CALIFORNIA WHITE SEABASS STOCK ASSESSMENT IN 2016

Juan Valero
jvalero@iattc.org
Center for Advanced of Population Assessment Methodology (CAPAM)

Lynn Waterhouse
lynn@ucsd.edu
Scripps Institution of Oceanography and CAPAM

May 25, 2016

Stock Assessment Expanded Summary for California White Seabass

Juan Valero, Center for Advanced of Population Assessment Methodology (CAPAM)
Lynn Waterhouse, Scripps Institution of Oceanography and CAPAM

Summary

The first modern Stock Assessment for white seabass (*Atractoscion nobilis*) in California was completed recently. The white seabass is a nearshore finfish species found in the coastal waters of California (US) and Baja California, and to a much lesser extent, along the coast of Oregon and Washington. The species supports important California recreational and commercial fisheries, which are managed through California State regulations. The work was conducted in collaboration with Pfleger Institute of Environmental Research (PIER) and California Department of Fish and Wildlife (CDFW). The stock assessment was funded byPIER with contributions from the George T. Pfleger Foundation and the Offield Family Foundation. An independent peer-review of the stock assessment work took place in La Jolla during May 2 and 3, 2016. The review was open to the public with participants from California Department of Fish and Wildlife, Pfleger Institute of Environmental Research, California Sea Grant, Hubbs SeaWorld Research Institute, Scripps Institution of Oceanography, University of California San Diego and from the fishing community. We used the fisheries stock assessment modeling platform Stock Synthesis (SS) to assess the California population of white seabass. SS allows integrating all data available for white seabass into a modelling platform describing the population and fishery dynamics of white seabass.

The assessment results indicate large changes in white seabass abundance throughout history, with low estimated abundances during the 1920s-1930s and again during the 1960s-1970s. It is unclear if the very low abundances during those periods are in fact extremely low biomass of white seabass in California waters or they are due to changes in how available the fish were during those periods, for example if the fish moved to areas outside of California. The estimated biomass recovery from the very low levels in the 1970s to the maximum recent biomass levels in the mid 2000s is estimated to follow increased recruitment levels, particularly after the early 1990s. However, recruitment is estimated to have declined since the late 1990s-early 2000s and the model estimates an ongoing 9-year decline in white seabass spawning biomass to an estimated 27% of spawning biomass relative to what is expected under no fishing conditions.

Major research needs are identified, such as the need for more discard mortality, maturity and age information, increase collaboration with Mexican scientists, support of tagging programs and evaluation of alternative harvest strategies (including fishery selectivity, alternative size limits and/or seasonal closures, total catch, etc.). Timely updates to this stock assessment (the first white seabass) are recommended given the large changes in estimated biomass, the ongoing 9-year decline in spawning biomass, current depletion levels and the lack of updated data up to the final year of the model.

In this document we summarize only the major findings of the white seabass assessment, a more technical and complete description of the work and the review panel is available in separate documents.

Introduction

The white seabass, also known as Catalina salmon or by its scientific name *Atractoscion nobilis*, is the largest member of the croaker family found along the US West Coast. The maximum weight is over 80 pounds (36 kg) and greater than 4 feet long, while an average fish from the commercial fishery is typically between 20 (9 kg) and 40 pounds (18 kg) (Young, 1979). White seabass have been harvested by humans for thousands of years. The commercial catch of white seabass has been conducted with gillnets (both set and drift), round haul nets, lampara nets, purse seine nets, and some hook and line. Historically, much of the Mexican-caught white seabass was taken by purse seiners (Skogsberg, 1939), and a considerable but unknown amount of white seabass are still harvested by purse seine in Mexico. Recreational (sport) fishermen primarily fish by hook and line. Other species that they may target when fishing for white seabass include barracuda, kelp bass, and yellowtail (Skogsberg, 1939). Some free-divers also use spears to target white seabass. The commercial and recreational fisheries overlap spatially (Young, 1973).

Management History

White seabass is managed by the State of California via a combination of season closures, bag limits and minimum legal size (28 inch). Management regulations have changed substantially both for commercial and recreational fisheries over the past 80 years.

Figure 3-1. Plot of commercial catch from historic database, hook and line, drift net, and set net combined with all other means for white seabass in the state of California. Overlaid are key management regulations for the commercial fishery.

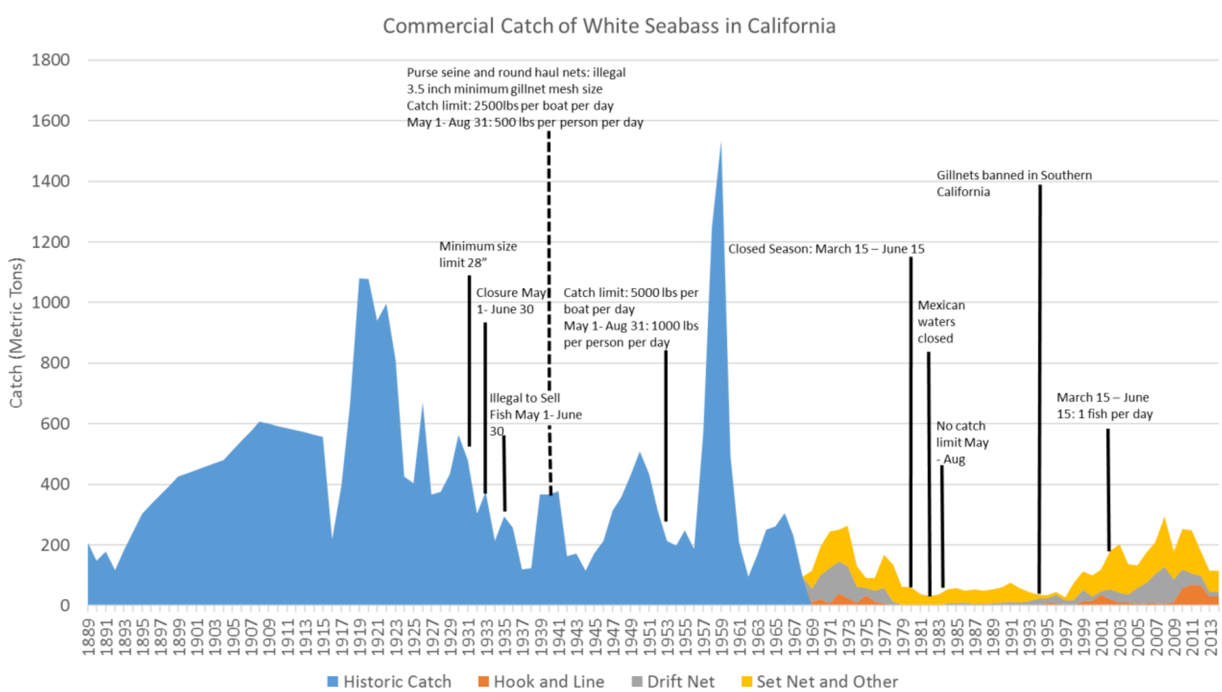
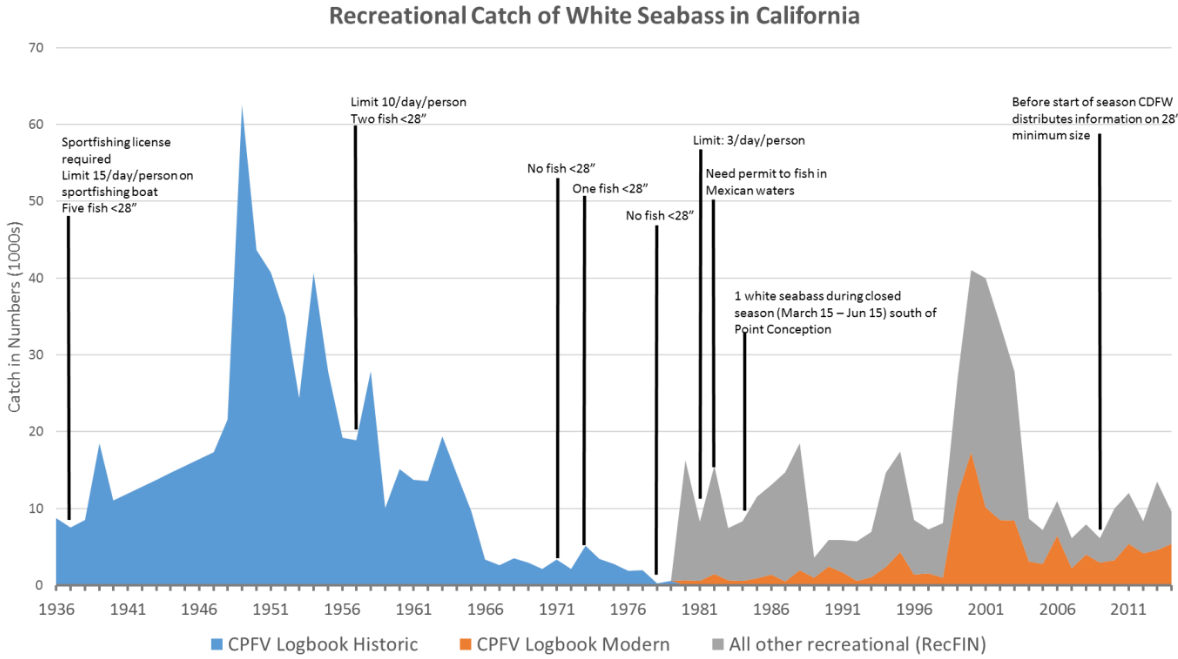


