn from the TIP data. Well-designed age and growth studies in Puerto Rico and the USVI should be instated to meet this research objective.

Review Workshop

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Lower priority

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SEDAR 27: Gulf of Mexico Menhaden

Data Needs:

Collection of structures from gillnet surveys – Need to start collecting scales from gulf menhaden captured during the state gillnet surveys. Collection of scales would allow for the age of individuals to be determined in order to provide gillnet survey age composition data for the stock assessment.

Adult Monitoring Survey - Need to expand existing sampling protocols or develop additional protocols to monitor adult populations that specifically target adult menhaden inshore. Aerial surveys may be useful tools with ground-truthing for size and age.

Standardized Juvenile Index Sampling - Design and implement a survey dedicated to determining menhaden recruitment in the rivers and upper bays of the northern Gulf of Mexico.

Maturity and Fecundity - The seminal study on fecundity and sexual maturity of gulf menhaden was published thirty years ago (Lewis and Roithmayr 1981) with data from the late 1970s. It is recommended that a study should be initiated to re-examine the reproductive biology of gulf menhaden in the northern Gulf of Mexico, which includes updating fecundity estimates, maturity schedules, and sex ratios. Any study needs to reinvestigate whether gulf menhaden are determinant or indeterminant spawners.

Understanding Predator/Prey Relations - Expand the diet and stable isotope database to determine the trophic role of gulf menhaden in the northern Gulf of Mexico. Investigate fatty acids profiles as an additional more specific indicator of important prey items of gulf menhaden.

Most data available for *Brevoortia spp*. feeding behavior is based on examination of Atlantic menhaden (*B. tyrannus*). One key research need is that data on gulf menhaden feeding be collected to improve the specificity of ecosystem models. This includes direct analysis of diet, as well as examinations of feeding behavior, in response to key prey items. Direct diet enumeration is difficult due to the planktonic nature of the prey, but biochemical techniques such as analysis of stable isotope ratios (Litvin and Weinstein 2004, Rooker et al. 2006) and fatty acid profiles (Rooker et al. 1998), provide valuable tools for diet analysis of filter feeders. These techniques can also be used to examine the role of gulf menhaden as a

prey item for higher trophic level piscivores, which will allow for a more precise inclusion of menhaden in food web models of the Gulf of Mexico. An emphasis on quantifying the trophic role of menhaden in the Gulf of Mexico is an important step in the move towards ecosystem-based management.

Genetics - There is a need for further research on gulf menhaden stock structure, with an emphasis on increased genetic sampling (i.e. larger nuclear DNA marker data sets). More specifically, priority areas should include:

1. Identification in the Clupeid literature of potential new heterologous nuclear DNA markers (preferably microsatellites or SNP's) which will potentially enhance genetic sampling in gulf menhaden.
2. Identification of menhaden-specific nuclear DNA markers (preferably microsatellites or SNP's) using a lab-based DNA library screening technique.
3. Evaluation of the markers identified in (1) and (2) for appropriateness in population genetic studies of gulf menhaden.
4. Reassessment of gulf menhaden samples throughout the range of the species using a larger, more informative genetic panel of markers than that described in Anderson (2006).

Tagging Studies - Re-institute the gulf menhaden tag/recovery study. Many more tools exist today to simplify tag/recapture of fishes, and an updated tag/recapture study would allow for the estimation of natural mortality. Generally, natural mortality is one of the most difficult values in a stock assessment to determine, thus empirical evidence of the natural mortality rate would be beneficial. In addition, redoing the natural mortality study of Ahrenholz (1981) would provide information on whether or not the natural mortality rate is changing through time and whether it is increasing or decreasing.

Further Analyses and Modeling Approaches:

Fishery-independent data – Further evaluation of the available fishery-independent data and exploration of ways to combine the data from each state in order to provide a single coastwide index would benefit the stock assessment by providing information on trends in abundance over time.

Environmental factors – Exploration of environmental factors that play a crucial role in gulf menhaden recruitment dynamics and catchability (both fishery-dependent and fishery-independent) would be beneficial. Relationships related to recruitment could be applied to the stock-recruitment curve in the model to better define the number of recruits produced each year. The effects that environmental factors have on catchability of different fishery-independent and fishery-dependent gears would provide

information to the model on if catchability is changing over time and how, which will lead to better estimates of abundance and trajectory over time.

Establish additional research of simulation models to incorporate the fishery into ecological scenarios which may include MSVPAs, ECO-SIM, EcoPath, etc. to get better estimates of natural mortality, which would account for predator-prey dynamics.

Review Workshop

Although results were unsatisfactory for this stock assessment, they did serve to clarify additional research necessary for future assessment efforts. Prioritized lists of short- and long-term research recommendations are presented below.

Prioritized list of short-term research recommendations:

Adult abundance index: Review methods that could be used to provide a reliable fishery-independent adult abundance time series. A pilot survey should be implemented as soon as possible. Development of a long-term time series is needed to increase the certainty of menhaden stock assessments.

Analysis of CDFR data: These data may contain an abundance signal on a weekly and/or an annual basis. In the long-term, the data should be fully analyzed in this regard. In the short- term, a standardized CPUE time series should be developed from the data for use in stock assessment.

Further analysis of fishery-independent state indices: These data need to be fully analyzed with regard to determining the best methods to use the data to provide potential juvenile and adult abundance indices.

Ageing: The consistency of the age readings throughout the whole time series should be checked. The current reader has read scales since 1969 and there may be some drift in her readings. Also, other readers participated up to the early 1970s and there is evidence of relative bias in the readings up to 1970 which should be investigated.

Further development of the SRA: The incorporation of catch-at-age data into the SRA approach is encouraged as this would allow the method to provide a stand-alone stock assessment for menhaden.

Prioritized list of long-term research recommendations:

Adult abundance survey: The existing state sampling of coastal waters is not adequate for providing a defensible adult abundance index. In the absence of such an index, stock assessment of menhaden will

continue to be problematic. The development of a fishery-independent adult-abundance index should be given a very high priority. A review of possible methods is the first step (see short-term research recommendations above). Aerial surveying using visual estimation and/or LIDAR should be considered among the options.

Biological data: All biological parameters pertinent to the stock assessment should be updated. Subsequently, they should be monitored every few years.

Catch sampling: The potential bias associated with sampling only the last catch of the day should be investigated. It is important to know if there could be a bias and whether it is towards larger/older fish or smaller/younger fish.

SEDAR 28: Gulf of Mexico and South Atlantic Cobia and Spanish Mackerel

South Atlantic Cobia:

Data Workshop

Life History

- The LHWG recommends implementation of a tagging study along the entire east coast of Florida and the evaluation of genetic samples from the same to determine more precise stock boundaries.
- Recommend developing a tagging program for inshore and offshore South Atlantic Cobia populations. The goal would be to deploy tags inshore during the spring migration and offshore during the fall and winter to get a clearer picture of fall and spring migrations and to better identify spawning areas and aggregations.
- Explore the feasibility of satellite tags for Cobia movement studies.
- Provide genetic sampling kits to interested groups to better understand the stock division line between the Gulf and Atlantic Cobia stocks. Possible collectors of genetic samples could include Charter operators, fishing clubs and state fisheries personnel.
- Further research is needed on Cobia and Spanish mackerel release mortality.
- To increase the overall amount of data available on Cobia, it is recommended that port samplers do complete workups when sampling, including otolith removal for aging, length, weight, sex, genetic sampling and record a catch location.

Commercial Statistics

Although under the category of research recommendations, this list is not research per se, but rather suggestions to improve data collection. The first three recommendations were modified from the SEDAR17 DW report.

- Need to expand observer coverage.
- Expand TIP sampling to better cover all statistical strata.
- Trade off with lengths versus ages, need for more ages (i.e., hard parts).
- Consider the use of VMS to improve spatial resolution of data.
- During discussions at the data workshop it was noted that the logbook categories for discards (all dead, majority dead, majority alive, all alive) are not useful for informing discard mortality. Consider simplified logbook language in regard to discards (e.g., list them as dead or alive).
- Uniformity between state and federal reporting systems/forms would vastly improve the ease and efficiency of data compilation.
- Establish online reporting and use logbooks as a backup.
- Establish a mechanism for identifying age samples that were collected by length or market categories, so as to better address any potential bias in age compositions.
- Compiling commercial data is surprisingly complex. As this is the 28th SEDAR, one might expect that many of the complications would have been resolved by now through better coordination among NMFS, ACCSP, and the states. Increased attention should be given toward the goal of "one-stop shopping" for commercial data.

Recreational Statistics

- Increase proportion of fish with biological data within MRFSS sampling.
- Continue to develop methods to collect a higher degree of information on released fish (length, condition, etc.) in the recreational fishery.
- Require mandatory reporting for all charter boats state and federal.
- Continue development of electronic mandatory reporting for for-hire sector.
- Continued research efforts to incorporate/require logbook reporting from recreational anglers.
- Establish a review panel to evaluate methods for reconstructing historical landings (SWAS, FWS, etc.).
- Quantify historical fishing photos for use in reconstructing recreational historical landings.
- Narrow down the sampling universe. Identify angler preference and effort. Require a reef fish stamp for anglers targeting reef fish, pelagic stamp for migratory species, and deepwater complex stamp for deep-water species. The program would be similar to the federal duck stamp required of hunters. This would allow the managers to identify what anglers were fishing for.
- Continue and expand fishery dependent at-sea-observer surveys to collect discard information, which would provide for a more accurate index of abundance.

Indices

- Explore SEFIS video data as a potential fishery independent index of abundance for cobia.
- Using simulation analysis, evaluate the utility of including interaction terms in the development of a standardized index and identify the potential effects these interaction terms have on stock assessments.

Assessment Workshop

The assessment panel made the following recommendations.

- Develop a fishery independent sampling program for abundance of cobia and other coastal migratory species. Fishery dependent abundance indices used in this assessment were uncertain in part due to the lack of an effective sampling methodology.
- Implement a systematic age sampling program for the general recreational sector. Age samples were important in this assessment for identifying strong year classes but sample sizes were relatively small and disparate in time and space.
- Better characterize reproductive parameters including age at maturity, batch fecundity, spawning seasonality, and spawning frequency.
- Better characterize the genetic structure of the stock and evaluate the possibility of local population structure.
- Better characterize the migratory dynamics of the stock and the degree of fidelity to spawning areas.
- Age-dependent natural mortality was estimated by indirect methods for this assessment of cobia. Tag-recapture programs for cobia exist and may prove useful for estimating mortality.
- Obtain MRIP intercept numbers at the DW for cobia and other rarely caught species.

Review Workshop

- Motives and selectivity of discarding fish by fishers. The current data compilation exercises appear to concentrate on estimating discard mortality, without any consideration of the selective impact of discarding. It would be beneficial to broaden our understanding on the

motives for discarding and the selectivity imposed by the behavior to aid considerations of size at age and what appropriate assumptions could be included in the assessment model.

- Further analysis of the interactions of length/age and maturity of Cobia. The number of observations that drive the maturity ogive is very low, even relative to the total number of Cobia aged. The minimum landing length appears to impact on the collection of potential samples and is above the likely length of 50% mature. A research approach needs to be developed that strengthens the estimation of the maturity ogive by considering the interaction of size and age and the impact of variability in female maturity on the estimation of benchmarks/reference points. This research will probably have to increase the number of observations of maturity status of 1, 2, 3 and 4 year old fish by sex.
- The DW recommended tagging to study movement patterns. The RW suggests that a tagging program may also help to inform the cobia stock assessment. The fishery and biology of cobia seems to be conducive for a successful tagging program. The fishery for cobia is currently dominated by a recreational fishery with a two-fish bag limit and a minimum landing size, resulting in a large portion of discarded catch. Discarded cobia appear to have high survival (e.g., 95% discard survival assumed in the assessment). Therefore, a tagging program conducted as an industry partnership could release tagged fish from normal fishing operations. Few cobia are discarded per trip, so the additional costs and resources required per trip would be expected to be small, and the data recording aspects at sea would be minimal. The impact on the fishing operations would be anticipated to be negligible. The major costs would be organization, tags, data collation, outreach, a reporting system for recaptured tags, and subsequent data analysis. Industry participation rates might be high if information is provided back to participants, and their collaboration improves stock assessment and fishery management. This information should improve estimates of discard numbers and potentially fish sizes. Estimates of discard mortality may be possible from initial Z from early returns compared with Z on later returns, though this will be compounded with selection. Estimates of Z or tag recovery rate on older ages will help to inform on the appropriate selection function to be used in the assessments could be obtained from ratio of tag returns on from one year to the next. Using tag return data the total mortality Z(i,j,y) between year i and year j, of fish belonging to year class y is obtained using the Jolly- Seber estimator (see Ricker, 1975):

  $$Z(i,j,y) = \log\{\_r(i,k,y)/\_r(j,k,y)*R(j,y)/R(i,y)\} \quad (1)$$

  where R(i,y) is the number of tagged fish of year class y that were released in year i , R(j,y) is the number of tagged fish of the same year class that were released in year j (j>i) and $\_r(j,k,y)$ is the numbers of such tagged fish that were recaptured in the years k summed over all k > j. Though variability may be caused by variation in initial tagging losses, small numbers of recovered tags and errors in ageing (Antsalo, 2006). If resources are available consideration should be given to coupling two types of tagging: 1) high volume, low cost tagging would be most informative for estimates of Z that would help with population level estimates of total mortality and possibly selection and natural mortality; 2) high cost, electronic tagging might give more detail on migration. Of the two methods, the high volume approaches are more likely to be informative for management parameters at a population level.

References:

Antsalo, M. 2006. Abundance estimation of the Northeast Atlantic mackerel (*Scomberscombrus*) with use of Norwegian tag data. University of Bergen, Department of Biology Bergen Norway. Dissertation 64 pp.

Ricker, W.E., 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 1–382.

South Atlantic Spanish Mackerel:

Data Workshop

Life History

- Collect Spanish mackerel maturity data from both regions and both sexes from specimens approximately 275 mm FL and lower to be staged via histological methods.

Commercial Statistics

Although under the category of research recommendations, this list is not research per se, but rather suggestions to improve data collection. The first three recommendations were taken verbatim from the SEDAR17 DW report.

- Need observer coverage for the fisheries for Spanish mackerel (gillnets, castnets (FL), handlines, poundnets, and shrimp trawls for bycatch):
    - 5-10% allocated by strata within states
    - possible to use exemption to bring in everything with no sale
    - get maximum information from fish
- Expand TIP sampling to better cover all statistical strata
    - Predominantly from Florida and by gillnet & castnet gears
    - In that sense, we have decent coverage for lengths
- Trade off with lengths versus ages, need for more ages (i.e., hard parts)
- Consider the use of VMS to improve spatial resolution of data
- During discussions at the data workshop it was noted that the logbook categories for discards (all dead, majority dead, majority alive, all alive) are not useful for informing discard mortality. Consider simplified logbook language in regard to discards (e.g., list them as dead or alive)
- Uniformity between state and federal reporting systems/forms would vastly improve the ease and efficiency of data compilation.
- Establish online reporting and use logbooks as a backup.
- Establish a mechanism for identifying age samples that were collected by length or market categories, so as to better address any potential bias in age compositions.
- Compiling commercial data is surprisingly complex. As this is the 28th SEDAR, one might expect that many of the complications would have been resolved by now through better coordination among NMFS, ACCSP, and the states. Increased attention should be given toward the goal of "one-stop shopping" for commercial data.

Recreational Statistics

- Increase proportion of fish with biological data within MRFSS sampling.
- Continue to develop methods to collect a higher degree of information on released fish (length, condition, etc.) in the recreational fishery.
- Require mandatory reporting for all charter boats state and federal.
- Continue development of electronic mandatory reporting for for-hire sector.
- Continued research efforts to incorporate/require logbook reporting from recreational anglers.

- Establish a review panel to evaluate methods for reconstructing historical landings (SWAS, FWS, etc.).
- Quantify historical fishing photos for use in reconstructing recreational historical landings.
- Narrow down the sampling universe. Identify angler preference and effort. Require a reef fish stamp for anglers targeting reef fish, pelagic stamp for migratory species, and deepwater complex stamp for deep-water species. The program would be similar to the federal duck stamp required of hunters. This would allow the managers to identify what anglers were fishing for.
- Continue and expand fishery dependent at-sea-observer surveys to collect discard information, which would provide for a more accurate index of abundance.

Indices

- Collect and analyze fishery independent data for adult Spanish mackerel.
- Using simulation analysis, evaluate the utility of including interaction terms in the development of a standardized index and identify the potential effects these interaction terms have on stock assessments.

Assessment Workshop

The research recommendations from the AW panel were as follows:

- Establish a fishery-independent survey meant to capture the population trends of coastal pelagics in the south Atlantic.
- Examine how schooling or migratory dynamics may influence the catchability of the species. In particular, research the assumption of the hyperstability of indices that sample the schooling portion of the stock.
- Determine whether it is important to model both sexes in the population for assessment purposes.

Review Workshop

- Stock structure. Following on from the comments in section 2.3 of SEDAR 28, South Atlantic Spanish mackerel Section II, the review recommends that recently developed genetic techniques be utilized to investigate the stock structure of Spanish mackerel. The studies cited are relatively old, and use techniques that could be now considered antiquated and may not have the power to distinguish population structure in highly migratory species. Microsatellite information should be explored to consider both stock identity and internal population structure.
- Investigation of steepness and alternative models for the stock recruit relationship. In particular evaluate if there is newer data available on steepness from other analyses of S-R for pelagic stocks with similar reproductive strategies. However, the RP was uncertain as to how much the analysis would further inform the model or management at present.

Gulf of Mexico Cobia:

Data Workshop

Life History

1. Implement a tagging study along the entire east coast of Florida and evaluate genetic samples from the same to determine more precise stock boundaries.
2. Explore the feasibility of satellite tags for Cobia movement studies.
3. Provide genetic sampling kits to interested groups to better understand the stock division line between the Gulf and Atlantic Cobia stocks. Possible collectors of genetic samples could include Charter operators, fishing clubs and state fisheries personnel.
4. Recommend developing a tagging program for inshore and offshore South Atlantic Cobia populations. The goal would be to deploy tags inshore during the spring migration and offshore during the fall and winter to get a clearer picture of fall and spring migrations and to better identify spawning areas and aggregations.
5. Conduct research on cobia release mortality.
6. To increase overall amount of data available, have port samplers do complete workups when sampling, including otolith removal for aging, length, weight, sex, genetic sampling and record a catch location.

Commercial Statistics

The WG determined the following recommendations be added to any pending recommendations issued in SEDAR 17 that have not been addressed.

- •Need expanded observer coverage for the fisheries encountering cobia
- – 5-10% allocated by strata within states
- – get maximum information from fish
- •Need research methods that capture cobia in large enough numbers to create a reasonable index for young (age 0) cobia
- •Expand TIP sampling to better cover all statistical strata
- – Predominantly from Florida and by hand line
- – Greater emphasis on collecting unbiased samples
- •Establish a mechanism for identifying age samples that were collected by length or market categories, so as to better address any potential bias in age compositions.
- •Need better information on migration patterns
- •Need to address issue of fish retained for bait (undersized) or used for food by crew (how tocapture in landings)
- •Compiling commercial data is surprisingly complex. As this is the 28th SEDAR, one might expect that many of the complications would have been resolved by now through better coordination among NMFS, ACCSP, and the states. Increased attention should be given toward the goal of "one-stop shopping" for commercial data.

Recreational Statistics

1) Increase proportion of fish with biological data within MRFSS sampling.
2) Continue to develop methods to collect a higher degree of information on released fish (length, condition, etc.) in the recreational fishery.
3) Require mandatory reporting for all charter boats state and federal.
4) Continue development of electronic mandatory reporting for for-hire sector.
5) Continued research efforts to incorporate/require logbook reporting from recreational anglers.
6) Establish a review panel to evaluate methods for reconstructing historical landings (SWAS, FWS, etc.).

7) Quantify historical fishing photos for use in reconstructing recreational historical landings.
8) Narrow down the sampling universe. Identify angler preference and effort. Require a reef fish stamp for anglers targeting reef fish, pelagic stamp for migratory species, and deepwater complex stamp for deep-water species. The program would be similar to the federal duck stamp required of hunters. This would allow the managers to identify what anglers were fishing for.
9) Continue and expand fishery dependent at-sea-observer surveys to collect discard information, which would provide for a more accurate index of abundance.

Indices
None provided.

Assessment Workshop
Gulf of Mexico cobia suffers some of the same problems that make assessments of data poor species so difficult. There is not a large targeted fishery for cobia and they tend to occur mostly as an opportunistic catch. For this reason, many sources of data lacked sufficient sample sizes to be included in the assessment. Given the low frequency of positive catches pre trip, both of the fishery dependent indices of abundance and the annual estimates of recreational discards were sensitive to individual positive catches.

The majority of the length composition data, all of the age-composition data, and both indices of abundance came from the recreational fishery which is the primary fishery. The landings data are dominated by the recreational fishery; however, catches prior to 1981 are likely highly uncertain. Uncertainty in the hindcast estimates of recreational landings was not incorporated into the model and should be evaluated in future assessments.
Data on the size of discarded fish was lacking for the recreational fishery. The reef fish observer program provided some information on the size composition of released fish for the commercial fishery in recent years. This information helped in estimating the selectivity and retention parameters of the commercial fishery. Length composition data of discarded fish for the recreational fishery would have improved the assessment model.

Lack of age composition data restricted the assessment from being able to track cohorts through time or identify strong year classes. A systematic age sampling program for the recreational fishing sector would improve future assessments.

The parameters describing early growth of cobia and the selectivity pattern of the shrimp fishery had the greatest uncertainty and required extensive model diagnostics to reconcile. Additional information on the size selectivity patterns for the shrimp fishery would have improved the assessment model.

Gulf of Mexico Spanish Mackerel:

Data Workshop

Life History
None provided.

Commercial Statistics

The WG determined the following recommendations be added to any pending recommendations issued in SEDAR 17 that have not been addressed.

- •Need expanded observer coverage for the fisheries for Spanish mackerel.
- – 5-10% allocated by strata within states
- – get maximum information from fish
- • Need research methods that capture Spanish mackerel in large enough numbers to create a reasonable index for young (age 0) Spanish mackerel.
- • Expand TIP sampling to better cover all statistical strata.
- – Predominantly from Florida and by gillnet
- – Greater emphasis on collecting unbiased samples
- • Establish a mechanism for identifying age samples that were collected by length or market categories, so as to better address any potential bias in age compositions.
- • Need better information on migration patterns.
- • Need to address issue of fish retained for bait (undersized) or used for food by crew (how to capture in landings).
- •Compiling commercial data is surprisingly complex. As this is the 28th SEDAR, one might expect that many of the complications would have been resolved by now through better coordination among NMFS, ACCSP, and the states. Increased attention should be given toward the goal of "one-stop shopping" for commercial data.

Recreational Statistics

1) Increase proportion of fish with biological data within MRFSS sampling.
2) Continue to develop methods to collect a higher degree of information on released fish (length, condition, etc.) in the recreational fishery.
3) Require mandatory reporting for all charter boats state and federal.
4) Continue development of electronic mandatory reporting for for-hire sector.
5) Continued research efforts to incorporate/require logbook reporting from recreational anglers.
6) Establish a review panel to evaluate methods for reconstructing historical landings (SWAS, FWS, etc.).
7) Quantify historical fishing photos for use in reconstructing recreational historical landings.
8) Narrow down the sampling universe. Identify angler preference and effort. Require a reef fish stamp for anglers targeting reef fish, pelagic stamp for migratory species, and deepwater complex stamp for deep-water species. The program would be similar to the federal duck stamp required of hunters. This would allow the managers to identify what anglers were fishing for.
9) Continue and expand fishery dependent at-sea-observer surveys to collect discard information, which would provide for a more accurate index of abundance.

Indices

None provided.

Assessment Workshop

Gulf of Mexico Spanish mackerel has a lengthy history of exploitation dating to the early late 1800s. Directed commercial gillnet fisheries have operated on this resource for well over a

hundred years and recreational fisheries more than 65 years. However detailed catch statistics on size and individual weight of removals only exists for the recent time period, since the mid to late 1980's. In addition, management measures including size limits (30.5 cm FL beginning 1983) and quotas (beginning in 1987) have resulted in discards for both fisheries.

Gulf of Mexico Spanish mackerel are not a directed target of the commercial line gear fisheries (COM_RR fleet) therefore extensive samples for length and/or age-length key characterizations are not available. Efforts should be made to obtain samples from this fleet in order to better inform future stock assessment evaluations as relates length composition and discard levels. In particular, a review of the sampling protocols for length and age – length collections is needed to better characterize the catch length and age at length compositions. In addition, attention is needed to evaluate optimal spatial sampling factors in relation to overall removals throughout the year and region.

The magnitude of discards from the recreational fleet is high and very variable over the time series for which estimates exist from the MRFSS/MRIP survey (1981 forward). Hind casting was used to develop estimates of recreational removals and discards prior to 1981 however information on uncertainty in the hind casting was not incorporated into the stock assessment. Future assessments should consider uncertainty around hind casted data.

The indices of abundance are generally flat but variable yielding little information with which to characterize abundance. In addition the additional observations of length and conditional age at length are more recent thus providing only limited history of data with which to estimate the spawner- recruit relationship during the early part of the time period. The quantity and quality of length and age composition information directly impacts the ability to estimate recruitment.

There was difficulties with estimating steepness thus the AW felt that providing benchmarks at several levels and making projections using several levels of steepness was needed.

SEDAR 29: HMS Gulf of Mexico Blacktip Sharks

Research recommendations from the Standard Assessment Report

- Conduct age, growth and reproductive studies of blacktip sharks in the western Gulf of Mexico.
- Examine the stock structure of blacktip sharks in the Gulf of Mexico using genetic analyses, continued conventional tagging and advanced tagging technologies.
- Benchmark assessment to be undertaken focusing on treating blacktip sharks in the eastern and western Gulf of Mexico as separate stocks.
- A brief technical document should be produced to define "post release", "at vessel mortality", "status" and other terms for consistency and future discussions.
- Mexican colleagues must be involved in the next assessment to improve data inputs.
- Continue to work to achieve good species identification for weighouts/landings/reporting for commercial fisheries. Continue to have workshops for fishers/dealers to learn species identification. Workshops for recreational fishermen to work towards better species ID are also needed.
- Add a discards section to the logbooks for commercial fisheries.
- More research is necessary on post-release live discard mortality for both commercial and recreational fisheries

SEDAR 30: Caribbean Blue Tang and Queen Triggerfish

Blue Tang:

Assessment Process

The ability to utilize length-frequency data is contingent upon having reliable estimates of life history parameters (von Bertalanffy parameters in particular). Studies on basic life history (e.g. age-growth relationships and estimating natural mortality) in the US Caribbean will greatly enhance the utility of the existing length-frequency data and should provide the greatest benefit to providing management advice in the short term. Studies should be carefully planned to ensure a representative sample of individuals by age/size, region, season etc. This type of research should be placed as a top priority for key species.

Blue tang are a seemingly fast growing fish species with a long life-span. Beyond the age of five, length information is not informative about the age-structure of blue tang populations. A better understanding about how fishing mortality influences population structure will come from collection of catch-at-age data. Sampling efforts should be carefully planned to ensure representative sampling of individuals by fishing gear, mode, region, season etc.

Fishery-independent surveys should be considered as a top research priority for additional data collection. Fishery-independent surveys designed using a rigorous statistical framework will allow for the collection of species-specific catch and effort data that can be used to develop indices of abundance. Indices of abundance are used in stock assessments to inform models about how a population may be changing over time. Fishery-independent surveys can also be used to supplement existing programs by collecting age, length, weight, and reproductive data.

It is essential that continued efforts to improve the data collection of fishery-dependent catch and effort statistics be made. More specifically, continued efforts to collect species-specific catch statistics will be important for future assessments.

Reviewer Recommendations

Cardinale Recommendations

The assessment team does provide an exhaustive shopping list for future data to be collected, which would greatly improve the capability of assessing the status of the Caribbean queen triggerfish and blue tang stock. However, I also suggest that effort should be devoted to selectivity experiments aimed to evaluate the theoretical changes in selectivity linked with the historical changes in the mesh size of the traps.

Chen Recommendations:

The AW panel recommends improving the quality of life history parameter estimates; developing a fishery-independent monitoring program; continuing the efforts to improve the collection of species-specific catch and effort data; and modifying the length-based total

mortality estimator to account for potential changes in selectivity. I consider these research areas are important for reducing the uncertainty and improving the quality of the assessment. The AW panel probably needs to prioritize the research recommendations and separate the short-term research plan from the long-term plan.

Given the problems associated with the data, an important research goal should be to improve the data quality and quantity. Short-term and long-term plans should be developed to achieve the goal. Short term research priority may include (1) improvement of life history data estimates and the quantification of their uncertainty in the form of probably distributions; (2) identification of major fishing areas and their spatio-temporal variability via conducting interviews with fishermen involved in the fishery; and (3) identification of potential approaches that can be used to estimate species-specific landing data (e.g., based on species composition of landings that become available in recent years). The long-term research plan should include the development of a fishery-independent monitoring program and continued improvement of the sampling protocol for the collection of fishery-dependent data (catch and effort).

Given the data limitations, I believe another research priority that should be addressed soon is to evaluate the performance of the length-based estimator (Gedamke and Hoenig 2006) for the total mortality. Based on the information available and with some assumptions, a queen triggerfish fishery can be simulated, following the approach used in Gedamke and Hoenig (2006). A simulation study can be conducted with this simulated fishery to evaluate the performance of this length-based estimator for estimating the total mortality. Different scenarios can be developed to identify key factors that may have significant impacts on the performance of the estimator. This can guide the future model development and data collection.

Trzcinski Recommendations:

I set this out more generally below. I cannot prioritize these well because I do not know 1) the species biology, ecosystem and fishery well, 2) the long-term assessment goals or 3) the financial constraints. I think the assessment team would benefit from a meeting to discuss these issues and help set out the overall assessment framework. But if prioritizing is at all useful given my limited knowledge, I would work on getting a fisheries independent survey together, I might even do this over the life history work although that should be done as well.

Presumably some discussion occurred about whether the method used was the best given the available data. I think it is important to review and recapitulate that argument in the introduction to the assessment report.

