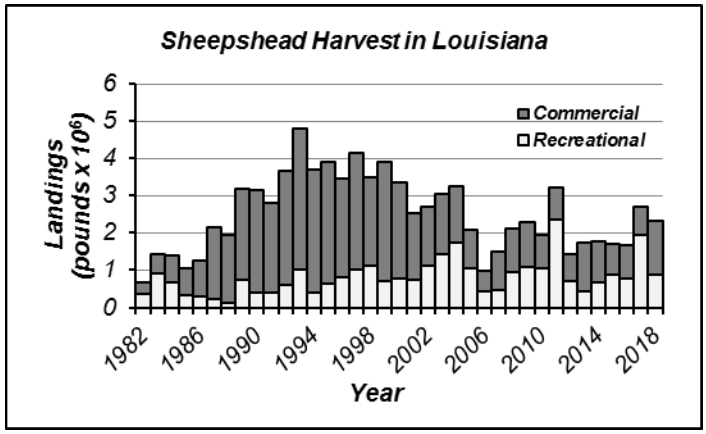
Assessment of Sheepshead *Archosargus probatocephalus* in Louisiana Waters
2020 Report

<u>*Executive Summary*</u>

Landings of sheepshead in Louisiana have averaged over 2 million pounds per year in the most recent decade. The highest harvests on record (over 4 million pounds) occurred during the mid-90's. After commercial gear restrictions were enacted in 1995, commercial landings declined. In the most recent years, recreational landings comprise approximately 50% of the total Louisiana sheepshead harvest.



A statistical catch-at-age model is used in this assessment to describe the dynamics of sheepshead occurring in Louisiana waters from 1982-2018. The assessment model projects abundance-at-age from estimates of abundance in the initial year of the time-series and recruitment estimates in subsequent years. The model is fit to the data with a maximum likelihood fitting criterion. Minimum data requirements are fishery catch-at-age and an index of abundance. Landings are taken from the Louisiana Department of Wildlife and Fisheries (LDWF) Recreational Creel Survey and Commercial Trip Ticket Programs, the National Marine Fisheries Service (NMFS) commercial statistical records, and the NMFS Marine Recreational Information Program (MRIP). An index of abundance is developed from the LDWF marine trammel net survey. Age composition of fishery catches are estimated with age-length-keys derived from samples directly of the fishery and a von Bertalanffy growth function.

There are currently no management thresholds established for the Louisiana sheepshead stock and no biological basis to establish management limits based on the history of the stock. Until biologically-based thresholds are established, a default limit of a 20% spawning potential ratio is proposed. Based on results of this assessment, the Louisiana sheepshead stock is currently neither overfished or experiencing overfishing. The current spawning potential ratio estimate is 69%.

<u>*Summary of Changes from 2015 Assessment*</u>

Assessment model inputs have been updated through 2018. No changes have been made to the assessment model itself. A number of changes have been made to the data inputs of the assessment model that are described below. Because of these changes, this stock assessment is considered a benchmark assessment rather than an update of the previous assessment.

The time-series of recreational landings estimates used in this assessment has changed. In the previous assessment, recreational landing estimates were taken from the NMFS MRIP survey. In this assessment, recreational landings estimates are taken from the LDWF Recreational Creel Survey (LA Creel; 2014-2018) and estimates hindcast to the historic MRIP time-series (1982-2013; details in *Appendix 1*).

A new sampling program was established by LDWF in 2014, at the same time as the transition from MRIP to LA Creel, to provide biological information characterizing the size and age composition of LA fishery landings. In earlier assessments, size composition information of recreational landings was taken entirely from the MRIP survey. In this assessment, beginning in 2014, size composition of recreational landings was obtained from the LDWF Biological Sampling Program and from MRIP for years prior (details in *2. Data Sources*).

The LDWF marine trammel net survey is used to develop an index of abundance as a data input of the assessment model. This survey was conducted from 1986 to October 2013 at fixed sampling stations within each LDWF Coastal Study Area (CSA). In October 2010, additional fixed stations were added to allowing more spatial coverage within each CSA. Beginning in 2013, the survey design was modified where sampling locations are now selected randomly from the established stations within each CSA (details in *2. Data Sources*).

The sex-specific von Bertalanffy growth models that were used in the previous assessment to describe male and female growth rates and develop age-length-keys for age assignments of fishery and survey catches has been replaced in this assessment with a non-sex-specific von Bertalanffy growth model fit to a LDWF dataset (details in *Appendix 2*).

The weight-length regression used in the previous assessment has been replaced in this assessment with a regression fit to a LDWF dataset (details in *Appendix 2*).

A change was also made to better represent the uncertainty of recreational and commercial landings in the assessment model. In the previous assessment, variability of landings was assumed constant across each time-series. In this assessment, annual values of variability are used to control model fits of fishery yield (details in *6. Assessment Model*).

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1. Introduction

A statistical catch-at-age model is used in this assessment to describe the dynamics of sheepshead *Archosargus probatocephalus* occurring in Louisiana (LA) waters from 1982-2018. The assessment model forward projects abundance at age from estimates of abundance in the initial year of the time-series and recruitment estimates in subsequent years. The model is fit to the data with a maximum likelihood fitting criterion. Minimum data requirements are fishery catch-at-age and an index of abundance. Commercial landings values are taken from the Louisiana Department of Wildlife and Fisheries (LDWF) Trip Ticket Program and the National Marine Fisheries Service (NMFS) commercial statistical records. Recreational harvest estimates are obtained from the LDWF Recreational Creel Program (LA Creel) and the NMFS Marine Recreational Information Program (MRIP). An index of abundance is developed from the LDWF marine trammel net survey. Age composition of fishery catches are estimated with age-length-keys derived from samples directly of the fishery (2002-2018) and a von Bertalanffy growth model (1982-2001).

1.1 Fishery Status

A comprehensive history of the sheepshead (SH) resource and associated fishery within LA is described in Schexnayder et al. (1998) and for the Gulf of Mexico (GOM) in GSMFC (2006). A current summary of the Louisiana SH fishery is presented below.

Commercial

The commercial SH fishery operates primarily in larger bays and lakes within state inside waters from the coast inland to the freshwater-saltwater line, including the Mississippi River, and state outside territorial waters from the coastline seaward to the state territorial sea boundary. Some harvest also occurs from federal waters of the Exclusive Economic Zone (EEZ). While SH are harvested year round as bycatch, the winter fisheries will target sheepshead opportunistically as encountered (GSMFC 2006).

Recreational

The recreational fishery for SH operates primarily within state inside waters from the coastline inland to the freshwater-saltwater line and state territorial waters from the coastline seaward to the state territorial sea boundary, with very little harvest from federal waters of the EEZ. Sheepshead are infrequently targeted recreationally with less than 1% of LA anglers reporting sheepshead as their primary target in 2018 (LA Creel unpublished data).

1.2 Fishery Regulations

The LA SH fishery is governed by the Louisiana State Legislature, the Wildlife and Fisheries Commission, and the LDWF. Reviews of LA commercial and recreational regulations are presented below.

Commercial

Commercial SH harvesters are limited to a 10-inch minimum size limit. Rules for the commercial harvest of SH in LA changed substantially from 1995 through 1997. Commercial harvest methods were restricted in 1995 when the Marine Resources Conservation Act of 1995 (Act 1316 of the 1995 Regular Legislative Session) became effective. This act prohibited the use of "set" gill nets and trammel nets in saltwater areas of LA, and restricted SH harvest by the use of "strike" nets to the period between the third Monday in October and March 1 of the following year. A "Restricted Species Permit" issued by LDWF was required in order to harvest SH, and several criteria were established in order to qualify for that permit. After March 1, 1997, all SH harvest by gill and trammel nets was banned, and commercial harvesters were required to utilize other legal commercial gear to harvest sheepshead such as trawls, set lines, or hook and line.

Recreational

There are currently no size or creel limit regulations for the recreational harvest of SH in LA.

1.3 Trends in Harvest

Time-series of recreational and commercial SH landings are presented in Table 1 and Figure 1.

Commercial

Commercial harvest of SH in LA was relatively light (<0.4 million pounds) until the 1980s when commercial harvest expanded. Commercial harvest rapidly increased in the early 1980s and into the 1990s, peaking at 3.8 million pounds in 1993. Landings remained high throughout the 1990s, averaging close to 3 million pounds. During the 2000s, commercial SH harvest declined from 2.6 million pounds harvested in 2000 to under 1 million pounds in 2006. Commercial landings in 2006 were greatly influenced by the passage of hurricanes Katrina and Rita the previous year, which caused extensive damage to infrastructure, vessels, and gear of the inshore and offshore trawl fleets. Commercial harvest of SH rebounded in the late 2000s with harvests averaging just over 1 million pounds in the most recent decade. In 2018, 1.4 million pounds of sheepshead were commercially harvested in LA.

Recreational

Recreational landings of SH in LA has varied from a low of 0.11 million pounds harvested in 1988 to a high of 2.4 million pounds harvested in 2011. Other peaks in harvest were observed in 2004 (1.8 million pounds) and 2017 (2.0 million pounds). In 2018, 0.88 million pounds of SH were recreationally harvested in Louisiana.

2. Data Sources

2.1 Fishery Independent

The LDWF fishery-independent (FI) marine trammel net survey is used in this assessment to develop an index of abundance as an input of the assessment model. Below is a brief description of this survey's methodology. Complete details can be found in LDWF (2018).

For sampling purposes, coastal Louisiana is currently divided into five LDWF coastal study areas (CSAs). Current CSA definitions are as follows: CSA 1 – Mississippi State line to South Pass of the Mississippi River (Pontchartrain Basin); CSA 3 – South Pass of the Mississippi River to Bayou Lafourche (Barataria Basin); CSA 5 – Bayou Lafourche to eastern shore of Atchafalaya Bay (Terrebonne Basin); CSA 6 – Eastern shore of Atchafalaya Bay to western shore of Freshwater Bayou Canal (Vermillion/Teche/Atchafalaya Basins); CSA 7 – western shore of Freshwater Bayou Canal to Texas State line (Mermentau/Calcasieu/Sabine Basins).

The LDWF Marine Fisheries Section conducts routine standardized sampling within each CSA as part of a long-term comprehensive monitoring program to collect life-history information and measure relative abundance/size distributions of recreationally and commercially important species. These include the experimental marine gillnet, trawl, trammel net, and bag seine surveys.

In this assessment, only the FI marine trammel net survey is used. This survey is conducted with standardized design from October-March. Hydrological and climatological measurements are taken with each biological sample, including water temperature, turbidity, conductivity and salinity. Survey gear is a 750-foot long and 6-foot depth net, consisting of 3 walls constructed of nylon. The inner wall has 1 5/8-inch bar mesh wall, and the two outer walls have 6-inch bar mesh wall.

Samples are taken by 'striking' the net. All captured SH are enumerated and a maximum of 50 randomly selected SH are collected for length measurements, gender determination, and maturity information. When more than 50 SH are captured, catch-at-size is derived as the product of total catch and proportional subsample-at-size.

This survey was conducted from 1986 to October 2013 at fixed sampling stations within each CSA. In October 2010, additional fixed stations were added to allowing more spatial coverage within each CSA. Beginning in 2013, the survey design was modified where sampling locations are now selected randomly from the established stations within each CSA

2.2 Fishery Dependent

Commercial

Commercial SH landings are taken from the LDWF Trip Ticket Program and the NMFS commercial statistical records (NMFS 2019; Figure 1).

Annual size compositions of commercial sheepshead harvest (Table 2) are developed from samples from the Trip Interview Program (TIPS; 1982-2002) the Fishery Information Network (FIN; 2002-2013), and the LDWF Biological Sampling Program (2014-2018). Due to very limited size composition samples collected in early years of the commercial fishery, the 1995 TIPS size composition data are pooled with the available size data from earlier years and used as a proxy of the 1982-1994 size compositions. For other years where annual size composition samples were < 200 (1998, 1999, and 2001), samples from the previous and prior years were pooled with that year's size composition samples. Due to low sample size in 2002, the available TIPS and FIN size composition samples were combined.

Commercial live release estimates of SH are not available and are approximated in this assessment using recreational estimates. The proportion of annual recreationally landed SH <10-inches total length (TL) are used as a proxy of commercial discards. Annual commercial SH landings are expanded by these proportions to approximate the number of commercially discarded SH per year. The size composition of annual recreationally landed SH <10-inches TL are then used as a proxy of the size composition of commercial live releases.

Ages of commercial sheepshead landings are derived from a von Bertalanffy growth model (1982-2001) and otoliths collected directly from the commercial fishery (2002-2018; see *5. Catch at Age Estimation*).

Recreational

Recreational SH landings and live release estimates are taken from the LDWF recreational creel survey (LA Creel; 2014-2018) and estimates hindcast to the historic MRIP time-series (1982-2013; details in *Appendix 1*). Consequently, the pre-2014 recreational estimates used in this assessment differ from the LA estimates currently published by MRIP (https://www.st.nmfs.noaa.gov/recreational-fisheries/data-and-documentation/queries/index). Furthermore, due to changes made to the MRIP Access Point Angler Intercept Survey (APAIS) in 2013 (see https://www.fisheries.noaa.gov/topic/recreational-fishing-data#making-improvements) and the recent transition from the MRIP Coastal Household Telephone Survey to the new Fishing Effort Survey (FES; see https://www.fisheries.noaa.gov/recreational-fishing-data/types-recreational-fishing-surveys#fishing-effort-survey), harvest estimates currently available from MRIP also differ from those used in the prior LA SH stock assessment (West *et al.* 2015).

