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August 13, 2009 F/SEC2: TJ

MEMORANDUM TO: Roy E. Crabtree, Ph.D.
Regional Administrator, Southeast Regional Office

FROM: Bonnie Ponwith, Ph.D. Theo R. Brainerd
Science Director, Southeast Fisheries Science Center

SUBJECT: SEFSC Revised Report on Red Snapper in the U.S. Atlantic: Sensitivity Analyses Using Dome-Shaped Selectivity for Recreational Sectors

As per request by the South Atlantic Fishery Management Council (SAFMC) and the NMFS Southeast Regional Office (SERO), the Southeast Fisheries Science Center (SEFSC) completed a sensitivity analyses on Dr. Frank Hester's query. These analyses were contained in the earlier SEFSC memo to SERO dated August 5, 2009.

The SEFSC submits the following revised report containing the results of the sensitivity analyses to the Southeast Regional Office for transmission to the SAFMC:

- ***Red Snapper in the U.S. Atlantic: Sensitivity analyses using dome-shaped selectivity for recreational sectors (12 August 2009).***

Please contact Erik Williams (erik.williams@noaa.gov) if you have any questions.

Encl.

CC: F/SEC - Theo Brainerd
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Red snapper in the U.S. Atlantic: Sensitivity analyses using dome-shaped selectivity for recreational sectors

Prepared by Southeast Fisheries Science Center
12 August 2009

1 Executive summary

Although the SEDAR-15 red snapper stock assessment for the U.S. South Atlantic has been through exhaustive review, concern remains within the fishing community. Dr. Frank Hester, a consultant hired by the fishing industry, conducted his own review of the stock assessment and issued his report on May 8, 2009. Most of Dr. Hester's concerns have already been addressed by the South Atlantic Fishery Management Council or by previous work conducted through the SEDAR process. For example, Dr. Hester questioned the use of historical Fish and Wildlife Service (FWS) recreational catch data. Those data were already considered by SEDAR to be a source of uncertainty, and sensitivity analyses had previously addressed the issue: Assessment results are qualitatively insensitive to those historical FWS recreational catch data. The primary subject of this report is the effect of a dome-shaped selectivity curve for the recreational sector, as hypothesized by Dr. Hester. Here, three additional sensitivity runs were conducted using various combinations of estimated dome-shaped selectivity curves and a curve proposed by Dr. Hester in his report. Dr. Hester's selectivity curve assumes no fish over age 10 are caught in the fishery, an assertion that is demonstrated here to be incorrect (samples of recreational catches do include fish over 10 years old, including a 50 and 53 year old fish). More realistic dome-shaped selectivity curves yield results very similar to the base stock assessment model run. Nonetheless, the nature of the fisheries and analyses in this report do not support the use of a dome-shaped selectivity function for commercial handline or recreational sectors. Nearly forty different sensitivity analyses of the red snapper model have been conducted, and although results vary quantitatively, they are all in strong qualitative agreement pointing to a stock that is depleted and experiencing overfishing. This red snapper stock demonstrates hallmarks of stock depletion: truncated age structure and constricted spatial range.

2 Background

The SEDAR-15 stock assessment of red snapper in the U.S. Atlantic has been through exhaustive review, first by internationally esteemed independent experts within the SEDAR process, and then through multiple reviews conducted by scientists of the South Atlantic Fishery Management Council's own Scientific and Statistical Committee. Following those scientific reviews, the Southeastern Fisheries Association, Inc. hired a consultant, Dr. Frank Hester, to conduct a review on behalf of the fishing industry. In his report dated 8 May 2009, Dr. Hester raised several questions about the stock assessment. The Council has already addressed those questions in a previous document (attached here as an Appendix). One question left unanswered, however, was whether selectivity of recreational sectors might have been dome-shaped (i.e., excluded older fish) rather than flat-topped (i.e., included older fish, as in the SEDAR assessment). This report explores such an assumption for its effects on assessment results.

3 Sensitivity analyses

In his report, Dr. Hester guessed at a possible shape of recreational dome-shaped selectivity (reproduced in Fig. 6.1—top panel). Here, the hypothesis of dome-shaped selectivity was applied to the red snapper assessment in three different ways. In the first application, Dr. Hester's assumed shape was applied to both headboat and general recreational fishing throughout the entire assessment time frame (1945-2006). In the second application, his assumed shape was applied to both headboat and general recreational fishing in the early time period (1945-1983), and in later periods (1984-1991 and 1992-2006), dome-shaped selectivities were estimated (separately for each period). The third application was similar to the second, but differed by applying the estimated selectivity of the middle time period to the early time period, rather than applying Dr. Hester's assumed shape. The three different approaches are labeled S37, S38, S39 (36 sensitivity analyses have been conducted previously as part of the assessment and review workshops):

- S37: Hypothesized dome-shaped selectivity (Fig. 6.1—top panel) applied to headboat and general recreational sectors throughout the entire assessment time frame.
- S38: Hypothesized dome-shaped selectivity (Fig. 6.1—top panel) applied to headboat and general recreational sectors in the early time period, and estimated dome-shaped selectivities used in subsequent periods.
- S39: Estimated dome-shaped selectivities (Fig. 6.1-bottom panel) applied to headboat and general recreational sectors throughout the full assessment time frame.

Initial runs of these analyses fitted the age and length composition data poorly. Thus, the likelihood weighting on those components were increased by a factor of ten (relative to the weights used in the base assessment) to give these hypotheses a chance to achieve reasonable fits to data. Weights on other data components (e.g., landings, CPUE) remained the same.

For each sensitivity run, management benchmarks were based on the proxy of $F_{40\%}$. The equilibrium spawning biomass and yield corresponding to $F_{40\%}$ were computed through long-term projections.

4 Results

As expected, sensitivity runs with dome-shaped recreational selectivities estimated somewhat different time series of fishing rate and spawning biomass than those of the base assessment model (Fig. 6.2). In the early years, sensitivity runs had higher estimates of full fishing mortality rates, and different absolute levels of spawning biomass (although similar trends). However, since about 1980, estimates of full F have been similar among the four models (base, S37, S38, and S39), as have been estimates of spawning biomass.