Queen Triggerfish:

Assessment Process

The ability to utilize length-frequency data is contingent upon having reliable estimates of life history parameters (von Bertalanffy parameters in particular). Studies on basic life history (e.g. age-growth relationships and estimating natural mortality) in the US Caribbean will greatly enhance the utility of the existing length-frequency data and should provide the greatest benefit to providing management advice in the short term. This should be placed as a top priority for key species.

Fishery-independent surveys should be considered as a top research priority for additional data collection. Fishery-independent surveys designed using a rigorous statistical framework will allow for the collection of species-specific catch and effort data that can be used to develop indices of abundance. Indices of abundance are used in stock assessments to inform models about how a population may be changing over time. Fishery-independent surveys can also be used to supplement existing programs by collecting age, length, weight, and reproductive data.

It is essential that continued efforts to improve the data collection of fishery-dependent catch and effort statistics be made. More specifically, continued efforts to collect species-specific catch statistics will be important for future assessments.

During the assessment workshop, the fishers from the USVI indicated that the selectivity pattern for queen triggerfish violated the assumption of knife-edge selectivity in the mean-length model. Efforts should be made to expand this model to accommodate other selectivity patterns.

Reviewer Recommendations

Cardinale Recommendations

The assessment team does provide an exhaustive shopping list for future data to be collected, which would greatly improve the capability of assessing the status of the Caribbean queen triggerfish and blue tang stock. However, I also suggest that effort should be devoted to selectivity experiments aimed to evaluate the theoretical changes in selectivity linked with the historical changes in the mesh size of the traps.

Chen Recommendations:

The AW panel recommends improving the quality of life history parameter estimates; developing a fishery-independent monitoring program; continuing the efforts to improve the collection of species-specific catch and effort data; and modifying the length-based total mortality estimator to account for potential changes in selectivity. I consider these research areas are important for reducing the uncertainty and improving the quality of the assessment. The AW panel probably needs to prioritize the research recommendations and separate the short-term research plan from the long-term plan.

Given the problems associated with the data, an important research goal should be to improve the data quality and quantity. Short-term and long-term plans should be developed to achieve the goal. Short term research priority may include (1) improvement of life history data estimates and

the quantification of their uncertainty in the form of probably distributions; (2) identification of major fishing areas and their spatio-temporal variability via conducting interviews with fishermen involved in the fishery; and (3) identification of potential approaches that can be used to estimate species-specific landing data (e.g., based on species composition of landings that become available in recent years). The long-term research plan should include the development of a fishery-independent monitoring program and continued improvement of the sampling protocol for the collection of fishery-dependent data (catch and effort).

Given the data limitations, I believe another research priority that should be addressed soon is to evaluate the performance of the length-based estimator (Gedamke and Hoenig 2006) for the total mortality. Based on the information available and with some assumptions, a queen triggerfish fishery can be simulated, following the approach used in Gedamke and Hoenig (2006). A simulation study can be conducted with this simulated fishery to evaluate the performance of this length-based estimator for estimating the total mortality. Different scenarios can be developed to identify key factors that may have significant impacts on the performance of the estimator. This can guide the future model development and data collection.

Trzcinski Recommendations:

I set this out more generally below. I cannot prioritize these well because I do not know 1) the species biology, ecosystem and fishery well, 2) the long-term assessment goals or 3) the financial constraints. I think the assessment team would benefit from a meeting to discuss these issues and help set out the overall assessment framework. But if prioritizing is at all useful given my limited knowledge, I would work on getting a fisheries independent survey together, I might even do this over the life history work although that should be done as well.

Presumably some discussion occurred about whether the method used was the best given the available data. I think it is important to review and recapitulate that argument in the introduction to the assessment report.

SEDAR 31: Gulf of Mexico Red Snapper

Data Workshop

Life History

- Review the evidence for density dependence in older ages (e.g. ages 2-3). Incorporate full age model of recruitment to examine density-dependent effect.
- Site and habitat specific comparisons from more regions of the Gulf are needed for estimation of age-0 and age-1 mortality, accounting for shelf characteristics (e.g., width, slope, depth) in tests of density-dependent variation in M and emigration.
- Broader understanding of habitat value and areal estimates of habitat (distribution—areas of trawlable vs. untrawlable bottom; more refined maps Gulf-wide etc) are needed to further inform the habitat limitation hypothesis for density dependence.
- Assess the impact of potential predation/competition for taxa of particular interest (lionfish, marine catfish, sciaenids, and red grouper). As well, investigate alternative population regulatory mechanisms including potential sources of density-independent increases in mortality and distant sources of recruitment (but see stock delineation section).
- Evaluate the potential for sea-bottom restoration or other means to expand habitat and increase survival for post-settlement red snapper.
- The LHW recommended that existing otolith archives (e.g., NOAA) be used to further investigate interpretation of increment formation based on section orientation, sample source (location), season and year. This could be conducted as a graduate student project in collaboration with agency personnel.
- Interested Academic representatives (e.g. Auburn University, University of S. Florida) should be included at Gulf States Marine Fisheries Commission sponsored otolith workshops (e.g., May 2013) to review age determinations and promote standardization.
- Based upon the results of Szedlmayer and Beyer (2011 SEDAR31-RD20), further investigation of longevity is warranted. More recent catches of older fish should allow a direct comparison to 14C coral chronologies established during the nuclear testing period and extend the age that can be directly validated (beyond 38 years in the earlier study by Baker and Wilson 2001).
- A general recommendation of the LHW is to expand design-based fishery-independent sampling to elucidate regional (i.e., eastern and western GOM) and sub-regional differences in the demographics of red snapper.
- A further recommendation is to increase random, representative sampling of the catch in order to avoid clustering effects and non-representative sampling which could lead to spurious differences in growth rates. Alternatively, and for localized- or small-scale studies, corrections for length limits and appropriate weighting may need to be utilized to treat data gaps, missing ages and adjust for selectivity (see Chih 2012 SEDAR31-DW18).
- Future surveys should collect ovarian samples fixed in formalin for histology analysis, spawning marker fraction analysis and age/size at maturity analysis.
- Additional fecundity collections are necessary from all areas of the Gulf.

- Additional research is necessary to further clarify regional reproductive and demographic differences.
- More information is needed to understand movement of young and older adult red snapper across along shore barriers. In particular the LHW recommends a large scale tagging study focused west and east of the Mississippi River.
- Telemetry versus tagging approaches need to be expanded and evaluated according to shelf characteristics; e.g. cross compared in areas with little natural hard bottom habitat (yet high artificial reefs) versus areas with relatively high areal coverage of hard bottom and with more dispersed artificial reefs.
- The LHW recommends a workshop or research symposia be convened to synthesize results and assess methodology for estimating red snapper movements and home range.
- In order to reduce measurement error in the future, the LHW recommends that port agents, observers and field scientists record maximum total length for red snapper.

Commercial Fishery Statistics

Landings

- Revisit how the historical landings were constructed.
- Explore ways to ensure that IFQ and trip ticket landings match.
- Apportion landings accordingly in ALS for TX landings with missing gear.

Discards

- Add species to discard logbook form.
- Provide better instructions on how to complete the discard logbook.
- Consider and use relevant input from external review of observer program.
- Social and economic impacts on fisher behavior in terms of fish discards.
- Better determine available allocation to vessels on a given trip.

Length/Age

- Standardize length and age data formats from various data sources.
- Build age databases with Trip ID number for FL and FIN data.
- Evaluate how to handle catch at age of non-representative age samples.

Recreational Fishery Statistics

- Evaluate the technique used to apply sample weights to landings. Investigate the SEFSC
- Method by analyzing the order of variables in the hierarchy and the minimum number of fish used. Furthermore, evaluate alternative methods, including a meta-analysis of the existing information from difference sources, areas, states, surveys, etc. that could be performed.
- Develop methods to identify angler preference and targeted effort. Require a reef fish stamp for anglers targeting reef fish, pelagic stamp for migratory species, and deep-water complex stamp

for deep-water species. The program would be similar to the federal duck stamp required of hunters and could help managers identify what anglers were fishing for.

- Continue and expand fishery dependent at sea observer surveys to collect discard information. This would help to validate self-reported headboat discard rates.
- Track Texas commercial and recreational discards.
- Estimate variances associated with the headboat program.
- Evaluate existing and new methods to estimate historical landings. Hind-casting of red snapper landings is complicated by a lack of reliable historical effort data. To get at estimating historical effort, analysts could track consumables (gas, ice, bait) to develop price indices.
- Investigate how CPUE changes over time due to technological advances and changes in fishing practices.

Measures of Population Abundance

The following are research recommendations that may improve the utility (precision) of the

SEAMAP larval index for red snapper.

- Expand the use of molecular genetics to identify the smallest and most abundant snapper larvae in SEAMAP samples that cannot be positively identified as red snapper because diagnostic morphological characters are not yet developed.
- Begin directed sampling for fish eggs on SEAMAP summer trawl and fall plankton surveys using vertical nets hauls. The protocols for fish egg sampling have been established by NMFS/SWFSC scientists and are in use on the west coast. Fish egg collections are easy to make and take little additional sampling time. The eggs in these samples would have to be identified genetically but the protocols for genetic identification of red snapper eggs have been worked out by Frank Hernandez and Keith Bayha at DISL. The results of their MARFIN funded project using CUFES samples from our SEAMAP Fall Plankton surveys are impressive and significant. They produced maps of red snapper egg (i.e. spawning) distribution over the entire Gulfwide survey area.
- Estimates of egg abundance data coupled with the updated reproduction parameters spawning frequency and fecundity) generated by NMFS scientists at the Panama City Lab could eventually be used to produce an actual spawning biomass estimate for red snapper.
- Continue aging red snapper larvae from SEAMAP samples to improve the age-length relationship (key). This should improve the precision of the SEAMAP larval abundance index that is now based on a single age class of larvae across years.
- Produce a SEAMAP larval index based on the abundance of red snapper larvae captured during SEAMAP summer shrimp/groundfish surveys (past and present). This survey has for a number of years now been expanded to include the entire northern Gulf of Mexico shelf. The data from summer months (i.e. during peak red snapper spawning months) could be a far better indication of spawning production than data from the end of season from which the current SEAMAP larval index is derived.
- Explore the utility of a larval red snapper index based on a comprehensive modeling approach that includes all SEAMAP stations (regardless of how many times they have been sampled over

the time series) and both sampling gears, i.e. neuston and bongo samples. There are other likely explanatory variables (e.g., salinity) that could ultimately improve the index.

Discard Mortality Rate

Future surveys, at minimum, should be structured around quarterly sampling, collect water temperature profile data, reflect the range of depths associated with the fishery, and strive to calculate season and depth specific estimates. Due to the limited number of experiments evaluating the relationship between thermal stress and release mortality, it is strongly encouraged that investigators measure and report water temperatures and thermocline profiles associated with capture. More studies evaluating the use of bottom release devices are also needed. Future discard observation surveys should collect frequency data regarding specific barotraumas incurred and loss of reflex response, because similar relationships could be developed as better techniques are developed to measure the delayed mortality component. Experiments estimating impairment scaling, and both immediate and delayed mortality, would be particularly useful so that a relationship among components could be developed and historical immediate release mortality estimates could potentially be adjusted.

Assessment Workshop

No recommendations were provided.

Review Workshop

Below, the RW Panel highlights research recommendations they feel should be emphasized, and provides new recommendations partly based on assessment methodology and results.

Age and Mortality

The RW Panel recommends that research effort be focused on the issue of ageing error, both within and among ageing facilities. A more comprehensive analysis of ageing error should permit its inclusion in the SS3 model.

There appeared to be some confusion in the DW report as to the purpose of and resultant data from bomb radiocarbon analysis of otoliths. This method is a means to evaluate the estimated birthdate of a fish relative to the $\Delta^{14}C$ preserved in other aragonitic structures, such as corals. Radioactive ^{14}C was enriched in oceanic waters in the late 1950s and early 1960s following above ground nuclear weapons testing. Coral skeletons, for example, reflect this enrichment by having peak $\Delta^{14}C$ values in skeletons formed during the early to mid 1960s and then declines thereafter. If opaque zones in otoliths are formed annually, then fish estimated to have birthdates in the early 1960s should have similar high $\Delta^{14}C$ values at the core of their otoliths. Other radio chemistry validation techniques, such as $^{210}Pb/^{226}Ra$ dating, provide estimates of absolute fish age; bomb radiocarbon analysis only provides a relative age estimate but can be used to validate opaque zone formation. Both of these age validation techniques have been applied to red snapper, along with other validation and verification techniques. In fact, no other marine fish has been the subject of as many different age validation/verification studies as red snapper. Results of these studies are overwhelming: opaque zones in red snapper otoliths are formed annually.

Growth

The RW Panel recommends further analysis on the growth function fit to size at age data from 2003-11. The fitted model included in the assessment tends to overestimate size at age for fish <5 yr, overestimate size at age for fish 5-10 yr, and underestimate size at age for fish >20 yr. Part of this results from the manner in which the model accounts for variable size limits through time. However, the RW Panel expressed concern whether some of the observed variability in size at age in the data resulted from ageing error between laboratories. In the future, modeling growth with a random effects approach may be more appropriate.

Population Structure

The RW Panel reiterates various research recommendations focused on the population structure of Gulf red snapper. Hydrographic models should continue to be employed to estimate potential larval dispersal within the US Gulf, between the eastern and western Gulf, and on smaller spatial scales. A large-scale conventional tagging study might be useful to examine post-settlement mixing both between the eastern and western Gulf and within these areas. Lastly, advances in restriction-site-associated-DNA (RAD) sequencing mean that much more powerful genetic population structure analysis is now possible relative to historical mitochondrial DNA or microsatellite DNA approaches previously applied to Gulf red snapper.

Discard Mortality

Estimation of dead discards is a product of the number of discards and the discard mortality rate, both of which are highly uncertain for red snapper. Observer data in the shrimp trawl and directed commercial fisheries enable estimates of the magnitude of discards. There are much more limited data available in the recreational fishery to estimate the magnitude of discards. There are some observer-based estimates available for the headboat and charter boat sectors, but efforts to collect those data should be expanded. Reliance on self-reported discards in the MRIP to estimate discards in the private recreational sector is problematic with no clear solution. Electronic reporting through smart-phone applications does provide for instantaneous reporting of discards, but the process involved remains reliant on self-reporting which has been shown to be biased in other sectors where both self-reporting and observer-based estimates of discards are available.

Further research appears warranted with respect to estimating the magnitude of discards among fishery sectors, as well as providing more robust estimates of post-release mortality. Few of the existing discard mortality studies address the issue of depredation on released fish and that should be a focus moving forward. Several existing lines of research indicate chronic effects of barotrauma which may lead to mortality are pervasive in released red snapper, and that studies which simply examine surface condition or submergence of released fish may grossly underestimate release mortality. Therefore, a focus moving forward should be on conducting studies that examine both depredation on released fish and chronic versus acute mortality caused by catch and release.

Episodic Mortality Events

Episodic events have the potential to impact red snapper population ecology in the northern Gulf of Mexico. Among recent and ongoing events that have this potential are hypoxia associated with plumes of the Mississippi and other northern Gulf rivers, harmful algal blooms, particularly along the west Florida shelf, and the Deepwater Horizon Oil Spill (DHOS). Potential impacts of the DHOS were discussed during the RW but little work had been done attempting to examine potential impacts in either the DW or AW. In fact the words "Deepwater Horizon" appear only once in the DW Report and never in the AW Report. Part of this issue may stem from the fact that if potential impacts were restricted to recruitment effects then an assessment model would not capture that signal until affected cohorts moved into the fishery. Future assessments of Gulf red snapper should be conducted with the explicit goal of attempting to model any enduring DHOS effects.

Recommendation for Research on Improvement of the SS Model

The RW Panel recommends changing the model's code to enable separate sets of SR parameters to be estimated for the different population subunits.

Recommendations for Improvement of the SEDAR Process

The third charge included in RW TOR number 6 is to provide recommendations on possible ways to improve the SEDAR process. Improvements should include:

- The most critical need is for timeliness in completion of tasks and reports. The SEDAR process is complex and demanding, involving scientists with diverse areas of specialization and including a large array of issues and concerns. Completion of work requirements on schedule is challenging and demanding, but the more closely that deadlines are met, the more efficient and productive the process can be.

- More standardization of report format would be helpful. Sections of reports are written by different individuals and groups, all of which have their own writing styles and preferences, but content of reports would be improved if each workgroup provided summaries of their results and conclusions, enumerated or in paragraph form. In addition, a more uniform identification of procedural and research issues, presented at the end of each workgroup section would be informative. Proposals and rationale for further study have potential for moving forward directly on problems that are recognized as especially important.

- Given that the AW analyzes the extant databases for the species under consideration, the group would be well placed to be critically aware of additional data needs. Recommendations for future research could profitably be a standard part of their SEDAR report.

Guidance on key improvements in data and modeling approaches which should be considered when scheduling the next assessment:

The RW Panel expressed serious concerns regarding the amount of time allotted for review of this assessment. As noted above, the AW Report was provided to the RW Panel on Friday, April 26th for a

RW beginning on Monday, April 29th. Furthermore, the AW Report had not been reviewed by the AW Panel. The AW Report was incomplete, contained errors, and the documentation of the model inadequate for a thorough review.

The RW Panel recommends that given the data and model complexities inherently associated with stock assessment of Gulf red snapper, more realistic timelines be considered for the next assessment.

SEDAR 32: South Atlantic Blueline Tilefish and Gray Triggerfish

Blueline Tilefish

Data Workshop

Life History

- Stock Structure
    - Blueline tilefish stock definition needs to be investigated further. Genetic study or some other form of stock identification study needs to be undertaken with samples (muscle, fin clips, etc.) collected from several locations within the Gulf of Mexico and the northwestern Atlantic.
    - Habitat studies of deep water sites in the mid-Atlantic, specifically Norfolk Canyon, Balitmore Canyon, and Hudson Canyon need to be undertaken. Temperature data from research conducted in the 1970s in Norfolk Canyon can be used for comparison purposes.
- Age Data
    - Age readings of blueline tilefish need to be validated. Within and between lab variability in readings is large and needs to be addressed. The potential bias in age readings between laboratories also needs to be addressed with another age workshop and exchange of calibration sets of samples.
    - Marginal increment analysis needs to be undertaken in order to convert increment counts to calendar ages. Samples processed and read in older studies will need to be re-examined and margin codes recorded for each.
    - More recreational fishery age samples need to be collected.
- Reproductive Biology Data
    - Overall, more reproductive samples need to be collected. Because small, young fish were lacking from the biological collections, specimens under 18 inches will be needed to address age and size at maturity. Whole gonads will need to be collected for a fecundity study. Specimens collected from throughout the species range and covering all months of the year are needed to better describe spawning season and spawning periodicity.
- Ad-hoc Discard Mortality Sub-group
    - Future research is needed to examine discard mortality rates for this species, as well as factors that affect survival (e.g., gear type, temperature, depth).

Commercial Statistics

- Discard
    - Investigate the validity and magnitude of “no discard” trips. This may include fisher interviews throughout the region.
    - Examine potential impacts on “no discard” trips, including:
        - Trip length

        - Trip dates in relation to fishery regulations
        - Trip targeting
        - Trip area fished
    - Improve discard logbook data collections via program expansion or more detailed reporting (e.g. more detailed logbook, electronic reporting)
    - Develop an observer program that is representative of the fishery in the South Atlantic.
- Biosampling
    - Standardize TIP sampling protocol to get representative samples at the species level.
    - Develop an observer program that is representative of the fishery in the South Atlantic.
    - Increase untargeted sampling in NE and Mid-Atlantic observer programs.
    - Increase untargeted dockside sampling in NE and Mid-Atlantic.

Recreational Statistics

- Continued research efforts to incorporate/require logbook reporting from recreational anglers.
- Quantify historical fishing photos for use in future SEDARs.
- Fund research efforts to collect discard length and age data from the private sector.
- Improve metadata collection in the recreational fishery.
- Pre-stratify MRIP Keys, N-S Canaveral, N – S Hatteras.
- Research possibility of implementing private recreational reef fish stamp to determine universe and reporting strategies.
- At-sea observers collect surface and bottom temperature.
- At-sea observer protocols should include all fields currently used in FL i.e., condition and depth of released fish.

Indices

- Evaluate various sub-setting methods to identify effective effort. Methods that have been applied or considered include in this and previous SEDAR assessments include the Jaccard statistic, Stephens and MacCall approach, variations of Stephens and MacCall approach (e.g., using amount of catch rather than presence-absence), and other multivariate statistical approaches (e.g., cluster analysis).
- Evaluate various standardization methods to handle zeros in the catch, e.g., delta-GLM, zero-inflated Poisson, zero-inflated negative binomial, hurdle models, etc.
- Evaluate possible effects of circle hooks on catchability of reef fishes.
- Need fishery independent sampling of deep-water species, including blueline tilefish. Need funding to support these efforts.

Assessment Process

The assessment panel made the following recommendations.

- Develop a fishery independent sampling program for abundance of the deepwater snapper-grouper complex (including blueline tilefish). Fishery dependent abundance indices used in this assessment were uncertain in part due to the lack of an effective sampling methodology.
- Implement a systematic age sampling program and systematic evaluation of aging error. Age samples were important in this assessment but reasonable sample sizes were only available for the last 3-4 years of the assessment.
- Better characterize reproductive parameters including age at maturity, batch fecundity, spawning seasonality, and spawning frequency.
- Better characterize the genetic structure of the stock and evaluate the possibility of local population structure.
- Better characterize the inshore-offshore migratory dynamics of the stock and the degree of fidelity to spawning areas. Portions of the stock may be further offshore in some years and hence not available to the fishery.
- Age-dependent natural mortality was estimated by indirect methods for this assessment of blueline tilefish. Tag-recapture programs may prove useful for estimating mortality.

Review Workshop

Research recommendations for blueline tilefish were provided in the data and assessment working group documents. The Panel noted that many of these recommendations reflected concerns across a range of deep-water species and therefore confined their attention to those specific to the stock assessment of blueline tilefish.

While the panel supports work on stock structure, we recommend starting with the available information on describing the differences in demographics/life history characteristics over the range of the management area. Additionally, the available information on habitat in the areas listed should be evaluated before initiating any new studies.

Given that this is an age-based assessment, the comparison and calibration studies for the age determination should receive high priority along with the marginal increment analysis to determine if the opaque zone is formed annually. Many species would probably benefit from expanding the MRIP program to include age sampling.

The collection of information to better describe spawning season and spawning periodicity could probably start with fishery-dependent sources, but will need data from fishery-independent programs to cover the range of the species. The latter program would probably have to be tailored to provide samples across the deep-water snapper/grouper complex.

Studies of discard mortality should be low priority given the current negligible discard rate in the commercial fishery. The collection of additional information on discards and catch (e.g, lengths, ageing material) is important especially for the areas north of Hatteras, but would likely require an observer program developed for all fisheries focusing on the deep-water snapper/grouper complex.

The BAM model is reliant on historical information and any data on size compositions, maximum size, etc., that can be obtained from historical recreational fishing photos could be quite useful. One of the main issues raised about the recreational fishery concerned the high landings in the mid-late 2000s, especially the high landing and discard estimates for 2007. Closer scrutiny of these estimates requires data at higher resolution than was apparently available for this stock assessment.

With respect to developing a fishery-independent survey, sampling of deep-water habitats may elucidate habitat characteristics, and spatial distributions of blueline tilefish and other deep-water reef fishes. If a sufficient time series is developed, then a fishery-independent index may be developed.

Gray Triggerfish

Data Workshop

Life History

- Stock Structure
    - Gray triggerfish stock definition needs to be investigated further. Genetic study or some other form of stock identification study needs to be undertaken with samples (muscle, fin clips, etc.) collected from several locations within the Gulf of Mexico and the northwestern Atlantic. Special attention should be given to fish from the southern tip of Florida, to determine stock split for the South Atlantic and Gulf of Mexico.
- Age Data
    - Age readings of gray triggerfish need to be validated. Uncertainty in the interpretation of the zones formed on the spines of the triggerfish is high.
    - More recreational age samples are needed to better characterize the catch.
- Reproductive Biology Data
    - Overall, more reproductive samples need to be collected. Fecundity data for the South Atlantic was not available. Whole gonad samples will need to be collected to estimate fecundity of this fish. Samples are also needed from the entire region and all months of the year to better describe spawning season and spawning frequency.
- Ad-hoc Discard Mortality Sub-group
    - The majority of the discard mortality rates discussed for gray triggerfish are for fish observed at the surface. There is no information on delayed sources of mortality for discarded fish. Research investigating the factors that impact discard survival (i.e., gear, hook type, depth, presence and type of barotrauma) is needed.

Commercial Statistics

- Landings
    - Require species level reporting in state trip ticket programs.
- Discard

  - Investigate the validity and magnitude of "no discard" trips. This may include fisher interviews throughout the region.
  - Examine potential impacts on "no discard" trips, including:
    - Trip length
    - Trip dates in relation to fishery regulations
    - Trip targeting
    - Trip area fished
  - Improve discard logbook data collections via program expansion or more detailed reporting (e.g. more detailed logbook, electronic reporting)
  - Develop an observer program that is representative of the fishery in the South Atlantic.
- Biosampling
  - Standardize TIP sampling protocol to get representative samples at the species level.
  - Develop an observer program that is representative of the fishery in the South Atlantic.
  - Increase untargeted sampling in NE and Mid-Atlantic observer programs.
  - Increase untargeted dockside sampling in NE and Mid-Atlantic.

Recreational Statistics

- Continued research efforts to incorporate/require logbook reporting from recreational anglers.
- Quantify historical fishing photos for use in future SEDARS.
- Fund research efforts to collect discard length and age data from the private sector.
- Improve metadata collection in the recreational fishery.
- Pre-stratify MRIP Keys, N-S Canaveral, N-S Hatteras.
- Research possibility of implementing private recreational reef fish stamp to determine universe and reporting strategies.
- At-sea observers collect surface and bottom temperature.
- At-sea observer protocols should include all fields currently used in FL i.e., condition and depth of released fish.

Indices

- Evaluate various sub-setting methods to identify effective effort. Methods that have been applied or considered include in this and previous SEDAR assessments include the Jaccard statistic, Stephens and MacCall approach, variations of Stephens and MacCall approach (e.g., using amount of catch rather than presence-absence), and other multivariate statistical approaches (e.g., cluster analysis).
- Evaluate various standardization methods to handle zeros in the catch, e.g., delta-GLM, zero-inflated Poisson, zero-inflated negative binomial, hurdle models, etc.
- Evaluate possible effects of circle hooks on catchability of reef fishes.

SEDAR 32A: Gulf of Mexico Menhaden

Data/Assessment Workshop

Throughout the course of the DW and AW, a number of items were identified as important research topics for future stock assessments. The assessment panel evaluated the various items and developed a consensus priority list.

DATA ELEMENT	RECOMMENDATION	PRIORITY
FISHERY-INDEPENDENT ADULT INDEX	Collect Gulf menhaden ageing structures (scales and otoliths) from alternate fishing gears (e.g., gill nets and trawls) to determine gear selectivity. Need to expand efforts to age menhaden by state agencies. Determine readability of whole versus sectioned otoliths.	**Very High**
FISHERY-INDEPENDENT ADULT INDEX	Improve species identifications at the periphery of the Gulf menhaden's range in Texas and Alabama/Florida waters.	**Very High**
GENETICS AND STOCK STRUCTURE	Identification of menhaden-specific nuclear DNA markers (preferably microsatellites or SNP's) using a lab-based DNA library screening techniques. Evaluation of these markers for use in genetic studies of Gulf menhaden	**Very High**
FISHERY-DEPENDENT SURVEYS	A Gulf-wide aerial survey would be a useful tool to measure adult gulf menhaden abundance; "ground-truthing" for fish size and age and school size, would be a necessary adjunct to the survey	**High**
FISHERY-DEPENDENT SURVEYS	Additional sampling needs to be conducted to address the homogeneity of the catch in the hold of the reduction fishery vessels at the four Gulf menhaden factories. Supplemental samples must be pulled from throughout the fish hold during the pumpout process to determine if the assumption that the traditional 'last set of the trip' accurately represents the age composition for the catch for the given port-week	**High**
FECUNDITY/MATURITY	The seminal study on fecundity and sexual maturity of Gulf menhaden was published thirty years ago (Lewis and Roithmayr 1981) with data from the late 1970s. It is recommended that a study should be initiated to re-examine the reproductive biology of gulf menhaden in the northern Gulf of Mexico, which includes updating fecundity estimates, maturity schedules (GSI), and sex ratios. Any study needs to reinvestigate whether gulf menhaden are determinant or indeterminant spawners. Survey necessarily needs to include spawning from winter collections.	**High**

FISHERY-INDEPENDENT JUVENILE INDEX	Improve species identifications at the periphery of the Gulf menhaden's range in Texas and Alabama/Florida waters.	**High**
GENETICS AND STOCK STRUCTURE	Identification in the Clupeid literature of potential new heterologous nuclear DNA markers (preferably microsatellites or SNP's) which will potentially enhance genetic sampling in Gulf menhaden.	**High**
GENETICS AND STOCK STRUCTURE	Reassessment of Gulf menhaden throughout its range using a larger, more informative genetic panel of markers than that described in Anderson (2006).	**High**
FISHERY-INDEPENDENT JUVENILE INDEX	Design and implement a survey dedicated to determining menhaden recruitment in the coastal rivers and upper bays of the northern Gulf of Mexico.	**Med/High**
FISHERY-INDEPENDENT ADULT INDEX	Need to develop/expand menhaden sampling protocols for gill nets and trawls in inshore waters Standardize protocols and gears across states.	**Med/High**
MODELING	Benchmarks – Develop procedures to establish assessment benchmarks (e.g., Fmsy or proxies) that account for the multiple priorities of ecosystem management; such as an alteration of the calculation of Fmsy that includes predation mortality as a component of ecological yield separate from other forms of natural mortality.	**Med/High**
FISHERY-DEPENDENT SURVEYS	Develop fish spotter plane survey to estimate relative abundance of adult gulf menhaden; incorporate search time/flight path into survey as potential survet effort value	**Medium**
TAGGING STUDY	Re-visit the historical Gulf menhaden tag/recovery study. Replicate the study using 21st century tag/recapture technology. Potential products include better estimates of natural mortality, migration, growth, etc which are inputs for the stock assessment.	**Medium**
FISHERY-INDEPENDENT ADULT INDEX	Develop side-by-side gear comparisons among the states for standardization (trawls and gill net/strike nets).	**Low/Med**
PREDATOR/PREY	Expand the diet and stable isotope database to determine the trophic role of Gulf menhaden in the GOM. Investigate fatty acids profiles as an additional more specific indicator of important prey items of Gulf menhaden.	**Low/Med**
PREDATOR/PREY	Need to initiate food habits of major predator species in the northern GOM to determine the importance of menhaden in the diets of fish, seabirds, and marine mammals.	**Low/Med**
FISHERY-INDEPENDENT JUVENILE INDEX	Expand state independent sampling to include more sites in under-represented areas (Perdido Bay, Florida Panhandle, Mississippi Sound) on a monthly schedule.	**Low**

FISHERY-INDEPENDENT JUVENILE INDEX	Develop side-by-side gear comparisons between the states for standardization (seines and trawls).	**Low**
MODELING	Additional research into simulation models such an MSVPAs, ECO-SIM, EcoPath, etc.; results could produce better estimates of natural mortality as well as other fishery parameters.	**Low**
MODELING	Develop a habitat index to examine the potential shift in the Gulf menhaden population to more inshore waters as marsh converts to open water from coastal land loss.	**Low**

Review Workshop

The RW panel suggested there should be evaluation of the utility of using ovarian egg number as a proxy for SSB and notes that this will depend not only on biological considerations but also on ageing validation and errors, and selectivity determination. Ultimately, the utility of egg numbers versus SSB will depend on how status benchmarks and control rules are determined.