Annual size composition of recreational SH harvest estimates are derived from the LDWF Biological Sampling Program (2014-2018) and MRIP (1982-2013, prior to the APAIS and FES calibration changes; Table 3). Size composition estimates of recreational live releases are not available. Due to no size limit regulation on the recreational fishery, annual size compositions of live releases are assumed equivalent to harvest. Statewide size compositions obtained from the LDWF Biological Sampling Program are derived by statistically weighting the CSA-specific size compositions by the corresponding recreational landings estimates.

Ages of recreational sheepshead landings are derived from a von Bertalanffy growth model (1982-2001) and otoliths collected directly from the recreational fishery (2002-2018; see *5. Catch at Age Estimation*).

3. Life History Information

3.1 Unit Stock Definition

Genetic analyses of SH collected between North Carolina and Texas suggest no distinct geographic stock in the Southern Atlantic and the GOM (Murphy and MacDonald 2000). However, for purposes of this assessment and to remain consistent with the current statewide management strategy, the unit stock is defined as those SH occurring in LA waters.

3.2 Morphometrics

The weight-length regression from Beckman et al. (1991) used in the previous assessment (West et al. 2015) is replaced in this assessment with a regression fit to a LDWF dataset (see *Appendix 2*). Regression equation slopes comparing males and females were not significantly different. For the purpose of this assessment, the non-sex-specific formulation is used with weight calculated from size as:

$$W = 7.30 \times 10^{-4} (TL)^{2.96} \quad [1]$$

where W is whole weight in pounds and TL is total length in inches.

Fish with only FL measurements available are converted to TL from the following relationship provided by the Florida Fish and Wildlife Research Institute for an earlier LDWF sheepshead stock assessment (Blanchet 2008):

$$TL = 4.233 + 1.090 \times FL \quad [2]$$

where FL is in units of mm.

3.3 Growth

The sex-specific von Bertalanffy growth models from Beckman et al. (1991) used in the previous assessment (West et al. 2015) are replaced in this assessment with a non-sex-specific von Bertalanffy growth model fit to a LDWF dataset (see *Appendix 2*). Sheepshead total length-at-age is calculated with the von Bertalanffy growth model as:

$$TL_a = 19.1 \times (1 - e^{-0.460(a+0.0858)}) \quad [3]$$

where TL_a is TL-at-age in inches and years.

3.4 Fecundity / Maturity / Sex Ratio

Sheepshead are group-synchronous fractional spawners (Render and Wilson 1992). To realistically estimate annual fecundity, the number of eggs spawned per batch and the number of batches spawned per season must be known. Estimates of batch fecundity and spawning frequency for GOM sheepshead as a function of size/age/weight are not available. For purposes of this assessment, female spawning stock biomass (SSB) is used as a proxy of total egg production. This may introduce bias if fecundity does not scale linearly with body weight (Rothschild and Fogarty 1989).

An age-specific maturity vector (Render and Wilson 1992) is used in this assessment where no female age-1 sheepshead spawn, 95% of age-2 females spawn, and 100% of age-3 and greater females spawn.

Sex ratios observed in LDWF fishery-independent and fishery-dependent samples are also very close to 1:1. For purposes of this assessment, the sex ratio-at-age is assumed to be 50:50.

3.5 Natural Mortality

Sheepshead can live to at least twenty years (Beckman et al. 1991; see *Appendix 2*). For purposes of this assessment, a value of constant M is assumed (0.21) based on the longevity of the species, but is allowed to vary with weight-at-age to calculate a declining natural mortality rate with age. This value of M is consistent with a stock where approximately 1.5% of the stock remains alive to 20 years of age (Quinn and Deriso 1999, Hewitt and Hoenig 2005). Following SEDAR 12 (SEDAR 2006), the value of M is rescaled where the average mortality rate over ages vulnerable to the fishery is equivalent to the constant rate over ages as:

$$M_a = M \frac{nL(a)}{\sum_{a_c}^{a_{max}} L(a)} \quad [4]$$

where M is the constant natural mortality rate over exploitable ages a , a_{max} is the oldest age-class, a_c is the first fully-exploited age-class, n is the number of exploitable ages, and $L(a)$ is the Lorenzen curve as a function of age. The Lorenzen curve as a function of age is calculated from:

$$L(a) = W_a^{-0.288} \quad [5]$$

where -0.288 is the allometric exponent estimated for natural ecosystems (Lorenzen 1996) and W_a is weight-at-age.

3.6 Relative Productivity and Resilience

The key parameter in age-structured population dynamics models is the steepness parameter (h) of the stock-recruitment relationship. Steepness is defined as the ratio of recruitment levels when the spawning stock is reduced to 20% of its unexploited level relative to the unexploited level and determines the degree of compensation in the population (Mace and Doonan 1988). Populations with higher steepness values are more resilient to perturbation and if the spawning stock is reduced to levels where recruitment is impaired are more likely to recover sooner once overfishing has ended. Generally, this parameter is difficult to estimate due to a lack of contrast in spawning stock size (*i.e.*, data not available at both high and low levels of stock size) and is typically fixed or constrained during the model fitting process. Estimates of steepness are not available for sheepshead.

Productivity is a function of growth rates, natural mortality, age of maturity, and longevity and can be a reasonable proxy for resilience. We characterize the relative productivity of GOM sheepshead based on life-history characteristics, following SEDAR 9 (SEDAR 2006), with a classification scheme developed at the FAO second technical consultation on the suitability of the CITES criteria for listing commercially-exploited aquatic species (FAO 2001; Table 4). Each life history characteristic (von Bertalanffy growth rate, age at maturity, longevity, and natural mortality rate) is assigned a rank (low=1, medium=2, and high=3) and then averaged to compute an overall productivity score. In this case, the overall productivity score is 2.50 for GOM sheepshead indicating medium to high productivity.

4. Abundance Index Development

A sheepshead index of abundance (IOA) is developed from the LDWF marine trammel net survey. Samples collected during the months of January, February, and March are grouped with the previous year's October, November, and December samples for IOA development. Catch per unit effort (CPUE) is defined as the number of SH caught per trammel net sample. To reduce unexplained variability in catch rates unrelated to changes in abundance, the IOA was standardized using methods described below.

A delta lognormal approach (Lo et al. 1992; Ingram et al. 2010) is used to standardize sheepshead catch-rates in each year as:

$$I_y = c_y p_y \quad [6]$$

where c_y are estimated annual mean CPUEs of non-zero sheepshead catches assumed as lognormal distributions and p_y are estimated annual mean probabilities of sheepshead capture assumed as binomial distributions. The lognormal and binomial means and their standard errors are estimated with generalized linear models as least squares means and back transformed. The lognormal model considers only samples in which sheepshead are captured; the binomial model considers all samples. The IOA is then computed from equation [6] using the estimated least-squares means with variances calculated from:

$$V(I_y) \approx V(c_y)p_y^2 + c_y^2 V(p_y) + 2c_y p_y \mathrm{Cov}(c,p) \quad [7]$$

where Cov$(c,p)\approx \rho_{c,p}\left[SE(c_y)SE(p_y)\right]$ and $\rho_{c,p}$ represents the correlation of c and p among years.

Because of the designed nature of the LDWF marine trammel net survey, model development was rather straightforward. Variables considered in model inclusion were year, CSA, and sampling location. Because only seasonal samples are included (*i.e.*, October-March), time of year was not considered in model inclusion. To determine the most appropriate models, we began the model selection process with a fully-reduced model that included only year as a fixed effect. More complex models were then developed including interactions and random effects and compared using AIC and log-likelihood values. All sub-models were estimated with the SAS generalized linear mixed modeling procedure (PROC GLIMMIX; SAS 2008). In the final sub-models, year was considered a fixed effect, CSA was considered a random block effect, and sampling locations within CSAs were considered random subsampling block effects.

Sample sizes, proportion positive samples, nominal CPUE, the standardized index of abundance, and coefficients of variation of the standardized index are presented (Table 5). Standardized and nominal CPUEs, normalized to 1 for comparison, are also presented graphically (Figure 2).

5. Catch at Age Estimation

Age-length-keys (ALKs) are developed to estimate the annual age composition/catch-at-age of commercial and recreational sheepshead landings and survey catches as described below.

Sheepshead spawn offshore during the spring with a peak in March and April (GSMFC 2006). An April 1st birthday is typically assumed as a biological birthday. However, for purposes of this assessment, ages are assigned based on the calendar year by assuming a January 1st birthday, where SH spawned the previous year become age-1 on January 1st and remain age-1 until the beginning of the following year.

5.1 Fishery

1982-2001 Probabilities of age a given length l for recreational and commercial sheepshead landings are computed from:

$$P(a|l) = \frac{P(l|a)}{\sum_a P(l|a)} \quad [8a]$$

where the probability of length given age is estimated from a normal probability density as:

$$P(l|a) = \frac{1}{\sigma_a\sqrt{2\pi}} \int_{l-d}^{l+d} exp\left[-\frac{(l-l_a)^2}{2\sigma_a^2}\right] dl \quad [8b]$$

where length bins are 1 inch TL intervals with midpoint l, maximum $l + d$, and minimum $l - d$ lengths. Mean total length-at-age l_a is estimated from Equation [3]. The standard deviation in length-at-age is approximated from $\sigma_a = l_a CV_l$, where the coefficient of variation in length-at-age is assumed constant (in this case approximated as 0.05). To approximate changes in growth through the year, mean length-at-age is calculated at the mid-point of the calendar/model year. The resulting $P(a|l)$ matrix is used to assign ages to SH fishery landings from 1982-2001 (Table 6) and also for instances discussed below.

2002-2018 Fishery-specific f (*i.e.*, commercial and recreational) probabilities of age given length are computed from:

$$P(a|l)_{yf} = \frac{n_{layf}}{\sum_a n_{layf}} \quad [9]$$

where n_{layf} are annual fishery-specific sheepshead sample sizes occurring in each length/age bin. When $\sum_a n_{layf} < 10$, the $P(a|l)$ for that 1 inch TL interval is estimated with Equation [8]. The resulting $P(a|l)_{yf}$ matrices are presented (Tables 7 and 8).

Annual fishery-specific catch-at-age is then calculated as:

$$C_{ayf} = \sum_l C_{lyf} P(a|l)_{yf} \quad [10]$$

where C_{lyf} are annual fishery-specific catch-at-size in TL and $P(a|l)_{yf}$ are taken from Equations [8 or 9]. Discard mortalities are incorporated directly into each fisheries catch-at-age by applying a 1% discard mortality rate to the estimated live releases-at-size and combining them with the harvest-at-size estimates.

For modeling purposes, catches ≥ age-8 are summed into a plus group. Resulting annual fishery-specific catch-at-age and corresponding mean weights-at-age are presented (Tables 9-11).

5.2 Survey

Probabilities of age given length for SH catches of the LDWF marine trammel net survey are computed from Equation [8]. Mean total length-at-age is estimated from equation [3]. Variance in length-at-age is approximated as $\sigma_{as} = l_{as}CV_l$, where the coefficient of variation in length-at-age CV_l is assumed constant (0.05). To approximate survey timing (i.e., a December 31st midpoint), mean total length-at-age is calculated at the end of the calendar/model year. Resulting $P(l|a)$ for SH catches of the marine trammel net survey is presented (Table 12). Annual survey catch-at-age is then taken from Equation [10] with annual survey catch-at-size (Table 13) substituted. Resulting annual age compositions of SH catches of the LDWF marine trammel net survey are presented (Table 14).

6. Assessment Model

The Age-Structured Assessment Program (ASAP3 Version 3.0.12; NOAA Fisheries Toolbox) is used in this assessment to describe the dynamics of SH occurring in LA waters. ASAP is a statistical catch-at-age model that allows internal estimation of a Beverton-Holt stock recruitment relationship and MSY-related reference points. Minimum data requirements are fishery catch-at-age, corresponding mean weights-at-age, and an index of abundance. ASAP projects abundance-at-age from estimates of abundance in the initial year of the time-series and recruitment estimates in subsequent years. The model is fit to the data with a maximum likelihood fitting criterion. An overview of the basic model configuration, equations, and their estimation, as applied in this assessment, are provided below. Specific details and full capabilities of ASAP can be found in the technical documentation (ASAP3; NOAA Fisheries Toolbox).

6.1 Model Configuration

For purposes of this assessment, the model is configured with annual time-steps (1982-2018) and a calendar year time-frame.

Mortality

Fishing mortality is assumed separable by age a, year y, and fishery f as:

$$F_{ayf} = v_{af}Fmult_{yf} \quad [11]$$

where v_{af} are age and fishery-specific selectivities and $Fmult_{yf}$ are annual fishery-specific apical fishing mortality rates. Apical fishing mortalities are estimated in the initial year and as deviations from the initial estimates in subsequent years.

Fishery-specific selectivities are modeled with double logistic functions as:

$$v_{af} = \left(\frac{1}{1+e^{-(a-\alpha_f)/\beta_f}}\right)\left(1 - \frac{1}{1+e^{-(a-\alpha 2_f)/\beta 2_f}}\right) \quad [12]$$

Total mortality for each age and year is estimated from the age-specific natural mortality rate and the estimated fishing mortalities as:

$$Z_{ay} = M_a + \sum_f F_{ayf} \quad [13]$$

For reporting purposes, annual age-specific fishing mortalities are averaged by weighting by population numbers at age as:

$$F_y = \frac{\sum_a F_{ay} N_{ay}}{\sum_a N_{ay}} \quad [14]$$

Abundance

Abundance in the initial year of the time series and recruitment in subsequent years are estimated and used to forward calculate the remaining numbers at age from the age and year-specific total mortality rates as:

$$N_{ay} = N_{a-1,y-1} e^{-Z_{a-1,y-1}} \quad [15]$$

Numbers in the plus group A are calculated from:

$$N_{Ay} = N_{A-1,y-1} e^{-Z_{A-1,y-1}} + N_{A,y-1} e^{-Z_{A,y-1}} \quad [16]$$

Stock Recruitment

Expected recruitment is calculated from the Beverton-Holt stock recruitment relationship, reparameterized by Mace and Doonan (1988), with annual lognormal deviations as:

$$\hat{R}_{y+1} = \frac{\alpha SSB_y}{\beta + SSB_y} + e^{\delta_{y+1}} \quad [17]$$

$$\alpha = \frac{4\tau(SSB_0/SPR_0)}{5\tau - 1} \text{ and } \beta = \frac{SSB_0(1-\tau)}{5\tau - 1}$$

where SSB_0 is unexploited female spawning stock biomass, SPR_0 is unexploited female spawning stock biomass per recruit, τ is steepness, and $e^{\delta_{y+1}}$ are annual lognormal recruitment deviations.