Management benchmarks differed among the four models (Table 6.1). This result is expected, because benchmarks are conditional on selectivity. However, stock and fishery status in the terminal assessment year were qualitatively the same across these models and other sensitivity runs: the stock is experiencing overfishing and is depleted relative to the benchmark level (Fig. 6.3).

5 Discussion

5.1 Sensitivity runs using dome-shaped selectivity

Of the three sensitivity runs described in this report, S37 (which applies Dr. Hester's selectivity) is the most questionable, for at least three reasons. First, S37 does not account for changes in size limits. Second, one cannot reliably guess the shape of selectivity simply by visual inspection of data (as Dr. Hester attempted), for reasons detailed in the subsequent section §5.2. Third, Dr. Hester's assumed selectivity does not include fish older than age 10 (Fig. 6.1—top panel), which is demonstrably wrong (Fig. 6.4). Runs S38 and S39 do not suffer from those same problems, and their results were quite similar to those of the base run.

Although S38 and S39 are clearly preferable to S37, all three should be viewed with strong skepticism. By objective criteria (discussed in subsequent sections), the assumption of dome-shaped selectivity for red snapper in the Atlantic does not appear to be realistic. Evidence suggests flat-topped selectivity, and therefore sensitivity runs using dome-shaped selectivity (S37, S38, S39) do not deserve equal footing as other sensitivity runs (although results were qualitatively the same).

5.2 Selectivity (general)

The commonly used term "selectivity" in stock assessment modeling refers to an age-specific (or length-specific) schedule composed of spatial/temporal availability and fishing gear selectivity. The concepts of availability and selectivity should not be confused with vulnerability and catchability, which relate primarily to a unit of effort. Because selectivity includes both gear characteristics and population availability components, it unfortunately cannot be surmised simply by visual inspection of catch-at-age or average-weight data. In many fisheries around the world, the tendency is to target the largest and oldest individuals, simply because they tend to be more valuable. Red snapper is one of the U.S. South Atlantic's more valuable snapper-grouper species.

When modeling selectivity, stock assessments tend to use functional curves to describe selectivity-at-age. One reason for doing this is to use fewer parameters in the model, thus increasing the statistical degrees of freedom. Often a model can achieve the same fit to the data with fewer parameters being estimated, a property referred to as parsimony.

Stock assessment models used in the U.S. South Atlantic have primarily used one of two functional forms for selectivity-at-age, the logistic and double-logistic equations. The two-parameter logistic function results in a flat-topped selectivity curve and assumes that the oldest and largest fish are fully available to the fishery. The four parameter double-logistic function can assume either a flat-topped or dome-shaped selection curve. A dome-shaped curve implies that the oldest and largest fish are not fully available to the fishery. Dome-shaped selectivity can result from factors such as 1) the oldest fish move to areas that are not fished, 2) fish outgrow the gear being used for capture, or 3) regulations inhibit the ability to capture the oldest fish.

The primary data that stock assessment models draw upon for the estimation of selectivity are the age and length composition data from the fishery. The slope of the decline of the oldest or largest fish in the age and length composition data is a function of both mortality and age-specific selectivity. Separating mortality and selectivity can be difficult, especially when dome-shaped selectivity is suspected in a given fishery. Fortunately, for most fisheries, there is at least one sector that tends to target the oldest largest fish (flat-topped selectivity). The establishment of at least one sector as having flat-topped selectivity tends to anchor the other sectors, enabling the estimation of dome-shaped selectivity functions. If a fishery is suspected of being composed entirely of dome-shaped selectivity functions, the estimation can be difficult and often gets confounded with mortality estimates.

5.3 Selectivity (red snapper)

It has been demonstrated for some snapper-grouper species in the U.S. South Atlantic that older larger individuals tend to occur in deeper water, although the patterns differ across species. For example, in the case of red grouper, the pattern suggests that shallower waters contain both big and small fish, and that as depth increases the smaller fish disappear. In this case the largest fish are available across both shallow and deep depths. For many species, relationships between size and depth are weak or nonexistent. Unfortunately, the U.S. South Atlantic has very little depth or detailed spatial data to definitively describe depth-size relationships for our snapper-grouper species. To complicate the issue, seasonal shifts in species distributions can occur as well. Anecdotal reports from fishermen off the coast of northeast Florida have suggested that the largest red snapper tend to move inshore during June–September to depths as shallow as 60–90 feet. Such a pattern of seasonal shift would support using a flat-topped selectivity curve.

Commercial fishermen often have economic incentive to catch large fish, and thus if possible, will rationally do so. Indeed, evidence suggests that the commercial sector does fish in depths and areas where the oldest and largest red snapper exist. For example, vessels with bandit rigs, a type of hook-and-line gear, fish in depths that are likely beyond where red snapper occur (e.g., when fishing for snowy grouper and tilefish). This strongly suggests that the full depth range is covered by commercial vessels. Furthermore, in areas off northeast Florida where red snapper are most abundant, the shelf edge is relatively close to shore, suggesting that travel distance is not likely an impediment to fishing in the deeper waters for large red snapper. It is difficult to imagine a plausible scenario in which selectivity for the commercial handline fishery is anything but flat-topped. (However, for the commercial diving sector, the SEDAR-15 red snapper stock assessment did assume a dome-shaped selectivity function; the clear reason being that divers are depth limited.)

In the recreational fishery the sectors include private/shore fishermen, charter boats, and headboats. These recreational sectors can fish quite differently in some cases. The charter and headboats tend to fish snapper-grouper species in similar areas, using similar gear. A common pattern for charter boats in the Carolinas is to troll in the Gulf Stream for pelagic species and then bottomfish for snapper-grouper species. In those cases, the vessels are fishing deep enough depths where the largest red snapper are likely to occur. Headboats may be constrained in the distance they can travel offshore because they are typically slower and may only fish half-day trips. Unfortunately, the ability to know fishing locations is lacking in the U.S. South Atlantic. The implementation of Vessel Monitoring Systems (VMS), as applied in other regions of the United States, would help resolve such data needs.