Figure 3-2. Plot of recreational catch from historic CPFV logbook, modern CPFV logbook, and RecFin data for white seabass in the state of California. Overlaid are key management regulations for the recreational fishery.



Data and Biological Characteristics

Environment and Ecosystem Role

The diet of white seabass consists primarily of squid, sardines, anchovies, other small fishes and a small amount of pelagic red swimming crabs when available (Young 1973). As prey, white seabass are eaten by other fish and sea lions. There may also be competition between white seabass and other species such as Pacific Bonito and Yellowtail Jack. In years of warmer sea surface temperatures, the spatial distribution of white seabass shifts northward, up to San Francisco Bay (Young 1973). Adults may also become more common near outer edges of kelp beds during warmer summer months and El Niño years (Dayton et al., 1998). El Niño events are expected to affect white seabass habitat and prey. Juvenile and adult white seabass are associated with kelp beds, which tend to be adversely affected by anomalously warm water (CDFG 2002). During El Niño events two key white seabass prey items, anchovies (Fiedler 1984) and market squid (CDFG 1999) were not present, or were greatly reduced, in the Southern California Bight, however other prey items such as sardines increase in abundance during El Niño (CDFC 2002).

Sex ratio

There is very little information on the sex ratio of white seabass. However, there is indication of temporal and spatial segregation by sex. Aalbers and Sepulveda (2015) found that 77% of recaptured individuals from tags deployed during the spawning season (March-July) were identified as female.

Spatial distribution and stock structure

White seabass are distributed over the continental shelf from Alaska to Baja California, Mexico (Thomas, 1968), with the center of the population typically south of Point Conception to Ballenas Bay, Baja California, Mexico (Young, 1973). There is no evidence that white seabass between the Pacific coast of California (USA) and Baja California (Mexico) are from different reproductive groups. Additional studies are needed to fully elucidate white seabass stock structure in this region.

Movement

Recent work done by PIER using archival tags have shown that adult white seabass have marked seasonal movements both in vertical and horizontal planes (Aalbers and Sepulveda, 2015), moving seasonally in a north and westerly direction from July to September, as sea-surface temperatures (SSTs) increased throughout Southern California. A vertical distributional shift toward the surface as water temperatures increase during the spring and summer months contributes to heightened vulnerability to fishing during the spawning season (Aalbers and Sepulveda, 2015). They also found individual fish moving more than 500 km from their initial point of release, although recoveries happened at smaller distances from the point of release, suggesting white seabass maintain an affinity for distinct sites or habitats that are revisited annually for feeding or spawning (Aalbers and Sepulveda, 2015). More recent findings from warmer water periods suggest that white seabass can extend their horizontal range as far as the Canadian border when sea surface temperatures are within the preferred range for this species (12-18°C; 54-64°F Aalbers and Sepulveda, in preparation). Widespread horizontal movements during the spawning season are consistent with recent data that indicate limited residency periods at distinct spawning sites along the southern coast of California (Aalbers and Sepulveda, 2012). Aalbers and Sepulveda (2015) also found evidence of transboundary movement as 3 out of 41 white seabass tagged in California were recaptured in Mexican waters.

Maturity

The only published study on white seabass maturity is by Clark (1930). Her conclusion was that females began maturing at 60.7 cm (24 inches) and all white seabass are mature at 80 cm (31.5 inches) TL. However this study was based in only 8 maturing females, collected almost 100 years ago. A recent program by PIER resulted in the collection of 77 female and 20 male white seabass between 2007 and 2015 to evaluate maturity state by fish size and sex (Scott Aalbers, pers. comm.).

In summary there is limited information on maturity, the maturity information used as rationale for the current minimum size limit is both outdated and based on a very small sample. More updated and larger samples indicate that female white seabass mature at almost 87 cm (34 inch) instead of the 69 cm (27 inch), implying that a fraction of the white seabass landed legally are still immature.

Natural Mortality

Natural mortality describes the % of fish that die due to natural causes. We used an estimate of natural mortality based on how old white seabass get, resulting in approximately 20% of fish dying from natural causes every year.

Recruitment

White seabass spawning occurs from April to August with a peak in May/June, with northward movements to spawn in specific areas nearshore (Young, 1973; Aalbers and Sepulveda, 2012). White seabass have the largest eggs of the West Coast croakers. Eggs float and drift with the ocean currents (Moser et al. 1983). Larvae have been found along the coast mostly between May and August, peaking in July (Moser et al. 1983). Larvae appear to settle between Santa Rosa Island (California) to Bahia Santa Maria (Baja California, Mexico) (Moser et al. 1983).

History of modeling approaches

There are no prior modern stock assessments for white seabass. However, two works conducted in the mid-1970s and early-1990s estimated white seabass abundance. MacCall et al. (1976) estimated the abundance of white seabass in the mid-1970s, based on a simple model using fishery dependent data collected from 1947-1973 (MacCall et al. 1976). MacCall et al. (1976) used catch-per-unit-effort (CPUE) data from United States-based commercial and recreational catches and calculated an MSY for white seabass of 748 metric tons (1.65 million pounds). Dayton and MacCall (1992) used annual record weight (reported heaviest fish caught) of white seabass taken by Avalon Tuna Club member fishing out of Santa Catalina to estimate white seabass pre-exploitation biomass. Dayton and MacCall (1992) estimated pre-exploitation biomass of 20,000 tons (CV between 0.25 to 0.4) corresponding to 2-2.5 million fish. They also reported a Gulland potential yield rule-of-thumb of 500-900 metric tons.

Stock assessment

Model

An integrated statistical age-structured model with different growth for females and males was implemented using the modelling platform Stock Synthesis (Methot and Wetzel 2013) to assess White Seabass from California, USA. The model describes population dynamics (how white seabass grow, die, reproduce, are caught by the different fisheries, etc). The internal population dynamics model tracks ages 0-25. Alternative model runs were conducted covering white seabass dynamics between 1870-2014 and 1969-2014.