Spawning Stock Biomass

Female spawning stock biomass in each year is calculated from:

$$SSB_y = \sum_{i=1}^{A} N_{ay} W_{SSB,a} p_{mat,ay} \, e^{-Z_{ay}(0.33)} \quad [18]$$

where $W_{SSB,a}$ are spawning stock biomass weights-at-age, $p_{mat,ay}$ are the annual proportion of mature females-at-age calculated as the product of the female maturity at age vector and the annual female sex-ratio-at-age (assumed 50:50 through time), and $-Z_{ay}(0.33)$ is the proportion of total mortality occurring prior to spawning on April 1st.

Expected Catch

Expected fishery catches are estimated from the Baranov catch equation as:

$$\hat{C}_{ayf} = N_{ay} F_{ayf} \frac{(1-e^{-Z_{ay}})}{Z_{ay}} \quad [19]$$

Expected age composition of fishery catches are then calculated from $\frac{\hat{C}_{ayf}}{\sum_a \hat{C}_{ayf}}$. Expected fishery yields are computed as $\sum_a \hat{C}_{ayf} \overline{W}_{ayf}$, where $\overline{W}_{ayf}$ are observed mean catch weights.

Survey Catch-rates

Expected survey catch-rates are computed from:

$$\hat{I}_{ay} = q \sum_a N_{ay} (1 - e^{-Z_{ay}(1.0)}) v_a \quad [20]$$

where v_a are survey selectivities, q is the estimated catchability coefficient, and $-Z_{ay}(1.0)$ is the proportion of the total mortality occurring prior to the time of the survey (December 31st midpoint). Survey selectivities are modeled with double logistic functions (Equation [12]). Expected survey age composition is then calculated as $\frac{\hat{I}_{ay}}{\sum_a \hat{I}_{ay}}$.

Parameter Estimation

The number of parameters estimated is dependent on the length of the time-series, number of fleets and selectivity blocks modeled, and number of abundance indices modeled. Parameters are estimated in log-space and then back transformed. In this assessment, 136 parameters are estimated:

1. 16 selectivity parameters (2 blocks for the commercial fishery, 1 block for the recreational fishery, and 1 block for the survey).
2. 74 apical fishing mortality rates (F_{mult} in the initial year and 36 deviations in subsequent years for 2 fisheries)
3. 37 recruitment deviations (1982-2018)
4. 7 initial population abundance deviations (age-2 through 8-plus)
5. 1 catchability coefficient (1 survey)
6. 1 stock-recruitment parameter (R_0; the steepness parameter is fixed at 1.0 for the base run).

The model is fit to the data by minimizing the objective function:

$$-ln(L) = \sum_i \lambda_i (-ln\, L_i) + \sum_j (-ln\, L_j) \quad [21]$$

where $-ln(L)$ is the entire negative log-likelihood, lnL_i are log-likelihoods of lognormal estimations, λ_i are user-defined weights applied to lognormal estimations, and lnL_j are log-likelihoods of multinomial estimations.

Negative log-likelihoods with assumed lognormal error are derived (ignoring constants) as:

$$-ln(L_i) = 0.5 \sum_i \frac{[ln(obs_i) - ln(pred_i)]^2}{\sigma^2} \quad [22]$$

where obs_i and $pred_i$ are observed and predicted values; standard deviations σ are user-defined CVs as $\sqrt{ln(CV^2 + 1)}$.

Negative log-likelihoods with assumed multinomial error are derived (ignoring constants) as:

$$-ln(L_j) = -ESS \sum_{i=1}^{A} p_i \, ln(\hat{p}_i) \quad [23]$$

where p_i and $\hat{p}_i$ are observed and predicted age compositions. Effective sample-sizes ESS are used to create the expected numbers $\hat{n}_a$ in each age bin and act as multinomial weighting factors.

6.2 Model Assumptions/Inputs

Model assumptions include: 1) the unit stock is adequately defined and closed to migration, 2) observations are unbiased, 3) errors are independent and their structures are adequately specified, 4) fishery and survey vulnerabilities are dome-shaped, 5) abundance indices are proportional to absolute abundance, and 6) natural mortality, fecundity, growth and sex ratio-at-age do not vary significantly with time. Lognormal error is assumed for catches, abundance indices, the stock-recruitment relationship, apical fishing mortality, selectivity parameters, initial abundance deviations, and catchability. Multinomial error is assumed for fishery and survey age compositions.

A base model was defined with an age-8 plus group, the steepness parameter fixed at 1.0, two commercial fishery selectivity blocks, one recreational selectivity block, and input levels of error and weighting factors as described below.

For the commercial fleet, the two selectivity blocks correspond to the following time-periods of consistent regulation: 1) 1982-1996 (pre-gillnet and trammel net bans), and 2) 1997-2013 (commercial gill and trammel nets banned). Within the recreational fleet, only one selectivity block is modeled due to no major regulation changes over the time period modeled.

Input levels of error for commercial fishery landings were specified with CV's of 0.1 for years where landings were obtained from NMFS commercial records (1982-1998) and CV's of 0.05 for years where landings were obtained from the LDWF Trip Ticket Program (1999-2018; Table 9). Input levels of error for recreational fishery landings estimates were specified with the corresponding CV's estimated from the LDWF LA Creel survey (2014-2018) and estimates hindcast to the historic MRIP time-series (1982-2013; Table 10). Input levels of error for survey catch-rates were specified with CV's estimated from the IOA standardization (Table 5). Annual recruitment deviations were specified with CV's of 0.25 for all years of the time-series. To allow reasonable estimates of population size in the first year of the time-series (*i.e*., SSB_{1982}<SSB_0), the initial population abundance deviations were constrained with a CV of 0.001 to estimates from an exponential decline.

Lognormal components included in the objective function were equally weighted (all lambdas=1). Input effective sample sizes (ESS) for estimation of fishery age compositions were specified with ESS=50 for years where annual ALKs were available (2002-2018) and down weighted to ESS=10 for prior years. Input effective sample sizes (ESS) for estimation of survey age compositions were specified equally for all years of the time-series (all ESS=10).

6.3 Model Results

Objective function components, weighting factors, and likelihood values of the base model are summarized in Table 15.

Model Fit

The base model provides an overall reasonable fit to the data. Fits to the commercial and recreational landings are adequate, but generally are underestimated towards the middle of each time-series (Figures 3 and 4). Model estimated survey catch-rates also provide reasonable fits to the observations, but are also underestimated towards the middle of the time-series (Figure 5). Model estimated fishery and survey age compositions provide adequate fits to the input age proportions with noticeably better fits for the years where ages were assigned with annual ALK's (Figures 6-8).

Selectivities

Estimated fishery and survey selectivities are presented in Figure 9. Fishery estimates indicate full-vulnerability to the commercial fishery at age-3 during the 1982-1996 regulation block and age-5 during the 1997-2018 regulation block. Recreational estimates indicate full-vulnerability to the fishery at age-4. Survey estimates indicate full vulnerability to the marine trammel net survey gear at age-8+.

Abundance, Spawning Stock, and Recruitment

Total stock size and abundance–at-age estimates are presented in Table 16. Total stock size has varied over the time-series. Stock size estimates increased from 22.5 million fish in 1982 to a peak of 26.6 million fish in 1995. After 1995, stock abundance generally decreased to a low of 15.2 million fish estimated in 2012. The 2018 stock size estimate is 18.8 million fish.

Female spawning stock biomass estimates are presented in Figure 10. Female SSB has generally decreased over the time-series from a high of 24.8 million pounds estimated in 1982 to a low of 16.4

million pounds estimated in 2013. After 2013, female SSB estimates increased to 19.1 million pounds in 2016. The 2018 female SSB estimate is 18.7 million pounds.

Estimates of age-1 recruitment are presented in Figure 11. The average recruitment (geometric mean) over the entire time-series is 5.2 million fish. The average recruitment (geometric mean) in the most recent decade is 4.5 million fish. The 2018 age-1 recruitment estimate is 4.9 million fish.

Fishing Mortality

Estimated fishing mortality rates are presented in Table 17 (total apical, average, and age-specific) and Figure 12 (average only). Average rates are weighted by estimated stock numbers-at-age. Fishing mortality rates have varied over the time-series. Fishing mortality generally increased from 1982 to a peak of 0.08 yr^{-1} estimated in 1993. After 1993, fishing mortality generally decreased to a low of 0.02 yr^{-1} estimated in 2006. The 2018 average fishing mortality rate estimate is 0.04 yr^{-1}.

Stock-Recruitment

No discernable relationship is observed between female SSB and subsequent age-1 recruitment (Figure 13). The ASAP base model was run with steepness fixed at 1.0. The estimated unexploited recruitment and unexploited female SSB was 5.2 million fish and 27.3 million pounds. Alternate model runs with steepness values fixed at 0.9, 0.8, and 0.7 are discussed in the *Model Diagnostics* Section below.

Parameter Uncertainty

In the ASAP base model, 136 parameters are estimated. Asymptotic standard errors ($\pm$2) for the age-1 recruitment time-series are presented in Figure 11. Markov Chain Monte Carlo (MCMC) derived confidence intervals (95%) for the female SSB and average fishing mortality rate time-series are presented in Figures 10 and 12.

6.4 Management Benchmarks

Overfishing and overfished limits should be defined for exploitable stocks. The implication is that when biomass falls below a specified limit, there is an unacceptable risk that recruitment will be reduced to undesirable levels. Management actions are needed to avoid approaching this limit and to recover the stock if biomass falls below the limit.

There are currently no management thresholds established for the Louisiana sheepshead stock and no biological basis to establish limits based on the history of the stock. Until biologically based thresholds are established, a default precautionary limit of a 20% spawning potential ratio (SPR; Goodyear 1993) is proposed. The method for calculating the SPR_{limit} and the corresponding spawning stock biomass and fishing mortality rate limit reference points is presented below.

When the stock is in equilibrium, Equation [18] can be solved, excluding the year index, for any given exploitation rate as:

$$\frac{SSB}{R}(F) = \sum_{i=1}^{A} N_a W_{SSB,a} p_{mat,a}\, e^{-Z_a(0.33)} \quad [24]$$

where total mortality at age Z_a is computed as $M_a + v_a \times Fmult$; vulnerability at age v_a is taken by rescaling the current F-at-age estimate (geometric mean 2016-2018) to the maximum. Per recruit abundance-at-age is estimated as $N_a = S_a$, where survivorship at age is calculated recursively from $S_a = S_{a-1}e^{-Z_a}$, $S_1 = 1$. Per recruit catch-at-age is then calculated with the Baranov catch Equation [19], excluding the year index. Yield per recruit (Y/R) is then taken as $\sum_a C_a \overline{W}_a$ where $\overline{W}_a$ are current mean fishery weights at age (arithmetic mean 2016-2018). Fishing mortality is averaged by weighting by relative numbers at age.

Equilibrium spawning stock biomass SSB_{eq} is calculated by substituting SSB/R estimated from Equation [24] into the Beverton-Holt stock recruitment relationship as $\alpha \times SSB/R - \beta$. Equilibrium recruitment R_{eq} and yield Y_{eq} are then taken as $SSB_{eq} \div SSB/R$ and $Y/R \times R_{eq}$. Equilibrium SPR (e.g., SPR_{limit}) is then computed as the ratio of SSB/R when F>0 to SSB/R when F=0.

As reference points to guide management, we estimate the equilibrium female spawning stock biomass and average fishing mortality rate that lead to a 20% SPR (SPR_{limit}, $SSB_{limit,}$ and F_{limit}). Management targets for sheepshead were established by LAC 76: VII.385. The biomass target (SSB_{target}) is calculated as the average SSB (geometric mean) from the beginning of the assessed period through 2013. The average fishing mortality rate target (F_{target}) that corresponds to SSB_{target} when the stock is in equilibrium is then estimated from Equation [24].

The proposed limits and established targets of fishing are presented in Figure 14 relative to each time-series. Limit and target reference points are also presented in Table 18. Current estimates are taken as the geometric mean of the 2016-2018 estimates.

Also presented are a plot of the stock-recruitment data, equilibrium recruitment, and diagonals from the origin intersecting R_{eq} at the SSB_{target}, and the minimum and maximum SSB estimates of the time-series, corresponding with a SPR_{target} of 78%, and a minimum and maximum SPR of 60% and 91% (Figure 15).

6.5 Model Diagnostics

Sensitivity Analysis

In addition to the base model run, a series of sensitivity runs were used to explore uncertainty in the base model's configuration.

The ASAP base model was run with steepness fixed at 1.0. Alternate runs were conducted examining reference point estimates with steepness fixed at 0.9, 0.8, and 0.70 (Models 1-3).