Although precise data on fishing locations are unavailable, it is possible to explore the hypothesis of dome-shaped selectivity by comparing age composition data from different sectors. In the case of red snapper, recreational age composition data can be compared to those of the commercial handline fishery, which is believed to have flat-topped selectivity (for reasons described above). For evidence of dome-shaped selectivity in the recreational sector, one should expect the descending limbs of recreational age compositions to decline more quickly than those of the commercial sector. For red snapper in the U.S. South Atlantic, no such evidence exists (Figs. 6.4, 6.5), which supports using flat-topped selectivity for the recreational sector.

5.4 Early recreational landings

The base assessment model used recreational landings from the U.S. Fish and Wildlife Service (FWS) Salt-Water Angling Reports. As explained in the Council's response (Appendix of this report) to Dr. Hester's questions, those survey landings were used because 1) the surveys collected legitimate data, 2) they were preferable to any available alternatives (e.g., linear interpolation), and 3) they improved the model by helping to explain the already reduced population when age/size sampling began. Furthermore, angling effort in those surveys was corroborated by other data. Nonetheless, the FWS surveys were considered to be a source of uncertainty, and consequently several sensitivity analyses were run to address this issue (Runs S0, S7, S8, S32 and S33 in Table 6.1). Although use of FWS landings provided better fidelity to other data sources (age/length compositions), the qualitative results of current stock status were insensitive to the early recreational landings.

5.5 Stock status

In addition to applying multiple models, nearly forty different sensitivity analyses of the base model have been conducted on the red snapper assessment (as part of the assessment workshop, as part of the review workshop, and now in response to Dr. Hester's report). Although results vary quantitatively among the multiple assessment models and nearly forty sensitivity analyses, results are all in strong qualitative agreement. The base model and each sensitivity run show that overfishing is occurring and the red snapper stock is depleted to levels much lower than the spawning biomass benchmark (Table 6.1, Fig. 6.3).

The overfished status is consistent with two strong lines of evidence. First, red snapper can live more than 50 years, yet fish older than 10 years are rarely caught by fishermen. Such a severely truncated age structure typically signals that the exploitation rate does not allow many fish to reach older ages. Although some large fish are caught, they are not necessarily old fish, because of the variability of size at age. Second, red snapper were once abundant along the southeast U.S. coast, but now are primarily caught off northeast Florida, apparently the center of this stock's range. Relative to earlier decades, few red snapper are now caught, for example, off North Carolina's coast. The constriction of a fish population's range typically signals reduced abundance.

6 Tables and Figures

Table 6.1. Results from sensitivity runs of the red snapper catch-age assessment model. Runs S0–S31 were previously reported in the original Assessment Workshop Report (Table 3.13; S0 was then called base). Runs S32–S36 were previously reported in the Review Workshop Report (Table 2). Runs S37–S39 are new, described in this report. Note that S37–S39, as well as the base model, use $F_{40\%}$ proxies for MSY-based reference points.

Run	Description	F_{MSY}	SSB_{MSY} (mt)	MSY (1000 lb)	F_{2006}/F_{MSY}	SSB_{2006}/SSB_{MSY}	steep	R0(1000)
Base	—	0.104	8103	2304	7.67	0.02	0.95	638
S0	Recr L transposed	0.112	5184	2319	7.51	0.04	0.95	605
S1	Low M	0.097	6112	1977	10.36	0.03	0.95	377
S2	High M	0.112	5089	2362	7.25	0.04	0.95	673
S3	q slope 0.0	0.111	5304	2226	5.72	0.05	0.95	603
S4	q slope 0.04	0.107	5174	2355	9.20	0.03	0.95	606
S5	Rec dev 1972	0.106	5203	2299	7.82	0.04	0.95	608
S6	Rec dev 1976	0.106	5209	2302	7.79	0.04	0.95	602
S7	Low early recr L	0.143	1729	559	11.09	0.11	0.95	152
S8	Bias early recr L	0.104	9024	3927	7.72	0.02	0.94	1034
S9	Comm D mort 0.7	0.105	5180	2316	7.72	0.04	0.95	603
S10	Comm D mort 0.8	0.106	5186	2302	7.70	0.04	0.95	604
S11	Comm D mort 1.0	0.106	5238	2289	7.79	0.04	0.95	606
S12	Recr D mort 0.2	0.115	4978	2424	6.01	0.04	0.95	601
S13	Recr D mort 0.6	0.113	5417	2176	8.51	0.04	0.95	607
S14	D sel age 1 0.25	0.113	5201	2295	7.94	0.04	0.95	605
S15	D sel age 1 0.75	0.128	5157	2381	6.65	0.04	0.95	605
S16	steep=0.8	0.131	7648	2056	9.59	0.03	0.80	562
S17	steep=0.6	0.118	10554	1624	7.09	0.05	0.60	441
S18	Retro 2005	0.107	4812	2107	7.74	0.04	0.95	559
S19	Retro 2004	0.106	4936	2150	7.80	0.04	0.95	569
S20	Retro 2003	0.106	5020	2194	7.78	0.04	0.95	581
S21	Retro 2002	0.106	5109	2241	7.76	0.04	0.95	592
S22	Retro 2001	0.105	5367	2333	7.82	0.04	0.95	619
S23	B1/K=0.95	0.105	5463	2401	7.79	0.04	0.95	633
S24	B1/K=0.90	0.109	5588	2492	7.64	0.03	0.95	649
S25	B1/K=0.85	0.105	5706	2528	7.75	0.03	0.95	664
S26	B1/K=0.80	0.105	5851	2600	7.74	0.03	0.95	682
S27	B1/K=0.70	0.104	5211	2326	7.34	0.05	0.95	606
S28	B1/K=0.65	0.106	5197	2325	8.05	0.05	0.95	605
S29	B1/K=0.60	0.132	5070	2415	8.23	0.04	0.95	604
S30	B1/K=0.55	0.104	5239	2325	9.21	0.05	0.95	600
S31	B1/K=0.50	0.176	4870	2571	12.84	0.04	0.94	601
S32	0.5 Early recr L	0.112	3189	1314	8.3	0.06	0.95	356
S33	1.5 Early recr L	0.104	7419	3283	7.73	0.03	0.94	858
S34	Finit=0.05	0.106	5431	2416	7.71	0.06	0.95	635
S35	Finit=0.1	0.105	6069	2696	7.74	0.03	0.95	706
S36	Finit=0.15	0.104	6600	2912	7.83	0.03	0.95	764
S37	Dome recr sel 1	0.263	13110	1336	2.04	0.09	0.95	528
S38	Dome recr sel 2	0.156	12882	3129	6.16	0.02	0.92	595
S39	Dome recr sel 3	0.184	9846	2274	5.93	0.02	0.93	778

