White Seabass (*Atractoscion nobilis*)

2016 Stock Assessment Review Panel Report

Review conducted at Scripps Institute of Oceanography
La Jolla, CA, May 2-3, 2016

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Overview

A panel to review the 2016 white seabass (*Atractoscion nobilis*) stock assessment convened during May 2 and 3, 2016 at Scripps Institute of Oceanography in La Jolla, CA. The panel consisted of two stock assessment scientists from the Northwest Fisheries Science Center (NOAA Fisheries). The panel had extensive experience in applying data-limited stock assessments, the use of recreational and other data from California, and the modelling framework (Stock Synthesis (SS)) used to conduct the stock assessment.

The assessed white seabass (WSB) stock was defined as within United States waters only, up through the state of California. This is the first formal white seabass stock assessment performed in an integrated statistical catch-at-age modeling framework. The assessment was conducted in Stock Synthesis (ver. 3.24U), one of the most sophisticated and widely used stock assessment frameworks in the world. Despite this high-end modeling platform, the data for white seabass was from a variety of sources, but generally limited and of low quality. The review panel acknowledged the extreme difficulty in identifying and processing the various data streams for evaluation and inclusion into Stock Synthesis. This is particularly difficult when being done for the first time. The basic data summary and processing, and data gap analysis provided in the assessment document is a significant step in understanding the current limitations of the assessment and what will be needed to improve future stock assessments. The construction of the model in SS, a freely available modelling platform that has strong developmental support, allows future assessments to build upon the current assessment files. This attribute is another valuable product of the stock assessment team's (STAT) work.

The STAT provided a working document, SS model files, relevant literature and presentations, while responding to panel requests for further analyses on both days in a timely matter. Given the severe challenge of current data availability and the limited review period, the reviewers focused mostly on major modelling issues and future research recommendations.

The general conclusions of the assessment indicated a wildly dynamic stock, with one of the more notable attributes of the estimated population being its extraordinary low starting point in 1969. In fact, the base model estimates that the population remained below 5% of unfished status for the first decade of the assessment period (1970s), a condition that both the STAT and review panel found very hard to believe. Much time was spent in the review trying to figure out what was informing such a low stock status, and a low population in the early 1970s was supported by the high catches prior to that time, the lack of large fish in the early length samples, and the subsequently increasing indices of abundance, but the specific causes of the model estimates below 5% were not well understood despite several additional sensitivity runs. It was noted that the very low biomass estimates at the start of the model could be due to a violation of the closed population assumption of the assessment, with portions of the stock leaving the assessment area (e.g. transboundary movements between US-Mexico). This was an untestable hypothesis during the review, but figured into several of the future research recommendations. It was also somewhat discouraging that the full time series model, (which began in 1889 and still showed reduced population size in the 1970s but not to the great extent as in the proposed base) did not sufficiently converge to be considered as a viable base model. The STAT team attempted many runs to overcome this issue, but were not successful, which lead to their proposal of the shortened time series model as the base. Nothing in any of the additional requests by the reviewers supported critical changes to the original base model coming into the review. Thus the model that was provided to the reviewers was maintained as the base model.

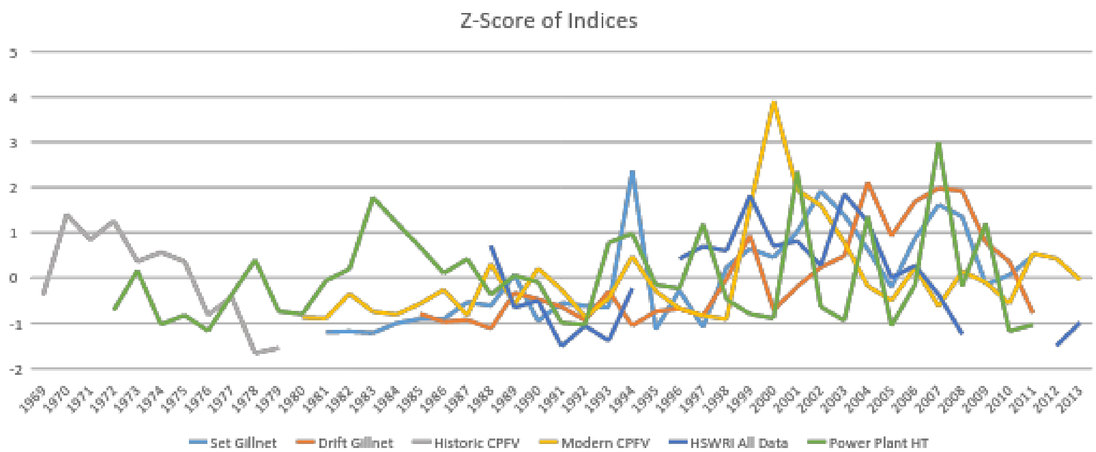
Overall, while the absolute scale of the population and the specific stock status trajectory produced by the base model remained questionable, especially for the 1970s, the general trend of the population trajectory was robust to numerous sensitivity runs. The final years of the model are also poorly informed by data since many of the time series of length compositions and indices of abundance end in 2011 or 2012 due to unavailability of more recent data to the STAT team. However, the proposed base case was nevertheless supported as a major improvement in the understanding of white seabass population dynamics and the assessment document contains the best available scientific information on the US white seabass stock.

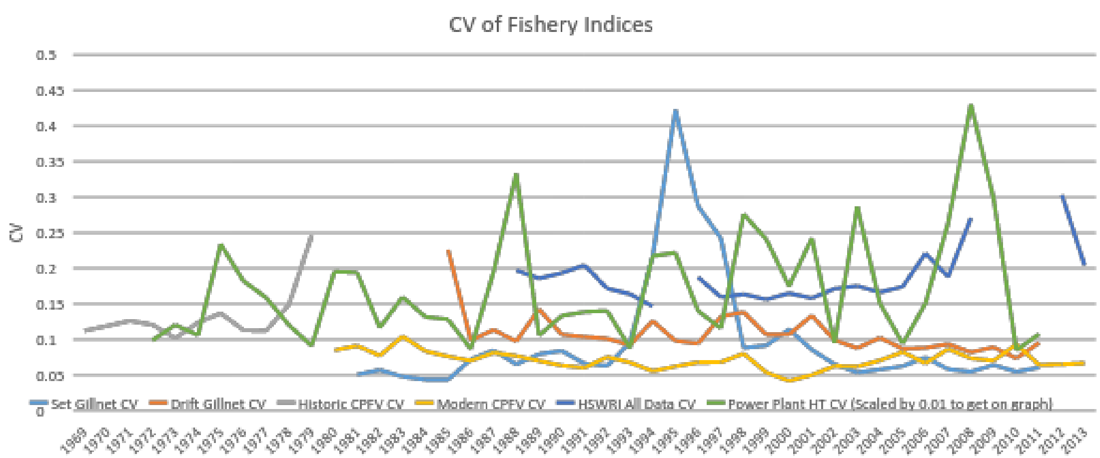
List of analyses requested during review panel