The Louisiana gillnet survey used in the menhaden assessment has a number of different mesh sizes and concern was expressed about developing a single index over these different mesh sizes, especially given the length frequencies presented in the assessment (AW Report, Fig. 5.44). The RW panel recommends evaluating the efficacy of developing separate indices by mesh or accounting for the different mesh sizes within the same index.

The panel did not see value in undertaking genetic studies to further elucidate Gulf menhaden population structure given the fishery operates in the center of the species distribution and it is unlikely that information gained would justify the expense of additional analyses. However, the RW panel did see considerable benefit in using simpler genetic techniques, such as DNA barcoding, to aid species identification, which is currently problematic in fishery-independent surveys conducted in peripheral range areas in Texas, Alabama, and Florida.

Throughout the course of the DW and AW, a number of items were identified as important research topics for future stock assessments. The RW Panel evaluated the various items in those lists and developed a consensus priority list.

DATA ELEMENT	RECOMMENDATION	PRIORITY
FISHERY-INDEPENDENT ADULT INDEX	Collect Gulf menhaden ageing structures (scales and otoliths) from alternate fishing gears (e.g., gillnets and trawls) to determine gear selectivity. Need to expand efforts to age menhaden by state agencies. Determine readability of whole	**Very High**

	versus sectioned otoliths.	
FISHERY-INDEPENDENT ADULT INDEX	Improve species identifications at the periphery of the Gulf menhaden's range in Texas and Alabama/Florida waters.	**Very High**
FISHERY-DEPENDENT SURVEYS	A Gulf-wide aerial survey may be a useful tool to measure adult Gulf menhaden abundance; "groundtruthing" for fish size and age and school size, would be a necessary adjunct to the survey.	**High**
FISHERY-DEPENDENT SURVEYS	Additional sampling needs to be conducted to address the homogeneity of the catch in the hold of the reduction fishery vessels at the four Gulf menhaden factories. Supplemental samples must be pulled from throughout the fishhold during the pumpout process to determine if the assumption that the traditional 'last set of the trip' accurately represents the age composition for the catch for the given port-week	**High**
FISHERY-INDEPENDENT JUVENILE INDEX	Improve species identifications at the periphery of the Gulf menhaden's range in Texas and Alabama/Florida waters.	**High**
FECUNDITY/MATURITY	The seminal study on fecundity and sexual maturity of Gulf menhaden was published thirty years ago (Lewis and Roithmayr 1981) with data from the late 1970s. It is recommended that a study should be initiated to re-examine the reproductive biology of gulf menhaden in the northern Gulf of Mexico,which includes updating fecundity estimates, maturity schedules(GSI), and sex ratios. Any study needs to reinvestigate whether gulf menhaden are determinant or indeterminant spawners. Survey necessarily needs to include spawning from winter collections.	**High**
GENETICS AND STOCK STRUCTURE	Identification of menhaden-specific nuclear DNA markers (preferably microsatellites or SNP's) using a lab-based DNA library screening techniques. Evaluation of these markers for use in genetic studies of Gulf menhaden	**Low**

GENETICS AND STOCK STRUCTURE	Identification in the Clupeid literature of potential new heterologous nuclear DNA markers (preferably microsatellites or SNP's) which will potentially enhance genetic sampling in Gulf menhaden.	**Low**
GENETICS AND STOCK STRUCTURE	Reassessment of Gulf menhaden throughout its range using a larger,more informative genetic panel of markers than that described in Anderson (2006).	**Low**

The panel provided the following comments on the research recommendations that given in the assessment documents.

Several issues were identified with ageing for menhaden including the lack of formal protocols for inter-reader comparisons and calibration/reference data sets. Given the short-lived nature of the fish, reader error of even one year can cause substantial bias in an age-based assessment. Given the pending retirement of the single ager, assessment of the accuracy of ageing and the establishment of formal protocols should be done as soon as possible.

It was not apparent to the panel that stock structure was an issue in the stock assessment and the panel did not see value in undertaking genetic studies on stock structure. However, the panel did see considerable benefit in using simpler genetic techniques such as DNA barcoding to aid species identification, which is currently problematic in peripheral range areas as sampled in the Texas, Alabama, and Florida surveys. Resolution of species identification and any other measures to ensure more consistency across the many state surveys that were excluded from the assessment could provide a more representative basis for monitoring abundance.

The recommendation to consider an aerial survey should be pursued, although the turbid waters close to the Mississippi may limit detectability of fish schools. This kind of survey offers an opportunity to form a partnership between the states, federal government and the fishing industry in a monitoring program to ensure sustainability.

The panel recommended that addressing the sampling of the catch throughout the holds of the reduction fishery vessels be rated as very high priority given concerns about the selectivity of larger fish to the catch. The 2012 study indicated that sampling only the top of the hold may underestimate the proportion of older fish in the catch and given the use of fecundity for spawning stock biomass result in an underestimate of productivity (see below).

While the studies proposed to update knowledge about the reproductive biology of Gulf menhaden would be nice to do, the panel felt that the current approach is adequate for now and more priority should be given to resolving the selectivity pattern of older fish to the fishery so that their reproductive contribution to the population can be better accounted for.

SEDAR 33: Gulf of Mexico Gag and Greater Amberjack

Gag

Data Workshop

Life History

Stock Definition

Increased genetic sampling should provide more precise estimations of exchange rates within the Gulf basin and the Atlantic. As well, The LHW recommends continued application of otolith chemistry methods to evaluate the population structure and connectivity of gag.

Oceanographic modeling efforts are advancing (3-d models). Larval transport and modeling efforts need to be supported and associated with development of an Integrated Coastal Ocean Observing System (ICOOS). There is evidence for different transport and retention processes operating along the northeastern Gulf and west Florida shelf. Attention should be given to different oceanic forcing mechanisms particularly focusing on wind-driven upwelling and Loop Current intrusion differences north and south of about latitude 28°. Further exploration of potential larval contribution (interannual variation) from Campeche to US waters is needed.

For the purpose of learning more about exchange between basins, and as indicated in SEDAR 10, tagging studies should be coordinated between researchers in the Gulf (including Mexico) and south Atlantic, particularly with respect to adult size and depth. Additional acoustic tagging of mature gag may contribute to identification of additional spawning aggregation sites warranting protection. In particular more investigation of potential spawning habitats south of 28° latitude along the WFS is needed.

Age and Growth

Gag age samples are under- represented from the recreational sector. This remains a trend over time and more attention to recreational sampling is warranted.

Reader comparison statistics can now be incorporated as uncertainty in aging within the Stock Synthesis model. Estimates of standard deviation at age will be calculated and forwarded for review at the assessment workshop.

Further review of the aging macro (the assignment of final annual age) is needed to deal with the possibility of early annulus formation (e.g. before January 1st). Thus the age macro may need to include the means of age demotion for some individual gag.

Natural Mortality

1.) As in SEDAR 10, recommended ranges of M: (0.10 - 0.20).

2.) Continue to investigate age-varying M models and their appropriateness.

3.) LHW recommends further research into mortality rates of pre-spawning gag as they migrate from seagrass meadows to the offshore environment.

Reproduction

Maturity: Continue to gather histological samples to monitor change in maturity that may occur over time. Further examination needs to be made regarding how uncertainty in maturity can be treated within Stock Synthesis. A research recommendation is that formal decision tables be developed regarding the assignment of maturity based upon the raw histological readings for tropical/subtropical species. Changes to a decision table could be made in a standardized way to gauge the effect of uncertainty in models and for different species. The LHW recommends that this subject be presented at workshops or scientific meetings to raise awareness and develop consensus and best approaches.

Sex ratio, spawning fraction and fecundity: Promote collection of grouper reproductive samples via observer programs. Scientific observers working onboard commercial vessels will be able to sample gag in the round (prior to routine gutting) throughout the year. With improved field sampling, estimation of sex ratio needs to be made with better design or accounting of factors such as cohort effect (strong vs. weak year classes), location, gear and seasonal timing (pre-aggregation, spawning, and post-aggregation).

Sex transition and mechanism of sex change: Further review of the utility of secondary sexual traits (copperbelly pigmentation) is warranted: 1) incorporate the secondary sex field formally into TIP 2) provide training to port agents and 3) for longitudinal analysis develop means to account for changes in fishery selectivity and cohort effects.

Mating system: The LHW recommends further study of the particular type of mating system in gag (leks or harems). The distinction may depend on the particular type and amount of androgen produced (Shepherd et al 2013). An expectation is that leks would be more male biased as opposed to harems. As well, more information is needed on the timing and control of sex change in gag.

Form of reproductive potential: Because of questions about how the stock synthesis model can incorporate reproductive potential, the LHW recommends that three forms of reproductive potential be examined further at the Assessment Workshop given the data and reproductive traits reviewed at the data workshop 1) SSB-combined for male & female 2) SSB-female only and 3) SSB-eggs based upon annual fecundity.

Fertilization success: Research needs to be conducted on the consequences of sex ratio on fertility. The LHW recognizes that experiments on fertility would be difficult to conduct directly on such a large bodied species as gag (but see Rowe et al. 2004, 2008). Improved understanding of the gag mating system together with better designed field estimation of sex ratios may advance our understanding. Together with better field data, further genetic monitoring of Allee or inbreeding effects may yield much more insight on fertility and male reproductive success.

Conversion Factors

Continue to work on adoption of consistent standards across survey and data collection programs. Encourage programs collecting gag meristics to report fork length. Avoid use of Excel trend line function with some known statistical deficiencies in favor of more robust algorithms for solving equations.

Commercial Fishery Statistics

Landings
-Improved dockside sampling for catch composition
-Improved dealer reporting to species
-Historical literature research for historical landings

IFQ
-Investigate dealer influence on IFQ allocation usage through dealer IFQ surveys

Discard
-Most appropriate method for incorporation of IFQ data into discard estimations
-Most appropriate method for incorporation of IFQ data into discard size compositions
-Increased observer coverage.
-More representative observer coverage.

Recreational Fishery Statistics

1) Evaluate the technique used to apply sample weights to landings

2) Continue and expand fishery dependent at-sea observer surveys to collect discard information.

4) Track Texas commercial and recreational discards.

5) Estimate variances associated with the headboat program.

6) Evaluate existing and new methods to estimate historical landings.

Measures of Population Abundance

Expand the use of molecular genetics to identify the grouper larvae in SEAMAP samples that cannot be positively identified as gag grouper because diagnostic morphological characters are not yet developed.

The IWG made note that the delta-lognormal index may not be the most appropriate distribution with some of the data presented. However, the lack of adequate diagnostics for different distributions prelude their use. The recommendation is that addition work be done with these other distribution (i.e. Poisson, negative binomial) in order to fully vet the methodology.

A calibration study is needed between the FWRI/NMFS video survey and the UF diver survey (UVC). The standardized reef systems reported in SEDAR33-DW03 are well suited for rigorous calibration studies, which could also include other sampling methods.

An exploration of the effects of the IFQ on the fishery dependent indices, specially the commercial handline and longline is needed. During the workshop, fisherman indicated that since the implementation of the IFQ, there has been a drastic change in fisheries behavior. There is also the possibility that dealers can directly influence this behavior. The need is to find a way to incorporate these years into the overall timer series or a recommendation to split the time series when the IFQ began.

Further consideration of how to combine the data from the juvenile surveys, including perhaps revisiting the seagrass weighting approach as well as incorporating otolith microchemistry data on the relative contribution of estuaries to nearshore populations, may improve the YOY index.

Discard Mortality Rate

Future studies reporting discard mortality estimates should provide data tables that report the number of fish by discard condition (e.g. dead or alive), the number of fish by depth and by length bin, complete descriptions of gear (reel and hook type), and whether fish were properly vented. In addition, analyses of long-term mortality estimates from tag-recapture studies should account for survivorship and the effects of variable fishing effort over spatial and temporal scales.

Integrated Ecosystem Assessment

Harmful algal blooms

A top research priority is to assess the long-term effects of periodic HAB disturbances on the biomass, spatial distribution and age distribution of exploited reef fish species and their prey. These effects are likely to impact population viability and safe extraction rates, and could become very important to Gulf of Mexico fisheries management if climate change brings with it an increased frequency and severity of HAB events. Research should explore two avenues: retrospective analysis of reef fish biomass trends using historic HAB time series as drivers of mortality and recruitment, and future projections that challenge the current management practices under a schedule of increasing HAB disturbance (e.g., as informed by IPCC climate change scenarios). Priority should be given to spatially-explicit and/or stochastic simulation methods able to integrate, at minimum, the following features: fisheries effects, age structure, trophic dynamics, habitat, nutrient loading and HAB considerations.

Extending the Walter et al. (2013) red tide index forward will also be important for species affected by harmful algal blooms. This would involve bridging the SeaWIFS-MODIS gap between 2010 and 2011 to maintain continuity of satellite data and calibration of information.

Ecosystem modeling

No stock-recruitment relationship is specified in OSMOSE-WFS. Rather, recruitment levels in OSMOSE-WFS emerge from model simulations, and are dependent on the survival of eggs and larvae in relation to the predation process and to the amount of plankton available. Therefore, the development of OSMOSE-WFS #2 will be useful to obtain estimates of recruitment deviations for gag in the past, present and future that will be compared to estimates of recruitment deviations by the Connectivity Modeling System. Discussions would then be needed on how the outputs of both the Connectivity Modeling System and OSMOSE-WFS could be integrated into Stock Synthesis.

The IEA working group would benefit from another biophysical modeling system based on a Lagrangian framework, Ichthyop (Lett et al. 2008), in the future, to obtain estimates of recruitment deviations for gag and other species evaluated within the SEDAR process. The use of the Ichthyop model would be interesting to have several different perspectives on the issue of recruitment deviations.

Estimates of natural mortality

The following research topics would be useful for improving estimates of M:

- Within-model framework hypothesis testing of whether M applies to all ages equally or whether certain size/ages more vulnerable due to life history, location, and physiology
- Simulation modeling work to determine how best to model episodic mortality in stock assessments
- Development of forecasting methods to incorporate some probability of red tide occurring in the future, i.e. is there some autocorrelation to annual events, etc.
- Field or lab based studies of the effects of red tides on fish; for example, can fish sense *K. brevis* and do they move in response?
- Research on how mortality occurs; asphyxiation, bioaccumulation of toxins, etc.
- Does the pattern of recolonization of areas decimated by red tide occur through movement of adults or through settlement of juveniles.
- Collections of fish during red tide events, which would allow for the size/age selectivity of mortality to be determined, and might also allow for some minimum estimates of total mortality

Estimates of recruitment

Increased knowledge on the reproductive behavior or adult gag and biology of larval gag grouper would lead to better parameterization of larval transport models, and thus more accurate estimates of recruitment strength. Specifically, three major areas of uncertainty exist:

- The location of gag grouper spawning. While some sites have been well-documented (e.g., the Madison-Swanson Reserve) it is unknown whether spawning occurs in other locations along the West Florida Shelf. Collaborative projects with fishers would be particularly helpful in regards to identifying other potentially important spawning sites.
- The density and size of gag grouper eggs. Because transport patterns are highly sensitive to the vertical location of eggs in the first several days after release, more realistic parameterization of

particles in this initial stage would lead to more accurate estimates. In particular, knowledge on the densities of both fertilized and unfertilized eggs, and the timing of fertilization, would be useful.

The vertical distribution of gag larvae in the post-flexion stage. Because gag grouper have an extended pelagic larval duration (up to about 2 months), the fate of these larvae is largely determined by the depth layer in which they exist. Because grouper larvae are found in relatively low abundances in plankton tows, very little data exists on the vertical distributions of Epinepheline larvae in the pelagic environment, and in most cases the larvae are only identified to subfamily level. Increased sampling and identification of these larvae to species level will be important for understanding the vertical distributions of this species in the pelagic phase.

Assessment Process

1. Develop scientific survey to obtain reliable age/size composition data. This is needed, particularly as the composition data coming from the fisheries is substantially impacted by changing selectivity. This might be done with a handline survey of fixed sites. The idea would be not necessarily to get a random sample of the age composition but a reliable, relative estimate where selectivity can be assumed constant. An index would be nice, too.
2. Develop/Evaluate methods to maintain continuity of fishery-dependent indices in light of management regulations and ITQs.
3. Determine most appropriate methods to deal with changing selectivity in fisheries over time, particularly changing selectivity related to management actions or targeting of specific cohorts.
4. Evaluate most appropriate methods to deal with unreliable historic discard size composition data so that discard ratios can be reliably estimated.
5. Evaluate the size/age specific mortality effects of red tides on gag populations.

Review Workshop

Below, the RW Panel highlights research recommendations they feel should be emphasized, and provides new recommendations partly based on assessment methodology and results.

A. Research needs and new suggestions partly based on assessment methodology and results:

(1) Research should be conducted for the most appropriate value of steepness to be used for Gag – either through across a range of species (e.g. Ram database) or use of a well-estimated value from a closely related stock or species.

(2) If an appropriate fixed value for steepness is found, further research to explore the estimation of parameters currently fixed in the model, such as natural mortality.

(3) Further work on improving selectivity parameters that are poorly estimated from the data available, or highly correlated with other model parameters.

(4) Need more work on whether it is best to use either female or sexes combines (more conservative). The combined was what the assessment panel recommended.

(5) More research on video survey methodology or increasing samples size, as there is concern as to why video estimates do not match other indices.

B. Recommendations to improve the SEDAR Process:

(1) Due to the inherent complexity of highly parameterized statistical catch at age models (i.e. stock synthesis) and the relative scarcity of expert users, the review panel recommends that each SEDAR assessment workshop panel include at least one nationally recognized expert in the model used (e.g. SS). This expert could participate in person or by electronic means and would greatly facilitate the review process.

(2) There is concern over a variety of issues that emerge as a result of the Assessment Workshop was exclusively performed via webinars. The Review Panel emphasizes the importance of face-to-face meetings for improving the model development during the assessment phase. The panel feels that many of the issues uncovered during the review process could have been avoided and may have enabled the assessment team to provide a more polished product for review and in the end resulting in the best model possible.

Greater Amberjack

Data Workshop

Life History

Natural Mortality

- Expand sampling in the commercial fishery to try and obtain larger/older individuals since most ages to date are from the recreational fishery.
- Use fishery-independent surveys to sample YOY greater amberjack over the entire first year of life.

Age

- Continue annual ageing workshops and reference collection exchanges among laboratories to standardize methods. As a group, decide how to deal with fish that form an opaque zone late in the year (i.e., to count last opaque zone or not).
- Due to the difficulty in distinguishing the first annulus from the core region, measurements should be taken on a subset of young-of-the-year to age one greater amberjack otoliths to use as a reference.
- Since there is large variation in length-at-age and Murie and Parkyn (2008) found a significant relationship between otolith weight and body weight, examine the relationship between otolith weight and age.

- Cross-reference trip tickets and log book data to Biological Sampling Database to complete spatial records (depth, grid, etc.) to allow for increased analysis of spatial demographics.
- Expand sampling of commercial and recreational spear landing and long-line landings, as these are under-represented in the dataset.
- Expand sampling in the Western Gulf of Mexico, in particular off Texas, as this region is under-represented in the dataset.
- A general recommendation of the LHW is to expand design-based fishery-independent sampling to elucidate regional (i.e., eastern and western GOM) and sub-regional differences in the demographics of greater amberjack.

Reproduction

- There is a lack of information on spawning frequency and fecundity with size and age for greater amberjack in the Gulf of Mexico. Given the observed differences in sexual maturity, peak spawning season, and potential growth differences between the South Atlantic and Gulf of Mexico stocks of greater amberjack, it should be a research priority to obtain information on spawning frequency and fecundity with size and age for Gulf of Mexico greater amberjack.

- Given that sex ratios are skewed to females for fish > 1 m fork length (Smith et al. 2013 SEDAR33-DW27), if release mortality is low (Murie and Parkyn 2013b SEDAR33-DW29), then a slot size limit could be explored as a means of rebuilding female SSB.

Movement and Migration

- More tagging information is necessary to understand seasonal movements of greater amberjack in the Gulf of Mexico (see Stock ID section). Satellite tags may provide better habitat and seasonal information compared to conventional dart tags that cannot provide serial location information on the fish throughout the year.

Commercial Fishery Statistics

Landings

-Improved dockside sampling for catch composition

-Improved dealer reporting to species

Discards

-Increased observer coverage.

-More representative observer coverage.

-Most appropriate method for incorporation of IFQ data into discard estimations

Recreational Fishery Statistics

1) Evaluate the technique used to apply sample weights to landings.
2) Develop methods to identify angler preference and targeted effort.
3) Continue and expand fishery dependent at sea observer surveys to collect discard information. This would help to validate self-reported headboat discard rates.

4) Track Texas commercial and recreational discards.
5) Evaluate existing and new methods to estimate historical landings

Measures of Population Abundance

- Expand the use of molecular genetics to identify the amberjack larvae in SEAMAP samples that cannot be positively identified as greater amberjack because diagnostic morphological characters are not yet developed.
- The IWG made note that the delta-lognormal index may not be the most appropriate distribution with some of the data presented. However, the lack of adequate diagnostics for different distributions prelude their use. The recommendation is that addition work be done with these other distribution (i.e. Poisson, negative binomial) in order to fully vet the methodology.
- A calibration study is needed between the FWRI/NMFS video survey.
- An exploration of the effects of the IFQ on the fishery dependent indices, specially the commercial handline and longline is needed. During the workshop, fisherman indicated that since the implementation of the IFQ, there has been a drastic change in fisheries behavior. There is also the possibility that dealers can directly influence this behavior. The need is to find a way to incorporate these years into the overall timer series or a recommendation to split the time series when the IFQ began.

Discard Mortality Rate

Future studies reporting discard mortality estimates should provide data tables that report the number of fish by discard condition (e.g. dead or alive), the number of fish by depth and by length bin, complete descriptions of gear (reel and hook type), and whether fish were properly vented. In addition, analyses of long-term mortality estimates from tag-recapture studies should account for effects of variable fishing effort over spatial and temporal scales.

Assessment Process

1. Review fishery dependent length and age sampling intensity protocols for Greater Amberjack. This is needed to optimize sampling coverage across the entire geographical area of catch.

2. Review fishery independent video surveys sampling design to determine if there are practical changes which could be implemented that would increase reliability in the indices. In particular, the Panama City trap video survey should be enhanced as this survey provides information on small Greater Amberjack. Improvements in the index could potentially yield more reliable estimates of size composition of recruits.

3. Develop fishery independent sampling programs for size/age composition. This research is needed to improve more reliable and accurate estimation of selectivity unaffected by fishery dependent data collections, the latter which are affected by management regulations

4. Evaluate method used to develop historical recreational effort.

5. Develop program/procedures to allow increased sampling of discarded fish for all fleets and initiate a program to collect size composition of discards from the private angler fleets. A program similar to the North Carolina Division of Marine Resources (i.e., the "Board Survey") used to obtain size compositor of discarded recreational fish) could be evaluated to obtain self-reported size composition form private anglers and other recreational components also.

Review Workshop

Below, the RW Panel highlights research recommendations they feel should be emphasized, and provides new recommendations partly based on assessment methodology and results.

A. Panel recommendations for other research needs and new suggestions partly based on assessment methodology and results:

1. Need more assessment analyses to determine whether it is best to use either female or sexes-combined biomass estimates

2. Improving discard mortality estimates should be considered

3. Species identification has the potential to be problematic. More studies using genetic approaches may be beneficial

B. Panel recommendations to improve the SEDAR Process:

1. Due to the inherent complexity of highly parameterized statistical catch at age models (i.e. stock synthesis) and the relative scarcity of expert users, the review panel recommends that each SEDAR assessment workshop panel include at least one nationally recognized expert in the model used. This expert could participate in person or by electronic means and would greatly facilitate the review process.

There is concern over a variety of issues that emerge as a result of the Assessment Workshop largely or even exclusively performed via webinars. The Review Panel emphasizes the importance of face-to-face meetings for improving the model development during the assessment phase. The panel feels that many of the issues uncovered during the review process could have been avoided and may have enabled the assessment team to provide a more polished product for review and in the end resulting in the best model possible.

SEDAR 34: HMS Atlantic Sharpnose and Bonnethead Sharks

Atlantic Sharpnose

Data Recommendations

- More research is necessary on review/improvement/development of shrimp bycatch estimation models for both data-poor and data-rich species
- More research is necessary on integration of various local abundance indices into a global abundance index based on spatio-temporal, physical-biological characteristics and variability.

Reviewer Recommendations

Apostolaki Recommendations

The research recommendations that the Panel made are appropriate and will add value to future stock assessments. I have listed here those I consider would make the greatest difference.

a) Clearly, a priority is to undertake work to provide all the relevant information to run single stock assessments instead of running assessment models for stocks combined.
b) Good estimates of by-catch in shrimp fisheries are very important since they drive total catch values and thus influence model predictions on MSY. Therefore, work to increase precision in those estimates would improve future model predictions. This refers to both catches before and after 1972.
c) Identification of additional information/factors that could improve the explanatory power of the standardization models for CPUEs or help understand the contradictory trends among the CPUEs series should also be supported.
d) Data collection to support calculations of gear selectivity and improve the quality of the results will also be beneficial.
e) Estimates of post release mortality are based on a small sample size so collection of additional data is recommended as well as species-specific collection of such data.

The SEDAR process is generally effective and achieves its objectives. Based on this specific SEDAR event and report, and previous experience in undertaking desk based reviews, I believe that if reviewers were given the option to have a short meeting (teleconference) with the relevant analysts, that would add value to the process.

Cook Recommendations

Two research recommendations are made in the report which relate to improving the shrimp by-catch estimates and the integration of indices. I would strongly support both of these recommendations. In the case of the shrimp bycatch it is of particular importance to develop a method that is able to reflect the response of the catch to changes in stock abundance. The method used for this assessment uses only effort and is a severe weakness which is bound to result in bias in the estimates.

Assessment models are often a matter of taste where practitioners adopt the model that they prefer. I felt the model used in this assessment demanded far too much from the data and as a consequence a very large number of assumptions had to be made which can only be examined by a very complex set of

sensitivity tests whose results themselves are not easy to digest or interpret. I would recommend that an assessment model that is more closely designed around the available data is developed. If, in reality, shrimp bycatch data cannot be estimated with any precision, then it might be better to treat these catches as unknown and use the effort data directly in the model. It would also be preferable to describe the population in terms of length rather than age.

The assessment report documents are very well written and presented. They were available on time and all this made the work of review much easier. I missed the opportunity to raise questions about the assessments with the assessment panel. It might be useful to try to organize a webinar at some stage during the review so that reviewers can seek clarification from the assessment panel to avoid mistakes and misunderstandings in their reports. I imagine that some of my comments may have arisen through incomplete understanding of what was done.

Rice Recommendations

There are sufficient data for further development of these assessments using sex-structured models that estimate selectivity inside an assessment model, fitting to size data, not length data converted to age. The assessment team mentioned that this is a desirable framework for the next assessment. Specific recommendations for research priorities include:

- To develop region specific indices of abundance. I note that this had been done, alongside the combined indices.
- Ensuring information about sex, length and age is collected in each fishery, throughout with respect to the spatial/temporal nature of the fishery.
- Research that improves the understanding of historical landings in the shrimp fishery, both in the modern and historical period and to support the assumptions about when stocks are at virgin biomass if this assumption is carried forward in future assessments.
- Research into the change in selectivity resulting from regulatory or gear changes (e.g. TEDs).

With respect to the overall SEDAR process, it is apparent that the some aspect of the process failed. The major issue detracting from the quality of any advice based on the bonnethead shark stock assessment is that it does not represent the status of either of the regional stocks.

Bonnethead

Data Recommendations

- More research is necessary on review/improvement/development of shrimp bycatch estimation models for both data-poor and data-rich species
- More research is necessary on integration of various local abundance indices into a global abundance index based on spatio-temporal, physical-biological characteristics and variability.

Reviewer Recommendations

Apostolaki Recommendations

The research recommendations that the Panel made are appropriate and will add value to future stock assessments. I have listed here those I consider would make the greatest difference.

a) Clearly, a priority is to undertake work to provide all the relevant information to run single stock assessments instead of running assessment models for stocks combined.
b) Good estimates of by-catch in shrimp fisheries are very important since they drive total catch values and thus influence model predictions on MSY. Therefore, work to increase precision in those estimates would improve future model predictions. This refers to both catches before and after 1972.
c) Identification of additional information/factors that could improve the explanatory power of the standardization models for CPUEs or help understand the contradictory trends among the CPUEs series should also be supported.
d) Data collection to support calculations of gear selectivity and improve the quality of the results will also be beneficial.
e) Estimates of post release mortality are based on a small sample size so collection of additional data is recommended as well as species-specific collection of such data.

The SEDAR process is generally effective and achieves its objectives. Based on this specific SEDAR event and report, and previous experience in undertaking desk based reviews, I believe that if reviewers were given the option to have a short meeting (teleconference) with the relevant analysts, that would add value to the process.