Figure 6.1. Dome-shaped selectivity for recreational sectors as considered in sensitivity runs of this report (see text for details). Top panel) Selectivity hypothesized by Dr. Hester (reproduced from Dr. Hester's report dated 8 May 2009) and applied in sensitivity runs S37 and S38 (full assessment period in S37; early time period only in S38). Bottom panel) Dome-shaped selectivities estimated in sensitivity run S39.

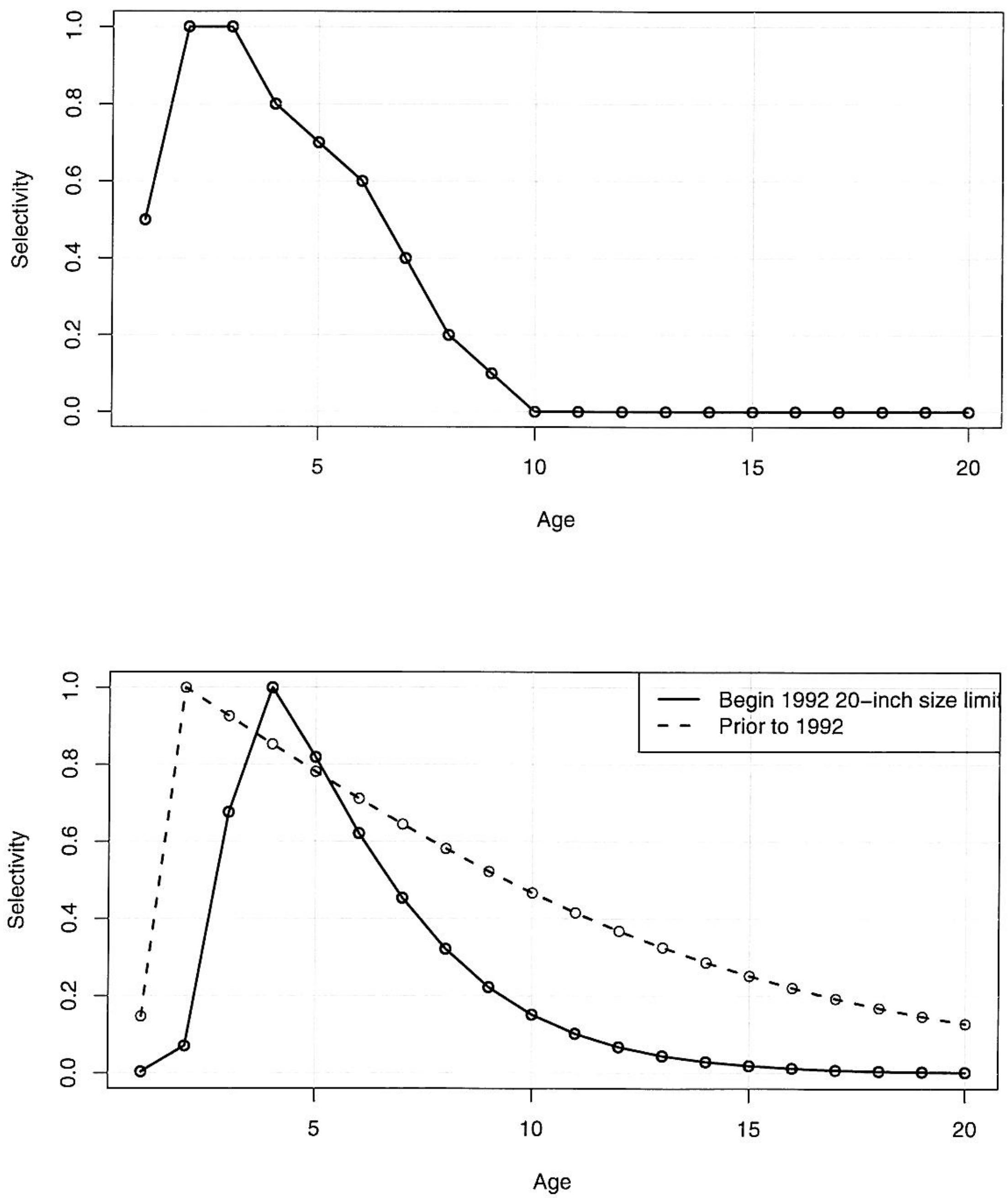
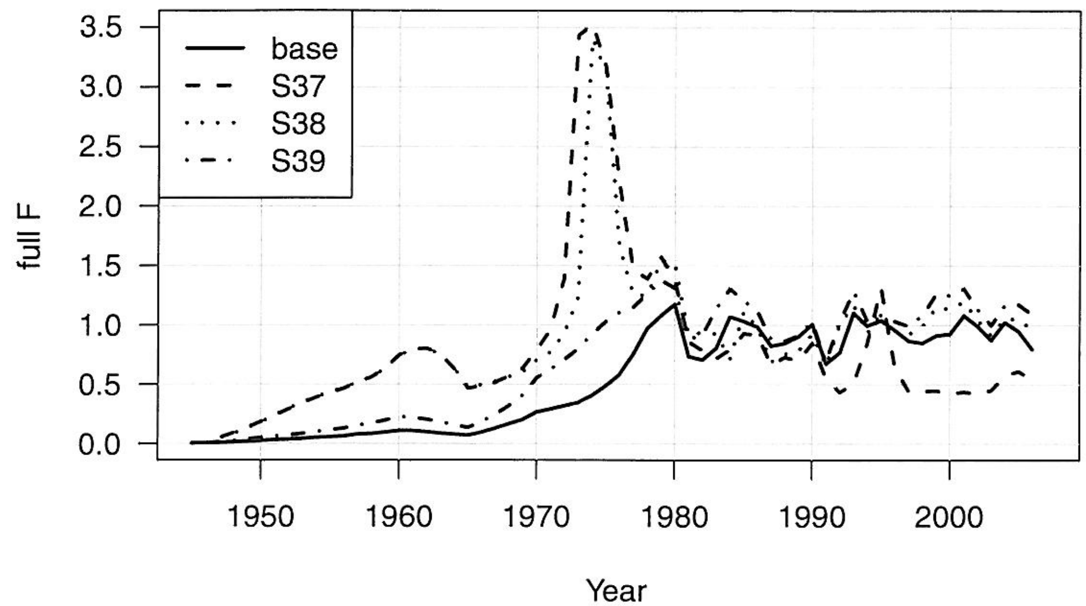