The model uses different types of information to anchor the modeling to reality, a process called fitting the model to data. This model is fit to indices of how abundant white seabass are at different times in history such as: catch per unit of effort (CPUE) from Commercial Passenger Fishing Vessels (CPFV), drift gillnet logbook CPUE, set gillnet logbook CPUE, survey gillnets from Hubss SeaWorld research Institute (HSWRI), CPUE and Power Plants Heat Treatment CPUE. The model is also fit to samples of fish size data for commercial fisheries such as hook and line, drift gillnet and set gillnet. For the recreational data the model was fit to lengths from CPFV observers (modern and historic) and lengths from a combined “Other recreational” group. The model was also fitted to lengths from HSWRI gillnet surveys, Power Plants (Heat Treatment).

Fisheries

White seabass are caught by multiple gears and fleets, some of which are of unknown gear or fleet and with varying degrees of other data available for gears and fleets (e.g. associated size compositions, CPUE, etc.). We combined the available information in seven fisheries. Commercial catch for each modelled fishery was included in metric tons and recreational catch was used in thousands of fish.

Initial conditions

White seabass have been exploited for more than 125 years, the quality and quantity of the data available decrease towards the early years. We built models describing white seabass dynamics from 1870 to 2014, from 1889 to 2014 and from 1969 to 2014. Different assumptions had to be made depending on the start of the model.

Model Results

More than 120 alternative models were developed to ensure that different assumptions did not affect the results of the work and that the major conclusions are robust to the particular decisions of the fisheries scientist conducting or reviewing the work. Most of the results presented here are those of the base model, what we consider the best representation of reality given the data available. The base model estimates of white seabass females to grow to larger sizes than males

Figure 6-1. Summary of data sources used in the SS models by fleet and year for Historical model runs.

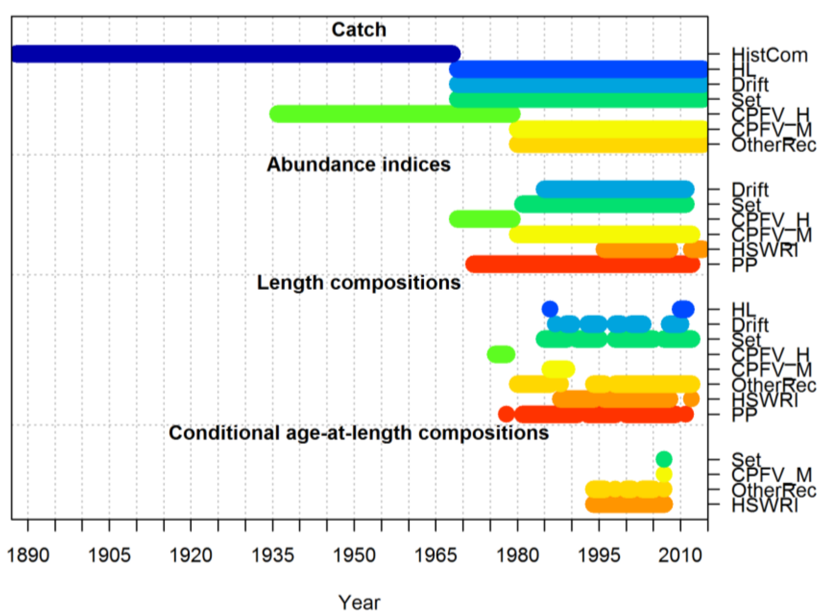


Figure 6-3. Total landings in metric tons (mt) from 1889 to 2014 by fleets as defined in the stock assessment model.

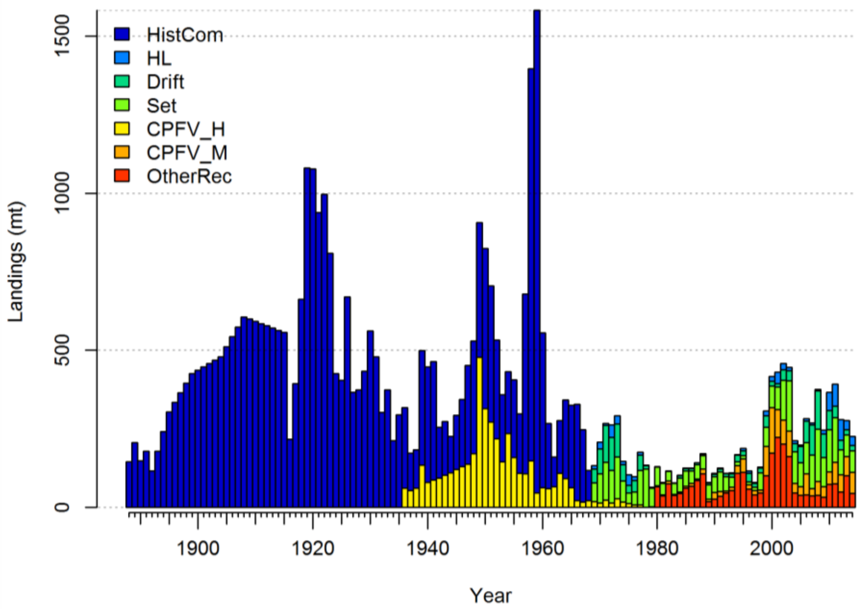
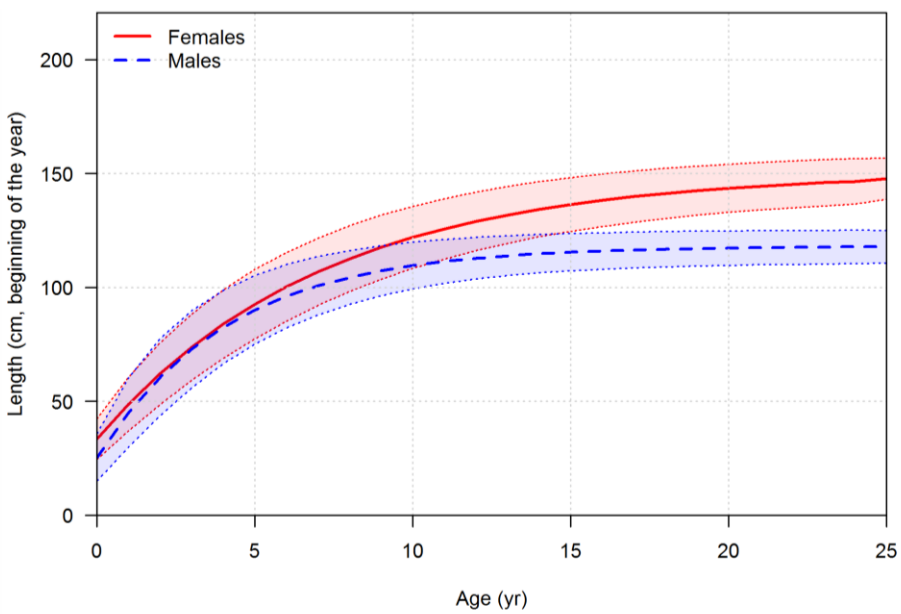
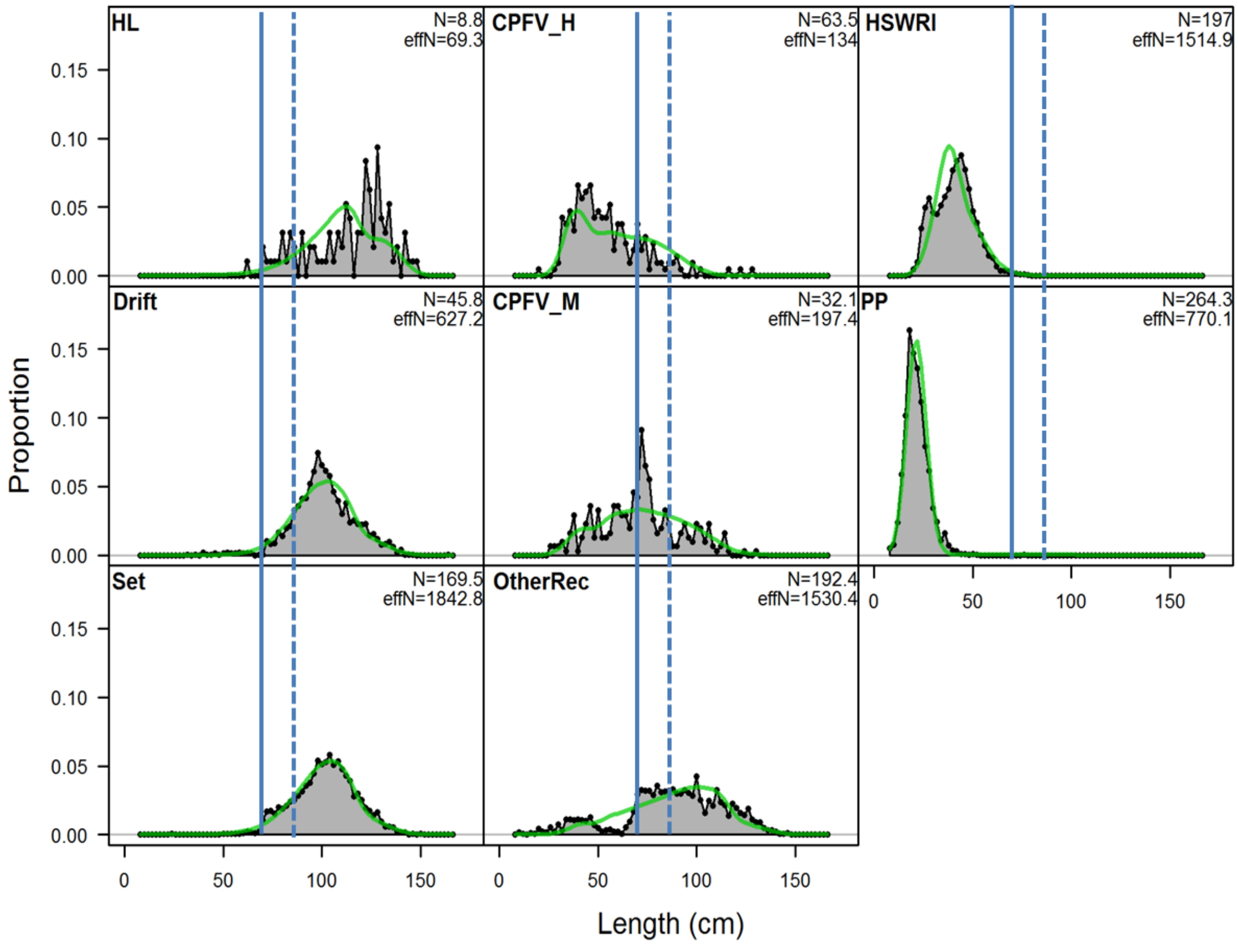