Cook Recommendations

Two research recommendations are made in the report which relate to improving the shrimp by-catch estimates and the integration of indices. I would strongly support both of these recommendations. In the case of the shrimp bycatch it is of particular importance to develop a method that is able to reflect the response of the catch to changes in stock abundance. The method used for this assessment uses only effort and is a severe weakness that is bound to result in bias in the estimates.

Assessment models are often a matter of taste, where practitioners adopt the model that they prefer. I felt the model used in this assessment demanded far too much from the data and as a consequence a very large number of assumptions had to be made which can only be examined by a very complex set of sensitivity tests whose results themselves are not easy to digest or interpret. I would recommend that an assessment model that is more closely designed around the available data is developed. If, in reality, shrimp bycatch data cannot be estimated with any precision, then it might be better to treat these catches as unknown and use the effort data directly in the model. It would also be preferable to describe the population in terms of length rather than age.

The assessment report documents are very well written and presented. They were available on time and all this made the work of review much easier. I missed the opportunity to raise questions about the assessments with the assessment panel. It might be useful to try to organize a webinar at some stage during the review so that reviewers can seek clarification from the assessment panel to avoid mistakes and misunderstandings in their reports. I imagine that some of my comments may have arisen through incomplete understanding of what was done.

Rice Recommendations

There are sufficient data for further development of these assessments using sex-structured models that estimate selectivity inside an assessment model, fitting to size data, not length data converted to age. The assessment team mentioned that this is a desirable framework for the next assessment. Specific recommendations for research priorities include:

- To develop region specific indices of abundance. I note that this had been done, alongside the combined indices.
- Ensuring information about sex, length and age is collected in each fishery, throughout with respect to the spatial/temporal nature of the fishery.
- Research that improves the understanding of historical landings in the shrimp fishery, both in the modern and historical period and to support the assumptions about when stocks are at virgin biomass if this assumption is carried forward in future assessments.
- Research into the change in selectivity resulting from regulatory or gear changes (e.g. TEDs).

With respect to the overall SEDAR process, it is apparent that the some aspect of the process failed. The major issue detracting from the quality of any advice based on the bonnethead shark stock assessment is that it does not represent the status of either of the regional stocks.

SEDAR 35: Caribbean Red Hind

Data Workshop

No specific recommendations were provided.

Assessment Process

In the short term, US Caribbean stock assessments will continue to rely on mean-length estimation given the data currently available. The ability to use the mean-length estimator is contingent upon having length-frequency data that are temporally consistent and representative of the population and upon having reliable estimates of life history parameters, in particular, the von Bertalanffy parameters. Efforts should be made to review the current TIP sampling structure in Puerto Rico and in the USVI to ensure sampling is representative. Studies on basic life history (e.g., age-growth relationships, length/age-at maturity) in the US Caribbean will greatly enhance the utility of the existing length-frequency data and should provide the greatest benefit to providing management advice in the short term. This should be placed as a top priority for key species.

Fishery-independent surveys should be considered as a top research priority for additional data collection. Fishery-independent surveys designed using a rigorous statistical framework will allow for the collection of species-specific catch and effort data that can be used to develop indices of abundance. Indices of abundance are used in stock assessments to inform models about how a population may be changing over time. Fishery-independent surveys can also be used to supplement existing programs by collecting age, length, weight, and reproductive data.

During the SEDAR 35 assessment workshop, and in previous assessment workshops in the US Caribbean, the fishermen from the USVI indicated that the size of landed fish is market driven for plate size fish. This may help to explain the relatively narrow size range of landed Red Hind. It also suggests that selectivity is dome-shaped, which violates the assumption of knife-edge selectivity in the mean-length model. One avenue of future research would be to expand the mean-length estimator to accommodate other selectivity patterns. Another avenue of research would be to quantify the selectivity patterns for the different gear types. During the data and assessment workshops, the Panel could not quantify discard rates nor could they ascertain the level of discard mortality. If discard mortality of larger fish is significant, the violation of the selectivity assumption may be moot. Efforts should be made to quantify discard and discard mortality rates for the US Caribbean fisheries.

Lastly, under the current management regime all US fisheries must be managed by annual catch limits (ACLs). In an ideal scenario, ACLs would be developed from estimates of abundance and sustainable yield. The mean length estimator does not provide these metrics. As such, it is essential that continued efforts to improve the data collection of fishery-dependent catch and effort statistics be made so that traditional biomass-based assessment approaches can be employed. Continued efforts to collect

species-specific catch statistics will also be important in moving towards more traditional assessment approaches and for more precise monitoring of ACLs.

Review Workshop

Research Recommendations from the CIE Reviewer Reports (Term of Reference 6)

Cardinale Recommendations

The Assessment team provides an exhaustive list for future data to be collected, which would notably improve the capability of assessing the status of the Caribbean red hind stock. However, I consider that the description of the additional research and future monitoring is not exhaustively presented and it could have been much more detailed and comprehensive.

The reviewer agrees with the Assessment team that priority should be to given to derive data which allows movement towards more traditional assessment approaches. However, the reviewer also considers that this could in part already be pursued by the Assessment team using other methods than the mean length analysis (see ToR 2 and ToR 3).

Additional Recommendations
• A virtual population analysis (VPA), assuming a steady state and combining different gears, should be used for selected combination of years, areas and gears in a future assessment of Caribbean red hind.

Dowling Recommendations

The research recommendations provided by the Assessment Workshop are:

--(top priority) Undertake studies on basic life history (e.g. age--growth relationships, length/age at maturity).

- Agree, in so much as these should reduce existing uncertainty – but are these realistic given the existing capacity? Why are not previous studies considered representative? Are there existing studies for the same species elsewhere that may be helpful?

--Review the current TIP sampling structure to ensure sampling is representative.

- Agree --but "representative" in what sense? Temporally, spatially, of the size structure of the total fished population, of the total fishing effort?
- I think this should rate as a higher priority than undertaking fishery--independent surveys. The priorities should be immediately focused on improving the input to, and outcomes, the existing assessment approach.

--top priority) undertake fishery-independent surveys that enable the development of abundance indices, and that collect age, length, weight and reproductive data.

- Fair enough – but again, are these realistic given the existing capacity?
- Moreover, this recommendation should be made in the context of the evaluations of the existing fishery independent data and/or survey protocols (e.g. the Mona Island and Abrir la Sierra (DW03) protocols and data had potential had the time series been longer).

--To expand the mean--length estimator to accommodate other selectivity patterns.

- I think this is an excellent recommendation.

--To quantify the selectivity patterns for the different gear types.

- I agree that this needs to be resolved, especially given the assumption of knife--edged selectivity underpinning the per---recruit analyses.

--To attempt to quantify discard and discard mortality rates.

- Agree that this would be useful, but how could this be achieved? Quantifying discarding is notoriously difficult.

- To continue to improve the data collection of fishery-dependent catch and effort statistics so that traditional biomass-based assessment approaches can be employed (and hence annual catch limits determined and monitored).

- I agree that this is a key priority.
- However, there is presumably no way to improve the quality of the historical catch and effort statistics, so the issue is also one of how best to work with the existing data.
- While it may be ideal to develop ACLs from estimates of abundance and sustainable yield, these are often unavailable. This does not preclude ACLs from being set. ACLs may be determined using simple empirical approaches, while acknowledging the increased risk associated with less information and certainty.

Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.

There are two arenas for research and monitoring. One is around improving the reliability and usefulness of the current assessment approach. This equates to narrowing the range of mortality estimates and so increasing the certainty around the probability of overfishing (and to introducing an overfished reference point threshold). The other is around improving the

quality of information available into the future such that alternative approaches may be permitted.

Against the current assessment approach, I agree that

- Reviewing the TIP length data for representativeness (temporally, spatially, of the size structure of the total fished population, of the total fishing effort) is important. This should include a careful consideration of the TIP length data in the context of the other available length frequency information.
- Whether by improving the understanding of life history, and/or by reviewing the available information and parameters and weighting or narrowing these to a more plausible subset, working to reduce the range of mortality estimates is also important.

In addition, monitoring and research to resolve uncertainties around:

- --Stock structure in the context of the three regions considered (whether by genetic testing (expensive), tagging studies (expensive), or considering spawning migration (per RD09) and larval transport data (per RD06), and/or studies of dispersal, mixing and stock structure from similar species elsewhere) (i.e. are we treating the three regions as three separate stocks, to which different stock statuses and hence difference management apply?) and
- --Gear/fleet reconciliation within regions (i.e. what is the extent of overlap of the fishable sizes targeted/captured by the different gear/fleet types? To what extent can the data from each be combined?)

should be prioritized, so that the probabilities of overfishing are useful in a management context. Currently there are six sets of probabilities (3 regions x 2 overfishing threshold reference points), with each gear/fleet considered to contribute equally to the frequency distributions used to determine the probabilities. Ideally, there should be a recommended preferred reference point (that which is more precautionary, in the absence of other information), a better quantitative articulation of the extent to which the information from each gear/fleet contribute to the overall frequencies on which the probabilities of overfishing are based, and an increased confidence of how these should be applied in the context of what is understood about stock structure.

Additional work to determine:

- A suitable reference point corresponding to an overfished stock status
- A target reference point that could underpin management decision/control rules is also recommended.

Against improving the quality of information available into the future, such that alternative approaches may be permitted

- There is no clear indication given as to whether formal logbook reporting is possible (or exists), but it seems that the best means of obtaining uniform catch and effort data on which alternative assessments may be based (e.g. simple production models).
- A reconciliation of the fishery independent approaches should be undertaken with a view to recommending a monitoring program that will optimize the utility of the information obtained. (To what extent would the protocol described in RD01 be sufficient?) Recommendations should be pragmatic given the available resources and capacity.

Meanwhile, I encourage

- --Avoiding tossing out data for the sake of being overly Puritan. Even if time series of CPUE, for example, are not considered of adequate quality to enable a formal stock assessment, the data may be useful in informing simpler, more empirical assessments (e.g. Froese 2004; Dowling et al. 2008; Prince et al. 2012; Edwards et al. 2012; Erisman et al. 2014). At the very least, they give some notion of historical high catches, and size-based catch rates.
- --At least attempting to fit a production model to the two sets of standardized CPUE (AW01; DW04). Even if there proves to be inadequate contrast in the data, the attempt to use it in an assessment would still place emphasis on what is needed from future data collection protocols.

Finally, I strongly encourage that more effort be dedicated to considering approaches to developing ACLs. The Assessment Workshop avoided developing ACLs because the mean length estimator "does not provide these metrics" and "in an ideal scenario, ACLs would be developed from estimates of abundance and sustainable yield". However, the yield-per-recruit/spawner-per-recruit analyses provide F_{MSY} target reference point proxies that could be used in determining an ACL via simulated projections. Second, fisheries arguably do not require "traditional biomass based assessment approaches" in order to set ACLs. Catch time series, triggers (as reference point proxies) or reference points, and empirical decision/harvest control rules can all be used to set an interim ACL (e.g. Dowling et al. 2008; Prince et al. 2012; Dowling et al. 2014).

Provide recommendations on possible ways to improve the SEDAR process.

On the basis of the documents provided, I have the following recommendations:

--Link the Data Workshop Report more closely to the Assessment Workshop Report, so that

- Data are consistently summarized between each report, preferably via a commonly presented summary table
- There is improved clarity on how and whether data are used in the assessment. There is minimal detail regarding data in the Assessment Workshop Report. It would have been useful had the Data Workshop Report indicated whether and how each type/set of available data was used in the assessment, both as a summary sentence at the time of its presentation, and in an overall data summary table.

--Prior to circulating for review, cross--check reports to ensure that report reference lists are complete and that key papers are included as background reading (or at least links provided). Perhaps allowing slightly more time for completion of reports may assist with this.

--As a required part of the Assessment Workshop Report, provide historical context and past precedence for assessments previously undertaken. This was not provided in current reports. If not previous precedent exists, this should be explicitly stated.

Maravelias Recommendations

The following are some general suggestions and recommendations to improve the current status of the fishery.

A. Improve the fishery information management system. The Puerto Rico's fishery has been monitored through the Fisheries Statistics Project (FSP) continuously since 1967. The project aimed to provide fisheries data for the resources in the waters of Puerto Rico and scientific information to support management plans. Despite this FSP initiative, the lack of reliable official fishery statistics is evident and constitutes a considerable handicap for the assessments. It is important to improve the official state authority design, implementation and integration of the system to collect and compile statistical data from the entire national fisheries. This data collection system should ideally cooperate with other authorities e.g. the port authorities, the local customs offices, correspondents in municipalities and communities, villages. The primary objective should be to collect fishery-dependent info: catch, effort, discards, fleet, economic (cost, profit), social (e.g. employment, education) statistics. Following standard and common sampling protocols for all isles, fleets, gears, seasons and strata. Similar data, especially catches, effort, discards, costs and profits, can be collected regularly using onboard sampling, i.e. following the fishers during their fishing trips. This will provide more realistic data that could then be compared with port sampling, intercepts, TIP, logbooks.

B. Basic research could be promoted to study Red Hind biological parameters. This research preferably

may include: age, growth, feeding, length/age-at-maturity, and fecundity to provide the fundamental knowledge that will support future assessments.

C. Fishery-independent surveys should be carefully designed and carried out in order to provide scientifically sound information and data to support stock assessment, fishery conservation and management. These ideally should cover the distribution of key species (including Red Hind) in all three studied regions, i.e. Puerto Rico, St Thomas/St John and St Croix. Such scientific surveys will provide abundance and biomass estimates but also additional size distribution, maturity, spawning season and areas, scales or otoliths for age and growth studies, stomach contents, fecundity information and they can target early-life stages and adult parts of the population. In addition a number of auxiliary data can be collected, e.g., oceanographic, seabed substrate, information on essential fish habitat of the species. These fishery-independent surveys will provide complete catch records in the area. Commercial vessels often discard many species and especially small fish (< MLS: minimum landing size), whereas research vessel surveys can provide information on the total species composition and size range available to the gear. The scientific information and data that will be collected will increase long-term economic and social benefits from the fisheries resources in the area. Once established, these surveys should be carried out routinely to support scientific monitoring of the living marine resources (e.g. annually or bi-annually).

D. Following the required provisions of the Magnuson-Stevens Fishery Conservation and Management Act, a number of management reference points for species undergoing overfishing were established by the 2010 Caribbean Annual Catch Limit Amendment 3. The Annual Catch Limit (ACL) is currently the main management tool and US fisheries should aim to specify ACLs and accountability measures, AMs, to prevent ACLs from being exceeded. Fishery-dependent catch, effort and discards statistics are urgently required to follow these provisions. As a first step, catch-based methods can be implemented that require only catch information. Biomass dynamic models can also be applied providing catch and effort data will become available. However, scientific advice to fishery managers needs to be expressed in probabilistic terms to convey uncertainty about the consequences of alternative harvesting policies. One avenue for future stock assessment could be to build informative prior probability distributions (priors) for r, K, q, M, F. Expert knowledge and the available fishery datasets may prove useful in building such priors. Then using a simple biomass dynamic model fitted to catch rate data, a risk assessment approach can be applied to evaluate the potential consequences of alternative ACLs. The benefit for the fishery from a probabilistic modeling method would be that uncertainties would have been considered but also estimates of biological risks of alternative ACL-policy options will be provided. This may serve as a basis for providing precautionary fishery management advice given the high degree of uncertainty.

E. Design and carry out gear selectivity studies aiming to disclose species' selectivity patterns and improve resource exploitation. This coupled with discard estimates from the fleet statistics and onboard scientific sampling will allow the assessment of discard mortality.

F. Improve the effectiveness of external partnerships with fishers, managers, scientists, conservationists, and other interested groups to build a balanced approach to meet common fisheries goals. This will

ensure best buy-in of any future management measure.

G. Enforce stringent monitoring, control and surveillance mechanisms to restrict unregulated fishing in spawning aggregations that restrain stock recovery.

SEDAR 36: South Atlantic Snowy Grouper

Research recommendations from the Standard assessment report.

- Increased fishery independent information, particularly for developing reliable indices of abundance, would greatly improve the assessments of deepwater species.
- More age samples should be collected from the general recreational sector and with more complete spatial coverage.
- Snowy grouper were modeled in this assessment as a unit stock off the southeastern U.S. For any stock, variation in exploitation and life-history characteristics might be expected at finer geographic scales. Modeling such sub-stock structure would require more data, such as information on the movements and migrations of adults and juveniles, as well as spatial patterns of larval dispersal and recruitment. Even when fine-scale spatial structure exists, incorporating it into a model may or may not lead to better assessment results (e.g., greater precision, less bias). Spatial structure in a snowy grouper assessment model might range from the very broad (e.g., a single Atlantic stock) to the very narrow (e.g., a connected network of meta-populations living on individual reefs). What is the optimal level of spatial structure to model in an assessment of snapper-grouper species such as snowy grouper? Are there well defined zoogeographic breaks (e.g., Cape Hatteras) that should define stock structure? Research into these questions could help inform future stock assessments.
- Protogynous life history: 1) Investigate possible effects of hermaphroditism on the steepness parameter; 2) Investigate the sexual transition for temporal patterns, considering possible mechanistic explanations if any patterns are identified; 3) Investigate methods for incorporating the dynamics of sexual transition in assessment models.
- In this assessment, the number of spawning events per mature female per year was implicitly assumed to be constant. The underlying assumptions are that spawning frequency and spawning season duration do not change with age or size. Research is needed to address whether these assumptions for snowy grouper are valid. Age or size dependence in spawning frequency and/or spawning season duration would have implications for estimating spawning potential as it relates to age structure in the stock assessment (Fitzhugh et al. 2012).

SEDAR 37: Southeastern U.S. Hogfish

Data Workshop

No specific recommendations were provided.

Assessment Workshop

Significant advancements in the understanding of life history for Hogfish were made since the last assessment in 2004 (SEDAR 6), mainly resulting from the effort of R. McBride and A. Collins (FWC-FWRI) and their collaborators from the fisheries, resulting in numerous publications and datasets. In particular, the age samples collected in both the WFL and FLK/EFL stock represent the vast majority of samples available for both stocks, providing for stronger estimates of growth and maturity than available from fisheries dependent sources or surveys.

While the life history is particularly well categorized in the WFL, where more research has focused (i.e., 2005-2007 life history study), questions still remain regarding the perceived differences in growth, maturity, and fecundity between the FLK/EFL and WFL stocks, and how these may be regulated by fishing pressures. In addition, life history studies and fisheries independent surveys are sorely needed for the GA-NC stock, particularly with respect to juveniles and mature females, since all available data is from fishery-dependent sources that catch primarily large, older males. Specific recommendations are as follows:

(1) Conduct focused life history studies in the FLK/EFL and GA-NC stocks across a range of sizes/ages in order to test for differences in growth, maturity, and fecundity relative to the WFL stock where more information is available. While estimates from the FLK/EFL exist from the earlier life history study (1995-2001), additional sampling across a broader age spectrum by targeting more remote regions with lower fishing pressure (e.g., Dry Tortugas) may allow for better estimates of functional relationships.

(2) Develop/improve fisheries-independent surveys for the GA-NC stock to specifically track Hogfish abundance. Currently, the SERFS video program only detects Hogfish in less than 5% of surveys, leading to difficulties in estimating abundance.

(3) Improve biostatistical sampling of Hogfish in all regions from fisheries-dependent sources for both length and age observations.

(4) Develop a life history study to ascertain the contribution of males to spawning reproductive potential (SRP). Appropriate determination of male contribution will provide more certainty in modeling reproduction, which has a strong influence on stock status and could be instrumental in designing appropriate management regulations with respect to size limits to protect the spawning biomass.

Review Process

Research Recommendations from the CIE Reviewer Reports

R.I.C. Chris Francis Recommendations

Consider the research recommendations provided and make any additional recommendations or prioritizations warranted.

a) Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.

The Assessment Report presented four research recommendations, which can be summarised as follows.

1. More growth, maturity, and fecundity information for FLK/EFL and GA-NC
2. Fishery-independent surveys for GA-NC
3. Improve age and length sampling of hogfish fisheries
4. Contribution of males to spawning reproductive potential

Of these, I think 3 and 2 are most likely to improve future assessments. With regard to 3, I would strongly emphasize the age data (age compositions are much more informative in a stock assessment model than length compositions) and comment that doubling the number of trips sampled has a much greater effect on precision than doubling the number of fish sampled per trip. There is a need to check that the ageing of the sampled fish is consistent with the validated method (see Section 3.1a) and to develop reliable methods to construct length compositions from these data (see Section 3.1a). With regard to 2, I note that GA-NC was the weakest of the three assessments because there was only one biomass index, and this was not well fitted by the model (see AR Figure 11.2.1.2.16).

I think that 4 is important, but perhaps more to inform fishery management (e.g., are special measures needed to protect males?) than to improve the stock assessment.

A comparative study of alternative methods of biomass index calculation would be useful. I was startled by the array of different methods used for indices in these assessments (markedly different methods are described in Background Documents 37-02, 37-05, 37-09, and 37-12) and wondered whether it was either necessary or desirable to use so many different methods. Perhaps some rationalization of methods would be possible. The study should include an investigation of sensitivity to habitat classification (see Section 3.1b) and the desirability of including year interactions (see beginning of Section 3.1) and, for the survey data, design-based methods (because they require fewer assumptions I think these methods are preferable unless demonstrated to be markedly less precise than the model-based methods).

Background Document 37-01 showed that fish from east Florida waters were genetically distinct from those from North Carolina waters, but was unable to be specific about the location of the boundary between these stocks. Samples from Georgia and South Carolina would be useful to check the stock assessment assumption that this boundary lies at the Florida-Georgia border.

b) Provide recommendations on possible ways to improve the SEDAR process.

I have no recommendations to make but would like to comment that I think the present review would have been much better informed, and thus more useful, had it involved participation in an assessment review meeting, during which both discussions with the assessment team and some additional model runs could have resolved some important uncertainties for me.

Improvements for next assessment

Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.
Three sets of data merit particular attention in the next assessment. For length compositions, improve their construction (Section 3.1a), and selections (i.e., dropping years with small [unrepresentative] sample sizes – see Section 3.1d), and improve their weighting (Section 3.1c). Initial equilibrium catches need to be better related to pre-1986 catches (Section 3.1.a). For recreational catches, use small SEs, smooth spikes, and construct alternative low and high catch histories (Section 3.1c) to use in sensitivity analyses.

Two other model assumptions are worth reconsidering: the default selectivity (Section 3.0.2), and the growth parameters (including CVs) used for each stock (Section 3.0.3).

Some other suggestions that might improve the next assessment are as follows.
• Use a likelihood profile on R0 to help understand the data sets affecting the estimation of this parameter, and thus the robustness of the assessments' estimates of initial depletion (Section 3.0.1).
• Use sensitivity analyses to investigate the effect of uncertainty in steepness, just as was done for natural mortality (Section 3.5a).
• Characterize uncertainty in the projections by repeating them for selected sensitivity analyses (Section 3.5a).

Recommendations
Amongst the Assessment Report's four suggestions for future research I recommend giving priority to the two concerning improve age and length sampling of hogfish fisheries (the focus should be on ages) and fishery-independent surveys for GA-NC. In addition, I recommend (a) research to rationalize the calculation of biomass indices, and (b) genetic sampling to better identify the location of the stock boundary between east Florida and North Carolina. (See Section 3.6a for more details).

For the next hogfish assessment I recommend that particular attention be paid to three data sets: length compositions (construction, selection, and weighting), initial equilibrium catches; and the treatment of uncertainty in recreational catches. Two hypotheses that should be reconsidered are those concerning default selectivities and growth. Other recommendations include a likelihood profile on R0, a sensitivity analysis for steepness, and a way of characterizing uncertainty in the projection results. (See Section 3.7 for more details).

Medley Recommendations:

Consider the research recommendations provided and make any additional recommendations or prioritizations warranted.

a.) Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.

The assessment document provides useful recommendations for further research, covering research on hogfish biology and improved monitoring data. Research on life history and growth has provided a good basis for the stock assessment modelling. While on-going research on hogfish biology will be useful, it is not a critical area for reducing uncertainty in the assessment at this stage. Improvements in monitoring data are more important.

Good stock assessments will not be possible without good estimates of catches and abundance indices. The assessment recommendations consist of improvements in biological sampling for

lengths and age across all fisheries, and development of a fishery independent abundance index for the GA-NC stock.

While the assessment report recommendations are important, other areas of the assessment will also require improvement. The most valuable improvement would likely be better recreational catch data reporting. The proportional standard errors are very high for all estimated landings and it seems unlikely that catches will vary so significantly year by year as currently estimated. Some of these problems are historical, and recent years' catches appear more accurate. Dealing with past errors is an issue of improved robust estimation only, whereas ongoing improved sampling and estimation procedures could reduce errors in future. With recreational catches being so high in many Florida fisheries, improvement in monitoring recreational catches should provide benefits to a wide number of fishery assessments.

b) Provide recommendations on possible ways to improve the SEDAR process.

The SEDAR process would benefit from greater guidance on assessment output and greater focus on assessing uncertainty. It is recommended that the SEDAR process include:
• The stock assessment should identify a pair of sensitivities to bracket the uncertainty and bootstrap or MCMC simulations should be applied to these as well as the base case. These uncertainties should be included in the projections.
• Sensitivities should report changes in stock and fishing status, not only changes in parameter estimates. Parameter estimates may be correlated, so important indicators (e.g. F_{2012}/F_{MSY}, SSB_{2012}/SSB_{MSY}) may change very little.
• The assessment should report the breakdown of negative likelihood contributions for each of the main data components.
• It is useful to provide the input data and results in spreadsheet or text form if possible, so that additional graphs and tables can be made if necessary as part of the review. Although in most, but not all cases, tables are provided in the report and data can be extracted from these with some effort, it would be easier if original information was provided. Further diagnostic plots, such as observed vs expected values, residual plots and so on would have been useful and some of the presented graphs were unclear. Information provided in text or spreadsheets allows reviewers to examine what they want while avoiding unnecessary work for the assessment team.

Terms of reference for the stock assessment and this review might be improved and better aligned. Specifically, the stock assessment ToRs should require that uncertainty is included in the projections, which is implied in the Review ToR 4.

The assessment should be given more guidance on practical management interventions so that the projection can be based on real options. In this case, it is also unclear how the fishing mortality targets used in the projections might be implemented where catches are so poorly monitored.

Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

It may be better to fit the model to the total recreational fishing effort (angler days) rather than

the catch directly (e.g. Porch et al. 2006). The year-to-year variation in effort is much lower than the estimated catches and probably provides a better estimate of the variation in fishing mortality. An explicit likelihood linking the intercept samples and the total catch can be included in the stock assessment. This would account for the sampling error explicitly, and allow the model to smooth through the catches providing more accurate estimates.

Currently, with no other information, the catch in the model is likely to follow the input estimate, while the implied catchability is not consistent with the abundance indices. If estimated within the model, the catches would be smoothed, but probably more accurate.

Including the catch estimation within the stock assessment is desirable, but may be too onerous as it would probably require developing a bespoke model. An alternative might be to link catch estimation to the development of abundance indices, which would limit the year to year variation in catch rates. Linear models could be used to build catch estimates conditional on observations across years consistent with the abundance indices implied catch rates rather than as independent samples.

Whereas parametric bootstraps provide an excellent tool for estimating uncertainty, the method used here does not account for much of the known uncertainty in input values. It would probably be better to simulate bootstrap datasets externally to SS3 where uncertainty in the dataset could be more accurately modelled. For example, the MRIP/MRFSS derived catch estimates could themselves be bootstrapped to generate alternative catch time series.

Identifying ways to remove the retrospective bias for the GA-NC and WFL stock assessments should help identify primary sources of structural error. Estimating time varying catchability is difficult within the model, but external adjustments to input data based on likely changes in catchability as well as adjusting catches (e.g. applying a smoothed catch time series) could at least identify possible causes for the bias as well as provide alternative sensitivities.

The purpose of sensitivity runs should not be so much to determine possible ranges for parameter estimates, but to try to incorporate uncertainty in key assumptions into management advice. The aim should be to identify a reasonable range from the sensitivities to capture this uncertainty and include the additional model configurations in projections.

Future additional sensitivities should be considered and include:
• Apply more changes on data component weights (lambdas) to explore how they affect the assessment outcome. Specifically for the GA-NC stock, weights to force fits alternately to the abundance index, landings and length frequency data (use the “continuous Fs” option) should help elucidate problems in this model.
• Time varying selectivity could improve abundance indices, including the WFL and FLK/EFL commercial spear, and the GA-NC commercial hook and line. The RVC Keys index selectivity should be split into two separate series before and after 2000, or possibly drop the earlier period from the assessment.
• Nominal indices and indices based only on non-°©-zero trips were not tried. It is not clear from the information presented how much influence the APC / binomial model has on the final index. It may be useful to consider the positives trips model alone (hogfish caught >= 1) as this could

avoid bias in the trip selection procedure which is always very uncertain. If these alternative abundance indices give different

Tingley Recommendations:

Consider the research recommendations provided and make any additional recommendations or prioritizations warranted.

a) Clearly denote research and monitoring that could improve the reliability of, and information provided by, future assessments.
b) Provide recommendations on possible ways to improve the SEDAR process.

a) Research and monitoring recommendations:
• In a fishery with multiple data deficiencies, one of the potential objects of modeling is to identify those datasets that, by their inadequacy, associated uncertainties or absence, have a disproportionate impact on the outcomes of the assessment that managers have a particular interest in. This can then provide a coherent input to the prioritization of future research effort aimed at improving the assessment most effectively. More effective progress may be made by using the model outputs to review the immediate future research focus and prioritization.

Four recommendations are made in the assessment document but are not prioritized. The prioritization recommended by the reviewer of these, is as follows:
1) Improve the biostatistical sampling of hogfish.
2) Develop/ improve the fishery-independent surveys for the GA-NC stock and fisheries.
3) Conduct focused life history studies for the FLK/EFL and GA-NC stocks.
4) Develop a life-history study to address male contribution to spawning reproductive potential.

The first two of these recommendations are by far the more important, as these sit right at the heart of delivering acceptable stock assessments for these stocks.

b) SEDAR process improvement recommendations:
The organizational approach, provision of clear ToR and provision of documents for the SEDAR process is of a very high standard. The recommendation that follows addresses minor issues that particularly address the needs of external reviewers and general readers alike in understanding these fisheries and the complex assessments in a relatively short space of time.