Figure 6.2. Comparison of full F (top) and spawning biomass (bottom) from the base assessment model (base) and three sensitivity runs (S37, S38, S39) with dome-shaped selectivity for recreational sectors (see text for details).



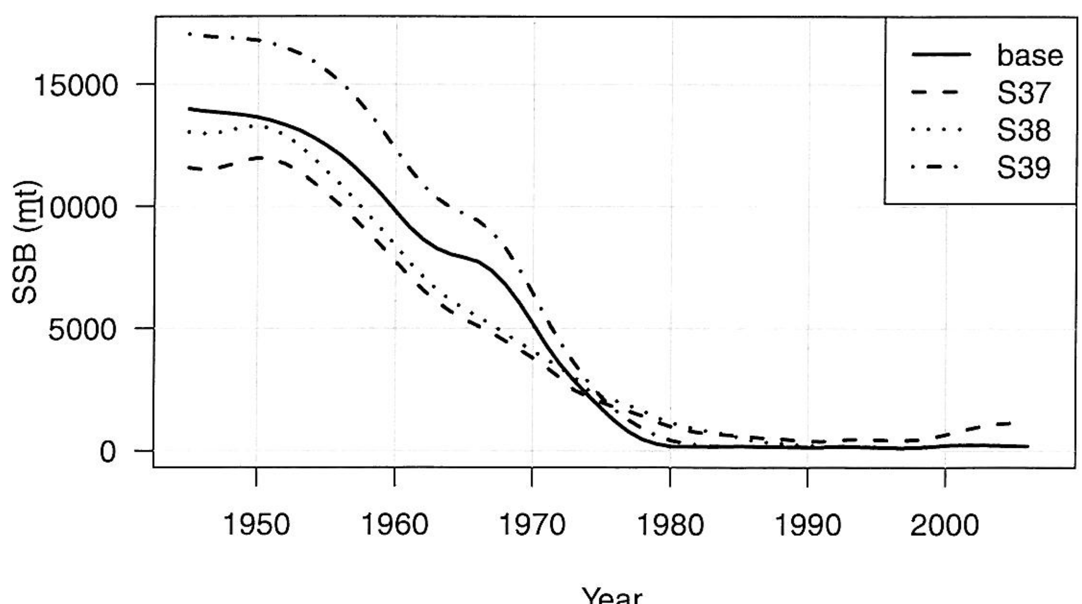


Figure 6.3. Stock and fishery status of base run (solid circle) and 40 sensitivity runs (open circles). Values have been jittered (small noise added) to improve distinction of overlapping circles. Note that sensitivity runs S37–S39, as well as the base model, use $F_{40\%}$ proxies for MSY-based reference points.