Figure 6-20. Sex specific growth curves with 95% confidence intervals



The model is consistent with the information provided in the samples of length composition for the different fisheries and surveys as well as to the CPUE indices of white seabass relative abundance.

Figure 6-22. Length compositions aggregated across time and fleet (grey areas) and model fits (green line). Solid vertical line is the current minimum size limit of 28 inches, dashed vertical line is 34 inches, close to the size at maturity for females based on PIER dataset.



The base-case model estimates extremely low spawning biomass during the 1970s (Figure 6-38). This does not necessarily imply that biomass was that low, but could instead be indicative of a violation of the closed population assumption of the assessment. There is evidence of transboundary movements between US-Mexico, so it could be also indicative of changes in availability of the stock, with portions leaving the assessment area. The base case model estimates white seabass female spawning biomass in 2015 at 569 mt (~95% asymptotic interval: 241- 896 mt) (Figure 6-38). Virgin unfished female spawning biomass (*B0*) is estimated at *B0*: 2092 mt (~95% asymptotic interval: 1600 - 2584 mt). Recruitment of age-0 white seabass is estimated to have been at lower levels during the 1970s and early 1990s, followed by an increase to higher levels during 1997-1998 and then by a decline to low values during the late 2000s, years after 2010 are estimated less reliably or forecasted so do not imply a recovery in recruitment (Figure 6-39). The base case model estimates 2015 depletion at 0.27 (~95% asymptotic interval: 0.16- 0.39). That is white seabass is estimated to be at 27% of its unfished level. White seabass biomass is estimated to be decreasing over the last 9 years (Figure 6-40).

Figure 6-32. Model fit (blue line) the drift gillnet commercial fishery (Drift). Lines indicate 95% uncertainty interval around index values. Thicker lines indicate input uncertainty before addition of estimated additional uncertainty.

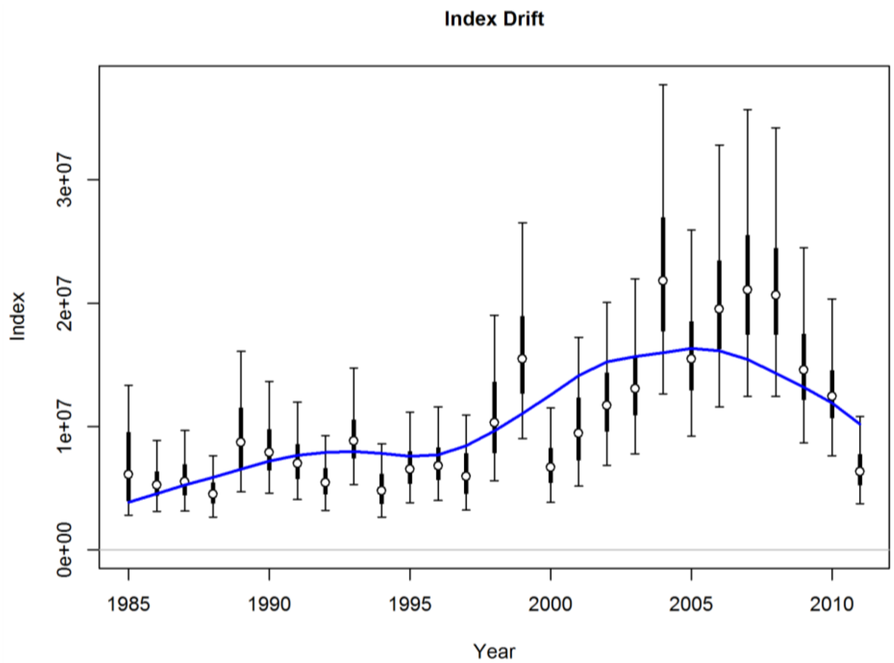


Figure 6-33. Model fit (blue line) the set gillnet commercial fishery (Set). Lines indicate 95% uncertainty interval around index values. Thicker lines indicate input uncertainty before addition of estimated additional uncertainty.