It is recommended that the following issues be considered for inclusion in future SEDAR assessment reports.
• A report structure with fully consecutive page numbering would have made the reading and reviewing the report easier.
• A list of acronyms should be included in the report. There was no list of acronyms in the assessment report which, given the number of acronyms used, would have been very useful and would have expedited the work of the review (see for example http://sero.nmfs.noaa.gov/sustainable_fisheries/more_info/documents/pdfs/glossary_of_fishery_terms.pdf).
• Tables in assessment reports need to be appropriately formatted to enable effective interpretation of their information content: in a number of key tables in the assessment

report, the columns of figures were neither right-justified nor aligned at the decimal point and the numbers had variable decimal places. The numbers in some of the tables were overly precise (i.e. there are too many places of decimals). While minor in themselves, these make reading the tables for scale, errors, outliers and areas of transition, both slower and harder.
• A map describing the key stock areas, locations and boundaries referred to, would have aided the reader's understanding of the spatial context of the fisheries, the stock structure, and sampling locations referred to.

Provide guidance on key improvements in data or modeling approaches which should be considered when scheduling the next assessment.

• It is recommended that there should be a specific requirement for assessment teams to consider and report on the quality of all time-series being considered as abundance indices. This consideration should take account of evidence, or if evidence is lacking, logical arguments that support or oppose the likelihood of each time-series indexing the stock in question. Where time-series are found to be unlikely or highly unlikely to index abundance they should be omitted from the assessment. Where evidence and/or logical arguments are inconclusive, the value of the time-series may be addressed through running sensitivities. Specific objectives of this approach should be to (i) raise the quality standard of the input data to help improve the fit of the model to the data and increase the robustness of the assessment; and (ii) to eliminate the inclusion of times-series that show opposing trends in abundance within the same model run where the time-series relate to the whole stock or the same stock components.
• Length frequency and age samples from these fisheries are of borderline quality for enabling adequate stock assessments for the three hogfish stocks to be developed.

Sampling in more recent years has been better than that from earlier years but ideally should be improved further. It is recommended that a more consistent approach to obtaining sufficient samples that are representative of each fishery in each year be developed. An approach that aims to obtain a balance of samples from the different fisheries and stocks should be developed and implemented. This will help enable stock assessments of adequate quality to be developed in future. This is essentially the same as the recommendation to 'improve the biostatistical sampling of hogfish' made by the assessment team (see section 6 above).

SEDAR 38 South Atlantic and Gulf of Mexico King Mackerel

Gulf of Mexico

Data Workshop

Life History Working Group Recommendations

1) Examine population connectivity throughout the Gulf and S. Atlantic using otolith elemental and stable isotope signatures of age-0 fish as natural tags of various regions. Otolith signatures of juvenile king mackerel collected in various resource surveys should first be examined to determine if population- or region-specific differences exist in otolith signatures, although success seems likely given the degree of classification success seen in adult mackerel whose otolith chemical signatures are integrated over several years of life, which adds greater variance to their signatures. Once otolith chemical signatures are determined, the chemistry of adult cores could be sampled to examine interregional mixing between purported migratory groups (populations) in the Atlantic, eastern Gulf, western Gulf, and even Mexico. **From SEDAR16**

2) Investigate and quantify mixing between eastern Gulf and western Gulf populations using the new next-generation DNA sequencing techniques and/or otolith elemental and stable isotope analyses. The magnitude of the Mexican landings in comparison to U.S. landings from the GOM unit (annually 3-4 times higher during last 20 yr) indicates clarification of this issue should be a priority for future assessments (see SEDAR38_com_DW_Day4-2 presentation). **Modified from SEDAR16 recommendation.**

3) Further investigate/estimate the vulnerability of the western Gulf migratory group to overfished Mexican fisheries in winter (Chavez and Arreguin-Sanchez 1995). **From SEDAR16**
4) Conduct studies and monitoring that will allow estimation of natural mortality. **From SEDAR16**

5) Continue holding ageing workshops and training to standardize techniques and increase the ageing precision among laboratories. **From SEDAR16**

6) Increase age sampling in South Carolina and Georgia and length sampling north of Florida in the Atlantic. **From SEDAR16**

7) Try to recover and include age and size data from Collins et al. (1989) Atlantic age and growth study in the next stock assessment of Atlantic king mackerel. **From SEDAR16**

8) Establish clear priorities for added reproductive information as expanded work would involve considerable costs for a long-term sampling program. **From SEDAR16**

9) If made a priority, more precisely determine 1) the extent of hydration that can be determined via routine observations in the field and 2) the timing of this phase relative to final oocyte maturation and spawning and 3) calibration of the degeneration of post-ovulatory follicles. This is needed to account for and correct a likely bias in spawning frequency estimates. **From SEDAR16**

10) If made a priority, design and implement a reproductive sampling program (in concert with age sampling) on an annual basis that expands and intensifies spatial and temporal coverage (particularly adding the western Gulf of Mexico). A goal would be to provide annual estimates of spawning frequency. This would include regular training of port agents and scientific observers in macroscopic methods and additionally include a quality control component of random sub-sampling for histological comparisons. **From SEDAR16**

Commercial Fisheries Working Group Recommendations

- Consistent and sufficient levels of observers are needed in both the Gulf of Mexico and the South Atlantic. The South Atlantic shrimp fishery has especially been under sampled.
- Increase Biological Sampling efforts to better define mixing zone boundaries in the South Atlantic and Gulf of Mexico.
- Increase cooperative research with Mexican scientists to understand the relationships between king mackerel exploited in Mexican and U.S. waters. Additionally, participation of Mexican scientists is needed in the assessment process (both accumulation and interpretation of data as well as assessment) to better understand the Mexican fisheries and possible connectivity of Gulf stocks.

Recreational Fisheries Working Group Recommendations

1) Evaluate the technique used to apply sample weights to landings.

2) Develop methods to identify angler preference and targeted effort.
3) Continue and expand fishery dependent at sea observer surveys to collect discard information. This would help to validate self-reported headboat discard rates.
4) Track Texas commercial and recreational discards.
6) Evaluate existing and new methods to estimate historical landings

Indices of Relative Abundance Working Group Recommendations

1) Fisheries independent sampling continues and be expanded to the extent practical, employing consistent sampling protocols.
2) The defined ages that each of the recommended fishery dependent indices applies to be evaluated based on catch-at-size or catch-at-age information.
3) Censored regression modeling approaches (adapted from SEDAR 31) be applied to recreational fishery dependent indices of abundance to evaluate bag limit effects on catch rate indices.
4) Evaluation of environmental (e.g., temperature, salinity) effects on CPUE indices. The workgroup recommends that inclusion of environmental covariates that demonstrate long-term trends be

carefully considered whether the covariates are likely to affect the population abundance or the catchability of the gear. If the effect is thought to be on the population abundance, then the covariate should be excluded from the catch rate standardization and incorporated into the assessment model. If the covariate is thought to affect the catchability of the gear (e.g., fish behavior changes as temperature increases or decreases), then the covariate should be incorporated into the catch rate standardization. The strongest effects are predicted to occur during distinct periods of coldwater upwelling, as this hypothesis deserves further evaluation.

5) The South Carolina Pier Recreational Pier Survey was excluded from the assessment model; however, the data represent a catch record from two fixed sites. Therefore, data from this survey represent repeated measures of catch and may be useful for evaluating environmental covariates effects on catches of King mackerel.
6) Evaluation of the delta-lognormal generalized linear model structure. Specifically, the appropriateness of modeling factor interactions as random effects and the effect of this assumption on the resulting mean and variance estimates.
7) Stock assessment analysts evaluate density-dependent effects on gear catchability, to the extent possible. The hypothesis that catchability increases with the abundance of King mackerel, particularly juveniles, was proposed by stakeholders at the data workshop. It is recommended that a sensitivity run of the base assessment model include this assumption, and that this sensitivity run is compared and ranked with a base model that assumes constant catchability over time.

Assessment Workshop

1. Develop scientific survey to obtain reliable age/size composition data. This is needed, particularly as the composition data coming from the fisheries is substantially impacted by changing selectivity. This might be done with a handline survey of fixed sites. The idea would be not necessarily to get a random sample of the age composition but a reliable, relative estimate where selectivity can be assumed constant. An index would be beneficial.

2. Evaluate environmental influence on recruitment, larval/juvenile survival

3. Determine stock mixing rates using genetic methods, otolith microchemistry or otolith shape.

4. Develop/Evaluate methods to maintain continuity of fishery-dependent indices in light of management regulations and ITQs.

5. Determine most appropriate methods to deal with changing selectivity in fisheries over time, particularly changing selectivity related to management actions or targeting of specific cohorts.

6. Evaluate most appropriate methods to deal with unreliable historic discard size composition data so that discard ratios can be reliably estimated.

7. Research on U.S. Gulf of Mexico stock overlap with King Mackerel landed by Mexico is needed.

Review Workshop

1. Develop a scientific survey to obtain reliable age/size composition data. This is needed, particularly as the composition data coming from the fisheries is substantially impacted by changing selectivity. This might be done with a handline survey of fixed sites. The idea would be not necessarily to get a random sample of the age composition but a reliable, relative estimate where selectivity can be assumed constant. An index would be beneficial. The review panel recommends that the design of a scientific survey be peer reviewed.

2. Determine most appropriate methods to deal with changing selectivity in fisheries over time, particularly changing selectivity related to management actions or targeting of specific cohorts. The review panel suggests that historical mark-recapture data available from NMFS SEFSC (Panama City) and FWRI could be used to compare size composition of recaptures for different fishing gears to evaluate selectivity for historic periods.

3. Conduct research on the U.S. Gulf of Mexico stock overlap with Mexico. The review panel recommends this work include determination of mixing rates/connectivity between the eastern and western Gulf migratory groups using otolith shape and/or microchemistry analysis, as well as model simulations to evaluate the impact of Mexican harvest on the putative single Gulf of Mexico stock.

4. Determine stock mixing rates using otolith microchemistry and/or otolith shape analysis on a routine basis that would allow future stock assessments to capture the dynamic spatial and temporal nature of mixing of the Atlantic and Gulf of Mexico stocks, and consider evaluating stock mixing within integrated modeling approaches.

5. Quantify tournament landings from the Gulf of Mexico.

6. Develop/Evaluate methods to maintain continuity of fishery-dependent indices in light of management regulations and ITQs.

7. Consider conducting an extensive tagging program to: a) better understand migration patterns; b) provide additional and individual growth rate information; c) better understand fishery selectivity; d) provide fishery exploitation rates; e) provide information about natural mortality rates. Fishery independent recapture information (i.e. use acoustic and satellite tags) will assist with a). Age at capture information of tagged animals will assist with b). A multi-year tagging program will be required for e). The review panel recommends that a specific workshop be held to consider in detail the design of a tagging program.

South Atlantic

Data Workshop

Life History Working Group Recommendations

1) Examine population connectivity throughout the Gulf and S. Atlantic using otolith elemental and stable isotope signatures of age-0 fish as natural tags of various regions. Otolith signatures of juvenile king mackerel collected in various resource surveys should first be examined to determine if population- or region-specific differences exist in otolith signatures, although success seems likely given the degree of classification success seen in adult mackerel whose otolith chemical signatures are integrated over several years of life, which adds greater variance to their signatures. Once otolith chemical signatures are determined, the chemistry of adult cores could be sampled to examine interregional mixing between purported migratory groups (populations) in the Atlantic, eastern Gulf, western Gulf, and even Mexico. **From SEDAR16**

2) Investigate and quantify mixing between eastern Gulf and western Gulf populations using the new next-generation DNA sequencing techniques and/or otolith elemental and stable isotope analyses. The magnitude of the Mexican landings in comparison to U.S. landings from the GOM unit (annually 3-4 times higher during last 20 yr) indicates clarification of this issue should be a priority for future assessments (see SEDAR38_com_DW_Day4-2 presentation). **Modified from SEDAR16 recommendation.**

3) Further investigate/estimate the vulnerability of the western Gulf migratory group to overfished Mexican fisheries in winter (Chavez and Arreguin-Sanchez 1995). **From SEDAR16**
4) Conduct studies and monitoring that will allow estimation of natural mortality. **From SEDAR16**

5) Continue holding ageing workshops and training to standardize techniques and increase the ageing precision among laboratories. **From SEDAR16**

6) Increase age sampling in South Carolina and Georgia and length sampling north of Florida in the Atlantic. **From SEDAR16**

7) Try to recover and include age and size data from Collins et al. (1989) Atlantic age and growth study in the next stock assessment of Atlantic king mackerel. **From SEDAR16**

8) Establish clear priorities for added reproductive information as expanded work would involve considerable costs for a long-term sampling program. **From SEDAR16**

9) If made a priority, more precisely determine 1) the extent of hydration that can be determined via routine observations in the field and 2) the timing of this phase relative to final oocyte maturation and spawning and 3) calibration of the degeneration of post-ovulatory follicles. This is needed to account for and correct a likely bias in spawning frequency estimates. **From SEDAR16**

10) If made a priority, design and implement a reproductive sampling program (in concert with age sampling) on an annual basis that expands and intensifies spatial and temporal coverage (particularly adding the western Gulf of Mexico). A goal would be to provide annual estimates of

spawning frequency. This would include regular training of port agents and scientific observers in macroscopic methods and additionally include a quality control component of random sub-sampling for histological comparisons. **From SEDAR16**

Commercial Fisheries Working Group Recommendations

- Consistent and sufficient levels of observers are needed in both the Gulf of Mexico and the South Atlantic. The South Atlantic shrimp fishery has especially been under sampled.
- Increase Biological Sampling efforts to better define mixing zone boundaries in the South Atlantic and Gulf of Mexico.
- Increase cooperative research with Mexican scientists to understand the relationships between king mackerel exploited in Mexican and U.S. waters. Additionally, participation of Mexican scientists is needed in the assessment process (both accumulation and interpretation of data as well as assessment) to better understand the Mexican fisheries and possible connectivity of Gulf stocks.

Recreational Fisheries Working Group Recommendations

1) Evaluate the technique used to apply sample weights to landings.

2) Develop methods to identify angler preference and targeted effort.
3) Continue and expand fishery dependent at sea observer surveys to collect discard information. This would help to validate self-reported headboat discard rates.
4) Track Texas commercial and recreational discards.
6) Evaluate existing and new methods to estimate historical landings

Indices of Relative Abundance Working Group Recommendations

8) Fisheries independent sampling continues and be expanded to the extent practical, employing consistent sampling protocols.
9) The defined ages that each of the recommended fishery dependent indices applies to be evaluated based on catch-at-size or catch-at-age information.
10) Censored regression modeling approaches (adapted from SEDAR 31) be applied to recreational fishery dependent indices of abundance to evaluate bag limit effects on catch rate indices.
11) Evaluation of environmental (e.g., temperature, salinity) effects on CPUE indices. The workgroup recommends that inclusion of environmental covariates that demonstrate long-term trends be carefully considered whether the covariates are likely to affect the population abundance or the catchability of the gear. If the effect is thought to be on the population abundance, then the covariate should be excluded from the catch rate standardization and incorporated into the assessment model. If the covariate is thought to affect the catchability of the gear (e.g., fish behavior changes as temperature increases or decreases), then the covariate should be incorporated into the catch rate standardization. The strongest effects are predicted to occur during distinct periods of coldwater upwelling, as this hypothesis deserves further evaluation.

12) The South Carolina Pier Recreational Pier Survey was excluded from the assessment model; however, the data represent a catch record from two fixed sites. Therefore, data from this survey represent repeated measures of catch and may be useful for evaluating environmental covariates effects on catches of King mackerel.
13) Evaluation of the delta-lognormal generalized linear model structure. Specifically, the appropriateness of modeling factor interactions as random effects and the effect of this assumption on the resulting mean and variance estimates.
14) Stock assessment analysts evaluate density-dependent effects on gear catchability, to the extent possible. The hypothesis that catchability increases with the abundance of King mackerel, particularly juveniles, was proposed by stakeholders at the data workshop. It is recommended that a sensitivity run of the base assessment model include this assumption, and that this sensitivity run is compared and ranked with a base model that assumes constant catchability over time.

Assessment Workshop

1. Evaluate environmental influences on recruitment and larval/juvenile survival, focusing on potential predator prey impacts, hydrodynamic influences on recruitment, pollution, HABs or excess nutrient run-off.
2. Develop scientific survey to obtain reliable age/size composition data and relative abundance of adult fish. This could be done using gillnets or handlines.
3. Determine dynamic stock mixing rates using genetic methods, otolith microchemistry, stable istopes or otolith shape. Even though the mixing zone is now smaller, stock mixing is a dynamic process and may vary substantially from one year to the next, particularly in relation to cold temperature years that may compress both the Gulf and Atlantic stock into South Florida waters.
4. Evaluate the stock mixing within integrated modeling approaches
5. Expand SEAMAP trawl survey below the Cape Canaveral area and potentially into deeper shelf waters
6. Quantify tournament landings from the Gulf of Mexico
7. Determine if female spawning periodicity varies by size or age.
8. More accurately characterize juvenile growth by increasing samples of age-0 and 1 fish.
9. Conduct studies to estimate of natural mortality.

Review Workshop

1. Develop a survey to obtain reliable age/size composition data and relative abundance of adult fish. This could be done using gillnets or handlines. The review panel recommends that the design of a scientific survey be peer reviewed.

2. Determine most appropriate methods to deal with changing selectivity in fisheries over time, particularly changing selectivity related to management actions or targeting of specific cohorts. The review panel suggests that historical mark-recapture data available from NMFS SEFSC and FWRI could be used to compare size composition of recaptures for different fishing gears to evaluate selectivity for historic periods.

3. Determine stock mixing rates using otolith microchemistry and/or otolith shape analysis on a routine basis that would allow future stock assessments to capture the dynamic spatial and temporal nature of mixing of the Atlantic and Gulf of Mexico stocks, and consider evaluating stock mixing within integrated modeling approaches.

4. More accurately characterize juvenile growth by increasing samples of age-0 and 1 fish. Further investigate 2-phase growth models including different breakpoints and different growth models to better model size and age. Consider if there is temporal (annual and seasonal) variability in growth rates. Results of this analysis in terms of the best model will need to be implementable in SS3 to continue with the integrated modeling approach.

5. Determine if female spawning periodicity varies by size or age.

6. Expand the SEAMAP trawl survey below the Cape Canaveral area and potentially into deeper continental shelf waters.

7. Consider conducting an extensive tagging program to: a) better understand migration patterns; b) provide additional and individual growth rate information; c) better understand fishery selectivity; d) provide fishery exploitation rates; and e) provide information about natural mortality rates. Fishery independent recapture information (i.e., use acoustic and satellite tags) will assist with a). Age at capture information of tagged animals will assist with b). A multi-year tagging program will be required for e). The review panel recommends that a specific workshop be held to consider in detail the design of a tagging program.

SEDAR 39 Highly Migratory Species Smoothhound Sharks

Gulf of Mexico Smoothhound Complex

Data Workshop

Life History Working Group Recommendations

1. Identify external characters from genetically verified specimens that will definitively differentiate among the three *Mustelus* species occurring in the northern Gulf of Mexico.

2. Increase tagging effort on the three *Mustelus* species occurring in the northern Gulf of Mexico to gain knowledge pertaining to movement patterns and seasonally mediated distribution.

3. Reexamine all aspects of the species-specific life histories of the three *Mustelus* species occurring in the Gulf of Mexico.

4. Encourage collection of the full suite of body length measurements (i.e. precaudal length, fork length, total length and stretch total length) of all *Mustelus* species occurring in the northern Gulf of Mexico to generate length-length relationships based on a robust sample size.

Commercial Fisheries Working Group Recommendations

1. Given the high difficulty in differentiating among the three species of *Mustelus* occurring in the Gulf of Mexico, even by experienced shark researchers, we feel it is not appropriate to recommend any species-specific identification by fishermen, observers, port samplers, or dealers. Collection of vertebral samples for systematic characterization of age compositions would also require that the whole specimen or a tissue sample be kept for subsequent macroscopic identification or for genetic analysis, respectively.

2. Increase temporal/spatial/fleet-specific shrimp fleet Observer Program coverage to improve bycatch estimates of *Mustelus* species in the shrimp trawl fishery.

3. Conduct research to explore and test the relationship between CPUEs based on shrimp fleet Observer Program and survey (SEAMAP) to indirectly estimate pre-2009 shrimp bycatch CPUE for *Mustelus* species when Observer program data were very limited.

Recreational Fisheries Working Group Recommendations

Given the high difficulty in differentiating among the three species of *Mustelus* occurring in the Gulf of Mexico, even by experienced shark researchers, we feel it is not appropriate to recommend any species-specific identification by fishermen or port samplers. Collection of vertebral samples for systematic characterization of age compositions would also require that the whole specimen or a tissue sample be kept for subsequent macroscopic identification or for genetic analysis, respectively.

Indices of Relative Abundance Working Group Recommendations

- Monitor/record bottom temperature, salinity, DO on all fishery independent surveys

Assessment Workshop

We list below research recommendations that are more feasible and would allow improvement of future stock assessments of this stock:

- Since catches are dominated by shrimp trawl fishery discards, increase the spatio-temporal observer coverage of the shrimp fleet
- Explore the relationship between catch rates derived from the shrimp fleet observer program and those based on the SEAMAP survey to indirectly estimate shrimp bycatch CPUE prior to 2009 when observer program data were especially limited
- Reexamine and/or investigate all aspects of the life histories of the three *Mustelus* species occurring in the Gulf of Mexico

Review Workshop

6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.

The panel concurred with the research recommendations of the DW an AW. It is particularly important to maintain the ability to estimate the shrimp trawl bycatch for the future. As more years of data accumulate there will be an improvement in the ability to assess the stock.

The present model software requires that complete catch data are input to the assessment and that they are treated as known error free values. In principle it should be possible to use the shrimp fishery effort data along with the more reliable estimates of catch from 2009 onwards within the model to estimate historical catch and the uncertainties relating to it. It would be desirable to develop such a model which would have wider applicability to stocks that are affected by the same catch data problems.

While it is acknowledged that the species within the smoothhound complex are quite similar biologically, it has been recognised by studies elsewhere (e.g. Gaichas et al. 2012) that individual more vulnerable species within a complex can be adversely affected by aggregated management. This vulnerability may be due to particular species interactions or environmental sensitivity and not just individual species productivity characteristics. Such simulation work could be carried out for the Gulf smoothhound complex to determine whether any of the species may be particularly at risk. The three species in the Gulf smoothhound complex have thus-far proved impossible to tell apart visually, and there does not appear to be plans to allow for future estimation of annual total catch per species due to this problem (unless diagnostic morphological features are found). It would be advantageous for future assessments to have such information. Simple and cost effective methods to allow catch estimation per species should be investigated (e.g. random genetic sampling of the catch by observers).

The general SEDAR process is fairly well structured with the development of data workshops and assessment workshops. It is helpful to have the copious documentation. One note is that the rationale for why the decisions were made is often as important as what the decision was. For abundance indices this was often documented in the index worksheets, but not all the decisions were listed in the data workshop report.

Atlantic Smooth Dogfish

Data Workshop

Life History Working Group Recommendations

- Increase tagging effort to examine if there is fine scale structure within *M. canis* off the east coast of the United States to determine if the stock is homogeneous or if it would be more accurately described by northern and southern groupings.
- Conduct genetic analyses in support of Research Recommendation 1.
- Better define seasonal distribution, including regional sex ratios, and identify nursery areas.
- Continue to monitor life history characteristics of *M. canis* off the east coast of the United States to detect potential temporal changes, density-dependent effects or clinal variability among individuals throughout the range.

Commercial Fisheries Working Group Recommendations

- Increase temporal/spatial/fleet-specific shrimp fleet Observer Program coverage to improve bycatch estimates of *Mustelus* species in the shrimp trawl fishery.
- Conduct research to explore and test the relationship between CPUEs based on shrimp fleet Observer Program and survey (SEAMAP) to indirectly estimate shrimp bycatch CPUE for *Mustelus* species when Observer program data were very limited.

Recreational Fisheries Working Group Recommendations

No research recommendations relative to recreational fisheries were formulated.

Indices of Relative Abundance Working Group Recommendations

- Monitor/record bottom temperature, salinity, DO on all fishery independent surveys

Assessment Workshop

1. Modeling considerations.

Improve the fits to length composition data. For example Stock Synthesis allows for the estimation of sex specific selectivity and includes options to utilize parameter offset approaches in the estimation of

selectivity parameters in order to improve parameter estimation. Several methods are also available for selecting among alternative functional forms for selectivity (e.g., Helu et al 2000; Maunder and Harley 2011; Punt et al. 2014). For example, the use of Akaike's information criterion (AIC) (Akaike 1973; Burnham and Anderson 2002; e.g., Hilborn and Mangel 1997) is appropriate for comparing alternative forms of selectivity, as implemented here for comparing proposed base runs Sel-1 and Sel-2, if models compared use the same data and have the same data structure (Helu et al 2000). Alternative methods would be required for selecting among models with different data or with different data structure. For example, the hold-out cross validation has been used for comparison of models run with different data sets (Maunder and Harley 2011).

2. Data Considerations.

Obtain age composition data from existing surveys in order to not have to rely solely only length composition data in the model.

Update age and growth studies in order to resolve potential differences in observed and predicted size at birth.

Review Workshop

TOR 6. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations or prioritizations warranted.

The research recommendations provided by the Data and Assessment Workshops are considered to be reasonable and would strengthen any future assessment. Research recommendations from the data workshop regarding commercial fisheries (point 1.2 in the Research Recommendations Report) focus on developing CPUE and catch estimates from the *Mustelus* bycatch in the Atlantic shrimp fishery. This is a good recommendation because currently the fishery is poorly accounted for in the assessment. However the data workshop indicated that due to the low spatial/temporal overlap (6.5% of the tow hours overlapped with the *M. canis* distribution) there was low probability of significant interaction and inadequate data to develop a catch history. Developing data from this fishery may be impractical given the uncertainty, in addition sampling from the edge of the distribution can be heavily influenced by factors other than abundance, especially in low information situations (SEAMAP recorded only 5 positive tows from 630 over the years 2001 – 2012). A more important research avenue would be to develop better data streams from the gillnet fishery. An additional research recommendation that would assist the SEDAR process from the data standpoint is to increase the monitoring on the gillnet fishery as it is currently the major source of fishing mortality.

Research is required into how to appropriately use the rankings of the CPUE series as weights in the modeling process. An additional need is to conduct research on the estimation of the effective sample

size (appropriate weights) of the length compositions outside the model. Research avenues that would directly assist the stock assessment process are: 1) to consider alternative recruitment functions; 2) using the equivalent of steepness for the Ricker model (as per the Brooks et al. paper) and potentially the low fecundity stock recruitment function which was developed by Ian Taylor for spiny dogfish in the Pacific. Additionally, investigate the modeling of initial depletion in the model (i.e. using estimated fishing mortalities, catches or recruitment offset), and to investigate projections from within SS3. These recommendations are in line with the DW and AW's recommendations of research on how to weight the length composition data, and improving the fits to the selectivities and to obtain age data.

Provide recommendations on possible ways to improve the SEDAR process.

The general SEDAR process is fairly well structured with the development of data workshops and assessment workshops. It is helpful to have the copious documentation. One note is that the rationale for why the decisions were made is often as important as what the decision was. For abundance indices this was often documented in the index worksheets, but not all the decisions were listed in the data workshop report.

Some of the panel's comments regarding the assessment were unable to be addressed because they dealt directly initial model formulation and/or with preliminary analysis. The SEDAR, and in particular the assessment process would have benefited from additional outside input during the assessment workshop (and webinars) from scientists particularly experienced with integrated models such as SS3.

SEDAR 40 Atlantic Menhaden

Data/Assessment Workshops

Research recommendations are broken down into two categories: data and modeling. While all recommendations are high priority, the first recommendation is the highest priority. Each category is further broken down into recommendations that can be completed in the short term and recommendations that will require long term commitment.

Annual Data Collection

Short term (next 3-6 years):

1. Continue current level of sampling from bait fisheries, particularly in the Mid-Atlantic and New England. Analyze sampling adequacy of the reduction fishery and effectively sample areas outside of that fishery (e.g., work with industry and states to collect age structure data and biological data outside the range of the fishery).
2. Ageing:
    a. Conduct ageing validation study (e.g., scale : otolith comparison), making sure to sample older age classes. Use archived scales to do radio isotope analysis.
    b. Ageing precision: conduct an ageing workshop to assess precision and error among readers (currently planned for January 2015).
3. Conduct a comprehensive fecundity study.
4. Place observers on boats to collect at-sea samples from purse-seine sets, or collect samples at dockside during vessel pump-out operations (as opposed to current top of hold sampling) to address sampling adequacy.
5. Investigate relationship between fish size and school size in order to address selectivity (specifically addressing fisher behavior related to harvest of specific school sizes).
6. Investigate relationship between fish size and distance from shore (addressing selectivity).
7. Evaluate alternative fleet configurations for the removal and catch-at-age data.

Long term (6+ years):

1. Develop a menhaden specific coastwide fishery-independent index of adult abundance at age. One possible methodology is an air spotter survey complemented with ground truthing for biological information (e.g., size and age composition). In all cases, a sound statistical design is essential (involving statisticians in the development and review of the design; some trial surveys may be necessary). **[Highest Priority]**
2. Conduct studies on spatial and temporal dynamics of spawning (how often, how much of the year, batch spawning, etc.)
3. Conduct studies on productivity of estuarine environments related to recruitment.
4. Investigation of environmental covariates related to recruitment.

Assessment Methodology

Short term (3-6 year):

1. Conduct management strategy evaluation (MSE). **[Highest Priority]**
2. Conduct multi-objective decision analysis (MODA). **[Highest Priority]**

3. Continue to develop an integrated length and age based model (e.g., SS3).
4. Continue to improve methods for incorporation of natural mortality (e.g., multi-species statistical catch-at-age model). See Appendix E.

Long term (6+ years):

1. Develop a seasonal spatially-explicit model, once sufficient age-specific data on movement rates of menhaden are available.

Review Workshop

The Technical Committee developed a set of "Research and Modeling Recommendations" that were categorized by time frame (short versus long term) and research type (data collection versus assessment methodology). The panel generally agreed with the TC's recommendations. There was strong agreement that developing a coast-wide fishery-independent index of abundance-at-age is the top priority for data collection. Related to this was a suggestion that collection of age composition data for the existing fishery independent surveys should also be a high priority. The AT noted that this was reflected in the existing recommendations under item 1 in the short-term data priorities: "work with industry and states to collect age structure data and biological data outside the range of the fishery". Given the challenges, discussed elsewhere in this report, of using index length-frequency data to inform index selectivity-at-age in the model, the panel concluded that having direct estimates of survey age composition would be a very valuable addition to the assessment data.