Day 1

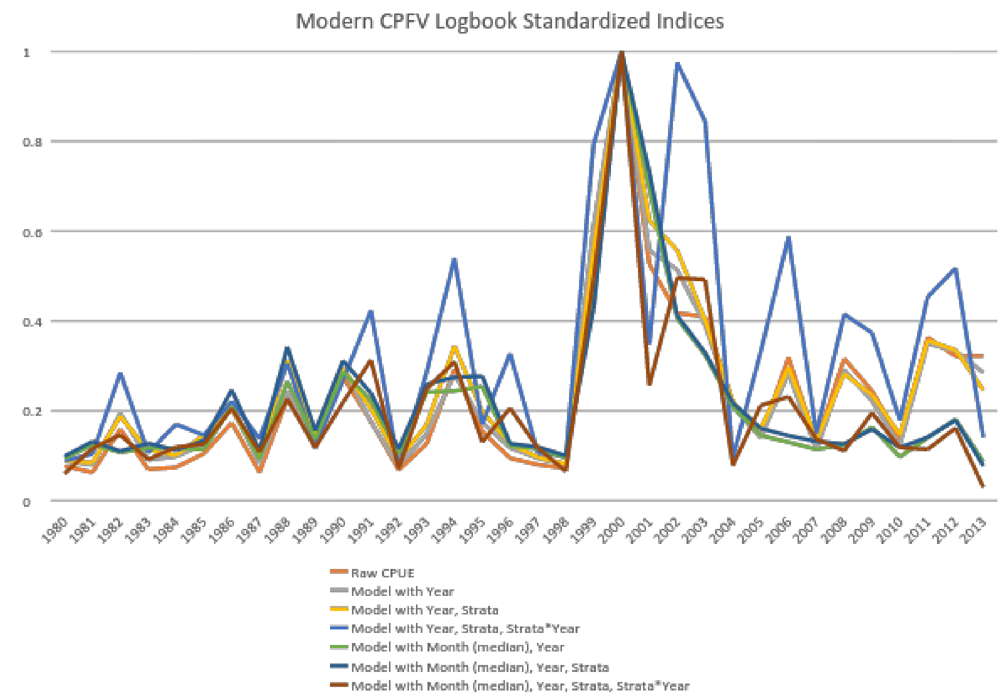
Index analysis

1. *Request:* Show standardized indices all on one plot and CVs in another for all indices used in the base model.
   Justification: There are several indices being used, but it is hard to tell if there is any concordance among them. It would also be useful to compare the assumed index uncertainty going into the model.
   Results: Indices generally in concordance. The CVs are very low, which points to the need of better characterization of uncertainty before applying the estimation of additional uncertainty in the model.

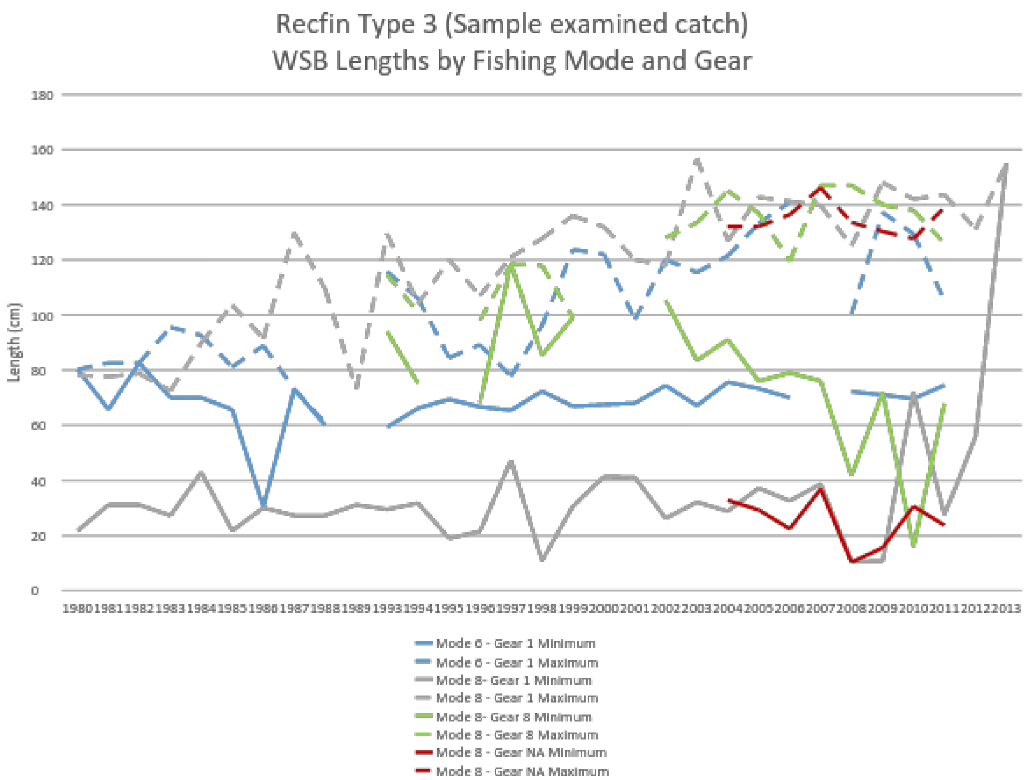




2. *Request:* Fix figure showing indices so that all have a max of 1
   Justification: Correct an error in the plot initially presented at the review meeting
   Results: The comparable scaling of the indices showed more similarity among alternative models than initially indicated (see below example).



3. *Request:* Fix RecFin type 3 plot so maximum and minimum are correct
   Justification: Correct an error in the plot initially presented at the review meeting
   Results: The corrected figure shows more clearly an increasing trend in the maximum observed length among RecFIN sample examined catch, from about 80 cm in 1980 to around 140 cm in 2010 (see figure below). This pattern is consistent with the model estimates of increasing numbers of older fish in the population over this period.