Additional sensitivity runs were conducted by separately up-weighting the contributions of fishery yield and the IOA components within the base models objective function (lambdas increased from 1 to 4; Models 4 and 5).

Another sensitivity run was conducted by increasing the discard mortality rate from 1% to 10% (Model 6).

An additional sensitivity run was conducted where the ALK developed from the von Bertalanffy growth model (Table 6) was used to assign ages to the entire time-series of fishery landings (Model 7).

Another sensitivity run was conducted using the MRIP ACAL time-series (see https://www.fisheries.noaa.gov/recreational-fishing-data/recreational-fishing-data-glossary#calibrated-data), rather than the FCAL time-series, to hindcast LA Creel estimates to the historic MRIP time-series (Model 8). This time-series was developed using the same approach described in *Appendix 1* with the ACAL estimates substituted for the FCAL estimates.

A final sensitivity run was conducted using the MRIP size distributions with the FES and APAIS calibrations applied (Model 9).

Results of each sensitivity run relative to the proposed limit reference points are presented in Table 19. Current estimates of female SSB and average F are taken as the geometric mean of the 2016-2018 estimates. Estimates from all sensitivity runs indicate the stock is currently above SSB_{limit} and the fishery is currently operating below F_{limit}.

Also presented are estimates of maximum sustainable yield (MSY) and associated reference points for those sensitivity runs with the steepness parameter not fixed at 1 (Table 20). Results of each run indicate that the fishery is currently operating under MSY, where ratios of current F and SSB to F_{MSY} and SSB_{MSY} are below and above 1 respectively.

Retrospective Analysis

A retrospective analysis was conducted by sequentially truncating the base model by a year (terminal years 2015-2018). Retrospective estimates of average fishing mortality differed only marginally from the base run (Figure 16). Retrospective estimates of age-1 recruits and female SSB differed to a greater extent, where estimates tend to decrease as additional years are added to the model.

7. Stock Status

The history of the LA sheepshead stock relative to F/F_{limit} and SSB/SSB_{limit} is presented in Figure 17. Fishing mortality rates exceeding F_{limit} (F/F_{limit} >1.0) are defined as overfishing; spawning stock sizes below SSB_{limit} (SSB/SSB_{limit}< 1.0) are defined as the overfished condition.

Overfishing Status

The current estimate of F/F_{limit} is <1.0 (0.13), indicating the stock is not currently undergoing overfishing. The current assessment model also indicates that no overfishing occurred during the time-series examined.

Overfished Status

The current estimate of SSB/SSB_{limit} is >1.0 (3.5), indicating the stock is not currently in an overfished state. The current assessment model also indicates that the stock has not been overfished during the time-series examined. The current SPR estimate is 69%.

Management Target Status

Management targets for sheepshead established by LAC 76: VII.385 indicate the stock is currently below its biomass target and the fishery is currently operating just above its fishing mortality rate target.

Control Rules

There is currently no harvest control rule established for the LA sheepshead stock.

8. Research and Data Needs

As with any analysis, the accuracy of this assessment is dependent on the accuracy of the information of which it is based. Below we list recommendations to improve future stock assessments of sheepshead in Louisiana.

Only limited age data are available from the LDWF marine trammel net survey. Ages of survey catches in this assessment were assigned from a von Bertalanffy growth function. Age composition samples collected directly from the survey would allow a more accurate representation of survey age composition in future assessments.

Female spawning stock biomass is used as a proxy of total egg production in this assessment. Spawning potential ratio estimates may be biased if egg production does not scale linearly with female body weight. Estimates of batch fecundity and spawning frequency as a function of age/size are needed.

The Southeast Area Monitoring and Assessment Program (SEAMAP) conducts fishery-independent monitoring surveys in the GOM. These surveys may provide useful information on adult sheepshead abundance in nearshore waters. Future efforts should explore these datasets and assess their potential for use in future stock assessments.

Fishery-dependent data alone is not a reliable source of information to assess status of a fish stock. Consistent fishery-dependent and fishery-independent data sources, in a comprehensive monitoring plan, are essential to understanding the status of fishery. Present monitoring programs should be assessed for adequacy with respect to their ability to evaluate stock status, and modified if deemed necessary.

Factors that influence year-class strength of sheepshead are poorly understood. Investigation of these factors could elucidate causes of inter-annual variation in abundance, as well as the species stock-recruitment relationship.

With the recent trend toward ecosystem-based assessment models (Mace 2000; NMFS 2001), more data is needed linking sheepshead population dynamics to environmental conditions. The addition of meteorological and physical oceanographic data coupled with food web data may lead to a better understanding of the sheepshead stock and its habitat.

9. References

Beckman, D.W., A.L. Stanley, J.H. Render, and C.A. Wilson. 1991. Age and Growth-Rate Estimation of Sheepshead *Archosargus probatocephalus* in Louisiana Waters Using Otoliths. *Fishery Bulletin*. U.S. 89:1-8.

Blanchet, H. 2008. Assessment of sheepshead in Louisiana waters – 2008 report. Report to the Louisiana Legislature by the Wildlife and Fisheries Commission. February 2008. 26 pp.

FAO. 2001. Second Technical Consultation on the Suitability of the CITES Criteria for Listing Commercially-exploited Aquatic Species: A background analysis and framework for evaluating the status of commercially-exploited aquatic species in a CITES context. Available: http://www.fao.org/docrep/MEETING/003/Y1455E.htm

Goodyear, C.P. 1993. Spawning stock biomass per recruit in fisheries management: foundation and current use. *pp* 67-81 *in* S.J. Smith, J.J. Hunt and D. Rivard [ed.]. Risk evaluation and biological reference points for fisheries management. *Canadian Special Publication of Fisheries and Aquatic Sciences*. 442 pp.

GSMFC. 2006. The Sheepshead Fishery of the Gulf of Mexico, United States: A Fisheries Profile. Gulf States Marine Fisheries Commission. Ocean Springs, MS. 176 pp.

Hewitt, D.A., and J. M. Hoenig. 2005. Comparison of two approaches for estimating natural mortality based on longevity. *Fisheries Bulletin*. 103:433–437.

Ingram, G.W., Jr., W.J. Richards, J.T. Lamkin, and B. Muhling. 2010. Annual indices of Atlantic bluefin tuna (*Thunnus thynnus*) larvae in the Gulf of Mexico developed using delta-lognormal and multivariate models. *Aquat. Living Resour*. 23:35–47.

LDWF. 2018. Marine Fisheries Section Independent Sampling Activities Field Manual. Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA.

Lo, N.C.H., Jacobson, L.D., and J.L. Squire. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. *Canadian Journal of Fisheries and Aquatic Science*. 49:2515–2526.

Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. *Journal of Fish Biology*. 49:627-642.

Mace, P.M., and I.J. Doonan. 1988. A generalized bioeconomic simulation model for fish population dynamics. Technical Report 88. New Zealand Fisheries Assessment Resource Document.

Mace, P.M. [ed.]. 2000. Incorporating ecosystem considerations into stock assessments and management advice. Proceedings of the 6th NMFS National Stock Assessment Workshop (NSAW). NOAA Technical Memorandum NMFS-F/SPO-46. 78 pp.

M.D. Murphy and T.C. MacDonald. 2000. An assessment of the status of sheepshead in Florida waters through 1999. Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute. St. Petersburg, Florida. 50 pp.

NMFS. 2001. Marine Fisheries Stock Assessment Improvement Plan. Report of the National Marine Fisheries Service National Task Force for Improving Fish Stock Assessments. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-F/SPO-56, 69 p., 25 appendices.

NMFS. 2019. Annual commercial landings statistics. National Marine Fisheries Service, Fisheries Statistics and Economics Division. Available: http://www.st.nmfs.noaa.gov/commercial-fisheries/index [accessed 4/2019].

NOAA Fisheries Toolbox. 2013. Age Structured Assessment Program (ASAP), Version 3.0.14. Available: https://www.nefsc.noaa.gov/nft/.

Quinn, T. J. II, and R. B. Deriso. 1999. Quantitative fish dynamics, 542 p. Oxford University Press, New York, NY.

Render, J. and C.A. Wilson. 1992. Reproductive Biology of Sheepshead in the Northern Gulf of Mexico. *Transactions of the American Fisheries Society*. 121(6): 757-764.

Rothschild, B.J., and M.J. Fogarty. 1989. Spawning-stock biomass: a source of error in recruitment/stock relationships and management advice. *ICES Journal of Marine Science*. 45:131-135.

SAS Institute Inc. 2008. SAS/STAT® 9.2 User's Guide. Cary, NC: SAS Institute Inc.

Schexnayder, M., R. Blanchet, D. Lavergne, and R. Pausina. 1998. A Biological and Fisheries Profile for Sheepshead. Louisiana Dept. of Wildlife and Fisheries. Fishery Management Plan Series. No. 7, part 1. Baton Rouge, La.

SEDAR. 2006. Gulf of Mexico Vermilion Snapper SEDAR 9 Assessment Report 3. SEDAR, Charleston, SC. Available at: https://sedarweb.org/docs/sar/SEDAR9_SAR3%20GOM%20VermSnap.pdf

SEDAR. 2006. Gulf of Mexico Red Grouper SEDAR 12 Assessment Report 1. SEDAR, Charleston, SC. Available at: http://sedarweb.org/docs/sar/S12SAR1%20Gulf%20Red%20Grouper%20Completev2.pdf

West, J., D. Davis, S. Beck, J. Adriance, and J.E. Powers. 2015. Assessment of sheepshead in Louisiana waters. 2015 Report of the Louisiana Department of Wildlife and Fisheries. 60 pp.

10. Tables

Table 1: Louisiana annual commercial and recreational sheepshead landings (pounds x 10^6) derived from NMFS statistical records, LDWF Trip Ticket Program, MRIP, and LA Creel. Landings represent harvest only.

	Harvest			
Year	*Commercial*	*Recreational*	*%Commercial*	*%Recreational*
1982	*0.30*	*0.36*	*45.2%*	*54.8%*
1983	*0.54*	*0.90*	*37.7%*	*62.3%*
1984	*0.72*	*0.68*	*51.4%*	*48.6%*
1985	*0.72*	*0.32*	*68.9%*	*31.1%*
1986	*0.96*	*0.29*	*76.7%*	*23.3%*
1987	*1.92*	*0.22*	*89.5%*	*10.5%*
1988	*1.85*	*0.11*	*94.3%*	*5.7%*
1989	*2.45*	*0.73*	*77.1%*	*22.9%*
1990	*2.77*	*0.39*	*87.7%*	*12.3%*
1991	*2.43*	*0.38*	*86.4%*	*13.6%*
1992	*3.06*	*0.60*	*83.6%*	*16.4%*
1993	*3.76*	*1.03*	*78.5%*	*21.5%*
1994	*3.29*	*0.40*	*89.2%*	*10.8%*
1995	*3.27*	*0.63*	*83.9%*	*16.1%*
1996	*2.64*	*0.80*	*76.7%*	*23.3%*
1997	*3.11*	*1.03*	*75.2%*	*24.8%*
1998	*2.37*	*1.14*	*67.6%*	*32.4%*
1999	*3.20*	*0.72*	*81.6%*	*18.4%*
2000	*2.59*	*0.76*	*77.3%*	*22.7%*
2001	*1.80*	*0.73*	*71.3%*	*28.7%*
2002	*1.58*	*1.13*	*58.3%*	*41.7%*
2003	*1.64*	*1.41*	*53.7%*	*46.3%*
2004	*1.52*	*1.75*	*46.5%*	*53.5%*
2005	*1.02*	*1.05*	*49.4%*	*50.6%*
2006	*0.57*	*0.43*	*56.9%*	*43.1%*
2007	*1.02*	*0.46*	*69.0%*	*31.0%*
2008	*1.17*	*0.96*	*55.1%*	*44.9%*
2009	*1.21*	*1.08*	*53.0%*	*47.0%*
2010	*0.92*	*1.04*	*47.1%*	*52.9%*
2011	*0.88*	*2.35*	*27.3%*	*72.7%*
2012	*0.74*	*0.70*	*51.3%*	*48.7%*
2013	*1.33*	*0.42*	*75.8%*	*24.2%*
2014	*1.09*	*0.68*	*61.5%*	*38.5%*
2015	*0.82*	*0.88*	*48.3%*	*51.7%*
2016	*0.90*	*0.78*	*53.3%*	*46.7%*
2017	*0.75*	*1.95*	*27.7%*	*72.3%*
2018	*1.43*	*0.88*	*61.8%*	*38.2%*

Table 2: Annual size composition samples of Louisiana commercial sheepshead landings derived from the Trip Interview Program (TIPS; 1982-2002) and the Fishery Information Network (FIN; 2002-2013). Cumulative size distributions are presented for years where limited size composition data were available. TL_in is total length in inches.