The panel also agreed that conducting a Management Strategy Evaluation to evaluate the performance of alternative harvest strategies and possibilities for reference points should be a high priority for the immediate future. Ideally the MSE should be informed by a structured Decision Analysis process (also listed as a research recommendation) that would both inform the MSE with respect to management objectives and options, and provide an opportunity for the MSE to be transparent for both stakeholders and decision makers.

The panel expressed some reservations about the recommendation to "develop an integrated length and age based model" and greater reservations about the recommendation to "develop a seasonal spatially-explicit model, once sufficient age-specific data on movement rates of menhaden are available". If the AT pursues the former, it may be more fruitful to adapt the BAM to integrate length and age than to use an alternative modeling platform, given the obvious expertise the AT has with the BAM. Regarding the latter, the panel cited previous experience with numerous challenges associated with developing spatial assessment models that explicitly incorporate movement, implying that the benefits (in terms of informing menhaden management) of pursuing this modeling strategy might not outweigh the costs (in terms of scientific effort).

The panel noted that two aspects of modeling are currently conducted in advance of the main BAM model:

1) Growth modeling.
2) Scaling of natural mortality based on tag data.

The panel suggests investigating the potential for including these aspects of the analysis as part of the assessment model. The model currently uses growth (length-at-age) as a basis for several aspects of the model. It may be possible to estimate selectivity-at-age using age data for the NAD and SAD survey indices, but if that is not the case and length composition data continue to be used in the assessment model, estimation of growth could be integrated in the assessment model.

If time-invariant mortalities are to be considered as part of future modeling, consideration should be given to estimating natural mortality in the assessment model, informed by the tagging data that are currently used externally. This would help to integrate the estimation process.

SEDAR 41 South Atlantic Red Snapper and Gray Triggerfish

Red Snapper

Data Workshop

Life History

Red Snapper Mini Season

If this program, along with continued closure of the fishery, is to extend into future seasons, an exploration of methods to further incentivize angler participation would be useful. After brief interviews with participants from the recreational fishers group at SEDAR 41, the following suggestions were provided to increase angler participation:

- Free fish cleaning at donation site.
- As people may be tired after being out on the water all day and with busy boat ramps, short questionnaire from a biologist on-site could be used instead of the anglers filling the forms out or requiring fishermen to fill out a survey online after they return home.
- Advertise data collection at local bait & tackle shops.
- Use NOAA's announcement system on weather radio channel where they also announce season closures, etc. Since fishermen are frequently monitoring this channel for weather updates, it could be an effective communication route to announce the collection information (drop locations, reward information, etc.).
- Dry storage areas are a good place to sample; many people store boats there instead of trailering home.

Life History Research

- More research on red snapper movements and migrations in Atlantic waters is needed. Available data and the results of studies in the Gulf of Mexico indicate high site fidelity, but that tropical storms may cause greater than normal movement that might help dispersal to depleted areas. This needs to be confirmed in the South Atlantic. Additional acoustic and traditional tagging is needed on known spawning locations to document spawning migrations or aggregations, and return of fish to non-spawning areas.
- Evaluate more thoroughly the data/sample collection during the mini-season to improve utility for assessments. This should include what samples should be collected (e.g. reproductive information).
- Possible changes in life history parameters, in particular relative to reproduction, need to be further investigated.
- Much is unknown about the early life history of Red Snapper, in particular relative to spawning areas, larval and juvenile stages, including habitat and dispersal.
- Alternative methods of reproductive output. The methods described in Klibansky's SEDAR41-DW49 may provide a more accurate estimate of reproductive output than previously used.

Further investigation into this modeling effort and use for future assessments should be investigated.

- Duration of spawning indicators. The definition of spawning indicators has received significant discussion recently. As this has significant implications for the estimates of reproductive output, further research is needed to define consistent criteria for spawning indicators in finfish.
- Continuing the age reading comparisons and calibrations between labs on a reference collection of known age fish would be beneficial for determining a more accurate aging error matrix and would provide accuracy to the age composition data.

Commercial Statistics

Landings

- Improve gear and effort data for each trip.
- Standardize methodology for developing average proportions to parse out unclassified landings.

Discards

- Investigate the validity and magnitude of "no discard" trips. This may include fisher interviews throughout the region.
- Examine potential impacts of "no discard" trips on estimated discards.
- Improve discard logbook data collections via program expansion or more detailed reporting (i.e. electronic logbooks, etc.)
- Establish an observer program that is representative of the fisheries in the South Atlantic

Biosampling

- Establish an observer program that is representative of the fisheries in the South Atlantic.
- Angler education with regards to recording depths on paper logbooks (i.e. standardized units); validation of additions to the logbook form still needed.
- Standardize TIP sampling protocol to get representative samples at the species level.
- Standardize TIP data extraction.

Recreational Statistics

- Complete analysis of available historic photos for trends in CPUE and mean size of landed Red Snapper and Gray Triggerfish for pre-1981 time period. (Ultimately all species).
- Formally archive data and photos for all other SEDAR target species.
- For Hire Survey (FHS) should collect additional variables (e.g. depth fished).
- Increasing sample sizes for at-sea headboat observers (i.e. number of trips sampled).
- Compute variance estimate for headboat landings.
- Mandatory logbooks for all federally permitted for-hire vessels.

Indices

- Compare existing methods and/or develop new methods to define effective effort in fishery dependent data.

- Estimate selectivity of video gear in the SERFS.
    - Tagging, stereo cameras
- For video reading, evaluate methods to score water clarity and habitat.
- Evaluate effect of (non) independence between chevron traps and videos, including methods to combine the indices.
- Continue exploring the use of continuous predictor variables (e.g., splines or polynomials) for ZIP and ZINB standardization models.
- Headboat at-sea observer program needs depth data from all states (not just FL) and increased coverage overall.
- SCDNR charterboat logbook program should be replicated by other states.
- Develop fishery independent hook-gear index (S41-DW08).

Assessment Workshop

- Increased fishery independent information, particularly maintaining reliable indices of abundance and composition data streams.
- Red Snapper were modeled in this assessment as a unit stock off the southeastern U.S. For any stock, variation in exploitation and life-history characteristics might be expected at finer geographic scales. Modeling such sub-stock structure would require more data, such as information on the movements and migrations of adults and juveniles, as well as spatial patterns of larval dispersal and recruitment. In addition, it is unclear whether a spatial model would improve the assessment.
- More research to describe the juvenile life history of Red Snapper is needed, including more work to identify the location of juveniles before they recruit to the fishery.
- The effects of environmental variation on the changes in recruitment or survivorship.
- The Florida sampling program, during the miniseason in particular, provided invaluable data to this assessment. Programs such as these would be useful in all South Atlantic states, particularly if the management regulations continue to make established methods of index development or composition sampling from fleets less regular or possible.

Review Workshop

The Review Panel considers the first three of the following bullets to be the highest priority for assessment improvement.

- Increased fishery independent information, particularly maintaining reliable indices of abundance and composition data streams.
- Improve the reliability of discard data as an abundance index by improving knowledge of private recreational fisherman behavior.
- Research to determine the spatial distribution (horizontal and vertical) of large adult Red Snapper using tracking and telemetry.
- The Review Panel reiterates various research recommendations focused on Red Snapper population structure in the South Atlantic. Red Snapper were modeled in this assessment as a

unit stock off the southeastern U.S. For any stock, variation in exploitation and life-history characteristics might be expected at finer geographic scales. Modeling such sub-stock structure would require more data, such as information on the movements and migrations of adults and juveniles, as well as spatial patterns of larval dispersal and recruitment, and spatially-explicit data of all types used in the assessment model. It is unclear whether a spatially-explicit model would improve the assessment. Given the robust ocean circulation in the South Atlantic Bight conditions creating population sub-structure. The research effort necessary to support such an effort would be extensive and probably unjustified on stock assessment improvement grounds, however, it would be needed to support MPA placement, performance evaluation, etc.

- More research to describe the juvenile life history of Red Snapper is needed, including more work to identify the location of juveniles before they recruit to the fishery.
- The effects of environmental variation on the changes in recruitment or survivorship.
- Investigate possible historical changes in sexual maturity. The current estimate of age of sexual maturity is low and unusual for other Lutjanids. Is it right or a compensatory response to heavy exploitation?
- Continue conducting studies to develop a time series of batch fecundity to obtain information on the inter-annual variation in reproductive output.

Gray Triggerfish

Data Workshop

Life History

- More research on gray triggerfish movements and migrations in Atlantic waters is needed. Available data and the results of studies in the Gulf of Mexico indicate high site fidelity, but that tropical storms may cause greater than normal movement that might help dispersal to depleted areas. This needs to be confirmed in the South Atlantic. Additional acoustic and traditional tagging is needed on known spawning locations to document spawning migrations or aggregations, and return of fish to non-spawning areas.
- Age validation study that should include edge type and the potential for using various age structures for use in assessment. This should include the logistical feasibility of using these alternative structures for routine sampling and processing.
- Early life history is largely unknown. E.g. size and age at settlement and length of the pelagic stage.
- Estimates of delayed bycatch mortality are needed. This should include the effect of cloacal protrusion as a result of barotrauma.
- Tagging studies are needed to define spawning locations (only shelf edge or not) and, movement, the results of which could be used to help inform fishing mortality and natural mortality.
- Impact of climate change on mortality and recruitment.

- Research on spawning behavior/nesting and how it impacts survivorship and stock productivity.
- Determine fecundity type and estimate annual fecundity in Atlantic waters.
- Alternative methods of reproductive output. The methods described in Klibansky's SEDAR41-DW49 may provide a more accurate estimate of reproductive output than previously used. Further investigation into this modeling effort and use for future assessments should be investigated.
- Duration of spawning indicators. The definition of spawning indicators has received significant discussion recently. As this has significant implications for the estimates of reproductive output, further research is needed to define consistent criteria for spawning indicators in finfish.
- Investigate gray triggerfish competition for nests. The presence of competition for nest space may affect, among other things, the spawning success (reproductive output) and the choice of a spawner recruit relationship. Further investigation into the nesting behavior of gray triggerfish is needed to provide information to address these issues.

Commercial Statistics

Landings

- Require species level reporting in state trip ticket programs. Some states in process of instituting species level reporting for all species.
- Improve gear and effort data collections.

Discards

- Investigate the validity and magnitude of "no discard" trips. This may include fisher interviews throughout the region.
- Examine potential impacts of "no discard" trips on estimated discards.
- Improve discard logbook data collections via program expansion or more detailed reporting (e.g. more detailed logbook, electronic reporting)
- Establish an observer program that is representative of the fisheries in the South Atlantic.

Biosampling

- Standardize TIP sampling protocol to get representative samples at the species level.
- Standardize TIP data extraction.
- Establish an observer program that is representative of the fisheries in the South Atlantic.
- Increase untargeted sampling in NE and Mid-Atlantic observer programs.
- Increase untargeted dockside sampling in NE and Mid-Atlantic.

Recreational Statistics

- Complete analysis of available historic photos for trends in CPUE and mean size of landed Red Snapper and Gray Triggerfish for pre-1981 time period. (Ultimately all species).
- Formally archive data and photos for all other SEDAR target species.
- For Hire Survey (FHS) should collect additional variables (e.g. depth fished).
- Increasing sample sizes for at-sea headboat observers (i.e. number of trips sampled).
- Compute variance estimate for headboat landings.

- Mandatory logbooks for all federally permitted for-hire vessels.

Indices

- Compare existing methods and/or develop new methods to define effective effort in fishery dependent data.
- Estimate selectivity of video gear in the SERFS.
    - Tagging, stereo cameras
- For video reading, evaluate methods to score water clarity and habitat.
- Evaluate effect of (non) independence between chevron traps and videos, including methods to combine the indices.
- Continue exploring the use of continuous predictor variables (e.g., splines or polynomials) for ZIP and ZINB standardization models.
- Headboat at-sea observer program needs depth data from all states (not just FL) and increased coverage overall.
- SCDNR charterboat logbook program should be replicated by other states.
- Develop fishery independent hook-gear index (S41-DW08).

Assessment Workshop

- Increased fishery independent information, in particular reliable indices of abundance and age compositions.
- Increased age sampling and evaluation of ageing error over the stock area and from all fleets, particularly the general recreational fleet.
- In this assessment Gray Triggerfish were modeled as a unit stock off the southeastern U.S. For any stock, variation in exploitation and life-history characteristics might be expected at finer geographic scales. Modeling such sub-stock structure would require more data, such as information on the movements and migrations of adults and juveniles, as well as spatial patterns of larval dispersal and recruitment. In addition, it is unknown whether a spatial model would improve the assessment.
- More research to better understand the life history of Gray Triggerfish is needed, including natural mortality, maturity, and reproductive potential, particularly for the youngest ages.
- The effects of environmental variation on the changes in recruitment or survivorship.

Review Workshop

- Increased fishery independent information, in particular reliable indices of abundance and age compositions.
- Increased age sampling and evaluation of ageing error over the stock area and from all fleets, particularly the general recreational fleet.
- More research to better understand the life history of Gray Triggerfish is needed, including natural mortality, maturity, and reproductive potential, particularly for the youngest ages.

- The effects of environmental variation on the changes in recruitment or survivorship of Gray Triggerfish.

SEDAR 42 Gulf of Mexico Red Grouper

Data Workshop

Life History Working Group Recommendations

Stock Structure

Population genetics - LHW recommends a study using next-generation sequencing of single nucleotide polymorphisms to generate a genetic map that may elucidate sub-populations and refine the stock structure of red grouper.

Larval transport and connectivity - Implement a survey to identify red grouper Age 0's locations for an index of recruitment and identify nearshore habitats that provide recruitment to offshore areas.

Habitat Requirements - Given the expected high site fidelity of red grouper, an acoustic array around a harem may provide essential information about mating movements, spawning frequency and duration during the spawning season. Anecdotal information about cohort and feeding movements following spawning may guide more targeted tagging studies.

Tagging, movements, and migrations - Gulf wide tag-recapture programs using multiple techniques (dart tags, PIT tags, telemetry, gene tagging) to improve estimates for release mortality and movements among and across regions. Some emphasis concentrated on areas of little known information, the northern and western Gulf of Mexico, as well as the Florida Keys, and should include the time of year as a factor.

Age and Growth

Sources of Age data

- 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, MRFSS/MRIP, SRHS; see Chih 2014a, 2014b).
- Bring increased attention to the need for strategies improving port sampling (representation of fishery sectors and random sampling)

- It is recommended that an increase in the number of trips intercepted by year by both the MRFSS/MRIP and SRHS occurs in the future and for a higher percentage of the intercepts include collecting biological samples (length, weight, and hard parts).

Reader Age Precision

- 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/among readers.
- Expand the current reference collections to include older age classes (> age 12).

Year Class Progressions

- Continue age structure sampling from all fishing sectors on an annual basis.

Age and Length Data

- Investigate methods to better collect age structure samples randomly and systematically from all fishing sectors.
- The recreational sector is still under sampling for biological samples (e.g., hard parts, n<100/year, all years). It is recommended that there is an increase in the number of trips intercepted by year by both the MRFSS/MRIP and SRHS and that a higher percentages of the intercepts include collecting biological samples (length, weight, and hard parts). In the past 4 years, only 166 trips (on average, 2010-2013; Table 4.8.11) intercepted included collecting biological samples (e.g., length, hard parts) by MRFSS/MRIP port agents and there was an estimated 22 million recreational trips made by recreational anglers in the more recent years (2010-2013; Table 4.8.17). Biological data collected at such a low percentage (< 0.0001%), provide very minimal information regarding age and growth of red grouper. An increase in the number of fish intercepted for biological samples will increase our knowledge of the size and age structure being intercepted by recreational anglers.

Modeling Growth

- Explore growth model alternatives that includes both the non-random sampling due to minimum size restrictions (Diaz et al. 2004) and non-random sampling due to biases in over/under sampling specific length bins (Chih 2014a, 2014b).

Mortality

Gulf wide tag-recapture programs using multiple techniques (dart tags, PIT tags, telemetry, gene tagging) to improve estimates for natural, discard, and fishing mortalities.

Natural Mortality

- Continue the collection of otoliths from all fishing sectors, as well as, fishery independent surveys to monitor any changes in longevity.
- Continue to investigate age-varying M models and their appropriateness.
- LHW recommends further research into mortality rates of juvenile red grouper as they migrate from inshore to the offshore environment.

Total Mortality

- Continue the annual collection of otoliths from all fishing sectors, as well as, fishery independent surveys to monitor any changes in annual catch by age.

Discard Mortality

- Direct estimates of latent discard mortality are needed for the commercial sector for both bottom long line and vertical line gears. Apply innovative tag-recapture programs to the observed discards to estimate discard and other types of mortality.

Reproduction

Improve our understanding of the spatio-temporal aspects of the reproductive strategy. An example may be screen for a spatial- or depth dependence in male transition. Conduct surveys for metapopulation structure in demographics and reproduction (example hogfish assessment, SEDAR 2014b).

As in SEDAR12, the LHW recommends continued work to better understand and discriminate between annual asynchrony in spawning (skipped spawning) and seasonal asynchrony in spawning. Results of

aquaculture rearing trials, review of histology, and new information or metadata regarding temperature and the development and duration of oocytes and follicles may increase our understanding.

Age and Size at Maturity - Continue to monitor changes in maturation schedules – evidence of earlier maturity since Moe 1969.

Age and Size at Transition - Continue to monitor changes in transition schedules, evidence of earlier transition since Moe 1969.

Mating Systems - Utilize new approaches to characterize the mating system such as measurement of the amount of androgen across species and across size within species (Shepherd et al. 2013).

Develop full egg production model by accounting for temporal changes in batch fecundity and intensity of spawning and incorporate spawning frequency by size and/or age.

Meristic & Conversion factors

Continue to communicate the need to standardize length (natural total length, maximum total length, fork length, and standard length), weight (whole and gutted) measurements and the units (metric –e.g., millimeters, kilograms) used in collecting data among all sampling programs to minimize measurement errors.

Commercial Fisheries Working Group Recommendations

Landings

- -Improve data quality of CFLP Logbook VTR number to state trip ticket for data reconciliation.
- IFQ
- -Investigate dealer influence on IFQ allocation usage through dealer IFQ surveys.
- -Explore fishermen behavior in relation to allocation available.
- -Add CFLP Logbook VTR number to IFQ landing transaction form for data reconciliation.
- -Translate IFQ allocation activity ledger into a useable data set for daily allocation balances.
- -Add actual landing date to IFQ reporting form.
- -Improved enforcement of IFQ reporting infractions.
- -Improve real time seizure reporting from states law enforcements agents. Need vessel, species, pounds, price per pound, dealer, and enforcement agent.
-

Discard

- -Most appropriate method for incorporation of IFQ data into discard estimations.

- -Most appropriate method for incorporation of IFQ data into discard size compositions.
- -Increased observer funding and coverage.
- -More representative observer coverage.
- -Assess reliability of effort data in logbook data.
-

Overall

Meet with fishermen prior to data workshops to provide supplementary information relevant to fishery dependent data.

Recreational Fisheries Working Group Recommendations

No research recommendations were provided, though the group supported the recommendation made the Life History group:

The recreational sector is still under sampling for biological samples (e.g., hard parts, n<100/year, all years). It is recommended that there is an increase in the number of trips intercepted by year by both the MRFSS/MRIP and SRHS and that a higher percentages of the intercepts include collecting biological samples (length, weight, and hard parts). In the past 4 years, only 166 trips (on average, 2010-2013; Table 4.8.11) intercepted included collecting biological samples (e.g., length, hard parts) by MRFSS/MRIP port agents and there was an estimated 22 million recreational trips made by recreational anglers in the more recent years (2010-2013; Table 4.8.17). Biological data collected at such a low percentage (< 0.0001%), provide very minimal information regarding age and growth of red grouper. An increase in the number of fish intercepted for biological samples will increase our knowledge of the size and age structure being intercepted by recreational anglers.

Indices of Relative Abundance Working Group Recommendation

- The IWG made note that the delta-lognormal index may not be the most appropriate distribution with some of the data presented and that alternative distributions should be considered. In addition, there is some variation in the SAS code used by the various labs to produce the indices. The recommendation is that a best practices workshop be convened to fully investigate different statistical models and produce a standard version of the appropriate programming code. Further, the use of R in place of SAS should be explored if the workshop warrants such consideration.

- As part of the proposed workshop, the approach to modeling 'success' in binomial portion of the delta models needs investigation. Currently, some labs model the 'proportion positive' rather than ‘success’ which can be an issue when used improperly.
- A calibration study is needed between the FWRI/NMFS video survey. The standardized reef systems are well suited for rigorous calibration studies, which could also include other sampling methods. In addition, exploration is needed for incorporating standardized video habitat covariates in the models.
- An exploration of the effects of IFQ’s on the fishery dependent indices, especially the commercial handline and longline is needed. During the workshop, fishermen indicated that since the implementation of IFQ’s, there has been a drastic change in fisheries behavior. There is also the possibility that dealers can directly influence this behavior. There is a need to incorporate these years into the overall time series in the most appropriate manner and to determine the means for doing so.
- The MRFSS data are clustered in the sense that some records represent individuals on the same boat (a cluster). An issue arose where the proper identifier for those clusters was not obvious in the data set. Hence, further investigation into ‘party id’ and what it represents in the MRFSS data in needed to accurately estimate the variability associated with the indices.
- Expansion of video surveys into Florida Bay
- Development of a YOY survey
- For reef-associated fisheries, the fishery-independent monitoring is based on known distribution of habitat. As side-scan sonar and similar activities increase the list of known habitat, there is a need to ensure that the sampling strategies for the FIM adjust appropriately and are optimized as habitat information becomes available.

Integrated Ecosystem Assessment Working Group Recommendations

Recommendation 1: Time varying natural mortality

Research is required to incorporate interannual variation in red grouper natural mortality within the assessment process. In particular, elevated mortality rates in fishes, including members of the shallow-

water grouper complex, can be caused by severe red tide events (Flaherty & Landsberg 2011). A red tide severity index (Walter et al. 2013) was previously included in the base stock assessment model for Gulf of Mexico gag grouper, which improved model fits to indices of abundance (Sagarese et al. 2014b). In the Gulf of Mexico gag grouper assessment (SEDAR 33), fluctuations in red tide mortality varied more than 10-fold through time, and were estimated to be commensurate with fishing mortality rates in several "severe" years (Sagarese et al. 2014b). Like the gag grouper SEDAR assessment, red tide severity should be considered as a source of mortality for red grouper. This recommendation requires at least four research steps.

First, length/age composition data are needed to determining lengths/ages susceptibility to red tide severity.

Collections of fish during red tide events would allow for the size/age selectivity of mortality to be determined, and might also allow for some minimum estimates of total mortality. Preliminary data were distributed by the NMFS Panama City lab containing red grouper lengths and estimated ages for 16 individuals collected from the Big Bend region during August 1st and 3rd of 2014. During plenary, various participants noted that collection of samples during the NMFS bottom longline survey was complicated by the decomposed nature of many fish encountered, which also prevented length estimates. In addition, otoliths were often difficult to recover from some specimens because they were missing anterior portions of their body.

Second, existing indices of red tide severity should be updated.

The IEA group recommends research to produce candidate indices of red tide severity and to devise scenarios based on red tide indices and methods for inclusion in the red grouper Stock Synthesis assessment model. Updating red tide indices is difficult because the original red tide indices (Walter et al. 2013) were created using SeaWiFS (operational 1998 – December 2010) satellite sensors. More recently, MODIS (Moderate Resolution Imaging Spectrometer) satellite sensors (July 2002 – present) have been used to detect and track harmful algal blooms (Stumpf et al. 2003, Hu et al. 2005). Thus, steps need to be taken to (i) calibrate SeaWiFS and MODIS satellite data during overlap periods; (ii) extend the red tide index through the present period (2014); and (iii) automate compilation of satellite data, and calculation and reporting of index values.

Third, procedures for incorporating red tide indices into Stock Synthesis should be critically evaluated.

Simulations should be conducted to evaluate the consequences of assuming constant or size specific natural mortality, when mortality actually fluctuates according to episodic temporal events. Further, approaches to incorporating environmental indices in stock assessment tuning procedures should be compared through simulated datasets to evaluate the effects of assessment model misspecification.

Fourth, the statistical properties of red tide indices should be characterized for use in simulations and assessment projections.

Evaluate whether all levels of red tide severity are equally likely in near-term future events, or whether information is contained in red tide indices that can be used to generate 'forecast distributions'. Time series decomposition can be used to statistically characterize red tide indices (Stumpf et al. 2003). By quantifying periodicity, trends, and stochasticity, 'forecast distributions' may enable plausible future scenarios to be considered in assessment projections.

Recommendation 2: Index of red tide mortality derived from Ecopath with Ecosim

The IEA working group agreed that additional efforts deriving natural mortality values from the WFS Red tide Ecopath with Ecosim model would be helpful as presented for gag grouper during SEDAR 33 (Gray et al. 2013). These modeling efforts would allow red tide events to affect multiple components of the West Florida Shelf ecosystem and to assess the overall effect of red tide and predator/prey dynamics on the mortality rates of Gulf of Mexico red grouper.

Recommendation 3: Elucidating the response of red grouper to red tide events

Future modeling efforts should aim to address whether groupers move in response to red tide events or if they experience elevated natural mortality during these episodic events.

Recommendation 4: Modifications to the CMS modeling framework

Additional fisheries-independent data (e.g., PCLAB data) will be incorporated in the datasets used for habitat modeling of red grouper. This will allow us to improve the predictions made by the binomial GLMs described in SEDAR42-DW-04. Thus, we will be able to better predict the probability of presence of adult red grouper on the West Florida Shelf and, therefore, to better simulate the production of red grouper eggs over space in the CMS.

The life history working group brought up concerns regarding the aggregated use of all adult red groupers in determining the number of eggs released at red grouper spawning sites. There is evidence in red grouper that the fecundity of large adult females is considerably higher than that of small adult females. To account for this, the IEA group will use data compiled by the life history group to calculate mean age at depth for red grouper. This information will be useful to estimate the number of eggs released at each red grouper spawning site based on (1) the probability of presence of adult red grouper at that site; and (2) the relative fecundity at that site. The relative fecundity at each spawning site will be determined from: (1) the depth at that site; (2) the mean age at depth profile; and (3) the fecundity-at-age (number of eggs released during a spawning event at age) profile.

The CMS index should be extended to cover 2014 to provide insight into potential recruitment for the first year of projections.

Recommendation 5: Enhance fish kill reporting, particularly in offshore regions

Current understanding of fish killed by red tide events largely originates from the Florida Fish and Wildlife Conservation Commission and Fish and Wildlife Research Institute fish kill database, which is informed by a statewide fish kill hotline (http://research.myfwc.com/fishkill/). Many of the observations are based on fish that washed ashore following red tide events. Enhanced reporting of red tides, in addition to observations from offshore waters by recreational and commercial fishermen, could increase understanding of how red tide events impact offshore species. This could be achieved through the creation of a national program or increased citizen science through outreach educating fishermen and other Gulf patrons on their ability to improve fish kill reporting.

Assessment Workshop

1. Evaluate existing methods for deriving historical discard numbers and discard rates and improve methods as appropriate.

2. Develop/evaluate methods to maintain continuity of fishery-dependent indices in light of management regulations and ITQs.

3. Considering red tide is an unpredictable event, but can be a significant source of mortality, a response protocol should be developed for data collection and incorporation of the information into updated assessments.

4. The start year of this assessment is 1986. Future assessments should investigate extending the assessment model further back in time.

Review Workshop

Recommendations numbered in order of priority:

1) Questions were raised in workshop discussions about changes in reproductive success with age and with population concentration. Although it is known that reproductive success is mitigated by social factors, the degree and extent of mitigation is not well understood. More data are needed to better address the topic, including addressing time-varying changes within age categories. How much variation exists in size at age? Insufficient information leads to greater uncertainty and can have impacts on reference points.

2) The review panel raised questions throughout the evaluation of the assessment reports about the basis or bases of decisions to use the variables actually used. The recommendation is for analysts to provide a justification or rationale for the selection criteria. Review panel evaluations could be more accurately motivated if the selection criteria were better reported. Selection criteria would thereby be carried forward in the evaluations.

3) Paralleling the AW Report, discussions in the Review Workshop focused on initial conditions of the red grouper stock, including assessment of the stock from 1986 to 1993. Composition data was more complete from 1993, raising questions about methods to approach composition prior to that data, in effect, how to decide on what methods and procedures to use and how to establish preferences. The sense of the Review Workshop members was that procedures of ramping up were needed.

4) The core problem in the red grouper assessment was the data on discards. Procedures for reporting discards were not consistent across the fleets, and the fit to indices were poor, leading to major sources of uncertainty. Numerous sensitivity runs helped to reduce the lack of fit, especially up-weighting the commercial fishery dependent data, but problems remain. Discards were missing from the shark longline fishery, raising questions about the amount of resultant uncertainty. Research to address best practices in the reporting of discards is needed in regard to the red grouper stock. Especially useful, also, would be to increase the number of observers and observations among the commercial fleets.

5) Develop a standard protocol for ensuring that appropriate uncertainty in recruitment is applied when developing projections. Using a long-term average recruitment, as the median was used in this assessment, may lead to very different projections, and thus different management advice, compared to a lower or higher average recruitment based on a more recent time-period that may be more likely to reflect the biological/environmental realty of the stock.

6) Research is needed to help address questions about how fecundity can best be measured. Fecundity is a preferred measure for stock biomass and is a function of the number of eggs produced, but it has to be measured indirectly. Gonad weight can be used as a proxy, but obtaining reliable weights can be problematic, dependent in part on methods and timing of data acquisition. Research to address more accurate measurement of gonad weight and to develop protocols would be helpful.

7) Actual measures of individual growth are needed within age categories, as opposed to relying on common assumptions about growth rates and outcomes. Differential growth rates may occur in stock sub-structure within localized species, due to characteristics of the stock and ecosystem variables, or both. They may also affect schedules for hermaphroditic changes, impacting sex-age class composition.