4. *Request:* Provide the most informative predictive species for white seabass from the Stephens-MacCall (SM) method.
Justification: The S-M filter is a method for using associated species to focus analyses on fishing trips that encountered species that would be expected to be in similar areas as white seabass. The default output of the initial application included too many species to review.
Results: The list (shown below) of most commonly associated species (negative and positive) was puzzling and supported the choice to not use the S-M filter in the development of indices for this assessment. The most associated species was "Agar", presumed to refer to kelp, but not something expected to occur with any frequency in commercial party fishing vessel (CPFV) trips. Furthermore, the correlation coefficients were higher than expected. These results point to the need to re-evaluate how the S-M approach is actually calculating these responses (e.g., it seems species with lots of zeros are being grouped together, though are not known to actually occur together).

Table: Species most unaffiliated with white seabass

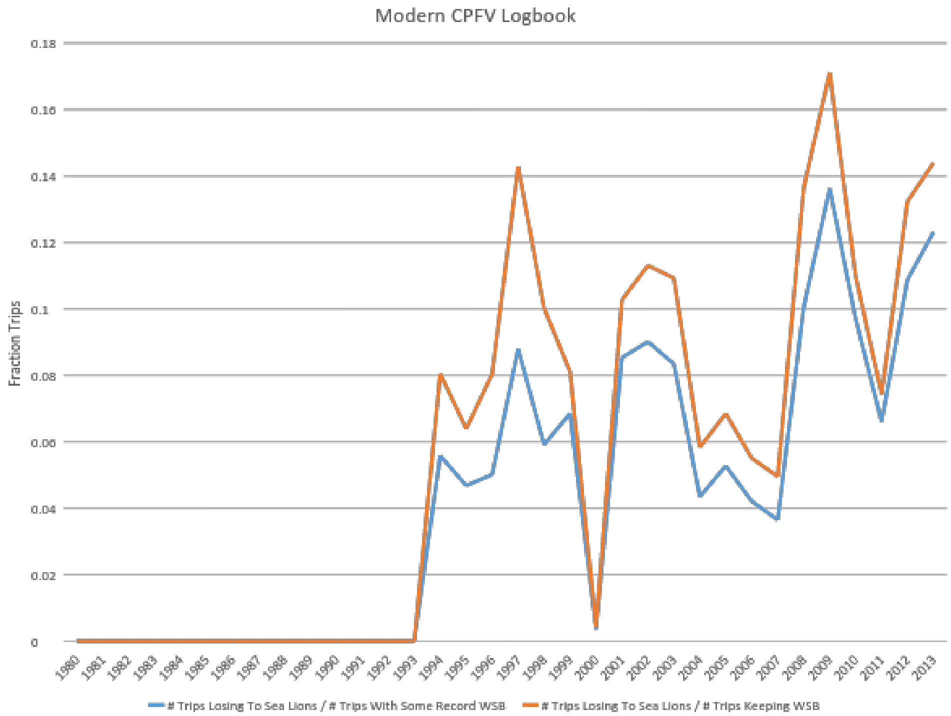
Coefficient	species
-15.0069	Tanner Crab
-14.5706	Kellet's Whelk
-14.4276	Common Washington Clam
-14.4272	Zebra Goby
-14.2864	Common Littleneck Clam
-13.9303	Shortfin Corvina
-13.9278	Group Slope Rockfish
-13.8546	Turtle
-13.8488	True Smelts
-13.8322	Mantis Shrimp
-13.7537	Curlfin Turbot

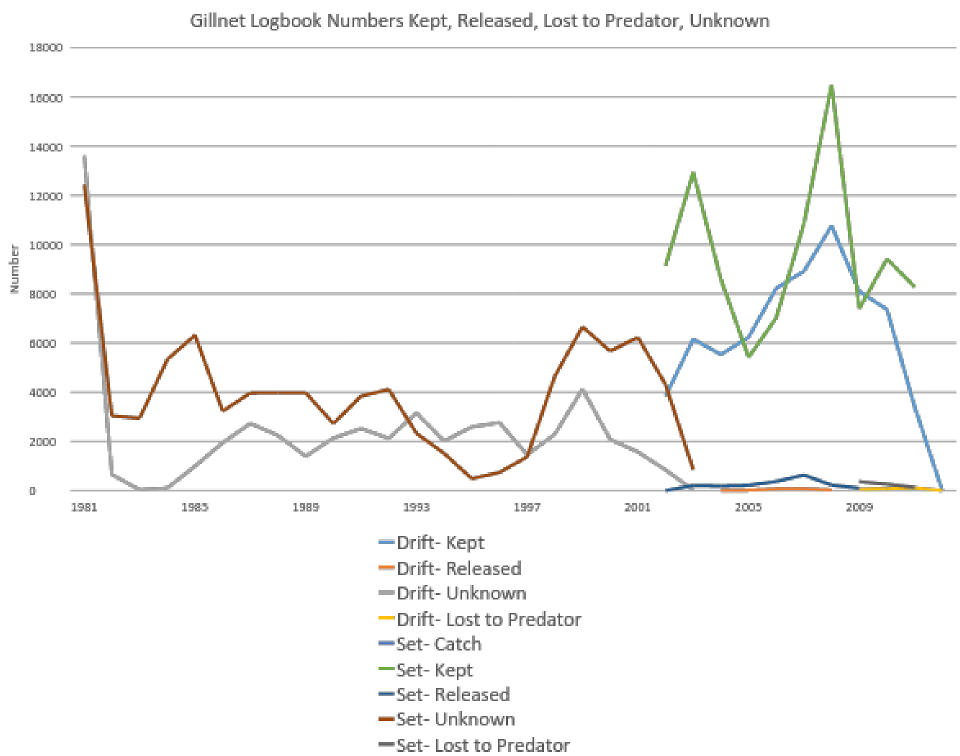
Table: Species most affiliated with white seabass

Coefficient	species
20.23476	Agar
4.042248	Greenstriped Rockfish
3.592488	Darkblotched Rockfish
2.717428	Rosethorn Rockfish
2.661827	Yellowfin Goby
2.387592	Sailfish
2.226259	Blacktip Shark
2.104356	Squarespot Rockfish
2.006967	Shark Bigeye Thresher
1.461455	Garibaldi
1.326137	Senorita
1.322518	Halibut