Commercial, 1982-2018													
TL_in	*1982-1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
6													
7													
8	*1*												
9													
10	*15*	*11*	*9*	*3*	*3*								
11	*50*	*39*	*27*	*6*	*8*	*2*							
12	*134*	*117*	*109*	*13*	*19*	*10*	*4*	*6*	*2*				
13	*233*	*205*	*177*	*49*	*70*	*30*	*9*	*12*		*4*	*9*	*13*	
14	*255*	*242*	*198*	*137*	*189*	*71*	*19*	*32*	*5*	*16*	*16*	*25*	*10*
15	*292*	*272*	*148*	*149*	*239*	*137*	*47*	*81*	*11*	*21*	*26*	*27*	*17*
16	*263*	*237*	*113*	*171*	*219*	*122*	*74*	*151*	*43*	*74*	*35*	*48*	*16*
17	*196*	*176*	*101*	*126*	*169*	*111*	*68*	*184*	*74*	*84*	*91*	*81*	*39*
18	*125*	*100*	*85*	*64*	*76*	*60*	*48*	*114*	*42*	*65*	*94*	*65*	*59*
19	*92*	*77*	*51*	*25*	*25*	*17*	*17*	*52*	*34*	*30*	*33*	*39*	*48*
20	*63*	*41*	*29*	*12*	*12*	*11*	*11*	*25*	*17*	*11*	*2*	*6*	*17*
21	*20*	*18*	*14*	*3*	*3*	*5*	*5*	*6*	*4*	*14*	*1*	*2*	*17*
22	*11*	*9*	*7*	*3*	*3*			*2*	*2*	*13*		*3*	*3*
23	*5*	*3*	*2*			*1*	*1*	*1*		*2*		*1*	*2*
24	*1*	*1*							*1*	*1*			*1*
25	*1*												
26													
Totals	*1757*	*1548*	*1070*	*761*	*1035*	*577*	*303*	*666*	*235*	*335*	*307*	*310*	*229*

TL_in	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*
6												
7												
8												
9												
10								*2*				
11	*1*							*2*		*1*		
12	*2*		*1*			*3*		*6*	*4*			*1*
13	*8*	*6*	*9*	*6*	*14*	*12*	*2*	*12*	*11*	*4*	*8*	*11*
14	*25*	*29*	*29*	*38*	*58*	*27*	*9*	*18*	*45*	*13*	*14*	*35*
15	*38*	*49*	*65*	*76*	*79*	*41*	*24*	*25*	*92*	*44*	*32*	*61*
16	*102*	*88*	*87*	*80*	*134*	*60*	*29*	*53*	*58*	*78*	*49*	*79*
17	*166*	*178*	*128*	*64*	*119*	*87*	*46*	*92*	*50*	*74*	*34*	*71*
18	*298*	*227*	*226*	*50*	*124*	*81*	*81*	*99*	*62*	*89*	*62*	*77*
19	*257*	*218*	*192*	*27*	*112*	*87*	*42*	*80*	*79*	*50*	*78*	*87*
20	*183*	*74*	*63*	*4*	*68*	*56*	*8*	*38*	*52*	*35*	*50*	*63*
21	*47*	*15*	*10*		*62*	*43*	*6*	*21*	*10*	*16*	*16*	*31*
22	*10*	*3*	*3*		*27*	*22*	*2*	*8*		*12*	*3*	*15*
23					*3*	*2*		*6*		*3*	*2*	*4*
24					*6*		*1*	*1*		*1*		*3*
25					*1*		*1*					
26												
Totals	*1137*	*887*	*813*	*345*	*807*	*521*	*251*	*463*	*463*	*420*	*348*	*538*

Table 3: Annual size frequency distributions of Louisiana recreational sheepshead harvest taken from MRIP (1982-2013) and the LDWF Biological Sampling Program (2014-2018). TL_in is total length in inches.

	Recreational, 1982-2018																		
TL_in	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
5														0.002					
6		0.003		0.019		0.024					0.199	0.001	0.019	0.013					
7	0.035			0.009	0.003	0.034					0.121	0.018	0.011	0.011	0.006	0.016		0.002	
8	0.050	0.050	0.063	0.029	0.001	0.061	0.032	0.004		0.002	0.046	0.018	0.010	0.001	0.024	0.009	0.004	0.006	
9	0.151	0.046	0.011	0.107	0.003	0.018	0.121	0.010	0.015	0.022	0.031	0.020	0.047	0.024	0.024	0.012		0.009	
10	0.130	0.088		0.193	0.106	0.041	0.107	0.007	0.016	0.060	0.073	0.061	0.044	0.074	0.034	0.044	0.004	0.006	0.011
11	0.046	0.130	0.084	0.036	0.019	0.042	0.049	0.027	0.145	0.210	0.072	0.077	0.086	0.126	0.072	0.031	0.015	0.052	0.051
12	0.046	0.125	0.106	0.102	0.010	0.054	0.045	0.117	0.040	0.060	0.026	0.058	0.177	0.138	0.043	0.072	0.068	0.069	0.073
13	0.259	0.178	0.193	0.064	0.200	0.156	0.111	0.120	0.067	0.117	0.042	0.111	0.155	0.121	0.084	0.117	0.076	0.062	0.039
14	0.051	0.048	0.074	0.148	0.114	0.091	0.077	0.139	0.054	0.117	0.088	0.076	0.128	0.180	0.187	0.118	0.099	0.117	0.044
15	0.119	0.046	0.087	0.054	0.116	0.127	0.143	0.055	0.071	0.089	0.037	0.108	0.105	0.090	0.214	0.161	0.126	0.152	0.116
16	0.022	0.064	0.117	0.152	0.225	0.132	0.164	0.150	0.169	0.132	0.069	0.104	0.098	0.113	0.141	0.132	0.184	0.166	0.103
17	0.041	0.060	0.099	0.025	0.095	0.173	0.029	0.096	0.176	0.110	0.053	0.145	0.036	0.025	0.067	0.191	0.157	0.161	0.119
18	0.020	0.010	0.039	0.023	0.092	0.021	0.064	0.153	0.119	0.037	0.045	0.053	0.037	0.027	0.053	0.044	0.125	0.076	0.165
19	0.007	0.113	0.106	0.031	0.004	0.025	0.020	0.066	0.047	0.014	0.038	0.072	0.015	0.020	0.034	0.033	0.079	0.067	0.102
20	0.014	0.034	0.018	0.007	0.006		0.026	0.053	0.039	0.015	0.035	0.047	0.005	0.007	0.005	0.010	0.043	0.019	0.139
21	0.010		0.004	0.003	0.004			0.002	0.041	0.007	0.013	0.026	0.009	0.011	0.005	0.004	0.015	0.014	0.015
22		0.005			0.001		0.009	0.002		0.007	0.009	0.003	0.005	0.014	0.006	0.003	0.004	0.015	0.001
23											0.002	0.001		0.003	0.001			0.005	0.011
24													0.004				0.003	0.000	
25											0.002		0.009			0.004		0.003	
26																			
27							0.003												0.011
28																			

TL_in	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*
5								0.004										
6				0.006	0.008				0.001									
7					0.030													
8	0.013	0.003	0.003	0.002	0.001		0.007	0.001	0.005	0.016			0.052				0.001	0.002
9	0.005	0.013	0.006	0.010	0.030	0.062	0.046	0.000	0.001	0.017	0.006	0.019	0.009	0.027	0.002		0.001	0.003
10	0.045	0.014	0.018	0.029	0.075	0.050	0.018	0.013	0.019	0.054	0.018	0.021	0.004	0.041	0.010	0.009	0.002	0.031
11	0.011	0.054	0.035	0.022	0.040	0.038	0.018	0.030	0.025	0.078	0.054	0.051	0.020	0.065	0.014	0.022	0.028	0.062
12	0.090	0.083	0.112	0.019	0.066	0.055	0.043	0.060	0.068	0.023	0.011	0.048	0.132	0.093	0.025	0.019	0.035	0.050
13	0.058	0.135	0.111	0.116	0.080	0.085	0.064	0.099	0.166	0.058	0.047	0.093	0.098	0.103	0.040	0.057	0.077	0.054
14	0.187	0.109	0.099	0.156	0.101	0.088	0.087	0.101	0.109	0.070	0.047	0.063	0.137	0.091	0.119	0.065	0.098	0.093
15	0.063	0.173	0.107	0.113	0.067	0.112	0.066	0.162	0.129	0.063	0.069	0.084	0.040	0.099	0.081	0.092	0.102	0.130
16	0.109	0.155	0.105	0.201	0.142	0.150	0.115	0.173	0.136	0.145	0.091	0.176	0.081	0.157	0.134	0.174	0.149	0.173
17	0.105	0.112	0.125	0.152	0.138	0.228	0.120	0.131	0.152	0.065	0.115	0.174	0.174	0.101	0.156	0.183	0.157	0.146
18	0.103	0.067	0.140	0.066	0.116	0.066	0.212	0.085	0.097	0.131	0.238	0.111	0.173	0.109	0.167	0.165	0.168	0.117
19	0.092	0.063	0.090	0.044	0.059	0.023	0.092	0.052	0.054	0.162	0.206	0.094	0.039	0.062	0.162	0.110	0.093	0.077
20	0.017	0.011	0.009	0.032	0.018	0.007	0.062	0.063	0.009	0.027	0.074	0.022	0.040	0.036	0.038	0.063	0.048	0.025
21	0.040	0.005	0.028	0.026	0.020	0.021	0.044	0.021	0.011	0.064	0.005	0.014		0.010	0.022	0.024	0.031	0.013
22	0.038	0.000	0.014	0.001	0.004	0.005	0.004	0.005	0.010	0.014	0.012	0.029		0.005	0.027	0.005	0.001	0.021
23	0.008	0.002			0.009	0.007	0.002	0.001	0.006					0.002	0.002	0.007		0.002
24				0.003		0.006			0.003	0.014	0.009					0.003	0.009	
25	0.015			0.001														0.002
26																		
27																		
28																		

Table 4: FAO proposed guideline for indices of productivity for exploited fish species.

Parameter	**Productivity**			**Species**	
	Low	Medium	High	Sheepshead	**Score**
M	<0.2	0.2 - 0.5	>0.5	**0.21**	2
K	<0.15	0.15 - 0.33	>0.33	**0.46**	3
tmat	>8	3.3 - 8	<3.3	**3**	3
tmax	>25	14 - 25	<14	**20**	2
Examples	orange roughy, many sharks	cod, hake	sardine, anchovy	**Sheepshead Productivity Score = 2.50**	

Table 5: Annual sample sizes, percent positive samples, nominal CPUE, standardized index of abundance, and corresponding coefficients of variation for sheepshead derived from the LDWF fishery-independent marine trammel net survey. Nominal CPUE and the standardized index of abundance have been normalized to their individual long-term means for comparison.

Year	n	%Pos	CPUE	IOA	CV
1985	83	20%	0.90	1.04	0.60
1986	92	29%	2.15	1.40	0.53
1987	180	28%	0.64	1.21	0.49
1988	165	30%	0.91	0.94	0.50
1989	202	18%	0.96	0.44	0.54
1990	191	30%	0.64	1.03	0.49
1991	207	24%	0.52	0.66	0.51
1992	220	29%	0.62	1.05	0.48
1993	225	23%	1.11	0.93	0.51
1994	213	30%	1.59	1.21	0.48
1995	215	30%	0.81	1.30	0.47
1996	216	25%	2.10	1.20	0.50
1997	219	24%	1.14	0.90	0.51
1998	223	23%	1.09	0.86	0.51
1999	217	27%	1.30	1.19	0.49
2000	209	27%	1.21	1.27	0.49
2001	219	26%	1.97	1.27	0.50
2002	217	31%	1.10	1.47	0.47
2003	222	29%	0.81	1.04	0.48
2004	222	32%	0.84	1.39	0.46
2005	215	27%	0.79	1.22	0.49
2006	217	31%	0.78	1.25	0.46
2007	226	23%	0.71	0.67	0.51
2008	219	23%	1.03	0.72	0.51
2009	222	23%	1.10	0.85	0.51
2010	508	21%	1.16	0.76	0.48
2011	543	20%	0.45	0.56	0.48
2012	515	23%	0.48	0.71	0.47
2013	263	24%	1.06	1.15	0.48
2014	263	22%	0.81	0.72	0.49
2015	271	19%	0.58	0.54	0.52
2016	271	22%	1.51	1.01	0.49
2017	269	34%	0.63	1.51	0.43
2018	265	20%	0.49	0.54	0.51

Table 6: Probabilities of age given length used in age assignments of sheepshead fishery landings, 1982-2001.

Fishery 1982-2001									
TL_in	Age_0	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+
5	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.29	0.67	0.03	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.73	0.21	0.03	0.01	0.00	0.01
16	0.00	0.00	0.00	0.17	0.40	0.18	0.07	0.04	0.15
17	0.00	0.00	0.00	0.00	0.11	0.15	0.12	0.08	0.53
18	0.00	0.00	0.00	0.00	0.01	0.05	0.07	0.07	0.80
19	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.92
20	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Table 7: Annual probabilities of age given length used in age assignments of commercial sheepshead landings 2002-2018. Shaded cells represent rows where probabilities of age given length from Table 6 are substituted ($\sum_a n_{lay} < 10$).