8) Sensitivity runs to assess the impact of the 2005 red tide event on red grouper landings did not show any significant differences from the base model, including fit to discards. Documentation of the red tide mortality, however, presents methodological difficulties. Although analyses of data suggest that red tide primarily affected ages 0+, composition of the red tide kills are difficult to measure, given problems of access to the red tide zones and incomplete records of age, size, and sex in the kills. In addition, red tide events may be best considered in reference to ecosystem considerations (SEDAR42-5W-01). As environmental indices become incorporated into single stock species, criteria for inclusion have to be tested and measured, toward a goal of balanced biological and mechanistic explanation, statistical significance, and predictive performance. More research for red tide impacts on red grouper stock status is especially appropriate, given that the majority of landings are on Florida's West Continental Shelf, where high concentrations of red tide tend to be located.

9) Red grouper are found throughout the Gulf of Mexico and in the Atlantic from Brazil to the southeastern US. Catch levels and age composition data from Cuba, the Caribbean, and especially Mexico would allow for more complete stock assessment. Data could be obtained from the Mexican organization MEXAS.

10) The average age and thus size of females changing to males are known, but a more complete understanding of the conditions under which the changes occur would be helpful for assessing stock size. The number of males in relation to minimum stock size would be a useful metric for stock assessments.

a) Clearly denote research and monitoring that could improve the reliability of, and information provided by future assessments with particular emphasis on the Deepwater Horizon Oil Spill.

SEDAR 42 did not directly address the impacts of Deepwater Horizon on red grouper stock status. Earlier SEDAR Workshops, for example, SEDAR 31 (red snapper), contained discussions and research recommendations. SEDAR 42 contains analyses and recommendations relevant for events such as oil spills, however, in the attention given to the 2005 and 2014 red tide events. Oil spills can be measured as environmental events in a variety of ways, including the event as equivalent to a fleet source for fishing mortality. Ecosystem considerations (see 9 above) can also be utilized to assess impacts on stock status.

b) Provide recommendations on possible ways to improve the SEDAR process.

A topic of discussion throughout the Review Workshop was the need for more attention to

commonly used assumptions in categories of data and analyses. The rationale was to make assumptions more explicit and for consideration to be given to criteria for selection of options. The selection criteria would therefore become a part of the record as analyses move forward, and they would be subject to considerations of clarity, efficiency, and parsimony.

The three days of Review Workshop proved insufficient to enable the pre-prepared assessment to be presented and address areas of concern through developing additional work. For the workshop component of the review to be effective (i.e. developing alternatives or options where issues are identified), some additional time would need to be made available to the Assessment Team during

SEDAR 43 Gulf of Mexico Gray Triggerfish

1. Evaluate existing methods for deriving historical discard numbers and discard rates and improve methods as appropriate.

2. Develop/evaluate methods to maintain continuity of fishery-dependent indices in light of management regulations.

3. Develop a relationship between catchability of Gray Triggerfish on circle hooks when compared to J hooks.

4. Identify underlying factors resulting in discrepancies between recent estimates of cpue between the MRFSS Index and the SRHS Index.

5. Explore separating fisheries by gear, rather than by area.

6. Identify factors resulting in the release of fish in excess of size limits and improve estimates of asymptotic retention.

SEDAR 44 Atlantic Red Drum

Data/Assessment Workshops

This includes research recommendations developed by the Red Drum Technical Committee and Red Drum Stock Assessment Subcommittee for the SEDAR 44 Stock Assessment. Research recommendations are divided into short and long term projects. Short and long term research recommendations are prioritized, with the highest priorities listed first under each section and the lowest priorities listed last under each section.

Short Term

- Conduct experiments using logbooks to develop estimates of the B2 catch length composition in both the North and South regions.
- Determine if existing and historic recreational data sources (e.g., tagging) can be used to evaluate better B2 selectivities.
- Further study is needed to determine discard mortality estimates for the Atlantic coast, both for recreational and commercial gears. Additionally, discard estimates should examine the impact of slot-size limit management and explore regulatory discard impacts due to high-grading. Investigate covariates affecting discard mortality (e.g., depth, size, seasonality).
- Continued and expand observer coverage for the NC and VA gill net fisheries (5-10% coverage).
- Expand observer coverage to include other gears of concern (i.e. haul seine, pound net, trawls). Expand biostatistical sampling (ages and lengths) to better cover all statistical strata (gears/states - principally NC and VA) and collect more ages proportional to lengths, preferably otoliths. Conduct statistical analysis to determine appropriate sample sizes to adequately characterize the age-size composition of removals.
- Conduct a tagging study using emerging technologies (i.e., acoustic tagging, satellite tagging, genetic tags) to evaluate stock mixing and identify movement of sub-adult fish transitioning to maturity.
- Determine batch fecundity estimates of red drum. Need to include age-specific spawning frequency and spawning season length for this indeterminate spawner.
- Update maturity schedules for Atlantic red drum from Florida to Virginia. Preferably, gonad histology samples should be collected from all sizes over time and archived.
- Otolith microchemistry analysis should be considered to look at state level differences between regions to support stock structure differentiation.
- Continue cooperation between state ageing labs, such as the October 2008 red drum ageing workshop, to provide consistent age verification between labs.

Long Term

- Investigate iterative re-weighting of data components to identify the appropriate weights given to each data component in the objective function.
- Investigate alternative functions for retention to include recreational harvest and dead releases in the same fleets. Commercial discards should also be considered as a discard component of the landings fleet.

- Allow for time varying reporting rate of tag recaptures in the assessment model. This would allow use of more recent tag-recapture data from NC and estimates of changes over time in both regions.
- Continue genetic analyses (i.e, SC DNR analyses) to evaluate stock structure and mixing and temporal changes in genetic composition of the red drum population.
- Consider a pilot Virginia adult survey and expanding current adult fishery-independent survey coverage in Florida waters.
- Identify impacts of water quality, environmental, and ecosystem changes on red drum stock dynamics. Incorporate in the stock assessment models.
- Quantify habitat changes for future management planning

Review Workshop

Research recommendations were presented to the Panel in working document RW01 and are reiterated below in italic font followed by comments by the Panel. Generally speaking, the Panel agreed with the list of recommendations, as well as the prioritization. Additional recommendations by the Panel are included at the end of the list provided by the AT. The Panel noted that the recommendations generally fell into two categories: those that addressed gaps in life history information, and those that addressed issues with the model. While both are important, it was recommended that the research to address model concerns should be given higher priority.

Short Term

• Conduct experiments using logbooks to develop estimates of the B2 catch length composition in both the North and South regions.

Recreational releases are becoming an increasingly important component of the total catch. Unfortunately, the recreational survey does not collect length information from released fish, so length composition for this sector was characterized with length frequency data borrowed from available tagging data. The Panel noted several concerns surrounding the tagging data, such as minimum size requirements for tagging. The Panel therefore agrees that this research recommendation receive a high priority in the short term. For the long term, the Panel recommends modeling the recreational harvest and discards as a single fleet with a discard function; however, this will require assistance from SS3 developers since SS3 software currently only allows a logistic retention function that is not appropriate for a slot limit. It was cautioned that the combined fleet should exclude any fleet that has "non-standard" discarding practices (*e.g.*, releases all red drum regardless of size) that might have a different selectivity pattern.

• Determine if existing and historic recreational data sources (e.g., tagging) can be used to evaluate better B2 selectivities.

The Panel noted that the selectivity pattern of recreational live releases is expected to be bimodal and cannot be modeled with the double normal selectivity option used for the other fleets. The Panel recommended investigating the non-parametric selectivity function available in SS3 in the short term, and modelling recreational live releases with recreational harvest as a single fleet in the long term (see previous recommendation).

• *Further study is needed to determine discard mortality estimates for the Atlantic coast, both for recreational and commercial gears. Additionally, discard estimates should examine the impact of slot-size limit management and explore regulatory discard impacts due to high-grading. Investigate covariates affecting discard mortality (e.g., depth, size, seasonality).*
A better understanding of discard mortality rates in the commercial and recreational sectors, and the covariates that influence mortality rates, is important to adequately characterize the removals by these sectors. This and the previous two recommendations should receive high priority to gain a better understanding of discard practices which are becoming a larger component of the fishery.

• *Continued and expand observer coverage for the NC and VA gill net fisheries (5-10% coverage).*
It was noted that the scale of discards in the gill net fishery is substantial, and an accurate characterization of these fish should be included in the total removals. Priority for this research/monitoring should be based on the scale of commercial discard removals relative to the recreational release mortalities.

• *Expand observer coverage to include other gears of concern (i.e. haul seine, pound net, trawls).*
The AT confirmed that harvest from these gears is substantially less than gill nets, and discard mortality is expected to be low. The Panel recommended that priority of this research recommendation be evaluated relative to other sectors of the red drum fishery in terms of their overall contribution to removals.

• *Expand biostatistical sampling (ages and lengths) to better cover all statistical strata (gears/states - principally NC and VA) and collect more ages proportional to lengths, preferably otoliths. Conduct statistical analysis to determine appropriate sample sizes to adequately characterize the age-size composition of removals.*
The Panel commented that having sufficient data is certainly important to inform the model, but cautioned that sampling for the sake of increasing sample size can be counterproductive. Targeted sampling plans should be developed that fill identified data gaps and improve the model and/or management decisions but minimize over sampling. It may be necessary to collect large numbers of samples in the short term to better understand key life history characteristics, such as growth patterns, but over time sample sizes could be scaled back to a maintenance level of sampling.

• *Conduct a tagging study using emerging technologies (i.e., acoustic tagging, satellite tagging, genetic tags) to evaluate stock mixing and identify movement of sub-adult fish transitioning to maturity.*
The Panel noted that the information presented on stock structure was sufficient and informative, so while a tagging program could provide useful information, it is more of a long term issue. The AT expressed a concern that there may be substantial mixing of stocks in offshore waters. However, harvest from the offshore areas is low, so there should be little concern for mixed stock harvest. The Panel suggested that this research recommendation receive a lower priority and also be considered as a long term monitoring project along with otolith microchemistry and genetic analyses (discussed below).

• *Determine batch fecundity estimates of red drum. Need to include age-specific spawning frequency and spawning season length for this indeterminate spawner.*
The model does not currently use fecundity information, and using spawning stock biomass as a proxy for fecundity is a commonly accepted practice, so this does not need to be considered a high priority research recommendation. That being said, basic life history information such as fecundity is important to have, particularly as it relates to size and age. For example, it is known that fecundity of some sciaenids is not linear with spawner biomass, and therefore the metric used may have management implications.

• *Update maturity schedules for Atlantic red drum from Florida to Virginia. Preferably, gonad histology samples should be collected from all sizes over time and archived.*
The Panel agreed that collecting histological samples to standardize maturity classification, confirm maturity schedules, and provide a reference collection is important but cautioned that such a program may be expensive. Cost should therefore be considered during prioritization of sample collection.

• *Otolith microchemistry analysis should be considered to look at state level differences between regions to support stock structure differentiation.*
As with the research recommendation on archival tagging, the Panel commented that the stock structure information provided during the RW was sufficient and informative. It was recommended that this research be considered as a long term project in conjunction with the genetic analysis (discussed below).

• *Continue cooperation between state ageing labs, such as the October 2008 red drum ageing workshop, to provide consistent age verification between labs.*
The Panel noted that coordination/verification of ageing practices is very important and that work should be ongoing and conducted at regular intervals. The Panel also recommended that the work be broadened to include coordinating the collection of age samples and the development of an ageing error matrix.

Long Term
• *Investigate iterative re-weighting of data components to identify the appropriate weights given to each data component in the objective function.*
The Panel recommended that this work be viewed as a short term recommendation in terms of improving the model. In addition, the Panel noted that the work should include additional methods for weighting the model inputs, with iterative reweighting as one possible method.

• *Investigate alternative functions for retention to include recreational harvest and dead releases in the same fleets. Commercial discards should also be considered as a discard component of the landings fleet.*
The Panel agreed that combining the recreational harvest and discards into a single fleet would be more appropriate but reiterated that SS3 does not currently have that functionality given the characteristics of the red drum fishery (slot limit). In addition, this step is not necessary to get a solid working model, so the Panel recommended that this work receive lower priority.

• *Allow for time varying reporting rate of tag recaptures in the assessment model. This would allow use of more recent tag-recapture data from NC and estimates of changes over time in both regions.*
The Panel recommended that both regions should continue their tagging programs to evaluate tag return rates, but identified two concerns with this research recommendation. First, given the available data, it is unlikely that SS3 would be able to reliably estimate time varying reporting rates. Second, even if the functionality were available, the data should be evaluated prior to use in the model to confirm that they are informative. It was cautioned that including uninformative data on this (or any other) parameter may be counterproductive to the model fitting process.

• *Continue genetic analyses (i.e, SC DNR analyses) to evaluate stock structure and mixing and temporal changes in genetic composition of the red drum population.*
Details regarding stock structure and stock mixing rates are important to understand in non-migratory stocks that extend over wide geographic scales. It was noted that the information pertaining to Atlantic red drum stock structure was informative, with the split between northern and southern, and southern and Gulf stocks clearly defined. However, monitoring of mixing rates and confirmation of stock boundaries is important over the long term, as well as investigating the possibility for finer scale stock structure, as new techniques are developed. Several research recommendations addressed stock structure and mixing, including acoustic tagging, otolith microchemistry, and genetic analysis. It was recommended that long term monitoring be conducted at modest levels of sampling using a combination of these three techniques.

• *Consider a pilot Virginia adult survey and expanding current adult fishery independent survey coverage in Florida waters.*
The Panel commented that fishery independent sampling should be representative of the entire population. The AT should evaluate the adequacy of current sampling levels and expand as necessary.

• *Identify impacts of water quality, environmental, and ecosystem changes on red drum stock dynamics. Incorporate in the stock assessment models.*
The Panel agreed that understanding external drivers on stock dynamics is important, but noted that this research recommendation is very broad and generic. Preliminary work should be done using available data to identify potential factors that affect red drum so that more directed work could be conducted moving forward. It was also suggested that the work be conducted by non-assessment biologists since it is less of a priority.

• *Quantify habitat changes for future management planning*
The Panel commented that the specific components of the previous recommendation could all be considered aspects of habitat. In that regard, this recommendation which addresses physical habitat can be included in with the previous recommendation.

Additional research recommendations identified by the Panel

In addition to the short and long term research recommendations provided by the Red Drum Technical Committee, the Panel identified a number of items that could improve the current model and future assessments.

The AT should conduct a comprehensive review of tag reporting rates, including identifying additional data sources, evaluating alternative estimation methodologies, and/or using information from similar species. This work should be done in the short term to update (or corroborate) data currently being used. The final value used should be sufficiently justified because of its apparent impact on the scale of model results.

As discussed under TOR 3, the AT should investigate the treatment of age and length data to fit selectivites for the longline survey. During this exploration the team should pay particular attention to the fitting of the growth function and its effect on model fitting for the other surveys, age composition, and historic recruitment; changes in selectivity estimates for the different fleets and fits to other datasets should also be examined for possible indication of conflict in the signals provided.

The Panel noticed an abnormal length frequency distribution (certain lengths in the heart of the distribution with 0 frequency) in the northern GNBS data which is likely an artifact of converting lengths in inch bins to centimeter bins. These data could be influencing the length composition fits (and therefore overall model results) and should be rectified before moving forward.

The AT should explore the effect of changing sample size cutoffs, such as the number of tag returns necessary for each tag group (currently using N = 300) or minimum sample size before data borrowing is necessary. This work should be viewed as a diagnostic and sensitivity exercise and should be explored in the short term but only after a solid base model is available.

One potential avenue for exploration could be to input size at age directly based on external estimates of growth. This would allow for non von Bertalanffy growth model to see if a different growth model addresses some of these perceived issues.

For this and future assessments, the Panel reiterates their recommendation to start simple and add complexity only after the model is providing credible results and the AT understands how the model is performing. This is particularly important when new data sources or alternative data treatments are being considered. Once a "simple" model has been developed, the Panel recommends investigating two "add-ons" independently of each other (*e.g.* extending the time series vs. adding selectivity blocks), and selecting the one that provides more information as the next scenario. This process should be repeated, adding complexity in a step-wise fashion, until sufficient complexity is achieved or model performance breaks down.

As noted in TOR 1, the Panel recommends additional time be spent evaluating available data sources prior to their use in the model. Simple exercises such as checking whether the different data sources

corroborate one another or indices can track strong year classes can help determine the information content of a particular data source. A thorough understanding of the input data strengths and weaknesses can be useful to pinpoint issues in model performance.

SEDAR 45 Gulf of Mexico Vermilion Snapper

Data/Assessment Workshop

Improve sample sizes in the recreational fisheries, particularly for age composition data, so that the recreational fleet can be modeled by mode and/or region.

Investigate a two-region model that may be better able to account for differences in age structure and recruitment across the Gulf of Mexico.

Continue to evaluate discards by fleet and incorporate them if they become significant portions of total catch.

Evaluate discard mortality.

Evaluate the protocol for estimating shrimp bycatch and update the WinBugs program with any changes to data collection protocols that may have occurred over the last decade.

Obtain age or length compositions from the shrimp bycatch fisheries to better inform shrimp selectivity estimates.

Perform simulation validation of IFQ standardization techniques.

SEDAR 46 U.S. Caribbean Data Limited Species

Data Workshop

Species Selection:

- Investigate additional data sets and re-evaluate species selection criteria for future stock evaluations.
- For example, consider the information available for queen conch (*Strombus gigas*) in the National Ocean Service's Biogeography visual surveys (Menza et al. 2006) and in data collected by universities in the region.
- Mesophotic reef surveys in western Puerto Rico (García-Sais et al. 2012), visual surveys and passive acoustic monitoring in western Puerto Rico and Mona Island (Scharer-Umpierre et al., 2014), and
- SEAMAP-C (Pagan 2002, Ingram 2014).

To the extent possible, these (and any other datasets) should be integrated and comprehensively summarized to facilitate comparisons and explorations in future analyses.

Life History:

- Representative sampling across size/age spectra for under-sampled US Caribbean stocks.
- Updated studies of life history and demographic characteristics are needed that focus on sampling under-represented size classes, particularly large (old) fishes to provide more accurate estimates of asymptotic length, and small (young) fishes to more accurately estimate the rate at which fishes approach asymptotic length. This recommendation stems from a concern that maximum lengths were too often considerably longer than L_∞ estimates. This observation could stem from inadequate sampling of the largest length classes, region-specific differences in asymptotic growth (where parameters were borrowed from other regions), or where exploitation has dramatically modified stock structure.
- Additional sampling is also necessary for improving stock-specific maturity schedules, and these data should be fit via modern logistic regressions methods to obtain the most robust estimates of length at maturity.
- Research efforts be put into compilation of various datasets of life history demographic parameters for all exploited species in the tropical western Atlantic, through a Regional Expert Demographic Workshop.

Fishery Statistics:

Commercial research recommendations

- Evaluate the efficacy of existing commercial landings expansion factors used in Puerto Rico; provide recommendations for improved methods to calculate expansion factors;

examine the impact on landings estimates due to methodological changes implemented in 2003 for calculating expansion factors
- Verify, using port samplers or other appropriate methods, self-reported landings in the US Virgin Islands and Puerto Rico
- Obtain species-specific estimates of discards from the commercial sector in Puerto Rico and in the US Virgin Islands
- Quantify the sizes and discard conditions of fish discarded by commercial fisheries in Puerto Rico and in the US Virgin Islands

Recreational research recommendations

- Increase representative sampling of the recreational sector in Puerto Rico and expand to collect recreational data in the US Virgin Islands
- Include spiny lobster and conch in the MRIP in order to estimate recreational catch for these important Caribbean species
- Explore changes in the Puerto Rico recreational catch estimates as a result of the change in intercept protocols and estimation methodologies from MRFSS to MRIP in 2014

Measures of Fishery Abundance:

- Conduct additional examinations to identify auxiliary variables that could be informative in standardization
- Begin the spiny lobster nominal and standardized index further back in time
- Invest in regional scale fisheries-independent surveys to estimate relative (or absolute) abundance
- Investigate methods for subsetting to trips targeting the target species
- Account for change in regulations that may affect CPUE
- Obtain supplementary information and evaluate the use of aggregation of data over gears. The recommendation for SEDAR 46 was to group gear types that were assumed to have similar selectivity's. Additional efforts could help determine when it is or is not appropriate to use gear groups.

Fishing Effort:

- Investigate issue associated with fishers not reporting effort information in St. Croix
- Review any caveats/concerns such as species having more than one dominant fishery or noted changes in fishing behavior
- Extend the data-limited approaches to allow two fisheries, or a single fishery with two distinct types of selectivity/catchability

Length Frequency Distributions:

- The TIP sampling operational framework in Puerto Rico and in the USVI should be reviewed to ensure sampling is representative of the primary fisheries.

- Conduct review of supplemental information on size from data series not readily available for these evaluations.
- Evaluate the use of aggregation of length samples over gears. The recommendation by the SEDAR 46 DW Panel was to group gear types that were assumed to have similar selectivities.
- Address difficulty in assigning the fishing areas to develop a continuous series for the USVI. Develop a consistent time series of area assignments for St. Thomas and St. John. Consider if alternative approaches to aggregating the fishing area information in the TIP data may be feasible.

Assessment Workshop

A number of research recommendations are identified throughout the SEDAR 46 stock evaluation. These arise from the perspective of information content (i.e., data availability, quantity, and quality and information content) and also the modeling approach. Within this context the following discussion and recommendations are made.

Regarding data availability, continued explorations are warranted on the following topics to address uncertainty within key data inputs for data-limited stock assessment models:

1. A statistical review of existing fishery independent surveys to identify an optimum sampling design for development of fishery independent abundance indices. Fishery independent surveys can contribute critical information regarding trends in stock abundance, which can be applied in relatively simple management procedures.

2. Develop indices of abundance for spiny lobster using all available data since 1970s with focus on a fishery independent survey.

3. Investigate more justifiable estimates of stock depletion (Dep) and depletion over time (Dt), such as through Productivity-Susceptibility Analysis (e.g., Cope et al. 2015) or using methods such as mean length estimators.

4. Investigate more justifiable estimates of current stock abundance.

5. Enhanced catch at length by gear sampling is needed to better inform selectivity at age.

6. Investigate fleet dynamics to more accurately capture fishery characteristics.

7. Identify target catch or index levels which could be used in conjunction with catch and index time series.

8. Identify target length levels which could be used in conjunction with catch and a length frequency series.

9. Develop a weighting scheme for length composition and multiple gear fisheries reflective of the stock.

10. Consider organizing species into species complexes for assessment based on similar life history, market characteristics, and vulnerability. This could help streamline the stock assessment process in a data-limited context.

Within the modeling framework used in SEDAR 46, many limitations are acknowledged within an MSE approach. Pragmatically, results are a product of the specific conditions of the simulation, which are assumed to be as simplistic as possible but contain sufficient complexity to reflect the system in a representative way. Methods tend to perform poorly when fundamental assumptions are invalid or inputs are strongly miss-specified. Detecting model misspecficiation for data-limited scenarios offers additional challenges including evaluating incongruency between data sources. As well, within the implementation model, assumed management target recommendations (i.e., TACs) were taken as catch with no implementation error simulated. Further, no uncertainty was considered in determining TACs via buffers to account for multiple sources of uncertainty (catch reporting, assessment procedure violations, etc). Thus, additional considerations towards confirmation of the stock and fleet subclass components of the operating models explored in SEDAR 46 are warranted. In particular, assumptions regarding the selectivity pattern of fleets should be further examined.

Recommendations for enhancing the practical use of the DLMtool from the analytical team.

- Revisions of the DLMtool software to enhance the model functionality to allow multiple indices of abundance.

- Revision of the DLMtool software to allow age varying M.

- Allow for implementation error of the harvest control rule (e.g., TAC overages) within the implementation model in the MSE.

Recommendations for enhancing the practical use of the DLMtool from the developer (Carruthers (2015a) that the SEDAR 46 analytical team considers of practical relevance to US Caribbean fisheries application of the toolkit:

- Idealized observation models for catch composition data

"Currently, DLMtool simulates catch-composition data from the true simulated catch composition data via a multinomial distribution and some effective sample size. This observation model may be unrealistically well-behaved and favor those approaches that use these data. Harvest control rules must be integrated into data-limited MPs".

- Harvest control rules

"In the version of DLMtool applied in SEDAR 46 (version 2.1.2), harvest control rules (e.g., the 40-10 rule) must be written into a data-limited MP. There is currently no ability to do a factorial comparison of say 4 harvest controls rules against 3 MPs (the user must describe all 12 combinations). The reason for this is that it would require further subclasses. For example the 40-10 rule may be appropriate for the output of DBSRA but it would not be appropriate for some of the simple management procedures such as DynF that already incorporate throttling of TAC recommendations according to stock depletion."

- Implementation error

"In this edition of DLMtool there is no implementation error. The only imperfection between a management recommendation and the simulated TAC comes in the form of the MaxF argument that limits the maximum fishing mortality rate on any given age-class in the operating model. The default is 0.8 which is high for all but the shortest living fish species."

Review Workshop

This section considers the research recommendations initially provided by the DW and AW that were then considered by the SEDAR 46 Review Panel. The Review Panel generally supported the recommendations from the DW and AW, and those from the assessment team. However, the Review Panel extended these recommendations as outlined below. Recommendations fell into two general categories: (1) data; and, (2) model.

Data

One of the fuzziest aspects of the data-limited process was how exactly data reliability was qualified or quantified. We discovered that fishery data precision (e.g., coefficient of variation, CV) was not able to be determined from the current fishery catch sampling methodologies that are employed in the Caribbean. While this was probably a topic of conversation at the DW, there was insufficient discussion of these critical issues in the SEDAR 46 DW/AW report (AW). There needs to be a solid focus on data design strategies as the data-limited process moves forward in the region to establish ACLs for a range of species presently not under consideration.

Thus, two aspects of model inputs must be addressed: (1) life history demographics; and, (2) fishery-dependent data (size-structured catch and fishing effort). Research into what defines the "best" demographic parameters for DLM model inputs, for example, most accurate and precise growth (length-at-age) curve, maximum age (i.e., natural mortality rate), size at first capture (selectivity ogive), size at first sexual maturity (maturation ogive), etc. There seemed to be insufficient attention to these issues in the workshop, and arbitrary (non-estimated) CVs were applied to data inputs. Perhaps the number one priority is to refine the life history demographic parameters identified by the DW across the region, and to improve accuracy and precision of those basic data. This strategy would likely be facilitated by a workshop of technical experts convened, in the near future, to review and analyse existing life history demographic data for all relevant exploited species in the U.S. Caribbean, Southeast U.S. and Gulf of Mexico. When joint parameter variance-covariance is not available, how will estimates of uncertainty for life history demographic parameters, for example, be provided? This would include quantitative justifications for error variances and CVs.

A focus on design-based strategies for ensuring collection of accurate and precise fisheries-dependent commercial and recreational data should be advanced in the region. This would greatly improve fishery-dependent mean (and variance) estimates of landings, discards and the

effort required to obtain them. The sampling protocols must be optimized to ensure representative sampling across size-age spectra over time and space. If precise estimates were obtained in the most recent years, then a data-limited analysis could identify current exploitation rates and resource sustainability. In addition, it makes sense to conduct a statistical review, analysis and optimal sampling design of complimentary fishery-independent surveys as these could provide extremely important spatially-integral, accurate and precise information on exploitation effects by measuring what is left in the water after fishing has occurred.

More work must be done on evaluation of species selection criteria. The adequacy of the choice of species suitable for these pilot species analyses was generally successful. However, a couple of those species provided little guidance on model performance. These analyses revealed issues in three areas: (1) appropriate models and benchmarks; (2) reliable life history demographic data; and, (3) adequate fishery-dependent data.

Model

A review of appropriate data-limited methods should be conducted as soon as possible, under the auspices of SEDAR, to allow evaluation of which methods should really be used in the DLM process for evaluation. Such a technical review would consider: (1) model theoretical basis and assumptions; (2) data requirements; (3) robustness of model to departures from assumptions and data requirements; and, (4) model responses (i.e., biases) to model uncertainty. This would include a systematic analysis of the sources of variability and how they influence OM dynamics. This was nearly impossible to discern in the way that the materials were presented at SEDAR 46, which was no fault of the analysts.

Some of the model estimates produced during SEDAR 46 were very troubling due to either: (1) application of an inappropriate or an inapplicable model(s) or MP; and/or, (2) very wide ranges of error variances, while unknown, that were applied to the input data. As a result, some MPs produced forecasts of unrealistic catch levels, suggesting that their usefulness is highly dubious. Not surprisingly, when appropriate variances and covariances were applied, the median of the output distribution do not change, but the range of model output metrics were substantially reduced. Nevertheless, that did not lead to any material change in the findings of the assessment with regard to MPs that performed better. The argument that this tested the MPs with greater uncertainty and therefore could still be used as a test of robustness was only partially accepted by the review panel.

While this AW was an examination of the potential efficacy of the approach due to its "newness", and the fact that it was 3rd party application not fully controlled by the analytical team, we believe that in future workshops the analysts should more clearly specify what is desired as an outcome of model simulations, so that the simulations can be more finely tuned to answer specific questions. Generally, feasibility and limitations of MPs to real world

applications is largely determined by data sufficiency and model adequacy. Additionally, there was no guarantee that the sampling algorithms in the OM reflected reality, and to some extent particular methodologies were difficult to assess given the information available to the Panel. In general, the AW would have run more smoothly if more attention were paid to the accuracy and precision of the basic data, and adherence to the assumptions required by the applicable MPs.

A better description and explanation of what is actually going on in the DLMtool OM at the outset would have been useful and clarifying to the Review Panel. As it was, application of methodologies at times appeared quite *ad hoc*, particularly as related to application of means, variances and coefficients of variations of model parameters. The parameters were treated as independent random variables, when we know they are dependent. But this is in fact the DLMtool default as it tries to cover a very wide range of uncertainties. There were a number of unclear definitions, such as "model stability", which roughly translated to how many simulation runs were required for an input level of variation where for some unspecified reason, all model parameters seemed to be varying simultaneously. This would suggest that some further attention to model sensitivity is highly warranted. Concepts as straight-forward as the number of required model runs to achieve stationarity were not well substantiated.

The apparent uncertainty in both data and models for U.S. Caribbean species suggests caution when selecting MPs intended to provide management advice. Selection of a particular MP for providing catch allocation strategies for management should consider: (1) MP sensitivity to parameters; (2) satisfying model assumptions; and, (3) information quality.