5. *Request:* Summarize trends over time in numbers of white seabass lost to sea lions from CPFV and gillnet database
   Justification: Anecdotal evidence provided at the meeting suggested that sea lion predation is a significant source of mortality but records are limited. Exploring the patterns in those records which are available could be useful for evaluating potential future uses of this information or identifying future data collection needs.
   Results: CPFV records indicate a relatively noisy pattern with a general increase with most years in the period 1994-2007 showing 5%-9% of trips with record of WSB showing a loss to sea lions vs. the all but one year in the period 2008-2013 showing greater than 10% of trips recording a loss to sea lions (blue line in upper figure below). The gillnet logbooks show very few records of

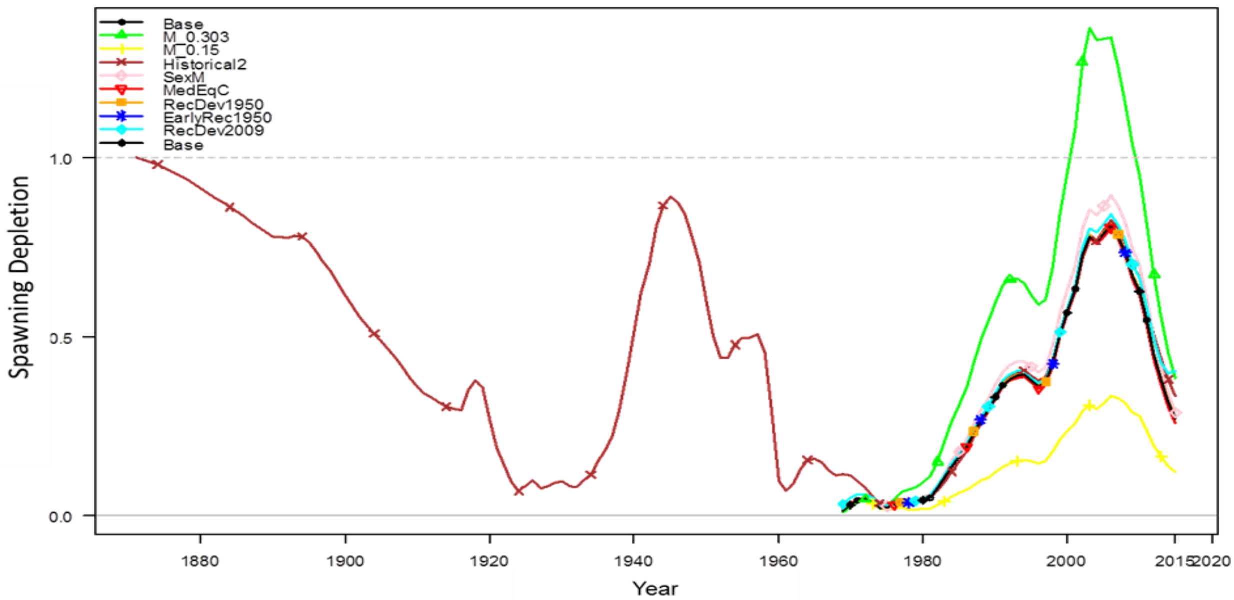
WSB lost to predators, with no such records prior to 2009 (black and yellow lines in lower figure below). In both cases, it is not clear how reliable or complete the records are.