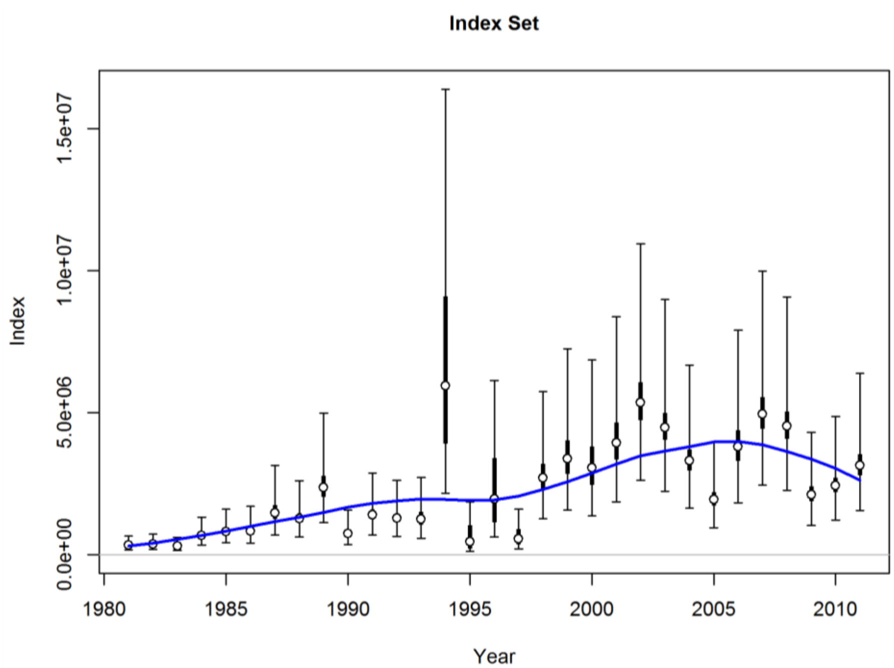


Figure 6-34. Model fit (blue line) to the historical CPFV index (CPFV_H). Lines indicate 95% uncertainty interval around index values. Thicker lines indicate input uncertainty before addition of estimated additional uncertainty.

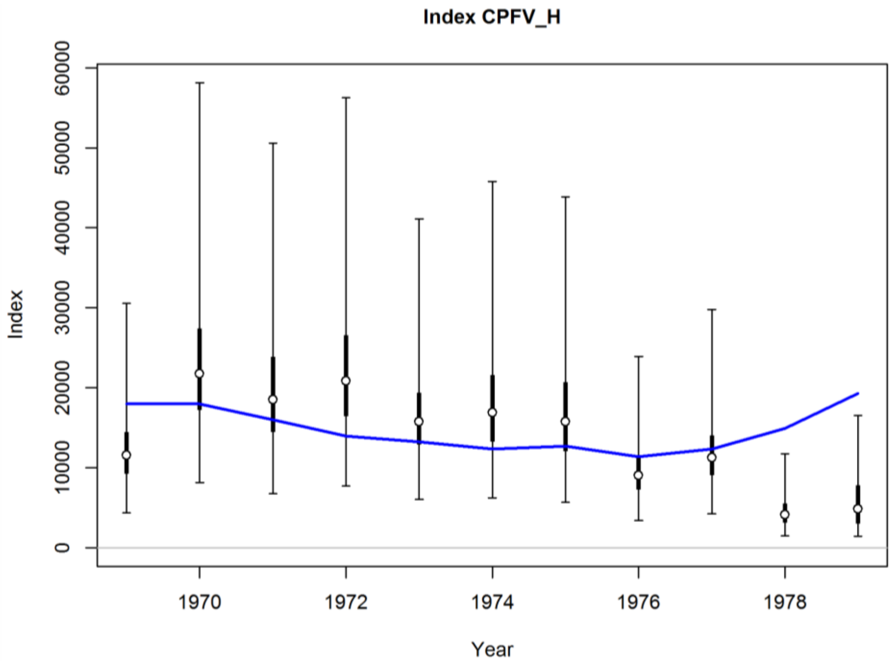


Figure 6-35-1. Model fit (blue line) to the modern CPFV index (CPFV_M). Lines indicate 95% uncertainty interval around index values. Thicker lines indicate input uncertainty before addition of estimated additional uncertainty.

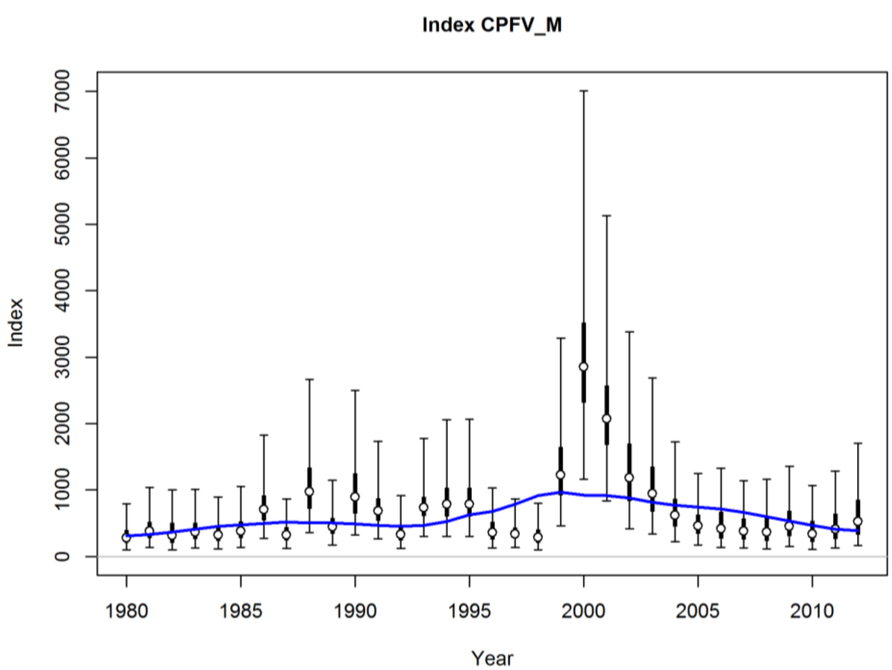


Figure 6-36. Model fit (blue line) to the HSWRI gillnet survey index (HSWRI). Lines indicate 95% uncertainty interval around index values. Thicker lines indicate input uncertainty before addition of estimated additional uncertainty.

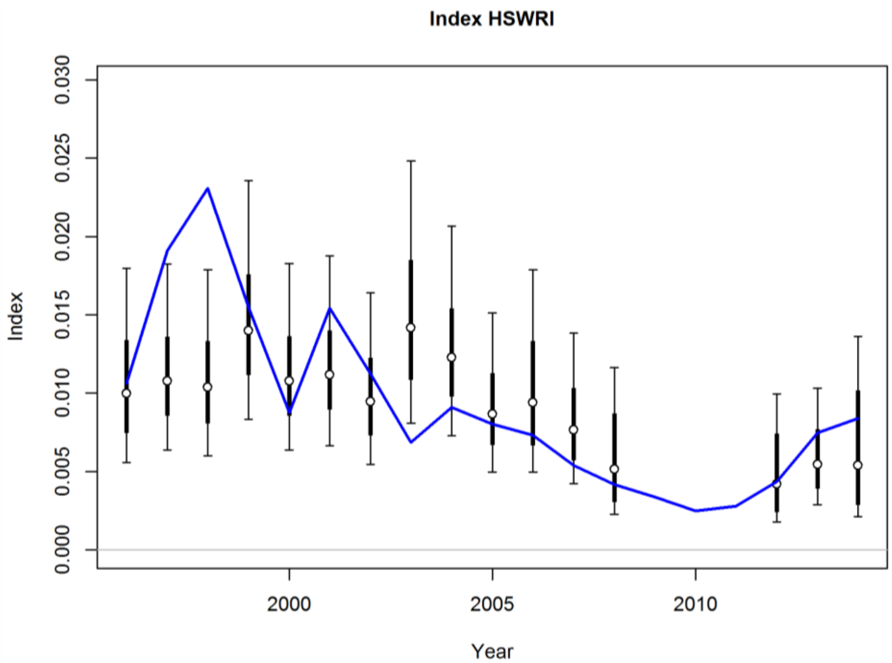


Figure 6-37. Model fit (blue line) to the Power Plant Heat Treatment (PP) index. Lines indicate 95% uncertainty interval around index values. Thicker lines indicate input uncertainty before addition of estimated additional uncertainty.