2002									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	
14	0.00	0.29	0.67	0.03	0.00	0.00	0.00	0.00	2
15	0.00	0.00	0.73	0.21	0.03	0.01	0.00	0.01	3
16	0.00	0.00	0.17	0.40	0.18	0.07	0.04	0.15	3
17	0.00	0.00	0.00	0.11	0.15	0.12	0.08	0.53	4
18	0.00	0.00	0.00	0.01	0.05	0.07	0.07	0.80	2
19	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.92	5
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	7
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	2
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	1
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2003									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	2
14		0.06	0.25	0.38	0.19	0.06		0.06	16
15		0.10	0.30	0.25	0.05	0.05	0.10	0.15	20
16		0.01	0.12	0.34	0.22	0.05	0.11	0.14	73
17			0.02	0.32	0.18	0.13	0.23	0.11	82
18			0.05	0.12	0.22	0.09	0.26	0.26	65
19			0.04	0.07	0.18	0.14	0.18	0.39	28
20			0.09	0.18		0.18	0.09	0.45	11
21				0.23	0.15	0.08	0.23	0.31	13
22			0.09	0.27			0.27	0.36	11
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

Table 7 (continued):

2004									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	9
14			0.25	0.63	0.13				16
15			0.04	0.50	0.35	0.08		0.04	26
16			0.03	0.31	0.31	0.11	0.06	0.17	35
17			0.02	0.11	0.44	0.18	0.01	0.23	90
18				0.02	0.29	0.20	0.10	0.39	92
19					0.16	0.19	0.13	0.53	32
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	2
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	1
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2005									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	8
14		0.36	0.29		0.14	0.21			14
15		0.10	0.50	0.10	0.30				20
16			0.15	0.27	0.51	0.05	0.02		41
17			0.09	0.06	0.45	0.15	0.05	0.20	66
18			0.04	0.04	0.30	0.23	0.09	0.32	57
19					0.13	0.31	0.16	0.41	32
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	5
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	1
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	1
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2006									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	
14		0.10	0.70	0.10			0.10		10
15		0.06	0.82	0.06		0.06			17
16			0.06	0.19	0.19	0.50	0.06		16
17			0.05		0.15	0.33	0.26	0.21	39
18				0.02	0.08	0.46	0.19	0.25	59
19				0.02	0.04	0.30	0.21	0.43	47
20			0.06			0.24	0.18	0.53	17
21							0.18	0.82	17
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	3
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2007									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	2
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	5
14		0.15	0.65	0.10	0.05		0.05		20
15			0.56	0.33	0.11				27
16		0.02	0.12	0.45	0.20	0.03	0.11	0.08	66
17		0.01	0.02	0.13	0.20	0.05	0.32	0.27	106
18			0.01	0.06	0.09	0.07	0.28	0.49	192
19				0.04	0.05	0.05	0.26	0.60	159
20				0.03	0.04	0.05	0.16	0.71	97
21				0.06	0.06	0.21	0.18	0.48	33
22						0.20		0.80	10
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2008									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	2
14		0.06	0.38	0.19	0.31			0.06	16
15		0.04	0.46	0.17	0.25	0.04		0.04	24
16			0.37	0.20	0.20	0.08	0.03	0.10	59
17			0.08	0.13	0.23	0.13	0.05	0.38	150
18			0.01	0.04	0.15	0.14	0.03	0.62	205
19				0.01	0.08	0.06	0.04	0.82	196
20					0.04	0.13	0.11	0.73	56
21					0.09			0.91	11
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	2
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2009									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	8
14			0.11	0.83	0.06				18
15			0.09	0.86		0.03		0.03	35
16				0.44	0.16	0.27	0.04	0.09	45
17			0.01	0.21	0.08	0.24	0.13	0.32	84
18				0.02	0.05	0.32	0.10	0.51	144
19				0.02	0.05	0.12	0.10	0.71	134
20					0.03	0.10	0.13	0.75	40
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	3
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	2
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

Table 7 (continued):

2010									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	2
14			0.05	0.52	0.43				21
15				0.16	0.75	0.03		0.06	32
16			0.02	0.06	0.63	0.13	0.10	0.06	62
17			0.02	0.02	0.25	0.08	0.17	0.46	48
18					0.13	0.02	0.15	0.70	46
19					0.12		0.20	0.68	25
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	3
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2011									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13		0.92				0.08			12
14		0.86	0.08		0.02	0.04			51
15		0.39	0.48	0.04	0.03	0.06			69
16		0.26	0.36	0.12	0.07	0.14	0.02	0.04	117
17		0.17	0.36	0.17	0.09	0.15	0.02	0.04	106
18		0.06	0.30	0.10	0.09	0.27	0.01	0.18	115
19		0.05	0.27	0.10	0.16	0.17	0.08	0.18	105
20		0.02	0.31	0.22	0.09	0.13	0.04	0.20	55
21		0.03	0.23	0.11	0.21	0.11	0.03	0.26	61
22		0.04	0.07	0.07	0.15	0.11	0.04	0.52	27
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	5
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2012									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	3
13		0.42	0.50				0.08		12
14		0.08	0.77	0.12			0.04		26
15			0.51	0.41	0.05		0.03		37
16			0.42	0.23	0.11	0.14	0.05	0.05	57
17			0.17	0.21	0.18	0.09	0.25	0.09	76
18			0.07	0.21	0.08	0.14	0.29	0.21	76
19			0.01	0.30	0.18	0.06	0.23	0.23	80
20				0.17	0.17	0.21	0.10	0.35	52
21				0.08	0.03	0.18	0.18	0.55	40
22				0.05	0.05		0.25	0.65	20
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2013									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	1
14	0.00	0.29	0.67	0.03	0.00	0.00	0.00	0.00	5
15			0.47	0.18	0.12		0.24		17
16		0.06	0.24	0.29	0.18	0.06		0.18	17
17		0.11	0.06	0.19	0.11	0.11	0.11	0.31	36
18			0.04	0.06	0.12	0.16	0.16	0.46	69
19			0.03	0.03	0.09	0.11	0.03	0.71	35
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	5
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	2
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	2
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2014									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	2
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	6
13		0.92			0.08				12
14		0.39	0.33	0.17				0.11	18
15		0.08	0.12	0.36	0.20	0.04	0.04	0.16	25
16		0.11	0.09	0.36	0.17	0.11	0.04	0.11	53
17		0.09	0.09	0.16	0.26	0.13	0.06	0.22	90
18			0.03	0.19	0.19	0.15	0.15	0.29	95
19		0.01	0.03	0.04	0.22	0.13	0.06	0.52	79
20				0.08	0.22	0.11	0.17	0.42	36
21					0.19	0.24	0.19	0.38	21
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	7
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	6
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2015									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	4
13		0.10	0.90						10
14		0.07	0.79	0.07	0.07				43
15		0.02	0.74	0.03	0.11	0.08		0.01	90
16			0.46	0.14	0.19	0.05	0.07	0.09	57
17			0.18	0.24	0.10	0.08		0.39	49
18				0.13	0.20	0.13	0.07	0.48	61
19				0.03	0.13	0.27	0.13	0.44	75
20				0.04	0.04	0.31	0.12	0.49	51
21			0.10		0.10	0.40	0.10	0.30	10
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

Table 7 (continued):

2016									
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*	*Total*
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	1
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	4
14		0.08	0.62	0.31					13
15			0.74	0.16	0.02	0.02	0.02	0.02	43
16		0.03	0.42	0.36	0.05	0.06	0.03	0.05	77
17			0.26	0.44	0.04	0.07	0.07	0.12	73
18			0.09	0.55	0.15	0.01	0.05	0.16	88
19			0.04	0.23	0.28	0.09	0.09	0.28	47
20			0.03	0.12	0.33	0.18	0.06	0.27	33
21					0.25		0.31	0.44	16
22					0.17	0.08	0.33	0.42	12
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2017									
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*	*Total*
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	8
14		0.21	0.29	0.29	0.14			0.07	14
15		0.16	0.41	0.25	0.13		0.03	0.03	32
16		0.07	0.30	0.17	0.26	0.07	0.04	0.09	46
17		0.03	0.21	0.18	0.41	0.03	0.09	0.06	34
18		0.02	0.08	0.21	0.41	0.07	0.03	0.18	61
19			0.01	0.03	0.49	0.05	0.12	0.30	77
20				0.04	0.38	0.18	0.14	0.26	50
21			0.06		0.19			0.75	16
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	3
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2018									
TL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*	*Total*
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	7
14		0.50	0.29	0.14	0.07				28
15		0.43	0.13	0.30	0.04	0.04		0.06	47
16		0.41	0.08	0.26	0.10	0.11		0.04	73
17		0.21	0.07	0.24	0.13	0.26		0.09	68
18		0.03	0.07	0.18	0.15	0.41	0.05	0.12	74
19			0.01	0.08	0.25	0.40	0.04	0.23	80
20			0.02	0.02	0.12	0.38	0.09	0.38	58
21					0.03	0.35	0.19	0.42	31
22					0.07	0.07	0.29	0.57	14
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	4
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

Table 8: Annual probabilities of age given length used in age assignments of recreational sheepshead landings 2002-2018. Shaded cells represent rows where probabilities of age given length from Table 6 are substituted ($\sum_a n_{lay} < 10$).

2002

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	6
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	2
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	2
14		0.67	0.17					0.17	12
15	0.00	0.00	0.73	0.21	0.03	0.01	0.00	0.01	4
16			0.62	0.31		0.08			13
17	0.00	0.00	0.00	0.11	0.15	0.12	0.08	0.53	9
18	0.00	0.00	0.00	0.01	0.05	0.07	0.07	0.80	8
19	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.92	7
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	3
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	2
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2003

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	7
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	8
14		0.07	0.47	0.27	0.07			0.13	15
15		0.10	0.29	0.33	0.24			0.05	21
16			0.55	0.18	0.27				11
17			0.17	0.44	0.11	0.06	0.11	0.11	18
18			0.23	0.31	0.15		0.23	0.08	13
19	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.92	9
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	3
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	3
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	2
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2004

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	1
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	4
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	7
14	0.12	0.06	0.29	0.47				0.06	17
15		0.11	0.11	0.61	0.14	0.04			28
16		0.06	0.18	0.39	0.24	0.09	0.03		33
17			0.10	0.42	0.32	0.06		0.10	31
18			0.08	0.21	0.26	0.11	0.05	0.29	38
19		0.25		0.42	0.08	0.08		0.17	12
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	5
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	2
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	2
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2005

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	7
12	0.05	0.73	0.18		0.05				22
13		0.33	0.57		0.05			0.05	21
14		0.25	0.50	0.07	0.07			0.11	28
15		0.06	0.29	0.20	0.29	0.10	0.02	0.04	49
16		0.04	0.21	0.12	0.46	0.12	0.02	0.04	57
17			0.03	0.06	0.49	0.21	0.13	0.07	67
18				0.02	0.47	0.19	0.09	0.23	43
19			0.06		0.22	0.33	0.11	0.28	18
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	3
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	4
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	1
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2006

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	7
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8
13	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	9
14		0.58	0.38	0.04					26
15		0.22	0.26	0.37		0.07		0.07	27
16		0.08	0.23	0.25	0.05	0.20	0.18	0.03	40
17			0.21	0.19	0.05	0.40	0.09	0.07	43
18			0.04	0.08	0.08	0.27	0.31	0.23	26
19				0.20	0.13	0.20	0.13	0.33	15
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	7
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	2
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	3
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1

2007

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
9	0.67	0.33							12
10	0.31	0.69							16
11	0.13	0.88							24
12		0.92	0.08						37
13		0.79	0.19					0.02	48
14		0.56	0.28	0.09	0.03			0.03	32
15		0.32	0.42	0.18		0.05	0.03		38
16		0.06	0.42	0.37	0.12			0.04	52
17		0.02	0.14	0.44	0.09	0.02	0.14	0.14	43
18			0.13	0.22	0.13	0.11	0.20	0.22	46
19			0.10	0.16		0.03	0.23	0.48	31
20			0.06	0.06	0.11	0.22	0.17	0.39	18
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	6
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	2
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	3
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1

Table 8 (continued):

2008

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
9	0.31	0.62	0.08						13
10	0.27	0.60	0.13						15
11		0.50	0.43	0.04	0.04				28
12	0.02	0.27	0.59	0.07				0.05	44
13	0.06	0.19	0.66	0.02				0.08	64
14		0.11	0.76	0.08	0.03	0.01		0.01	76
15		0.06	0.65	0.21	0.07			0.01	71
16		0.03	0.37	0.41	0.11	0.05	0.02	0.02	63
17		0.02	0.11	0.29	0.25	0.12	0.02	0.20	65
18			0.06	0.08	0.18	0.14		0.53	49
19			0.06	0.06	0.25	0.13		0.50	32
20			0.06	0.11	0.22	0.11		0.50	18
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	9
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	4
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2009

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5
10	0.50	0.42	0.08						12
11	0.21	0.32	0.32	0.16					19
12	0.16	0.47	0.11	0.26					19
13		0.20	0.43	0.31	0.02			0.04	54
14		0.11	0.29	0.57		0.02		0.02	56
15		0.07	0.26	0.59	0.04	0.01		0.03	74
16			0.18	0.64	0.14	0.01	0.01	0.01	73
17		0.01	0.03	0.42	0.18	0.15	0.07	0.13	67
18		0.01	0.03	0.13	0.18	0.15	0.13	0.36	67
19			0.13	0.09	0.06	0.09		0.63	32
20			0.27	0.13	0.07	0.13	0.07	0.33	15
21			0.18			0.18		0.64	11
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	5
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	5
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2010

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
11	0.18	0.68		0.09	0.05				22
12		0.53	0.42	0.05					19
13	0.03	0.35	0.38	0.21	0.03				34
14		0.16	0.29	0.45	0.10				51
15		0.05	0.14	0.48	0.34				65
16		0.02	0.16	0.28	0.48	0.03		0.03	58
17		0.04	0.09	0.22	0.30	0.09	0.07	0.20	46
18			0.08	0.06	0.19	0.06	0.11	0.50	36
19					0.33	0.10	0.05	0.52	21
20			0.08	0.08	0.33		0.08	0.42	12
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	2
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	5
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	4
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2011

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	5
12		0.35	0.65						17
13		0.26	0.47	0.21	0.05				19
14		0.29	0.24	0.24	0.10	0.12			41
15		0.11	0.32	0.14	0.25	0.16		0.02	44
16			0.32	0.28	0.17	0.23			47
17		0.02	0.08	0.08	0.20	0.33	0.02	0.27	49
18			0.03	0.08	0.11	0.37	0.10	0.32	63
19			0.07	0.07	0.03	0.24	0.07	0.52	29
20				0.06	0.12	0.29	0.06	0.47	17
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	6
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	6
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2012