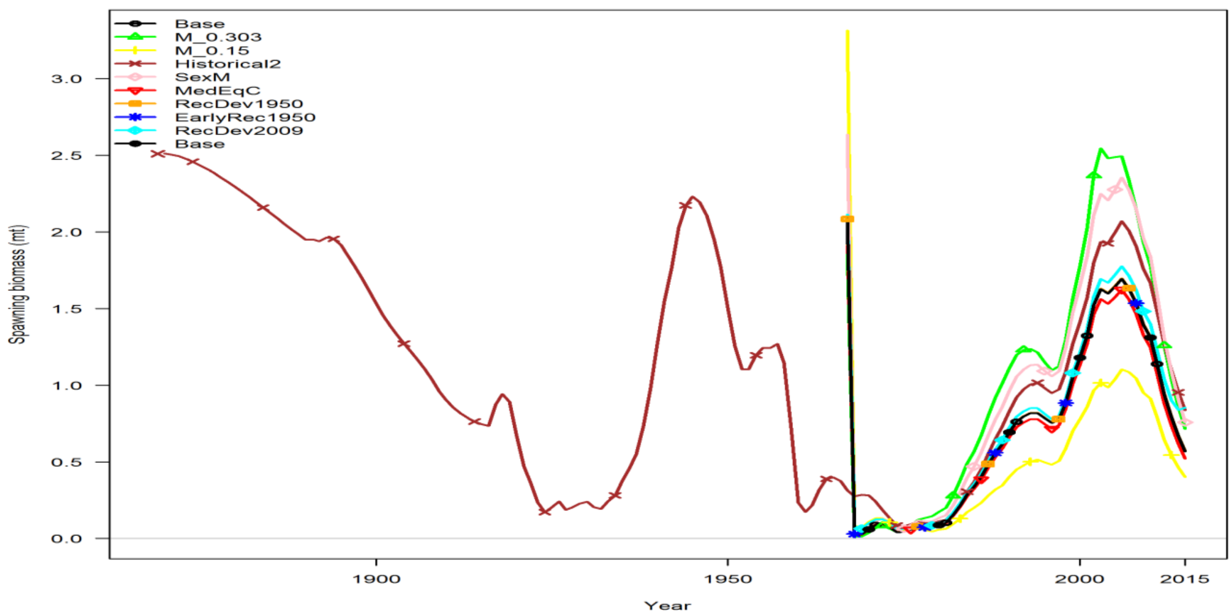




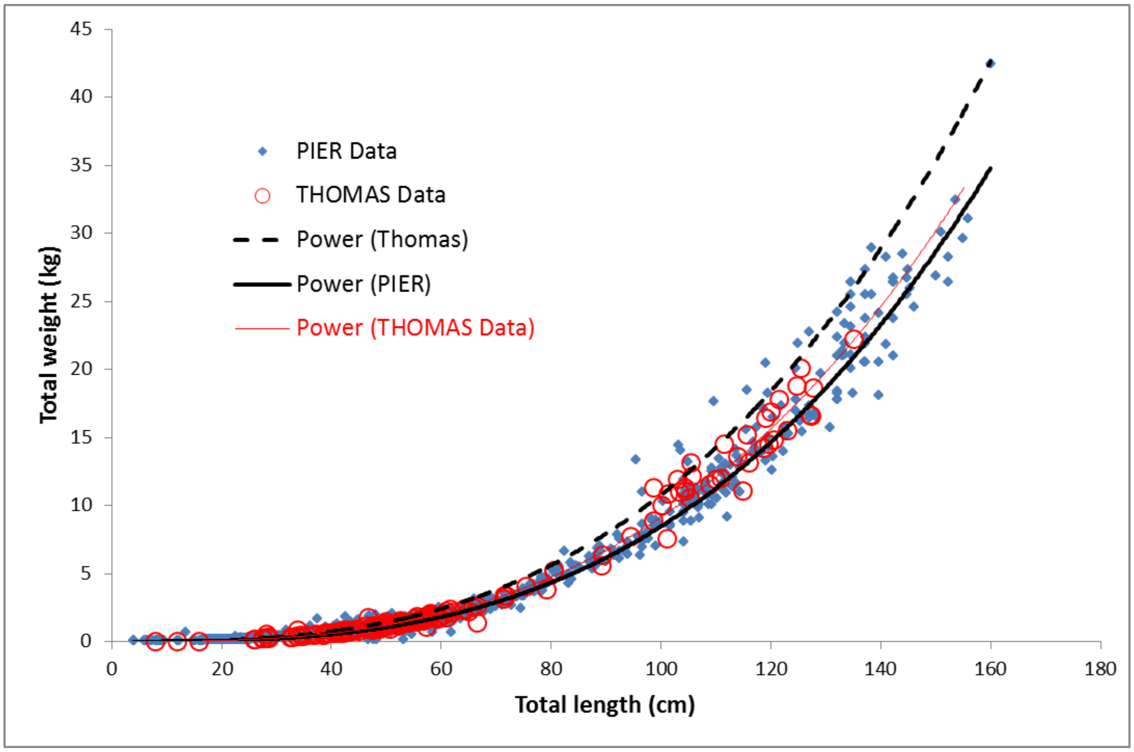
Model runs

6. *Request:* Sex-specific M run (Model 72)
   Justification: Different observed maximum age for males and females, when input to the Hamel method for estimating natural mortality, provide estimates of M = 0.225 for females and M = 0.360 (Table 4.10.1 in draft assessment report). The base model fixed M = 0.225 for both sexes which is very close to the best fit value in the likelihood profile over M. Understanding the sensitivity of the model results to a higher mortality for males helps understand whether the assumption is important.
   Results: Adding sex-specific M made very little difference to the model results (see pink line in the below figures). This is likely due to the mortality for females remaining constant as sensitivities included in the draft assessment previously indicated that changing the shared M parameter away from 0.225 results in larger changes in model results.

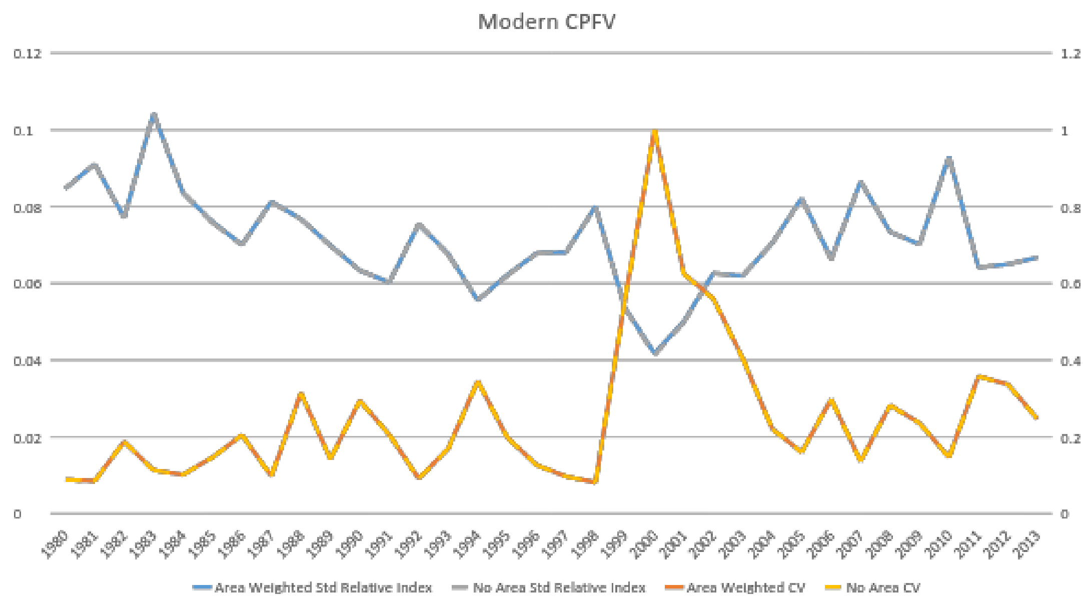




7. *Request:* Run with two L-W periods? Pre-1969 (Thomas) Post (PIER) (Model 77)
Justification: Published length-weight parameters in Thomas (1968) did not align well with parameters estimated from more recently collected data. The model sensitivity to the assumed single length-weight pattern would help guide future investigations into potential changes over time in this relationship.
Results: The assessment authors found a table of values on which the Thomas results were based and manually digitized these observations. The observations were closely aligned with the more recent samples, suggesting that there was either an error in the estimation process used by Thomas (1968) or a typo in the reported parameters. In either case, it appears that the length-weight relationship has remained stable over time and the base model assumptions are well justified.



8. *Request:* Fit to indices that were not expanded (Model 76).
   Justification: To determine whether the area-based expansion of the indices, which seemed an unnecessary step, affected model fits and whether it appropriately accounted for uncertainty (i.e., expanded the uncertainty as well). The uncertainty estimates seemed extraordinary low.
   Results: There was no detectable difference in the expanded versus non-expanded indices and associated CVs. An example of this is given below, but all comparisons were provided to the review panel.



9. *Request:* Do median equilibrium catch rather than mean (Model 73)
Justification: The historical catches that are truncated to an equilibrium catch are non-normally distributed through time, so a more appropriate central tendency is the median. The median also is less sensitive to outlier, of which there are a few. It was also hopeful that this change would cause the population in the first year to move away from the very low point in the base case, which seems an unreasonable state.
Results: Changing to the median catch had no appreciable change in either stock status or stock scale (see Day 1 Request 6 figures).