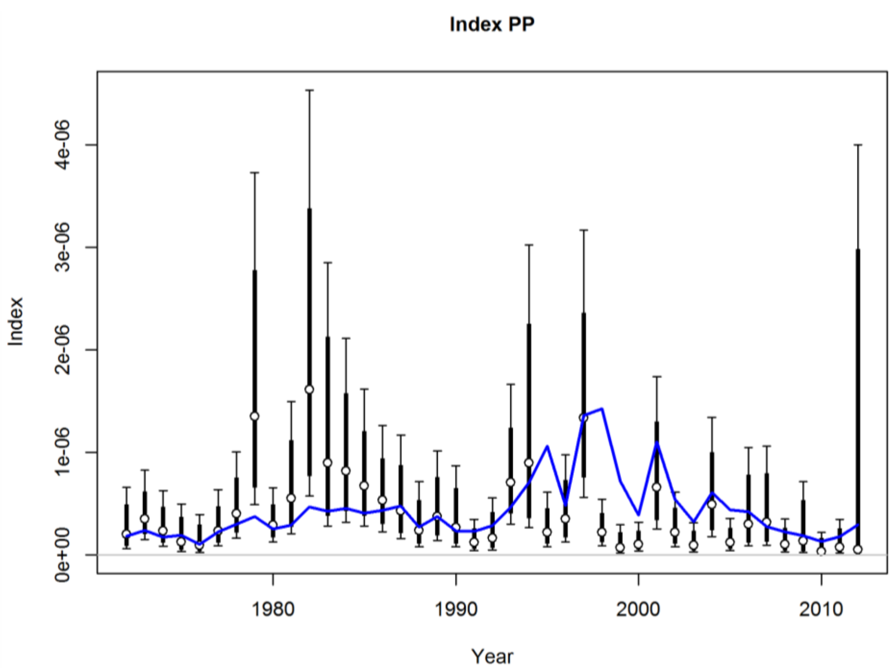


Figure 6-38. Time series of estimated female spawning biomass with 95% asymptotic confidence intervals. The blue dot before the start of the time series is the estimated equilibrium virgin unfished female spawning biomass (B0) with 95% asymptotic confidence interval.

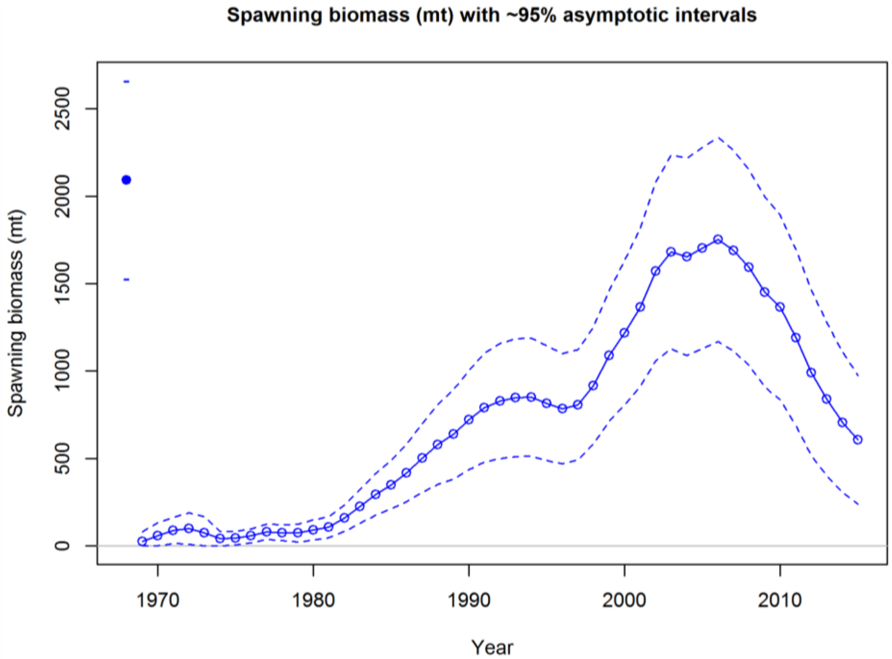


Figure 6-39. Time series of estimated age-0 recruits with 95% asymptotic confidence intervals. The blue dot before the start of the time series is the estimated equilibrium unfished average recruitment (R0) with 95% asymptotic confidence interval.

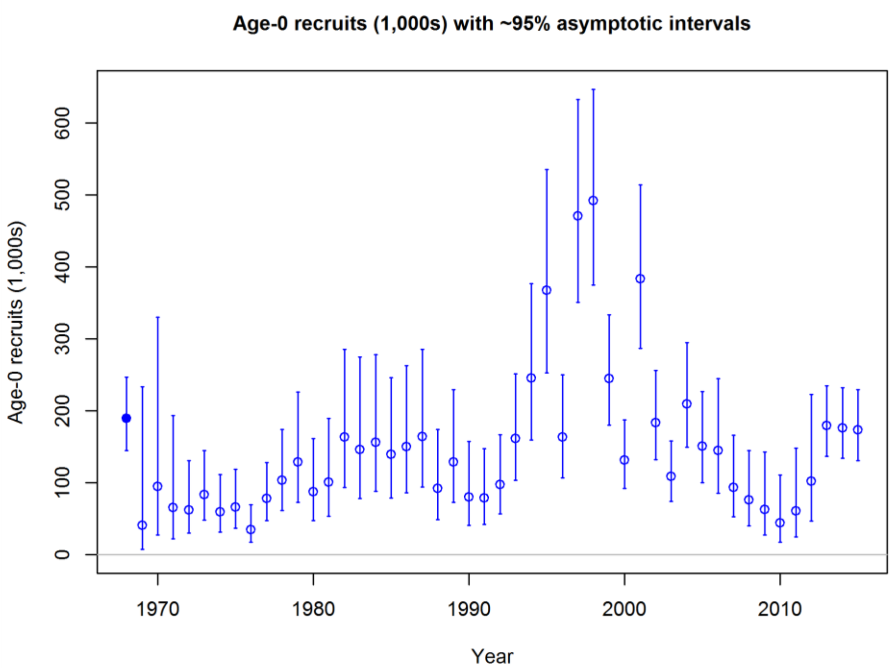
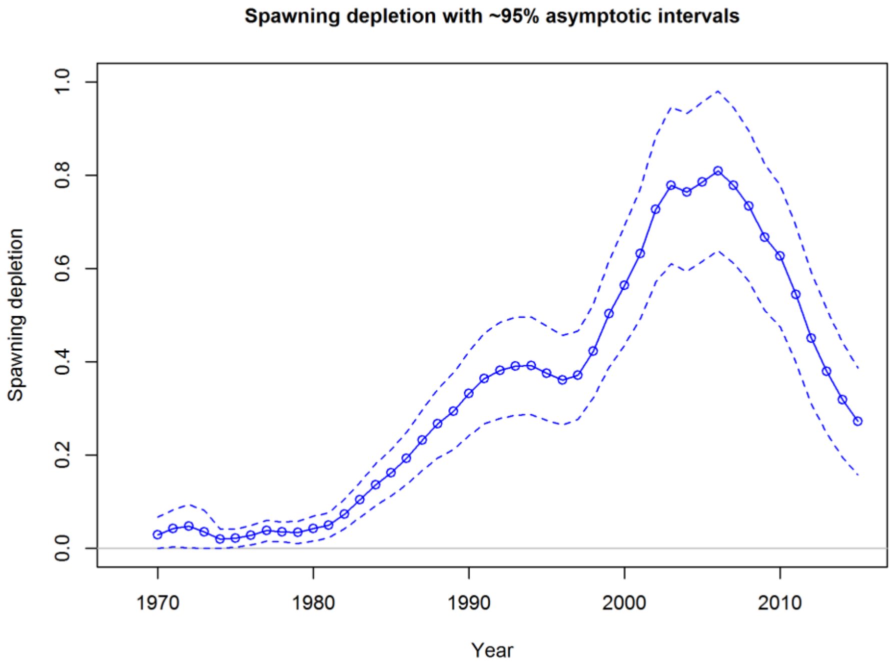