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	8
12	0.07	0.53	0.33	0.07					15
13		0.30	0.30	0.26	0.09	0.04			23
14		0.26	0.26	0.26	0.16	0.05			19
15		0.18	0.33	0.36	0.05	0.05	0.03		39
16		0.02	0.15	0.33	0.17	0.17	0.13	0.04	54
17			0.11	0.20	0.20	0.20	0.20	0.11	56
18			0.02	0.03	0.03	0.30	0.31	0.31	61
19				0.03	0.07	0.17	0.20	0.53	30
20	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.96	6
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	2
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2013

TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	6
12	0.21	0.21	0.57						14
13		0.25	0.44	0.31					16
14		0.20	0.52	0.20	0.04		0.04		25
15		0.03	0.34	0.28	0.17	0.07	0.05	0.05	58
16		0.02	0.26	0.22	0.33	0.05	0.03	0.09	58
17		0.01	0.14	0.27	0.24	0.14	0.10	0.11	94
18				0.05	0.13	0.18	0.13	0.51	84
19			0.03	0.13	0.18	0.08	0.18	0.43	40
20				0.12	0.12	0.06	0.06	0.65	17
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	5
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	3
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

Table 8 (continued):

2014									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	8
12	0.08	0.88	0.04						25
13		0.93	0.04	0.04					28
14		0.62	0.23	0.13				0.03	39
15		0.16	0.22	0.39	0.06	0.10	0.04	0.04	51
16		0.04	0.13	0.40	0.23	0.06	0.04	0.11	53
17		0.03	0.18	0.27	0.15	0.18	0.03	0.15	33
18				0.04	0.27	0.09	0.11	0.49	45
19			0.04		0.04	0.22	0.19	0.52	27
20			0.07		0.07	0.07	0.07	0.73	15
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	4
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	5
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2015									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	2
12	0.20	0.20	0.60						10
13	0.10	0.40	0.50						10
14		0.22	0.63	0.07	0.09				46
15		0.14	0.69		0.14		0.02		42
16			0.67	0.09	0.13	0.02	0.02	0.07	45
17		0.03	0.36	0.18	0.13	0.13	0.13	0.05	39
18			0.20	0.22	0.17	0.12	0.10	0.20	41
19			0.13	0.17	0.08	0.21	0.13	0.29	24
20				0.15	0.15	0.15	0.08	0.46	13
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	6
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	3
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2016									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	4
12	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	9
13	0.04	0.28	0.32	0.32				0.04	25
14		0.28	0.36	0.32		0.04			25
15		0.11	0.24	0.57	0.05		0.03		37
16		0.03	0.32	0.43	0.03	0.06	0.05	0.08	63
17		0.02	0.20	0.55	0.05	0.09	0.05	0.04	56
18			0.12	0.55	0.05	0.08	0.03	0.17	60
19		0.03	0.06	0.41	0.06	0.12	0.15	0.18	34
20				0.19	0.25		0.38	0.19	16
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	9
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	3
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2017									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2
11	0.19	0.81	0.00	0.00	0.00	0.00	0.00	0.00	5
12	0.42	0.17	0.42						12
13	0.07	0.38	0.45	0.07	0.03				29
14		0.13	0.78	0.08	0.03				40
15		0.07	0.53	0.07	0.31			0.02	45
16		0.06	0.36	0.21	0.34	0.02		0.02	53
17			0.21	0.21	0.49	0.05	0.02	0.02	61
18			0.03	0.21	0.51	0.06	0.08	0.11	63
19			0.03	0.15	0.41	0.06	0.09	0.26	34
20				0.15	0.40	0.15	0.15	0.15	20
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	8
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	2
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	

2018									
TL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
9	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
10	0.54	0.46							13
11	0.68	0.27		0.05					22
12	0.23	0.54	0.19	0.04					26
13		0.63	0.25	0.08		0.04			24
14		0.52	0.11	0.32				0.05	44
15		0.26	0.08	0.53	0.11	0.03			66
16		0.17	0.09	0.48	0.10	0.12	0.01	0.02	86
17		0.03	0.09	0.34	0.16	0.29		0.10	70
18		0.04	0.11	0.28	0.13	0.32		0.13	47
19			0.06	0.21	0.15	0.24		0.33	33
20			0.07	0.13		0.40		0.40	15
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	6
22	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	9
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1

Table 9: Annual commercial sheepshead catch-at-age and yield (pounds), and ASAP base model input coefficients of variation.

Commercial Catch-at-age										
Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Yield (lbs)	CV
1982	1,796	28,812	26,754	12,045	5,712	3,407	2,543	26,080	296,883	0.10
1983	3,022	52,761	48,991	22,056	10,459	6,239	4,658	47,758	543,510	0.10
1984	3,919	69,583	64,612	29,088	13,794	8,229	6,143	62,985	716,769	0.10
1985	4,169	69,899	64,905	29,220	13,856	8,266	6,170	63,271	720,142	0.10
1986	5,034	93,469	86,791	39,073	18,528	11,053	8,251	84,606	962,710	0.10
1987	10,918	186,215	172,911	77,845	36,914	22,021	16,438	168,558	1,918,294	0.10
1988	10,632	179,489	166,665	75,033	35,580	21,226	15,845	162,470	1,849,228	0.10
1989	12,864	237,885	220,889	99,445	47,156	28,132	21,000	215,329	2,450,203	0.10
1990	14,536	268,654	249,460	112,307	53,256	31,771	23,716	243,180	2,767,129	0.10
1991	12,827	235,458	218,635	98,430	46,675	27,845	20,785	213,132	2,425,258	0.10
1992	20,310	297,480	276,226	124,358	58,970	35,179	26,261	269,272	3,065,133	0.10
1993	20,354	365,429	339,320	152,763	72,440	43,215	32,259	330,779	3,764,127	0.10
1994	18,142	319,372	296,554	133,510	63,310	37,768	28,193	289,089	3,289,874	0.10
1995	14,752	322,615	317,845	139,658	65,127	38,122	27,888	272,461	3,266,716	0.10
1996	14,629	335,779	250,705	88,761	42,542	26,908	20,926	221,896	2,639,512	0.10
1997	6,303	150,649	332,502	169,714	83,137	47,710	33,105	265,150	3,114,700	0.10
1998	3,725	122,084	281,285	134,315	63,254	35,626	24,286	185,575	2,371,626	0.10
1999	876	114,742	317,186	173,071	86,503	51,243	36,229	295,423	3,201,615	0.05
2000		47,089	155,071	123,503	70,823	44,957	33,479	303,353	2,593,234	0.05
2001	98	21,280	84,547	78,467	49,932	33,309	25,320	229,841	1,803,677	0.05
2002	63	6,100	33,324	49,440	37,830	27,594	22,356	233,841	1,583,390	0.05
2003	36	10,009	35,083	103,362	71,904	38,674	75,258	88,482	1,637,961	0.05
2004	76	11,985	11,616	64,011	132,008	64,871	22,735	118,513	1,519,038	0.05
2005	196	22,527	35,337	21,276	90,947	43,957	15,735	59,846	1,022,294	0.05
2006	82	1,166	14,572	4,092	9,351	39,227	22,868	42,200	566,645	0.05
2007	165	3,624	11,752	24,794	22,910	13,663	52,742	107,900	1,024,288	0.05
2008	4	3,138	27,031	21,252	44,663	27,973	11,346	154,034	1,170,399	0.05
2009	19	3,622	4,010	58,226	18,184	58,976	26,602	135,810	1,213,893	0.05
2010	96	4,888	3,962	32,475	126,734	16,253	26,741	81,655	923,875	0.05
2011	13	44,873	64,223	23,359	20,640	31,371	5,332	29,005	884,614	0.05
2012	34	3,408	31,932	36,844	19,637	17,919	30,275	36,242	737,310	0.05
2013	207	15,375	42,655	37,733	35,273	33,316	34,034	141,155	1,326,327	0.05
2014	1,454	24,912	15,909	40,896	50,589	30,967	22,204	82,586	1,085,342	0.05
2015	4	5,054	74,062	19,113	27,255	31,373	12,680	58,134	823,237	0.05
2016	101	4,149	56,107	73,718	28,503	12,851	14,882	36,587	895,788	0.05
2017	3	10,872	24,104	22,773	61,759	11,092	12,645	37,838	746,478	0.05
2018	17	68,330	24,471	53,505	42,591	86,595	15,185	62,176	1,429,104	0.05

Table 10: Annual recreational sheepshead catch-at-age and yield (pounds), and ASAP base model input coefficients of variation.

Recreational Catch-at-age										
Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Yield (lbs)	CV
1982	94,653	87,540	34,199	10,288	3,926	2,304	1,720	18,016	403,868	0.31
1983	130,167	254,806	51,901	26,958	14,620	9,956	8,763	117,496	1,300,454	0.30
1984	24,321	103,029	38,190	21,308	11,295	7,165	5,649	59,476	652,016	0.27
1985	62,027	40,152	28,508	13,538	5,795	2,855	1,868	15,714	299,817	0.26
1986	16,877	36,112	29,862	18,559	9,021	4,984	3,360	24,841	346,237	0.31
1987	22,434	31,999	22,211	12,337	6,724	3,948	2,663	18,502	258,919	0.28
1988	40,261	32,049	28,317	15,275	6,244	3,244	2,261	22,138	321,911	0.36
1989	7,066	80,415	44,919	23,935	13,924	9,630	7,916	84,750	774,796	0.50
1990	7,944	32,830	16,662	14,456	9,024	5,952	4,568	46,308	402,862	0.32
1991	18,913	57,663	26,192	13,420	6,936	3,988	2,738	22,847	330,388	0.29
1992	144,215	45,115	29,781	13,286	7,272	4,798	3,924	50,464	521,619	0.33
1993	47,632	89,658	54,891	30,070	17,180	11,291	8,884	99,468	955,926	0.37
1994	30,609	89,989	38,691	14,534	5,940	3,150	2,175	22,999	427,372	0.22
1995	45,424	127,273	65,711	22,682	8,932	4,478	3,033	32,595	627,564	0.21
1996	33,266	77,398	100,838	37,679	14,920	7,965	5,525	48,589	768,512	0.26
1997	37,068	103,637	95,345	47,530	25,737	15,647	10,990	88,180	1,072,525	0.20
1998	3,972	72,757	77,511	48,731	27,113	17,553	13,630	138,916	1,244,624	0.23
1999	8,942	56,372	60,615	33,155	17,465	10,745	7,961	79,113	802,473	0.23
2000	5,405	44,264	36,112	22,063	13,305	10,205	9,252	128,206	968,122	0.30
2001	16,521	52,196	48,378	18,892	10,907	7,656	6,426	88,875	801,588	0.21
2002	20,247	166,763	124,582	49,636	13,741	16,707	9,100	105,719	1,309,188	0.23
2003	17,783	142,798	103,791	97,438	52,540	5,249	27,698	94,869	1,585,165	0.20
2004	45,871	127,230	78,488	209,170	88,916	28,390	7,043	73,861	1,882,090	0.29
2005	61,226	56,149	65,528	19,643	92,763	37,629	16,109	49,973	1,074,137	0.23
2006	20,888	44,533	26,388	23,600	4,612	26,506	12,511	16,783	476,216	0.25
2007	7,156	33,415	27,201	28,205	9,683	7,250	14,369	29,681	518,834	0.21
2008	4,277	29,621	135,014	61,427	38,165	17,972	1,763	59,889	1,037,524	0.22
2009	12,293	41,235	75,778	149,558	29,443	19,849	10,498	51,173	1,091,040	0.26
2010	32,627	33,262	32,584	46,311	67,409	10,664	9,414	85,830	1,057,028	0.28
2011	22,460	55,076	80,288	67,235	69,112	153,124	28,595	179,622	2,410,806	0.40
2012	12,339	30,553	31,847	40,876	22,538	29,103	26,642	41,003	726,362	0.21
2013	14,579	15,336	37,681	22,852	17,470	10,149	8,887	23,934	411,127	0.19
2014	22,986	82,018	24,635	39,184	23,819	16,560	10,283	44,299	713,351	0.27
2015	6,049	19,076	94,339	30,381	27,908	21,537	16,802	42,786	916,299	0.08
2016	3,575	21,164	40,930	93,842	11,483	12,828	14,971	27,194	790,628	0.11
2017	15,808	47,200	152,108	77,211	170,261	18,793	17,551	54,496	1,845,425	0.42
2018	23,327	66,213	28,227	90,800	25,280	41,593	710	34,050	937,535	0.12

Table 11: Annual mean weights-at-age (pounds) of commercial and recreational sheepshead landings.