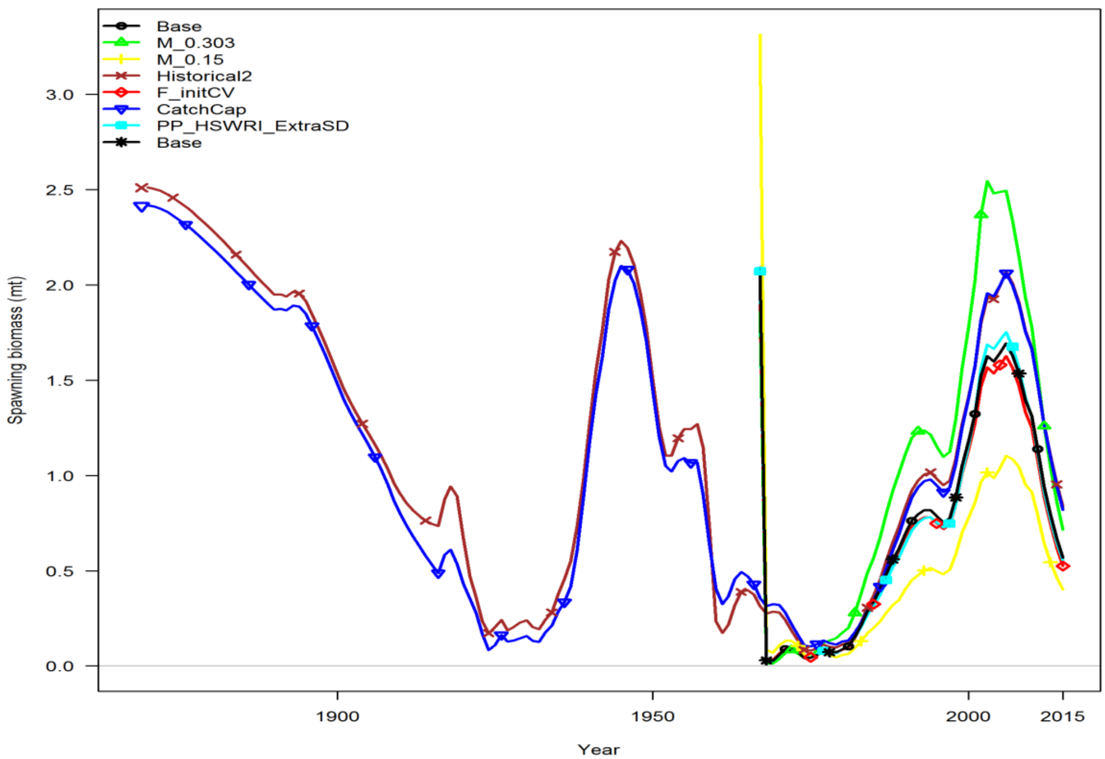
10. *Request:* Start rec devs in 1950 instead of 1965, keep initial year at 1969 (Model 74).
Justification: Seeking to understand better the robustness of the initial conditions of the base model.
Results: Very little change in model results (see Day 1 Request 6 figures).

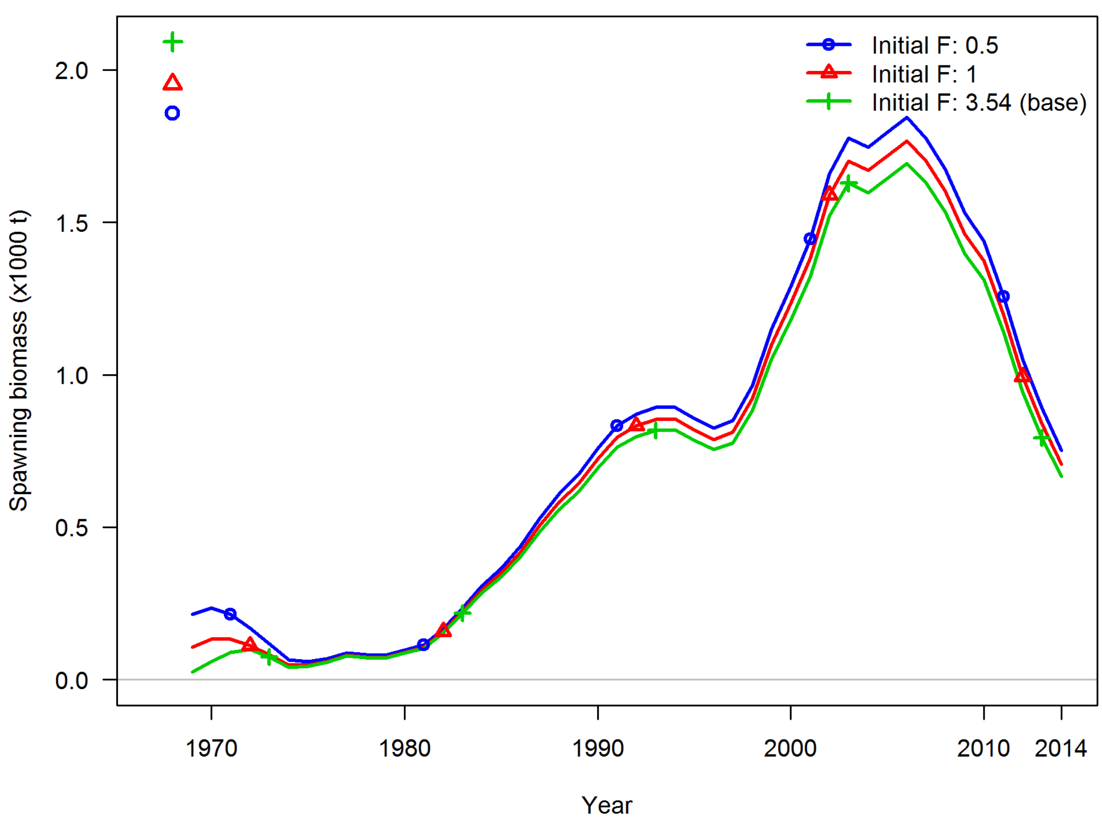
11. *Request:* Ending rec devs in 2009
Justification: Seeking to understand whether below-average recruitment at the end of the time series is the result of balancing positive and negative values in the recruit deviation vector rather than fit to data from the most recent years.
Results: Very little change in model results (see Day 1 Request 6 figures), indicating both that the data appear to be driving the low recruitment estimates and that the declining pattern at the

end of the time series is not strongly influenced by the recruitment estimates for the most recent years.

Day 2

1. *Request:* Initial F with large CV
   Justification: Continuing to explore factors influencing the initial conditions of the base model. This change allows the model to fit the initial equilibrium catch less well if a different initial equilibrium fishing mortality rate results in a better fit to other data sources.
   Results: Little change to base model (red line in upper figure below). An additional analysis conducted during this discussion was a likelihood profile over the initial F for the set gillnet fleet (which had the largest equilibrium catch). Reducing the equilibrium F from 3.54 to values as low as 0.5 resulted in a larger change in the initial spawning biomass (1969) but within 5 years, the time series had become similar to the base model (lower figure below).