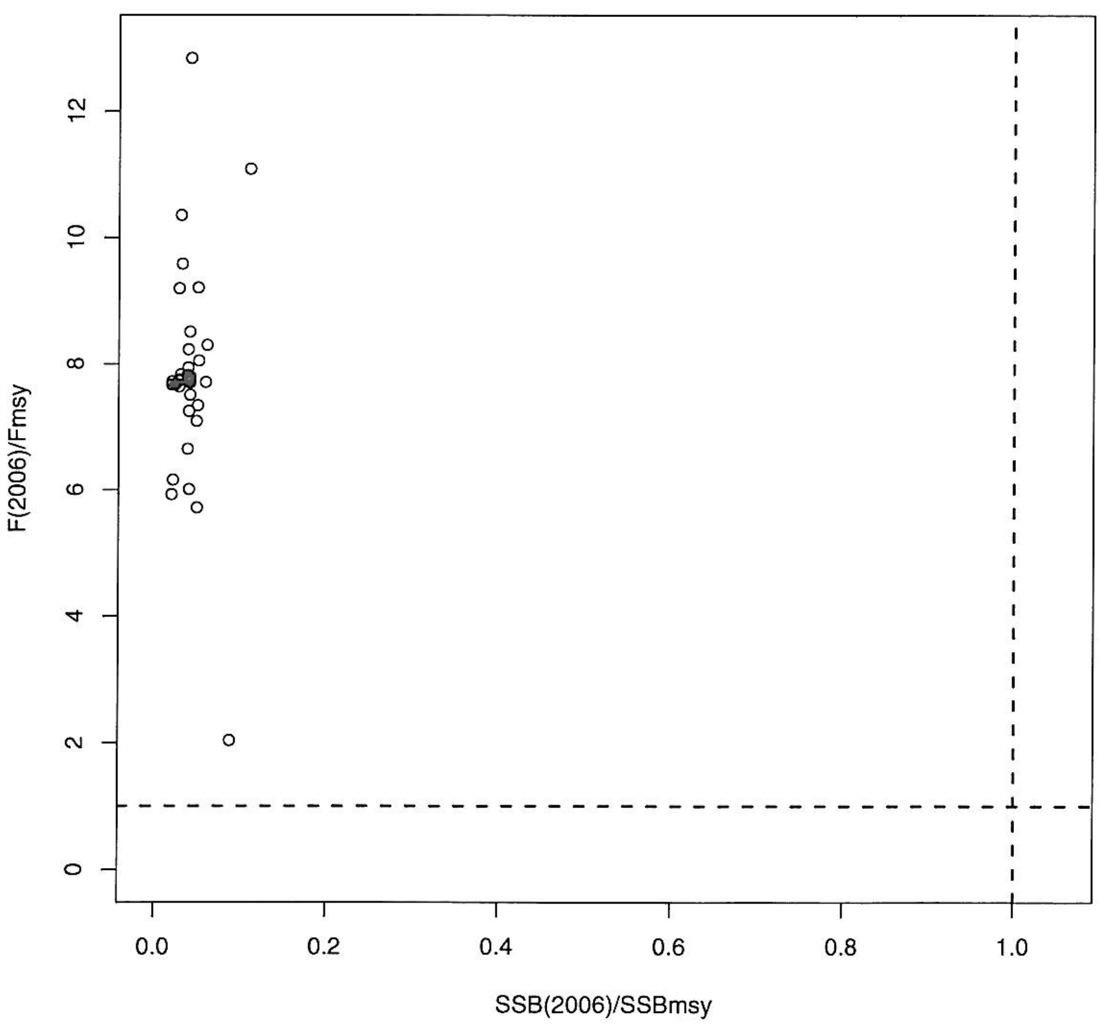


Figure 6.4. Comparison of catch-at-age data from recreational and commercial sectors. Y-axis is on log scale. Age 20 was pooled.

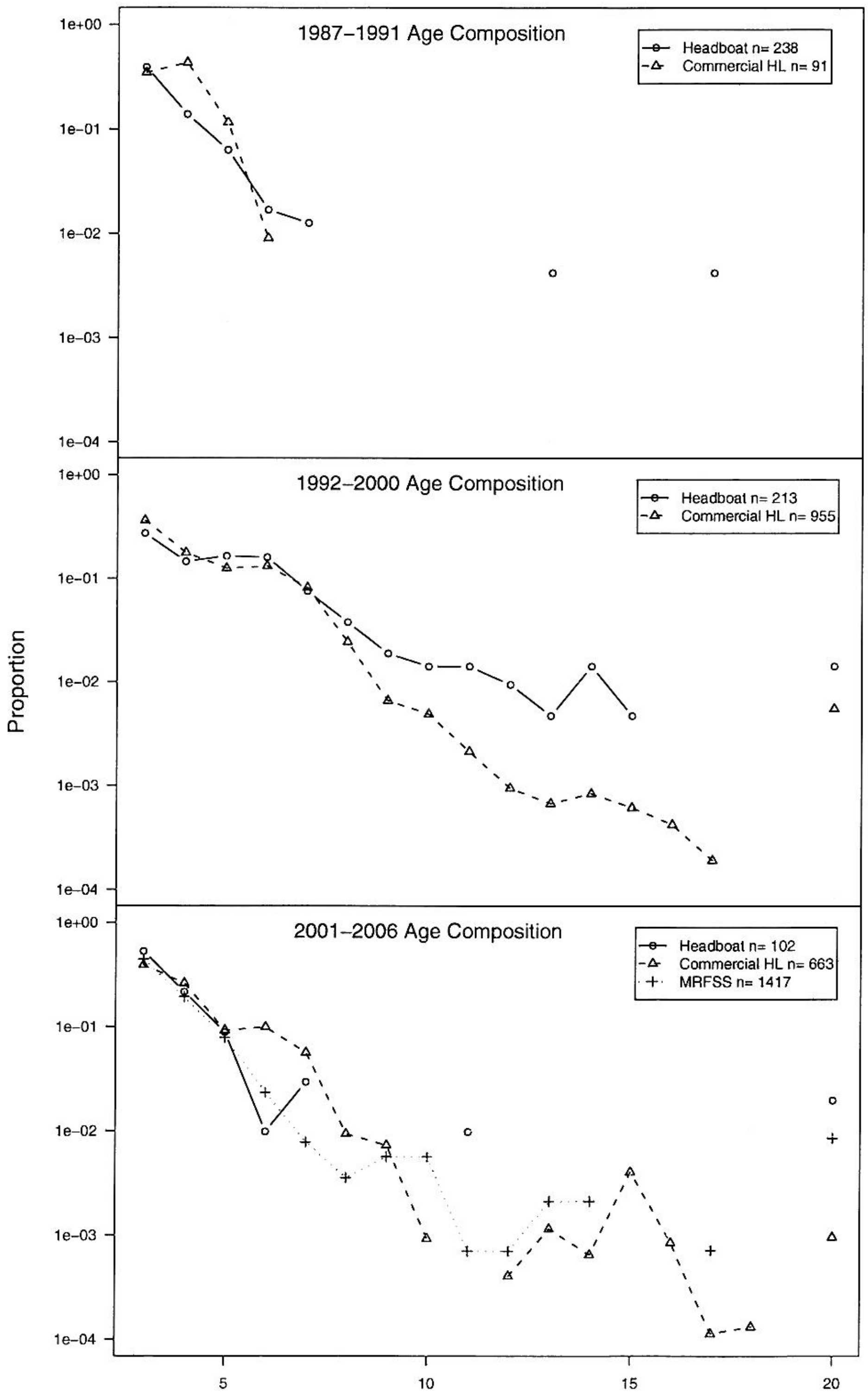
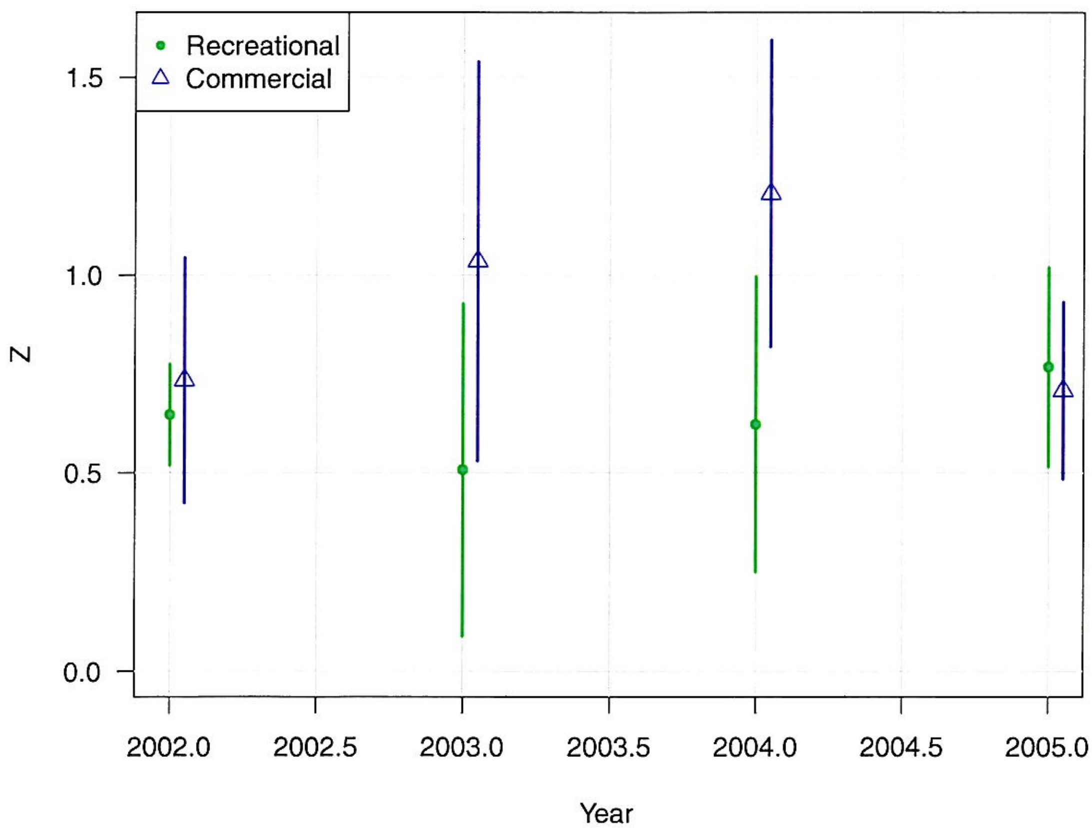