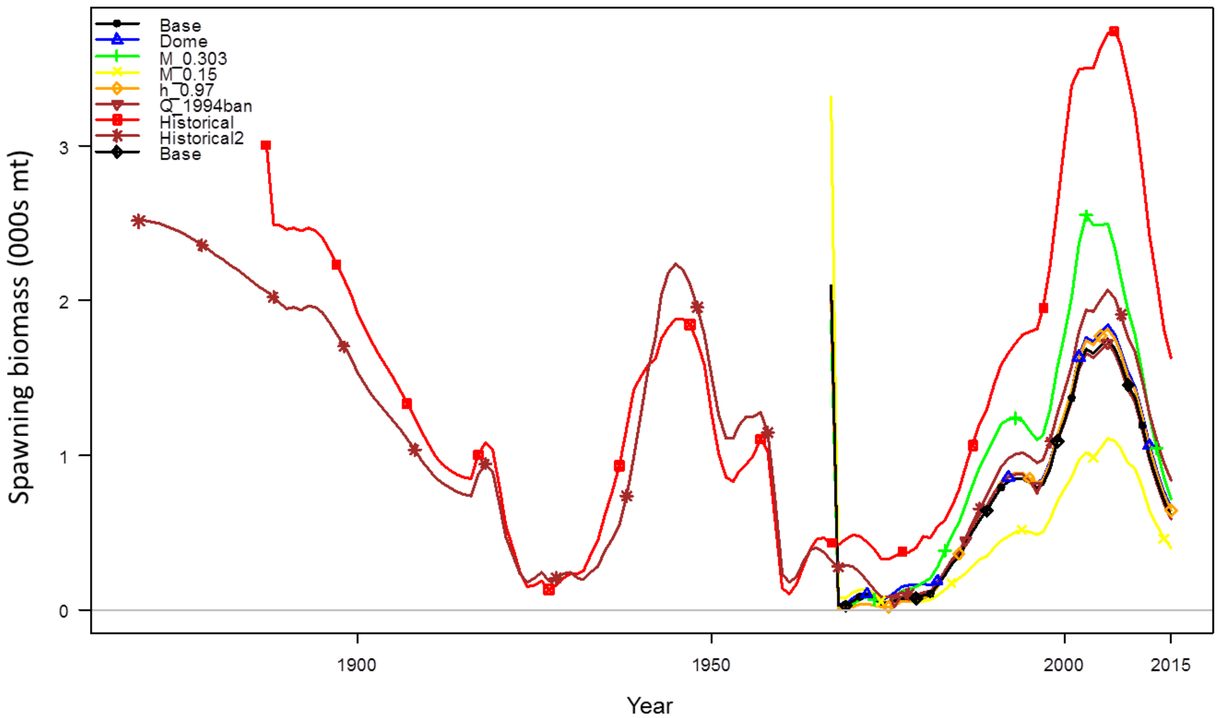
Figure 6-40. Estimated female spawning biomass depletion with 95% asymptotic confidence intervals.

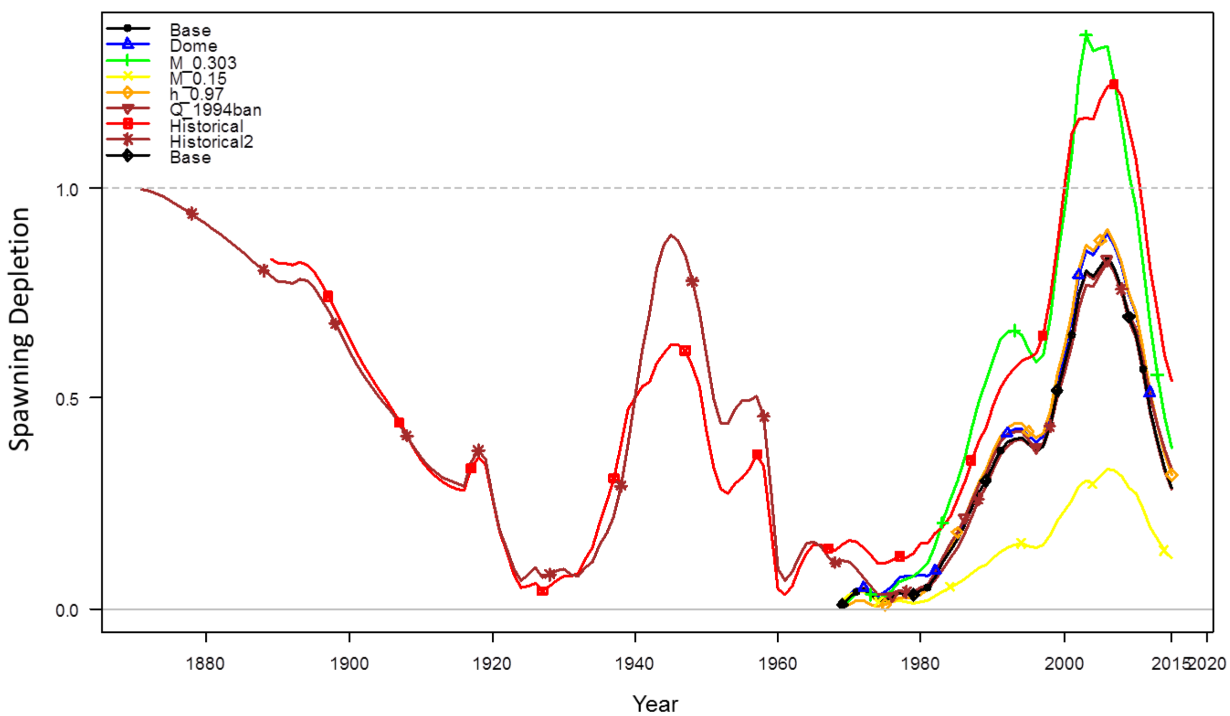


Alternative models explored

Sensitivity analyses included a comparison of key model assumptions and were based on nested models including asymptotic vs. domed selectivity, alternative values of *M*, *h*, proportional vs. non-proportional relationship between indices of abundance and biomass. Alternative models were run allowing for a change in catchability for the drift and set commercial gillnets in 1994, the year that the southern California nearshore gillnet ban went into effect (CDFG, 2002). Runs modelling dynamics between 1889 and 2014 (*Historical*), between 1870 and 2014 (*Historical2*) were conducted, contrasting with the base-case model 1969 to 2014 (*Modern*) time frame. Although *Modern* models explored during sensitivity analyses converged, *Historical* and *Historical2* models were unstable and had convergence issues. Additional sensitivities were conducted during the review and are also included in the Review Panel Report. Sensitivity analyses showed that the general results in terms of estimated population trajectories did not change markedly, although the estimated scale of the population showed some variability.