Base
M_0.303
M_0.15
Historical2
F_initCV
CatchCap
PP_HSWRI_ExtraSD
Base
Spawning biomass (mt)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1900
1950
2000
2015
Year

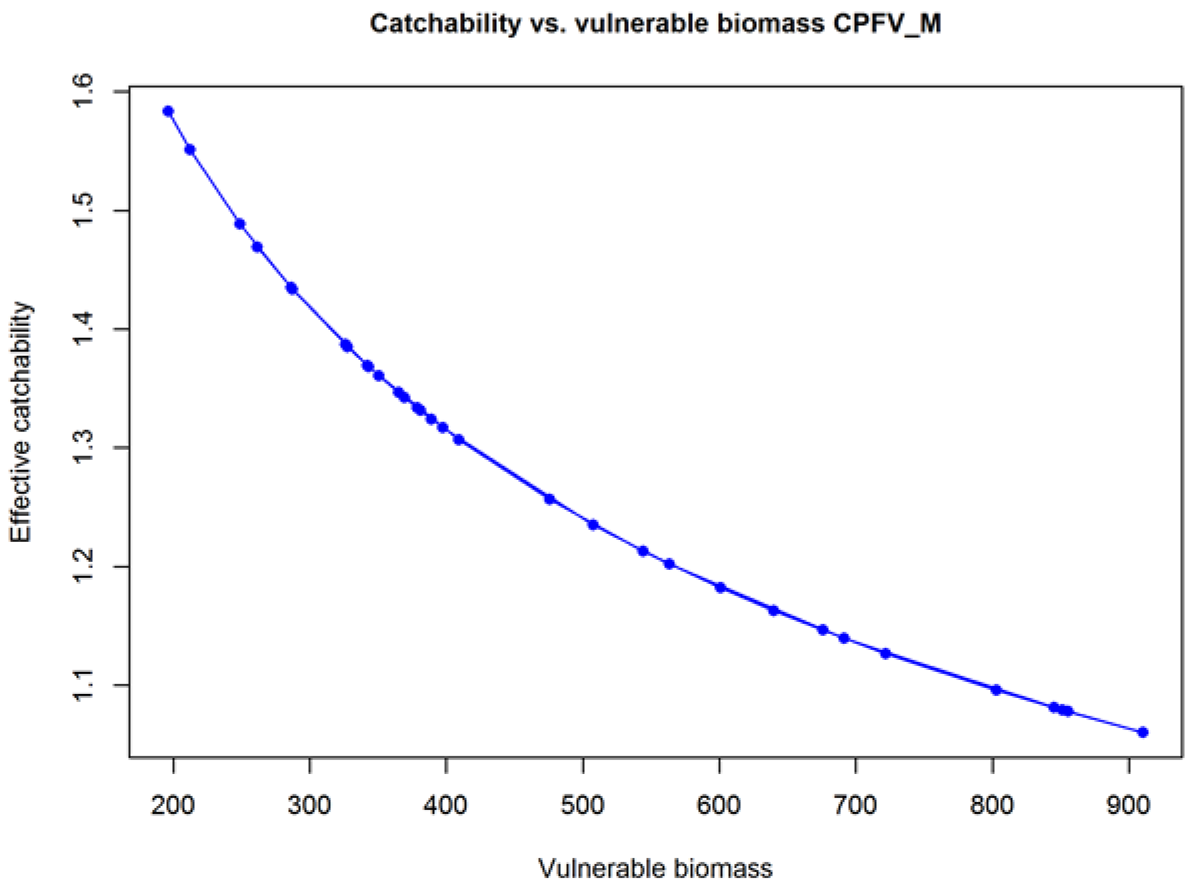

Initial F: 0.5
Initial F: 1
Initial F: 3.54 (base)
Spawning biomass (x1000 t)
0.0
0.5
1.0
1.5
2.0
1970
1980
1990
2000
2010
2014
Year

2. *Request:* Cap historical catches at 800 mt
   Justification: Test influence of large spikes in historical catch on model performance. Fishery participants at the meeting supported the veracity of those catch years but the specific values remain uncertain and the problems with the historical model (starting in the 1880s instead of 1969) may be related to the model having trouble removing such large catches in short time periods.
   Results: Similar overall results. Greatest differences occurred in the years just before and after the highest catches, but the biomass estimates for the years from 1975 onward were very similar to the base model.

3. *Request:* Report standard deviations of PP and HSWRI surveys
   Justification: These two indices were not included in the set with CVs shown in initial result of Day 1 Request 1.
   Results: Revised figure (shown below Day 1 Request 1 above) indicates that uncertainty in these two indices is similar to other indices. Base model includes additional uncertainty added for these indices. There was some discussion of whether the additional uncertainty should be estimated rather than fixed at 0.15, but model diagnostics indicated that estimated values would not be too much higher than the assumed value and that there was benefit to having these two fishery independent indices be weighted slightly higher than the fishery dependent CPUE.

Request to be done for the final document

- Add Q-Q plot to index diagnostic.
  Justification: Provides a diagnostic to see whether the assumption of the gamma distribution for the positive portion of the delta-GLM is appropriate.
- Likelihood component sensitivities.
  Justification: Allows examination of how the input data specifically affects parameter estimation and derived quantities.
- Add Biomass & catchability plot for CPFV_M using updated r4ss.
  Justification: Provides information on the estimated non-linear relationship estimated for this index (hyperdepletion or hyperstability). A bug in earlier versions of r4ss caused this plot to not be produced.
  Results: Effective catchability is larger at lower estimates of biomass


Catchability vs. vulnerable biomass CPFV_M
Effective catchability
Vulnerable biomass
1.1
1.2
1.3
1.4
1.5
1.6
200
300
400
500
600
700
800
900

Technical merits and/or deficiencies

The stock assessment is of high quality, despite severe challenges and limitations in the data, and is endorsed by the reviewers a major improvement over past white seabass population modeling exercises, and should be considered over past approaches when management measures for white seabass are developed. As the first modern stock assessment for this species, it required mining of numerous data sources and it provides valuable information on gaps in the data and areas requiring research that would improve updates to this assessment in the future. It also provides a sophisticated framework (SS) in which future models can be developed and alternative management strategies evaluated.

Areas of disagreement

No areas of disagreement were identified.