Recommendations

More precise and clearer descriptions and rationales for model thresholds and benchmarks used in the DLM process are needed. Analyses presented at the AW focused heavily on fishery yields (i.e., catches) which made it difficult to discern the rationale for what constituted a particular preferred choice of the MPs. A broader perspective might be entertained when setting OFLs and other appropriate benchmarks. This would likely include yield risks as they relate, in addition, to benchmarks specific to both economic and ecological risks. Adherence to this philosophy would require that model thresholds are set at more conservative resource use levels than are presently considered, and this in turn would avoid theoretical searches of infeasible or impractical model decision space. It is probably not useful to go too far into the weeds in trying to assess the full complexity of a fishery at first, rather the assessment needs to focus on distinguishing sustainable from non-sustainable rates of exploitation, and then identify the appropriate annual catches required to sustain the resource(s). If multiple MPs or a subset of tools are used, then some consideration must be given to model averaging. It would appear from the AW that many of the proposed estimation methods and MPs are non-starters from the outset. This seems an opportune time to conduct a thorough analysis of DLMtool efficacy. The Panel feels that the approaches presented could have broad potential for use in the Caribbean, but still

require deeper, more thoughtful consideration to determine what avenues of application allow one to achieve the greatest utility of the tool.

SEDAR 47 Southeastern U.S. Goliath Grouper

Assessment Team

The Florida Fish and Wildlife Conservation Commission held a workshop on March 14-16, 2016 to discuss recent research findings about Goliath Grouper in Florida waters. Before the close of the workshop, the participants provided their recommendations about additional research that should be conducted on this species to improve our understanding of this species.

Monitoring activities

- Genetics: sample from fish from around Florida, and particularly the Florida West Coast. Samples could be from removal of a few scales, fin clips, or needle biopsy. Consider training at-sea observers/samplers to collect these samples. Eggs could also be collected and analyzed. A repeat of the recent kinship analysis (Tringali) on a periodic basis (5-10 years) would help monitor for changes in the degree of relatedness in the Florida Keys and southeast Florida.
- Spawning aggregations – locate additional sites where aggregations occur, using a combination of sound and Didson sonar imaging to verify spawning activity. This is work currently in progress. Monitor currently known spawning sites for trends over time.
- Mark-recapture data needs to be analyzed from the acoustic tagging data and about 800 sampled and visually tagged fish on the east and west coast of Florida. Investigate the possibility of using genetic mark-recapture methods.
- Expand sampling for nursery habitat and targeted juvenile sampling, possibly using an existing fishery-independent sampling program. Recommend to the NMFS Cooperative Research Program the possible funding of projects to work with the blue crab trap fishermen to collect fin clips (for genetics) when there is bycatch of Goliaths.
- Annual age sampling on the level of 400-500 specimens to monitor age structure of adults. The fin ray-age validation work is in progress.
- Fecundity research – in progress.
- Investigate the use of wildlife models like occupancy modelling. This may require more regular, systematic sampling than is currently available.
- Use visual data from the REEF survey, NMFS-UM Reef Visual Census (though they do not sample artificial reefs and wrecks), and expand the Great Goliath Grouper Counts from once a year in June to twice a year (June and September) to help identify locations with larger fish to sample.
- Drop cam video from FWRI's FIM program could expand the coverage of visual surveys, but would need to expand sampling to artificial reefs/wrecks.
- Investigate feasibility of mounting video cameras on charter and head boats to obtain information on bycatch (some preliminary work by Mote Marine Lab may be useful).
- Discuss with the FWC Artificial Reef Program the possibility of grant funding for Goliath work.

- Promote the collection of Goliath lengths from anglers (Snook and Game Fish Foundation app)
- Use GIS artificial reef data to identify all artificial reef structures and related data (materials, heights) in the Gulf of Mexico for developing a sampling plan.
- Extract dates and locations from log book data especially during spawning season that may identify new aggregations/spawning sites.

Review Workshop

The data used in the models mostly originated from Florida. Sparse data from elsewhere in the species (historical) range may be indicative of low population size (either as a function of natural distribution patterns or constriction of the population due to heavy fishing pressure), or poor sampling (including landings). This issue needs to be further explored as it has bearing on the geographical validity and usefulness of the assessment for regional management.

There was some concern by the RP about the method the Assessment Team used for combining the GGGC and the REEF survey as there is a potential for bias (e.g. potential for targeting sites with known high abundance of Goliath Grouper in the GGGC survey). How influential the inclusion of the GGGC data was to the outcome of the model should be explored.

Many of the research recommendations provided in the Assessment Report include research that would not necessarily improve future assessments for this species. The SEDAR 23 RW concluded that "The next benchmark assessment cannot be successfully completed without data from the research recommended by the Data, Assessment, and Review Panels." The outcome of the SEDAR 47 benchmark assessment process indicates that much of this information is still needed in order to successfully complete an assessment for Goliath Grouper.

Specifically, research and monitoring efforts that could improve future assessments for Goliath Grouper include:

<u>Life history information</u>
Basic reproductive data is lacking throughout the species distribution. This includes size and age at maturity for each sex, sexual sequence with size and age for each sex, and fecundity. In the SEDAR 47 assessment, the reproduction functions used in the models made some strong assumptions about the maturity schedule and fecundity rates that were based on insufficient data. Greater resolution of data, especially maturity at size or age, would alleviate the impact of these assumptions for future assessments.

A limited research harvest should be considered to fill the remaining gaps in life history information for Goliath Grouper. Such a harvest should incorporate individuals from across the size spectrum, but should focus on larger individuals as they may be beneficial to ground truth the fin-ray aging techniques used for the offshore age composition, and to develop fecundity schedules.

Additional research on the age structure of the catch, especially in the offshore recreational fishery, is needed. The SEDAR 47 assessment used age composition of only 22 adult individuals that were caught by a research fishery and aged with fin rays (Koenig et al. 2013). This age

composition was used for multiple parts of the assessment and may provide a large source of the assessment uncertainty. Cooperative research efforts with the recreational charter and headboat fisheries could be informative towards generating better information on the offshore recreational age composition.

Discard mortality estimates are needed across the species distribution. For the SEDAR 47 assessment, a fixed discard mortality estimate was applied to the post-moratorium harvest. However, the uncertainty around this estimate is unknown and may be substantial.

Stock definition

SEDAR 23 recommended that Goliath Grouper should be genetically sampled from areas across the stock range in the South Atlantic and Gulf of Mexico to allow for a more thorough examination of the current single stock definition. The SEDAR 47 RW was presented with a brief summary of these efforts, which seem to support that single stock definition. Like many other sources of information informing the SEDAR 47 assessment, this information remains in progress or is incomplete and has not yet been vetted by peer review.

Examination of spawning aggregations over the entire distribution range should include seasonality, sex ratios, and individual fidelity.

Fishery independent sources of information are lacking or uncertain

The SEDAR 47 AT indicated that a specifically designed pre-fishery recruit survey (e.g. mangrove habitat) would help guide recruitment in the assessment model.

Develop and/or explore methods to take into account episodic mortality events.

One issue with the SEDAR 47 assessment was the use of a fixed value for natural mortality at age, despite evidence that episodic mortality events (i.e. cold-kills) have affected the Goliath Grouper population. Options to account for this mortality should be explored for future assessments. Methods used in other assessments (e.g. to address red tide events affecting red and gag grouper in the GOM) include incorporating episodic mortality events as a separate removal fleet. These methods may be appropriate for Goliath Grouper and could reduce some of the uncertainty in the estimates of natural mortality.

Reexamine methods of constructing historical removals

The use of length data from MRFSS/MRIP recreational Goliath Grouper removals need to be further examined. In SEDAR 47, the methods used to apply mean length of catch was inconsistent between years when there was missing and/or suspect data, and years with an estimate from the MRFSS/MRIP database. This introduced a significant amount of uncertainty to the harvest estimates.

Incorporate Data from Low Abundance Years into Indices

The Assessment Team discarded some of the data from index development due to very low catch rates in years adjacent to the moratorium. As a result, low abundance indices are removed from the assessment. Methods for incorporating these data into appropriate statistical models for standardization and development of indices should be explored.

SEDAR 48 Southeastern U.S. Black Grouper

Data Workshop

To be added

Assessment Workshop

To be added

Review Workshop

To be added

SEDAR 49 Gulf of Mexico Data Limited Species

Data Workshop

LIFE HISTORY RESEARCH RECOMMENDATIONS

Red Drum

The SEDAR 49 Gulf of Mexico data-limited stock assessment represents the initial attempt at assessing Gulf of Mexico Red Drum since the federal harvest moratorium. A comprehensive review of the literature, as well as inclusion of the most recent datasets available, provided the most up to date life history information possible (Table 2.12.1, 2.12.4). Through this review of the literature, it is apparent that GOM Red Drum remain a data-limited species. Below we provide the following research recommendations:

1. Increase offshore sampling across the entire GOM, especially at the individual school level, for biological samples (e.g., meristics, otoliths, reproductive tissues, fin clips). We recommend purse seine as the least size-selective sampling gear for this species in offshore waters.
2. Consensus and consistency is needed in assigning calendar age, calculating fractional ages and recording edge type across the GOM to ensure the age data collected are comparable between studies.
3. A concerted effort should be made to identify and record reproductive phase for oocyte development, both macroscopically and histologically. This is particularly true given that the most recent reproductive estimates are greater than 20 years old. Improved quantification (e.g., binary logistic regression) is needed for better point estimates of size and age at 50% and 95% maturity.
4. Collection of tissues (e.g., fin clips) is a low-cost and easy-to-archive means to ensure future studies examining stock delineation, site fidelity, effective population size, etc. for this species are possible.

Lane Snapper

A primary open question in the life history analyses is how the recreational fishery has impacted the stock since the early 1990's. There are no data available to make inferences about how age frequency in the fishery and stock may have changed over the time series.

Primary research needs identified by the team included the following. These are listed below in order of priority based on perceived priority:

1. Increase the precision (by increasing sample size and thorough validation) of estimates of length-at-age and maturity-at-age to provide rigorous estimates. This would require an increase in dockside and at-sea sampling for biostatistical information, especially the collection of otoliths and reproductive tissue.

2. Design random sampling protocol for NMFS Pascagoula's groundfish and small pelagic surveys to collect length- and age-composition of Lane Snapper encountered by these surveys.
3. Perform a survey of the genetic structure of the stock to more precisely understand spatial stock structure, in particular the potential for hybridization with other Lutjanids.

Wenchman

Due to the limited sampling of life history parameters (two months of data in a single year), more research is needed for all life history aspects of Wenchman. This includes aging, reproduction and maturity, and estimation of growth parameters.

Primary research needs identified by the LHWG included the following:

1. Increase dockside and at-sea sampling for biological samples (age structures, reproductive tissues, and genetic material).
2. An aging study that includes validation with increased sample sizes.
3. Design a random sampling protocol for NMFS Pascagoula groundfish and small pelagic surveys.
4. Collect reproductive maturity estimates.

Yellowmouth Grouper

Additional research is needed to obtain more recent estimates of all life history parameters for Yellowmouth Grouper. This includes aging, reproduction and maturity, and estimation of growth parameters.

Primary research needs identified by the LHWG included the following:

1. Increase in dockside and at-sea sampling for biological samples (age structures, reproductive tissues, and genetic material) for the GOM.
2. Conduct an updated age and growth study for GOM samples, including a validation study based on radiochemical dating.
3. Conduct an updated reproductive study for the GOM to examine not only maturity but the size and age of transition.

Snowy Grouper

Additional research is needed to obtain more recent estimates of all life history parameters for Snowy Grouper in the GOM. This includes aging, reproduction and maturity, and estimation of growth parameters.

Primary research needs identified by the LHWG included the following:

1. Increase in dockside and at-sea sampling for biological samples (age structures, reproductive tissues, and genetic material) for the GOM.

2. Conduct an updated age and growth study for GOM samples, which also includes a more extensive validation study based on radiochemical dating (see Harris 2005).
3. An increase in dockside and other sampling programs to complete a more comprehensive and an updated reproductive study for GOM to examine not only maturity but size and age of transition.

Speckled Hind

Additional research is needed to obtain estimates of all life history parameters for Speckled Hind in the northern GOM. This includes aging, reproduction and maturity, and estimation of growth parameters.

Primary research needs identified by the LHWG included the following:

1. Increase in dockside and at-sea sampling for biological samples (age structures, reproductive tissues, and genetic material) for the GOM.
2. Conduct an updated age and growth study for GOM samples, using the new criteria of counting narrower groups of translucent and opaque band increments on the dorsal side of the otolith (as described in Andrews et al. 2013).
3. An increase in dockside and other sampling programs to complete a more comprehensive and an updated reproductive study for the GOM to examine not only maturity but size and age of transition.

Lesser Amberjack

Additional research is needed to obtain estimates of all life history parameters for Lesser Amberjack in the GOM. This includes aging, reproduction and maturity, and estimation of growth parameters.

Primary research needs identified by the LHWG included the following.

1. Increase in dockside and at-sea sampling for biological samples including age structures, reproductive tissues, and genetic material.
2. While age has been attempted, finding an appropriate aging methodology that includes a way to validate age using multiple hard structures is suggested.
3. Further research is needed for natural mortality estimates.
4. Need for reproductive tissue to examine maturity.

Almaco Jack

Additional research is needed to obtain estimates of all life history parameters for Lesser Amberjack in the GOM. This includes aging, reproduction and maturity, and estimation of growth parameters.

Primary research needs identified by the LHWG included the following.

1. Increase in dockside and at-sea sampling for biological samples including age structures, reproductive tissues, and genetic material.
2. While age has been attempted, finding an appropriate aging methodology that includes a way to validate age using multiple hard structures is suggested.
3. Further research is needed for natural mortality estimates.
4. Need for reproductive tissue to examine maturity.

COMMERCIAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

Further development of methods for calculating overall uncertainty when summing total removals from commercial, recreational, and other fisheries (e.g., shrimp and other trawl fisheries). Methods should account for differences in programs; e.g., some programs provide CVs while others produce ranges of uncertainty based upon expert opinion.

Develop more robust estimates of discard mortality for all SEDAR 49 species from each sector of the commercial fishery.

Develop methods to more appropriately estimate uncertainty of discard estimates from each sector of the commercial fishery.

Red Drum

Develop data collection methods to enable investigation of the magnitude of bycatch in the Gulf of Mexico menhaden fishery for Red Drum. Investigate the impact of menhaden fishery bycatch on stock assessments.

Lane Snapper

Develop appropriate sampling methods to determine the size composition of Lane Snapper caught as bycatch in Gulf of Mexico shrimp fisheries.

Wenchman

During the Data Workshop, a northern Gulf of Mexico finfish trawl fishery (likely targeting Butterfish) was identified as being the primary commercial fishery for Wenchman. That fishery was recommended as the representative fleet for Wenchman. Further investigation of that finfish trawl fishery is recommended. Data sources useful for accurately determining targeting, effort, and landings of the fishery should be identified.

Develop appropriate sampling methods to determine the size composition of Wenchman caught as bycatch in Gulf of Mexico shrimp fisheries.

Yellowmouth Grouper
Develop genetic markers for species identification and determine the frequency of misidentification of Yellowmouth Grouper.

Use port samplers to determine the frequency of Yellowmouth Grouper misidentification or misreporting.

Snowy Grouper
No research recommendations were suggested for Snowy Grouper.

Speckled Hind
No research recommendations were suggested for Speckled Hind.

Lesser Amberjack
Use port samplers to determine the frequency of Lesser Amberjack misidentification or misreporting.

Almaco Jack
Use port samplers to determine the frequency of Almaco Jack misidentification or misreporting.

RECREATIONAL FISHERY STATISTICS RESEARCH RECOMMENDATIONS

Red Drum
- Improve discard length and age data collection in the recreational fishery.
- Develop directed effort estimates.
- Investigate self-reported discards to determine if there is bias or misidentification in the data.
- Determine implications of gaps in the available recreational discard data.

Lane Snapper
- Improve discard length and age data collection in the recreational fishery.
- Reliable estimates of discard mortality.
- Develop directed effort estimates.

Wenchman
- Improve discard length and age data collection in the recreational fishery.
- Determine whether species identification issues (not commonly known in the recreational fishery) affect reported landings/discards.
- Reliable estimates of discard mortality.

- Develop directed effort estimates.

Yellowmouth Grouper

- Improve discard length and age data collection in the recreational fishery.
- Determine whether species is underreported and the percentage of landings/discards underreported due to species misidentification as Scamp or Black Grouper.
- Reliable estimates of discard mortality.
- Develop directed effort estimates.
    - Species that are not typically targeted (ex: Yellowmouth Grouper) may benefit from a higher-level directed effort estimate (ex: shallow water grouper effort), as they are frequently caught in conjunction with associated species.

Snowy Grouper

- Improve discard length and age data collection in the recreational fishery.
- Determine whether species is underreported and the percentage of landings/discards underreported due to species misidentification as Black Grouper or Warsaw Grouper.
- Reliable estimates of discard mortality.
- Develop directed effort estimates.

Speckled Hind

- Improve discard length and age data collection in the recreational fishery.
- Reliable estimates of discard mortality.
- Develop directed effort estimates.
- Investigate self-reported discards to determine if there is bias or misidentification in the data.
- Determine implications of gaps in the available recreational discard data.

Lesser Amberjack

- Improve discard length and age data collection in the recreational fishery.
- Determine effect of misreporting due to species misidentification as Banded Rudderfish or Greater Amberjack.
- Reliable estimates of discard mortality.
- Develop directed effort estimates.

Almaco Jack

- Improve discard length and age data collection in the recreational fishery.
- Determine whether dead discards are underestimated in TX due to targeted bait fishery.
- Reliable estimates of discard mortality.
- Develop directed effort estimates.
    - In Texas there is a unique bait fishery which targets Almaco Jack. It was noted that b1 may be underestimated in Texas. It may be worth investigating the directed effort from this fishery.
- Investigate self-reported discards to determine if there is bias or misidentification in the data.
- Determine implications of gaps in the available recreational discard data

TOTAL REMOVALS RESEARCH RECOMMENDATIONS

See recommendations in Sections 3.6 and 4.6.

MEASURES OF FISHING EFFORT RESEARCH RECOMMENDATIONS

See recommendations in Sections 3.6 and 4.6.

INDICES OF POPULATION ABUNDANCE RESEARCH RECOMMENDATIONS

Red Drum

Given the importance of Red Drum to the recreational fishing interests of the Gulf Coast States, it was surprising to find that a survey designed to comprehensively sample both the near shore and offshore portions of the Gulf of Mexico stock does not exist. It is recommended that discussions be initiated into expanding an existing survey or developing a new survey to sample and characterize the composition and relative abundance of the Gulf of Mexico Red Drum stock, especially in federally managed waters where little data are available.

Lane Snapper

No research recommendations were suggested for Lane Snapper.

Wenchman

The small pelagics survey used as the index of abundance for SEDAR 49 is no longer in operation. The deep-water sampling of this survey provided the only data on a largely otherwise un-surveyed portion of the Gulf of Mexico Wenchman stock. Additional resources need to be put forward to promote and expand deep-water sampling efforts in the Gulf for species like Wenchman and numerous other deep-water species.

Yellowmouth Grouper

Additional information about Yellowmouth Grouper distribution and habitat utilization is needed to determine if low counts in the reef fish video survey are due to low abundance or survey habitat mismatch.

Snowy Grouper

Surveys designed to better cover deep-water habitat are needed to adequately sample the Snowy Grouper stock as well as many other reef fish managed under the reef fish FMP.

Speckled Hind

Surveys designed to better cover deep-water habitat are needed to adequately sample the Speckled Hind stock as well as many other reef fish managed under the reef fish FMP.

Lesser Amberjack

Species identification issues are of paramount concern for Lesser Amberjack, especially when dealing with fishery-dependent data sources. Efforts should be undertaken to determine whether port sampling data can be used to estimate the rate at which species like Lesser Amberjack are misidentified on an annual basis. This information could be used to adjust fishery-dependent landings data, allowing them to be used to construct indices of relative abundance.

Almaco Jack

Species identification issues are of paramount concern for Almaco Jack, especially when dealing with fishery-dependent data sources. Efforts should be undertaken to determine whether port sampling data can be used to estimate the rate at which species like Almaco Jack are misidentified on an annual basis. This information could be used to adjust fishery-dependent landings data, allowing them to be used to construct indices of relative abundance.

LENGTH FREQUENCY RESEARCH RECOMMENDATIONS

Red Drum

- Continue and expand fishery-independent collection efforts to collect length measurements at varying sizes, seasons or months, and locations, particularly for offshore Red Drum

Lane Snapper

- Continue and expand collection efforts to collect length measurements at varying locations, seasons or months
- Pursue statistical approaches to address sampling inconsistencies between random selection of small and large individuals in the SEAMAP groundfish survey, which could enable the use of length composition derived from the SEAMAP groundfish survey

Wenchman

- Continue and expand collection efforts to collect length measurements at varying locations, seasons or months
- Create sampling protocols to obtain lengths from NMFS Pascagoula small pelagic survey

Yellowmouth Grouper

- Expand collection efforts to collect genetic samples to ensure species identification along with length measurements at varying locations, seasons or months

Snowy Grouper

- Continue and expand collection efforts to collect length measurements at varying locations, seasons or months

Speckled Hind

- Continue and expand collection efforts to collect length measurements at varying locations, seasons or months

Lesser Amberjack

- Expand collection efforts to collect genetic samples to ensure species identification along with length measurements at varying locations, seasons or months

Almaco Jack

- Expand collection efforts to collect genetic samples to ensure species identification along with length measurements at varying locations, seasons or months

AGE FREQUENCY RESEARCH RECOMMENDATIONS

Red Drum

- Develop common practices for aging, interpreting edge, assigning annual or co-hort age, and calculating fractional age (or biological age) for Red Drum across federal and state agencies
- Expand collection efforts to collect age samples at varying sizes, seasons or months, and locations, particularly for offshore fish

Lane Snapper

- Expand collection efforts to collect age samples at varying sizes, seasons or months, and locations
- Validation of annual increments using methods such as tag and recapture, mark-recapture of chemically tagged fish, captive rearing from hatch, and radiochemical dating (Campana 2001)

Wenchman

- Increase collection of age samples at varying sizes, seasons or months, and locations
- Determination of the reproductive season to assist in determining when growth increments are deposited
- Validation of annual increments using methods such as tag and recapture, mark-recapture of chemically tagged fish, captive rearing from hatch, and radiochemical dating (Campana 2001)

Yellowmouth Grouper

- Expand collection efforts to collect age samples at varying sizes, seasons or months, and locations
- Validation of annual increments using methods such as tag and recapture, mark-recapture of chemically tagged fish, captive rearing from hatch, and radiochemical dating (Campana 2001).

Snowy Grouper

- Expand collection efforts to collect age samples at varying sizes, seasons or months, and locations
- Validation of annual increments using methods such as tag and recapture, mark-recapture of chemically tagged fish, captive rearing from hatch, and radiochemical dating (Campana 2001).

Speckled Hind

- Expand collection efforts to collect age samples at varying sizes, seasons or months, and locations
- Validation of annual increments using methods such as tag and recapture, mark-recapture of chemically tagged fish, captive rearing from hatch, and radiochemical dating (Campana 2001).

Lesser Amberjack

- Expand collection efforts to collect age samples at varying sizes, seasons or months, and locations
- Improvement of methods for aging *Seriola* sp. due to the difficulty in interpreting annuli marks
- Validation of annual increments using methods such as tag and recapture, mark-recapture of chemically tagged fish, captive rearing from hatch, and radiochemical dating (Campana 2001)

Almaco Jack

- Expand collection efforts to collect age samples at varying sizes, seasons or months, and locations
- Improvement of methods for aging *Seriola* sp. due to the difficulty in interpreting annuli marks
- Validation of annual increments using methods such as tag and recapture, mark-recapture of chemically tagged fish, captive rearing from hatch, and radiochemical dating (Campana 2001).

Assessment Workshop

A number of research recommendations were identified throughout the SEDAR 49 stock evaluation and are described below. Research recommendations for improvements to input data, which were provided at the end of each relevant section in the Data Report, are also reiterated by the analysts.

1. Fine-tuning of the index-based and length-based methods reported herein to achieve target performance metrics (e.g. probability of not overfishing closest to 50% or the highest LTY).

2. Exploration of the cost or benefit of specifying an operating model incorrectly and how this influences method selection over a range of operating model input parameters.

3. Calculation and presentation of performance metrics in relation to the status quo rather than a reference method.

4. Simulation testing of the non-equilibrium mean length estimator and yield-per recruit approach to assess method performance in comparison to other available methods, as well as testing different assumptions inherent in the approach (e.g. whether to use a time series of recent total removals or the terminal year's total removals in catch recommendations).

5. Evaluation of the updated Hoenig equation (described in Then et al. 2014) for estimating natural mortality using maximum age. The updated equation tends to produce higher estimates of natural mortality, which can have important implications for applications such as the mean length estimator.

6. Region-specific estimates of correlation coefficients for growth parameters derived from growth curves specific to the Gulf of Mexico.

7. Investigation of more justifiable estimates of stock depletion such as through Productivity-Susceptibility Analysis (Cope et al. 2015).

8. Estimation of current stock abundance from tagging studies (e.g. Red Drum), which could be used in methods such as the Beddington and Kirkwood (2005) approach.

9. Identification of a reference period for catches for Red Drum.

10. Discussions regarding the appropriateness of the reference period selected for each species.

11. Evaluation of the appropriateness of target catch or index levels which could be used in conjunction with catch and index time series.

12. Evaluation of the appropriateness of target length levels which could be used in conjunction with catch and a length frequency series.

13. Incorporation of observation error into the application of index-based (Islope0, Itarget0) and length-based (Ltarget0, LstepCC0) methods.

14. Future data-limited assessments should ensure that the reliability scores for data inputs are agreed upon at the conclusion of the Data Workshop to provide a more quantitative means of weighting methods for catch recommendations.

Within the modeling framework used in SEDAR 49, many limitations are acknowledged within the MSE approach. Pragmatically, results are a product of the specific conditions of the simulation, which are assumed to be as simplistic as possible but contain sufficient complexity to reflect the system in a representative way. Thus, additional considerations towards confirmation of the stock and fleet subclass components of the operating models explored in SEDAR 49 are warranted. In addition, no implementation error was considered in the current analysis which employed the DLMtool Version 3.2.1.

Recommendations for enhancing the practical use of the DLMtool from the analytical team.

1. Revisions of the DLMtool software to enhance the model functionality to allow multiple fishing fleets.

2. Revision of the DLMtool software to allow age varying natural mortality.

3. Allow for implementation error of the harvest control rule (e.g. catch recommendation overages) within the implementation model in the MSE.

Review Workshop

- Sea sampling programs to better quantify discards and discard mortality for all the eight species.

- The choice of reference time period for Tier 3A and Tier 3B stocks needs to be re-visited given the new information available and possible changes in the ecosystems.

- The operating model simulates the population dynamics of a given species conditional on the assumed depletion level which is usually unknown. Although the base case scenario for depletion level was developed for each species based on the best available information and a sensitivity analysis was conducted for alternative depletion levels, a reality check may be necessary to help simulate a fishery that realistically reflects the dynamics of fishery of interests. Reliable information on the fishery and population (e.g., temporal trend of fishing efforts, fishery-dependent and fishery-independent abundance indices and biological information such as age- and length compositions) needs to be collected to help define possible depletion level. These data can be used to tune the operating model parameterization to improve the fishery simulation realism by the operating models. Further, a number of surveys were considered at the DW but not all of them were deemed appropriate to inform a stock assessment. It is important to revisit the design of the surveys to ascertain whether changes could be made to get more value out of those surveys. The Review Panel also recommends that more time is spent to identify the methodology and indicators that are best for the type of exploitation and species we have. Trying to calculate MSY and other conventional metrics might not be the most

appropriate approach especially for species that are caught as bycatch. Similarly, collecting all the data that are needed to do a proper stock assessment is a very big task and it is important to identify some interim approaches such as using indicator species (to represent a complex of species) or maybe use the status of the targeted stock as a proxy for the status of the by-catch species.

SEDAR 50 Atlantic Blueline Tilefish

Stock ID

Stock ID Work Group

Genetics

- Given the results of the genetic work on Blueline Tilefish evaluated here and the limitations identified in the Katz et al. 1983 (SEDAR50-RD18) Golden Tilefish study, patterns in genetic population structure should be revisited for other deep-water species (including Golden Tilefish) using contemporary genetic approaches and analyses.
- To develop a mechanistic understanding of processes facilitating gene flow for Blueline Tilefish, further research should be undertaken to evaluate spawning season duration, pelagic larval stage duration, and adult movements.
- Additional genetic sampling should be conducted in the Gulf of Mexico (Florida Keys to the Texas-Mexico border) to further evaluate the potential for genetic structure across the Gulf of Mexico.

Life History

- Age reading interpretation of Blueline Tilefish otoliths need to be resolved. Other age validation techniques should be investigated (e.g., Pb\Ra ratio).
- Reproductive biology studies of Blueline Tilefish should be expanded to include the full distributional range of the species, specifically targeting samples from the west and east coasts of Florida and the Mid-Atlantic region. These data are needed to assess possible shifts in spawning season. Sampling of young fish is needed to improve the maturity ogive.
- Better information is needed on the movement or migration of juvenile and adult Blueline Tilefish.
- Studies should be conducted on the identification of Blueline Tilefish larvae and also on the location, duration, and dispersal mechanisms of the egg and larval stages.

Spatial Distribution

- Further research should be conducted to understand the thermal tolerance of Blueline Tilefish.
- Surveys should be conducted to try to document the distribution of early life stages.
- Further studies are needed on habitat preferences over the whole range of the species.
- Particle modeling to investigate hypotheses about movement of eggs and larvae.
- Research into movement of adults.

Overall

- A continuous, random, stratified survey should be developed and implemented for Blueline Tilefish throughout its range.

Joint SSC Sub-Panel

- The Panel recognizes the limited information to fully describe the population structure of Blueline Tilefish throughout the species' range in U.S. waters, and therefore endorses the research recommendations from the Stock ID work group report.

Science/Management Leadership Group

- The group also recommends that research be conducted to fully define population structure of Blueline Tilefish in the Gulf of Mexico, and to define the relationship between fish in the Gulf of Mexico with those in the Atlantic.

Data Workshop

To be added

Assessment Workshop

To be added

Review Workshop

To be added