Figure 6-43. Estimated female spawning biomass (Top panel) (in thousands of metric tons) and female spawning biomass depletion (Bottom panel) for the base and alternative models. Modern models starting in 1969 show a vertical line that is not the estimated trajectory but the difference between the estimated virgin spawning biomass and the estimated biomass in the first year. See text for description of alternative models.





Reference points

Reference points are benchmarks that allow fishery scientists and managers to evaluate where a fished population is with respects of those benchmarks. The White Seabass Fishery Management Plan (WSFMP) (CDFW, 2002) uses a framework plan approach for managing the white seabass fishery that relies on a series of trigger mechanisms and points of concern (CDFW, 2002). Management alternatives based on a theoretical maximum amount of catch that can be taken from a stock year after year in a sustainable way, this is called the Maximum Sustainable Yield (MSY) are also considered in the WSFMP. The MSY calculations used in the WSFMP are based on early population modelling on white seabass (MacCall et al. 1976; Dayton and MacCall 1992) and resulted in a MSY proxy of 1.6 million pounds (CDFW, 2002), or 726 metric tons. The WSFMP also defines alternative Optimal Yields (OY) of 0.75 and 0.8125 of MSY, corresponding to 1.2 and 1.3 million pounds (544 mt and 590 mt) respectively.

Maximum Sustainable Yield (MSY) is estimated by this stock assessment at less than half of that reported by previous works and to occur at a relatively low fraction of the unexploited female spawning biomass. The base case model estimates a MSY of 306 (95% asymptotic CI: 225 - 388) metric tons, corresponding to a female spawning biomass (B_{MSY}) of 447 mt (CV = 0.14) and to a depletion of 0.24. Alternative estimates of MSY ranged between 294 and 475 mt for alternative vales of natural mortality and between 260 and 336 mt for alternative values of the parameter that defines the productivity of the stock.

The base case model estimates white seabass female spawning biomass in 2015 at 569 mt (~95% asymptotic interval: 241- 896 mt) (Figure 6.38). Virgin unfished female spawning biomass (*B0*) is estimated at *B0*: 2092 mt (~95% asymptotic interval: 1600 - 2584 mt). The base case model estimates 2015 depletion at 27% (~95% asymptotic interval: 16%- 39%) (Figure 6.40). Under Pacific Fishery Management Council (PFMC) Groundfish management policy, if the current spawning biomass of a stock falls at or below 25% of the unexploited biomass, the stock is considered overfished. The estimated 2015 depletion of 0.27 (~95% asymptotic interval: 0.16-0.39) (Figure 6.40) is below what would be a PFMC biomass target of 40% depletion, but above what would be a PFMC minimum stock size threshold of 25% biomass depletion. White seabass biomass is estimated to be decreasing over the last 9 years (Figure 6.40). However, under California State guidelines (set in the white seabass fisheries management plan (CDFG, 2012)) white seabass would be considered overfished only if three conditions are met simultaneously: 1) total annual commercial catch of white seabass in pounds landed (from fish receipt data) for two consecutive years declines each year by 20% or greater from the prior five-year average of landings; 2) a 20% decline occurs in the number of fish and average size of fish (round weight) for the same two consecutive years for white seabass caught in the recreational fishery as determined from the best available data and 3) recruitment of juvenile white seabass declines each year by 30% or greater from the prior five-year average of recruitment as determined from the best available data.

8. Research needs

The following is a list of stock assessment and research recommendations. A complimentary list of research needs is available in the Stock Assessment Review Report.

- Additional research on the CPFV datasets.
- Additional work on the recreational data. In this assessment an “other” recreational fishery (“OtherRec”) was defined to separate it from the CPFV fishery. However, the OtherRec fishery could not be further separated given the lack of appropriate length composition data to be able to estimate separate selectivities, or develop indices of relative abundance.
- More information on mortality from other fisheries not targeting white seabass is needed.
- Collection and processing of otoliths for estimating age compositions of the catch of different gears is needed. The collection program should include gender-specific age sampling of commercial and recreational fishery catches and discards.
- The rationale behind the use of a minimum size limit is allowing the fish to spawn before being killed. A fish can be killed either by being retained when caught or by being discarded or released post-capture but not surviving the capture event. Given the current use of a minimum size limit, undersized white seabass caught by recreational and commercial fisheries are released or discarded. There is limited information on the total amount discarded, and only for some fisheries. There is very little information on size/age/sex of discards or released fish. Collection of discard data, both regarding the amount, size/age/sex compositions and survival of discarded fish would allow the estimation of retention curves and better estimation of total mortality of the stock.
- It is recommended to evaluate alternative potential harvest strategies (including selectivity, alternative size limits and/or seasonal closures, total catch, etc.).
- The available maturity information for white seabass is very limited. Additional data should be collected on the relationship between fish size and maturity state. Age data should also be collected to determine maturity at size and/or age.
- Sampling of the relationship between fork length and total length of white seabass is needed to convert between the two data types. Some of the historical recreational data is currently in fork length and there is no relationship available other than a length-invariant constant added. It would be expected that the amount to add to fork length will vary by total length.
- Support, enhance and expand tagging programs for white seabass. Fishery independent programs seem logistically challenging for this species. Tagging projects can be a way to incorporate less-fishery dependent data in future analyses. Tagging data can inform about fish movement, abundance, survival and growth.
- There is evidence of white seabass transboundary movements, both seasonal and inter annual, between Mexico and USA. Collaborative work between researchers of both countries is expected to increase understanding of white seabass dynamics under exploitation including: life history, history of catches, and interpretation of relative abundance indices in years where oceanographic conditions are suspected to affect distributional changes across the border.
- Timely updates to this stock assessment (the first white seabass) are recommended given the large changes in estimated biomass, the ongoing 9-year decline in spawning biomass, current depletion levels and the lack of updated data up to the final year of the model.

9. Acknowledgements

The white seabass stock assessment was funded by Pfleger Institute of Environmental Research (PIER) with contributions from the George T. Pfleger Foundation and the Offield Family Foundation. Tom Pfleger and the Late Paxon Offield were key supporters of this work.

Several Staff at CDFW provided invaluable assistance with obtaining, interpreting and answering questions about the data. These people include, but were not limited to: Debbie Aseltine-Neilson, Kathryn Crane, Valerie Taylor, Connie Ryan. Data was supplied by several people and entities, including, but not limited to: Michael A. Shane (Hubbs SeaWorld Research Institute), Larry G. Allen (California State University Northridge), Eric Miller (MBC Applied Environmental Sciences), Southern California Edison, Chugey Sepulveda and Scott Aalbers (Pfleger Institute of Environmental Research), Alfonsina Romo-Curiel (CICESE, México).

Mark Maunder, Paul Crone and Brice Semmens from the Center for the Advancement of Population Assessment Methodology (CAPAM) provided logistical and technical assistance at different stages of this project. Brice Semmens, Chugey Sepulveda and Scott Aalbers provided comments to an earlier version of this document that helped improve this report.

An Independent Review Panel reviewed this Stock Assessment during May 2-3, 2016 at the Scripps Campus in La Jolla. The review panel consisted of Ian G. Taylor and Jason Cope (FRAM stock assessment team members, NOAA Fisheries). The review was open to the public with participants from California Department of Fish and Wildlife, Pfleger Institute of Environmental Research, California Sea Grant, Hubbs SeaWorld Research Institute, Scripps Institution of Oceanography, University of California San Diego and from the fishing community. We want to thank both reviewers for their input; insightful comments and suggestions that helped improve the quality of this work.