Unresolved problems and major uncertainties

- **Initial conditions**
  The estimated initial spawning biomass in the base model was found by both reviewers to be implausibly low. However, numerous model sensitivities, both those brought to the meeting and those conducted in response to requests, showed that the estimated time series of spawning biomass for the years 1975 to 2015 was robust to changes in the assumptions about the initial conditions. Furthermore, the historical model which began in 1889, in spite of convergence issues, provided a very similar trajectory over this same later period. Therefore, we consider that the uncertainty associated with the initial conditions does not limit the usefulness of the model for making inferences about the current status of the stock or sustainable catch levels, but likely reflects the misspecification of the model in regard to fish movement outside the assessed area.

- **Stock boundaries**
  This stock assessment focused on the population of white seabass in California only. However, tagging studies have shown that there is movement of WSB between US and Mexican waters as well as movement north of California, potentially as far as Canada. Dynamics observed for California may be driven by migration in and out of this area and recruitment from spawning stocks outside of this area, contributing both to some of the rapid declines as well as the rebuilding periods. The data available at this time are inadequate to support a trans-boundary stock assessment, but this option should be considered if adequate data from Mexico can be included.

- **Hatchery program**
  A hatchery program for WSB contributes to the stock considered in this assessment but the extent of that contribution is unknown and was not considered in this stock assessment. The lack of information on the relationship between the hatchery and the wild population is an

impediment to the assessment as well as to any evaluation of the utility of the hatchery program. We understand that the hatchery program is being reviewed in the near future and hope that more information will be available in the future on the interactions between hatchery and wild populations and their contribution to the fishery.

Future assessment and research recommendations (not in priority order)

- **Understanding movement is an important issue in specifying the current assessment model.** It is one of the main barriers in understanding the model output and future model development. More work needs to be done to understand how much the population may be moving out of the geographic areas considered in the assessment, both domestically and internationally, in order to better interpret the fluctuations seen in the biomass trends. Coordinating this movement with water temperature or squid presence may be a fruitful research avenue. Tagging studies will likely play a big role in gaining insight into movement, and should therefore be continued, supported and expanded.
- **There is a critical need to establish and support fishery-independent surveys.** The use of fishery-dependent indices in this assessment proved very challenging, and requires much further consideration (see next recommendation). While it is admittedly very hard to design a proper fishery-independent index for white seabass given its infrequent occurrence patterns, the tagging program may be the most hopeful avenue in this regard, and could be used to estimate abundance and trends, along with possible other important parameters (e.g., natural mortality).
- **Explore how management changes may affect indices.** There were several changes to management measures throughout the time series of white seabass catches. Given the main source of adult abundance comes from fishery-dependent information, further understanding how the catchability may be affected by changes in management measures are needed to understand the appropriateness of using the catch-effort data as indices of abundance.
- **Consider other distributions for the positives in the GLMM (e.g., lognormal).** Only the gamma distribution was considered for the positive catch data in the GLMM. This may or may not fit the data well. Other distributions should be explored in order to find the most suitable GLMM for the given data. This will include using Q-Q plots to distinguish between/among candidate distributions.
- **Figure out how to get more uncertainty estimation in the GLMM, and not have to rely on the SS added variance estimation as much.** It was not fully clear how the uncertainty in the yearly indices were being calculated from the Bayesian data. There are many ways it can be done, but the current approach seems to be greatly underestimating the overall uncertainty. While this can be mitigated to a certain extent in the assessment by estimating additional uncertainty, that approach only adds variance across all years, thus preserving the relative uncertainties among years. Among year uncertainty will likely be sensitive to the way yearly uncertainty is being calculated, thus the need to establish those relative uncertainties to the extent possible before fitting them in the assessment is needed.

- **Explore alternative aggregation for the CPFV data.** Due to the sparseness of the data, the CPFV observations were aggregated on course 100-level blocks for development of the indices of abundance. Average catch rates were roughly similar across these blocks. Future index analysis should consider aggregating the smaller CPFV based on their proximity to islands and the coast which may better capture differences in catch rates among areas and improve the index standardization process.
- **Seek more understanding on the high catches in the 1920s and late 1950s.** These catches are extraordinary, particularly the ones in the late 1950s. While those fishing the resources could confirm those years did seem to be higher than normal, numbers near three times higher than some of the previously high catches are eye-popping and need to be investigated further.
- **Sorting out the bimodality in the "Other recreational" fishery.** The reason for this strange size distribution was unclear and needs further analysis. Given this is currently a mixed fishery distribution, it is highly undesirable to have such bimodality. Breaking this data into its components will hopefully resolve this issue.
- **Obtain more aged samples.** Age compositions can be information rich, and can allow internal estimation of growth and better resolution of population dynamics, such as recruitment events and changes in age structure. While there seems to be more work needed to both validate annuli growth in white seabass and verify ageing approaches, future assessments would greatly benefit from the addition of aged samples.
- **Need better maturity information.** Published maturity information is both old and of only limited samples for white seabass. A more formal and comprehensive study of maturity is highly recommended for this species.
- **All data should be sex-specific as possible.** There are distinct differences in the life histories of female and male white seabass. While initial sensitivities showed little differences in accounting for sex-specific natural mortality, having the data sorted by sex could greatly improve the fit and performance of the model. Future collections of data should prioritize identifying the sex of each sample.
- **Develop collaboration between US and Mexican scientists and resultant collection programs.** There is a strong sense that the US and Mexican stocks (the word stock here being interpreted as fish within those nations waters, not assuming any genetic or ecological differences) of white seabass exchange frequently and significantly. Having collaborative efforts in gathering and analyzing data would give a more complete picture of stock dynamics, allowing the assessment to more appropriately take into consideration effective population scales.
- **Extend all time series to a more recent year (instead of ending 5 years before final year of assessment) and continue to update the model frequently.** The dynamics of WSB show fast changes in abundance, both up and down, so basing management on outdated assessment results will be of limited value. This assessment represents a giant leap forward in the understanding of the population dynamics of this species but its value to management will quickly diminish if it is not updated regularly. Given what may be large fluctuations in the population over relatively short time periods, revisiting the assessment more frequently, particularly when new data becomes available or over periods of significant population or management changes is recommended.

- **Forecast under alternative management scenarios, including alternative size limits but also bag limits and/or limits on total catch.** The focus of this assessment was on estimating the changes in abundance, stock status, and impact of historical fishing on the population. However, the assessment model is also a useful tool for exploring potential impacts of future catches under either the status-quo management system or potential alternative management regimes. Such forecasts should be based on input from managers on the range of measures they might consider.