Figure 6.5. Estimates of total mortality (Z) from catch curve analysis using recreational or commercial catch-at-age data. Lines represent 95% confidence intervals. A higher estimate of Z indicates that the right-hand limb of age composition data descends more quickly, which could occur because mortality is higher or because of dome-shaped selectivity. Thus, assuming that selectivity of the commercial sector is flat-topped, one can compare estimates of Z for evidence of dome-shaped selectivity in the recreational sector. A much higher value of Z could indicate dome-shaped selectivity. This analysis reveals no evidence for dome-shaped selectivity of the recreational sector.



7 Appendix

SAFMC Staff Review of Comments Submitted by Dr. Frank Hester Regarding the Red Snapper Assessment

Upon review of the comments on the red snapper assessment submitted by Dr. Hester, there may be a need to further evaluate the selectivity assumption, its impact on the disparity between historical mean catch weight estimates and observations, and any potential impacts on recent SSB estimates. The underlying question is with selectivity, and whether a dome or flat top pattern is more appropriate for the recreational fishery. Potential evidence that the flat top assumption may bias some results is provided through Dr. Hester's comparison of the model produced mean catch weight (from total estimated catch in numbers and in weight) and the mean catch weight from the FWS reports in 1965 and 1970.

1. Dr. Hester criticizes the DW for information not provided. The observations are correct, but criticisms are somewhat unfounded as the DW report fully acknowledges these and several other data concerns.

- The DW provided the life history information that was available. Fecundity is seldom available for SG stocks, and this criticism would only be warranted if he cited some information that was overlooked. He does not.
- Very few species have available 'observations based estimates of natural mortality'. In fact, I cannot think of a single wild stock where such information is available.
- The DW provided one approach to estimating pre 1981 recreational catches – a linear interpolation that has little justification and is soundly disputed by the observations that area available in the FWS reports.
- No issues requiring additional analyses are raised in this section.

2. Comparison of VPA and forward projecting catch-age

- That VPA is more 'familiar' than catch-age is the opinion of the author. My opinion is that SEDAR participants are much more familiar with the model framework used for red snapper as it has been in use since the first SEDAR.
- It is true that both models suffer from poor data. Extensive comparisons of the various model classes in use today prove that all models suffer from poor and missing data, and that some models are better than others at dealing with particular data holes. SEDAR assessments seldom use VPA because VPA models require a complete catch-age input and apply an assumption that the catch is measured without error. Most stocks managed by the SAFMC have only a short time series of age observations adequate for constructing catch at age, and it is widely accepted that key catch sectors have considerable error in their catch estimates. In fact, determining the level of uncertainty in historic catch records is usually a topic of extensive discussion. The model used for red snapper is state of the art and has been extensively reviewed by independent peer review panels.
- Both models suffer from terminal year uncertainty and provide more accurate estimates farther back in time. This is a simple fact of all age structured assessments that essentially rely on tracking a cohort as it progress through its life.
- No issues requiring additional analyses are raised in this section.

3. It is stated that use of the FWS reports causes a major problem

- I disagree with this statement. As Dr Hester states in quotations from the AW report, initial model runs without the FWS observations suggested that pre-1981 catches were significantly higher than those estimated by the simple linear interpolation provided by the DW group. The fact is that age and length composition information suggest that the population was already reduced by the time sampling began, and observations of catch post-1981 were inadequate to drive the population down to accommodate the age composition observed when actual age composition observations became available. The model was looking for a way to remove fish, and since recreational catches are specified to have greater uncertainty than commercial catches, in terms of minimizing error the appropriate way for the model to do this was to increase early recreational catches. When reviewed further at the AW, the panel recognized that the FWS reports corroborated the path the model was determined to take, and therefore including those observations and developing an alternative historical catch series improved overall model performance, in terms of fit and residual patterns.
- The FWS observations are legitimate observations and deserved further consideration at the AW. They are based on survey results and recall, and their precision may be difficult to ascertain, but they are believed to provide better information than the linear interpolation put forth by the DW. Historical catch records are important to inferring long-term productivity, and this debate underscores the need to refine methods for estimating pre-1981 recreational landings and other historical removals

4. Conversion of catch in weight to catch in numbers. This section indicates that perhaps Dr. Hester believes that the problem with the assessment is more in how the FWS observations are incorporated than in the fact that they were incorporated at all.

