SEDAR 16 Research and Monitoring Recommendations

1. Data Workshop

Life History 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 subsampling for histological comparisons.

Commercial Statistics Group:

1. 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.
2. The Mackerel Stock Assessment Panel reports should be reviewed for information on the Mexican fishery.
3. 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 Group:

1. 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.
2. 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).
3. 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.
4. Expand existing efforts to collect length-age samples to more completely cover the geographic range of the stocks.

Indices Group:

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.

2. Assessment Workshop

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.

3. Review Workshop

1. 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.

2. 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.

3. 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.

4. 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.

5. The RP recommended that the behavior of the current control rules that use per recruit F30%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).

6. 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.

7. 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).

8. 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.

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

10. 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.

11. 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.

12. 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.

13. 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.