- I am not familiar enough with the internal workings of the model to know all the steps it takes to go from an overall annual weight to the annual estimates of abundance and then catches at age, but I am fairly certain it involves more than just the selectivity curve. We could request further clarification, but I don't think this is critical to the potentially relevant point that emerges later.
- It is stated "The fact that these are averages implies that half the landings are less than 3 pounds" . This is not always true. It is true, however, that the preferred statistic to describe the center value of a distribution is the median, and if the median were 3 pounds then half of the observations would be less than 3 pounds. However, the same cannot be said of the average. Consider a simple example with 3 observations: 25, 50, and 225. The average is 100 and the value of the median observation is 50, so in this example one-third of the values are less than the median and two-thirds have values less than the average. All of this is really beside, and unfortunately detracts from, the fundamental observation that is identified later— that there is a discrepancy between the mean weight from the FWS reports, which provide the bulk of the landings in the early years, and the mean weight from the overall, model-estimated catch at age.
- I don't see adequate information provided to support the statement that the catch at age should heavily favor fish less than three years old. I'm also confused by the switch from an argument based on pounds to an argument based on age. If the population was indeed lightly exploited in the earliest years, and retained reasonable numbers of older fish, it

should not be surprising that the sum total of catches across the oldest 17+ ages would be more than the total across the youngest 3 ages. Even more so when less than full selectivity is applied to age 1, a model feature that is not disputed.

5. Selectivity Issues
   - The model does incorporate a flat selectivity curve for the recreational fisheries. I am not clear whether this was a specification or whether the shape of the selectivity curve was something the model was free to determine. It is not apparent in the assessment report whether an alternative selectivity was forced in a sensitivity analysis and I can't recall that being explored at the AW.
   - Concerns over the use of the flat selectivity curve were raised by Roy Crabtree some time ago. The Gulf red snapper assessment used a dome curve, and while this alone is not ample reason to apply a dome shaped selectivity pattern to Atlantic red snapper, it does provide some justification to consider a sensitivity incorporating a similar pattern.
   - Some anecdotal reports suggest that species like red snapper which inhabit bottom substrates and can grow to very large size may have domed selectivity patterns by size because the largest fish are more difficult to land. There is some confounding though when selectivity is considered by age, especially for a stock such as this where the life history observations reveal that length is not informative of age. In other words, while the biggest fish may be harder to land, the biggest fish are not always and necessarily the oldest fish. Again, though, since this perception exists the domed selectivity pattern should be explored if it has not already.
   - The selectivity issue may somewhat alter the model estimates of overall annual catch mean weight.

6. Conclusions
   - Concerns are raised with the early catch records and the selectivity. To me, the issues go hand in hand as the selectivity assumption will influence the estimated catch age distribution and hence the back calculated average weight of the catch.
   - Given Dr. Hester's submission and prior concerns raised regarding selectivity, I would like to know more about how the selectivity curve was modeled. I would also like to see a sensitivity analysis fixing a dome shaped selectivity curve in the recreational fisheries, at least in the early years when there are substantial numbers of older fish in the estimated population.
   - I believe the issue of selectivity should be explored. I will be surprised if specifying a dome shaped selectivity curve will substantially change stock status estimates, but the issue requires attention so that the process can move ahead.
   - It is within reason to hypothesize that a domed shaped selectivity would increase the estimated abundance of older fish, impact SSB, and ultimately influence the Stock-Recruit relationship and steepness.
   - It is also within reason to hypothesize that switching to a dome shaped selectivity pattern will increase the overall F. The model needs to account for a certain number of dead fish, and if you specify that a certain segment of the population is 'off limits' or receives a smaller portion of the overall F, the model will likely be forced to increase the overall removal rate. Considering beyond the scientific ramifications, given this outcome, actions applied to the portion of the population that is exploited might need to be more severe.

- Hypothesizing even further along these lines, increased abundance of older fish would increase SSB and potentially decrease the extent to which the stock is overfished, but keep in mind that all estimates suggest the stock is severely overfished and current SSB is on the order of 3% of the desired level.

7. Discussion Items

- Dr. Hester's concluding discussion largely reflects the opinions stated by the Review Panel, namely that while the stock appears to be at a point of equilibrium, the relation of this point of equilibrium to desirable conditions and long term maximization of yields is uncertain.
- While current F may be sustainable over a short time, there is considerable evidence to suggest that yield is well below MSY. Also, evidence suggests the fishery is highly susceptible to fluctuations in correlation with year class strength which is risky and a classic sign of excessive exploitation.
- There is well noted uncertainty in the biological reference for exploitation, but it should be acknowledged that estimates of current F are well above any of the proposed values for MFMT.
- I am skeptical that new data sources will be found at this point, largely because none have surfaced over the last year as controversies regarding this assessment arose and because Dr. Hester, who clearly devoted considerable time and effort to reviewing the assessment, fails to point out any even potential sources of information to shed light on the uncertainties in the assessment.
- I am skeptical that increased sampling of the current population in the short term will resolve the problems with estimating long-term productivity. Improving estimates of productivity can only be achieved through reducing exploitation so the age structure can expand and ensuring adequate monitoring as the population recovers.
- Increased sampling may shed some light on the current age composition, and should at least provide greater confidence in the age composition estimates. Such endeavors should not be short lived however, as the assessment considerably suffers from a lack of both age and length sampling. Commercial age samples range from 7 to 332 annually, and only 1820 are available over nearly 20 years. That is less than 100 per year on average, which is pretty poor for a fish with a life span over 50 years.
- I agree the Council needs to take action, and all the available evidence indicates that fishing mortality must be reduced substantially.
- I strongly and completely disagree with the characterization that all assessment scientists presuppose a stock is depleted. This is one of several unfortunate opinion statements that detract from the potentially legitimate concerns raised regarding the selectivity pattern, and the questions raised regarding the differences in observed and estimated overall mean weight.