Commercial Mean Weight-at-age								
Year	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*
1982	0.80	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1983	0.82	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1984	0.82	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1985	0.81	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1986	0.84	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1987	0.80	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1988	0.82	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1989	0.84	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1990	0.84	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1991	0.84	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1992	0.72	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1993	0.83	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1994	0.82	1.54	2.31	2.81	3.15	3.45	3.72	4.46
1995	0.85	1.55	2.30	2.81	3.14	3.42	3.68	4.38
1996	0.81	1.55	2.24	2.79	3.19	3.51	3.79	4.46
1997	0.81	1.70	2.33	2.84	3.15	3.37	3.56	3.99
1998	0.85	1.70	2.33	2.82	3.13	3.35	3.52	3.90
1999	0.90	1.69	2.38	2.84	3.17	3.40	3.58	4.00
2000		1.67	2.45	2.92	3.23	3.48	3.68	4.17
2001	0.46	1.69	2.48	2.97	3.28	3.52	3.71	4.13
2002	0.54	1.60	2.57	3.07	3.36	3.60	3.83	4.38
2003	0.52	2.05	3.21	3.58	3.63	3.88	4.10	4.69
2004	0.43	1.62	2.51	2.77	3.55	3.83	4.12	4.07
2005	0.40	1.86	2.75	3.12	3.40	3.84	4.18	4.56
2006	0.57	2.22	2.55	3.18	3.76	4.07	4.35	5.20
2007	0.66	1.92	2.57	3.50	3.87	4.79	4.37	4.78
2008	0.42	1.87	2.80	3.20	3.63	4.06	4.36	4.51
2009	0.40	1.59	2.43	2.80	3.77	3.97	4.26	4.56
2010	0.50	1.62	2.67	2.32	2.80	3.10	3.74	3.98
2011	0.57	2.73	3.84	4.29	4.66	4.16	4.81	5.61
2012	0.57	1.60	2.71	3.95	4.29	4.57	4.49	5.45
2013	0.44	2.75	2.83	3.31	3.68	4.05	3.67	4.59
2014	0.80	2.27	3.12	3.47	4.09	4.28	4.52	4.80
2015	0.57	1.77	2.46	3.49	3.62	4.59	4.66	4.53
2016	1.01	1.95	2.97	3.68	4.77	4.32	4.97	5.04
2017	0.47	2.29	3.04	3.40	4.35	4.67	4.56	5.10
2018	0.52	2.61	2.94	3.27	4.24	4.59	5.76	5.44

Recreational Mean Weight-at-age								
Year	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*
1982	0.60	1.53	2.28	2.66	3.11	3.45	3.73	4.49
1983	0.66	1.38	2.27	2.88	3.23	3.65	4.05	4.67
1984	0.54	1.44	2.32	2.88	3.20	3.52	3.82	4.33
1985	0.65	1.47	2.25	2.83	3.02	3.24	3.51	4.13
1986	0.75	1.62	2.34	2.87	3.12	3.33	3.50	3.83
1987	0.48	1.52	2.33	2.89	3.19	3.36	3.47	3.69
1988	0.65	1.48	2.38	2.79	3.03	3.32	3.63	4.54
1989	0.69	1.50	2.25	2.91	3.27	3.60	3.87	4.34
1990	0.83	1.29	2.42	2.97	3.27	3.51	3.75	4.39
1991	0.80	1.33	2.29	2.87	3.16	3.36	3.54	4.17
1992	0.37	1.39	2.23	2.88	3.23	3.57	3.91	4.86
1993	0.65	1.43	2.33	2.89	3.25	3.53	3.82	4.55
1994	0.60	1.42	2.26	2.76	3.05	3.33	3.59	5.10
1995	0.68	1.41	2.22	2.76	3.01	3.28	3.60	4.81
1996	0.64	1.50	2.29	2.74	3.05	3.34	3.59	4.21
1997	0.63	1.52	2.32	2.87	3.21	3.41	3.56	4.07
1998	0.71	1.52	2.36	2.90	3.23	3.52	3.77	4.36
1999	0.70	1.45	2.34	2.87	3.20	3.45	3.69	4.49
2000	0.88	1.36	2.40	2.89	3.34	3.73	4.06	4.94
2001	0.69	1.56	2.20	2.88	3.28	3.62	3.93	5.17
2002	0.74	1.54	2.59	2.83	3.37	3.42	3.90	4.12
2003	0.75	1.46	2.86	3.16	3.10	3.90	4.04	4.88
2004	1.02	1.87	2.60	2.89	3.29	3.39	3.63	5.09
2005	0.63	1.51	2.16	2.82	3.37	3.74	3.85	4.78
2006	0.68	1.69	2.80	3.05	3.61	3.44	3.54	5.28
2007	0.59	1.63	2.99	3.54	3.83	4.45	4.31	4.98
2008	1.22	1.64	2.25	3.05	3.74	3.97	3.36	4.56
2009	0.92	1.60	2.23	2.58	3.43	3.85	3.82	4.73
2010	0.73	1.42	2.48	2.57	3.60	4.17	4.40	5.33
2011	0.81	1.48	2.77	3.30	3.55	4.07	4.47	4.85
2012	0.77	1.54	2.34	2.72	3.08	3.56	3.79	5.12
2013	0.72	1.60	1.98	2.84	3.52	3.84	3.77	4.29
2014	0.79	1.58	2.72	2.84	3.50	3.72	4.03	4.52
2015	1.04	1.87	2.83	3.95	3.59	4.32	4.13	5.26
2016	0.96	1.85	2.93	3.45	4.25	3.78	4.52	5.14
2017	1.22	1.69	2.44	3.56	3.74	4.31	4.61	5.55
2018	0.97	1.97	2.79	3.04	3.50	3.87	3.41	5.23

Table 12: Probabilities of age given length for age assignments of sheepshead catches from the LDWF marine trammel net survey.

	Survey								
TL_in	*Age_0*	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*
5	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.96	0.04	0.00	0.00	0.00	0.00	0.00	0.00
13	0.00	0.04	0.95	0.01	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.90	0.09	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.32	0.55	0.09	0.02	0.01	0.00	0.01
16	0.00	0.00	0.01	0.39	0.27	0.11	0.05	0.03	0.14
17	0.00	0.00	0.00	0.04	0.15	0.13	0.09	0.07	0.51
18	0.00	0.00	0.00	0.00	0.03	0.06	0.07	0.07	0.77
19	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.05	0.89
20	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.95
21	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.97
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Table 13: Annual sheepshead catch-at-size from the LDWF marine trammel net survey.

	Survey, 1985-2018																
TL_in	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
4																	
5											2					1	
6	1			2		3	6	21	7	7	3	3		5	4	5	
7	6	3	5	6	6	32	19	42	14	8	7	7	1	7	9	10	2
8		2	16	10		11	6	17	58	4	17	12	33	4	7	7	29
9	3	20	45	15	5		1	7	90	271	35	17	51	6	13	7	27
10	9	43	17	26	3	4	4	10	51	26	24	14	28	11	26	13	11
11	1	35	8	19	4	7	8	15	16	19	14	17	10	6	25	17	8
12	8	26	11	35	5	5	11	7	9	34	14	26	27	16	20	17	24
13	5	45	11	39	11	11	4	7	13	20	20	32	20	35	32	15	62
14	11	62	9	35	20	7	9	10	12	35	34	63	25	35	46	33	71
15	12	43	12	19	43	13	11	9	7	18	29	117	31	44	72	55	85
16	13	13	8	10	46	17	20	15	5	15	27	92	24	58	57	57	81
17	8	10	21	11	27	13	12	16	7	21	26	129	28	38	43	62	77
18	3	7	8	9	9	9	7	10	8	22	16	57	24	22	29	46	73
19	3	3		5	9	12	10	16	4	24	9	17	10	6	18	21	35
20			1		2	19	6	5	4	12	7	17	6	5	4	6	11
21					1	8	1	3	5	4	3	7	2	1	1	2	1
22					1	1		2					1	1			
23						1											
24																	
Totals	83	310	172	241	192	173	135	212	311	542	287	626	322	300	407	374	598

Table 13 (continued):

	Survey, 1985-2018																
TL_in	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
4																	
5		1		1													3
6		2	1	1				2	4		2	2		1	2	5	2
7	11	1	10	5	3		1	3	7	1	13	1	2	1	10	22	2
8	3	3	6	2	10	1		4	2	3	4	2	1	4	2	24	6
9	6	13	5	7	9	10	6	5	12	14	2	6	1	9	3	8	17
10	14	8	13	8	8	6	7	5	25	23	2	25	10	6	19	11	20
11	14	5	5	14	2	10	6	3	22	10	9	20	16	10	24	8	7
12	21	6	10	11	5	11	22	4	47	22	18	12	15	9	24	12	8
13	26	6	6	19	3	9	31	9	38	19	25	12	26	16	30	23	10
14	21	24	10	21	9	8	36	20	65	25	42	23	15	13	41	15	10
15	22	25	23	33	28	9	29	28	78	32	40	65	25	13	43	31	9
16	47	24	50	25	37	26	41	51	83	46	39	49	31	10	44	38	10
17	70	53	80	41	59	36	31	82	115	27	42	53	47	26	52	27	14
18	86	65	55	32	50	51	47	60	100	17	23	31	36	14	93	38	6
19	41	29	32	21	47	21	21	25	46	13	30	42	23	11	78	29	11
20	13	15	12	11	9	3	5	6	18	9	8	21	9	10	20	16	9
21	3		2	2	3		1	1	3	6	3	4	4	4	5	2	1
22	1				1			1		2	1		1	1			
23														1			
24																	
Totals	399	281	320	254	282	201	284	309	664	269	303	368	260	159	490	309	145

Table 14: Annual sheepshead survey age composition and sample sizes (> age-0) derived from the LDWF marine trammel net survey.

Year	n>Age_0	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+
1985	76	0.275	0.249	0.173	0.079	0.039	0.023	0.017	0.144
1986	305	0.405	0.370	0.116	0.031	0.013	0.008	0.006	0.050
1987	151	0.536	0.152	0.077	0.045	0.029	0.020	0.015	0.126
1988	223	0.426	0.344	0.084	0.029	0.016	0.011	0.009	0.083
1989	186	0.092	0.231	0.242	0.113	0.054	0.033	0.024	0.211
1990	127	0.128	0.168	0.120	0.064	0.037	0.028	0.027	0.429
1991	104	0.228	0.154	0.148	0.082	0.044	0.030	0.025	0.288
1992	132	0.295	0.144	0.095	0.058	0.037	0.028	0.025	0.317
1993	232	0.718	0.113	0.033	0.015	0.009	0.008	0.007	0.098
1994	523	0.669	0.111	0.039	0.019	0.013	0.011	0.010	0.128
1995	258	0.338	0.231	0.121	0.057	0.031	0.021	0.017	0.183
1996	604	0.121	0.210	0.187	0.095	0.055	0.037	0.029	0.267
1997	288	0.403	0.184	0.106	0.050	0.030	0.021	0.018	0.187
1998	284	0.140	0.282	0.185	0.093	0.048	0.030	0.022	0.200
1999	387	0.219	0.249	0.178	0.077	0.040	0.026	0.020	0.191
2000	351	0.154	0.179	0.168	0.090	0.053	0.037	0.030	0.290
2001	567	0.127	0.267	0.158	0.078	0.045	0.033	0.027	0.266
2002	385	0.143	0.136	0.094	0.073	0.054	0.044	0.038	0.418
2003	274	0.117	0.131	0.102	0.069	0.054	0.045	0.040	0.442
2004	303	0.108	0.076	0.122	0.097	0.068	0.051	0.042	0.435
2005	245	0.164	0.197	0.131	0.070	0.046	0.035	0.030	0.328
2006	269	0.089	0.076	0.124	0.086	0.060	0.048	0.042	0.474
2007	200	0.184	0.097	0.088	0.074	0.056	0.046	0.040	0.414
2008	283	0.147	0.256	0.131	0.071	0.043	0.033	0.028	0.291
2009	300	0.059	0.121	0.137	0.102	0.070	0.052	0.043	0.417
2010	651	0.162	0.186	0.134	0.078	0.050	0.038	0.031	0.320
2011	265	0.260	0.197	0.149	0.076	0.040	0.026	0.021	0.232
2012	284	0.110	0.266	0.153	0.076	0.044	0.032	0.027	0.293
2013	363	0.173	0.148	0.165	0.079	0.045	0.033	0.028	0.329
2014	257	0.165	0.183	0.114	0.073	0.049	0.037	0.032	0.347
2015	153	0.224	0.206	0.089	0.054	0.039	0.030	0.027	0.331
2016	476	0.148	0.169	0.100	0.056	0.041	0.036	0.034	0.415
2017	258	0.153	0.179	0.135	0.072	0.043	0.033	0.030	0.355
2018	132	0.394	0.165	0.080	0.045	0.028	0.022	0.019	0.246

Table 15: Summary of objective function components and likelihood values of the ASAP base model.

Objective function=	*2701.1*		
Component	***Lambda***	***ESS***	***negLL***
Catch_Recreational	*1*	*--*	*482.6*
Catch_Commercial	*1*	*--*	*459.2*
IOA	*1*	*--*	*-34.6*
Catch_agecomps	*--*	*2100*	*826.4*
IOA_agecomps	*--*	*340*	*252.7*
Selectivity_parms_catch	*12*	*--*	*23.3*
N_year_1	*1*	*--*	*111.7*
Recruitment_devs	*1*	*--*	*579.9*

Table 16: Annual sheepshead abundance-at-age and total stock size estimates from the ASAP base model.

Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Totals
1982	5,167,180	3,658,950	2,760,800	2,140,520	1,687,910	1,345,410	1,080,210	4,636,160	22,477,140
1983	5,427,670	3,658,960	2,760,800	2,140,520	1,687,910	1,345,410	1,080,210	4,636,150	22,737,630
1984	5,122,750	3,822,570	2,698,490	2,075,380	1,637,270	1,308,110	1,053,290	4,546,800	22,264,660
1985	5,893,470	3,620,330	2,839,090	2,051,320	1,606,400	1,283,280	1,034,750	4,490,920	22,819,560
1986	5,597,830	4,173,590	2,706,230	2,178,120	1,602,630	1,270,090	1,023,140	4,458,470	23,010,100
1987	6,260,440	3,962,070	3,098,470	2,059,050	1,688,750	1,258,470	1,006,560	4,403,010	23,736,820
1988	5,947,400	4,428,140	2,874,110	2,294,900	1,558,330	1,298,070	978,996	4,285,540	23,665,486
1989	4,969,490	4,205,940	3,215,850	2,131,120	1,738,360	1,198,700	1,010,410	4,172,380	22,642,250
1990	5,267,930	3,502,620	2,981,250	2,312,600	1,568,160	1,302,480	911,567	4,035,010	21,881,617
1991	5,432,630	3,718,520	2,470,360	2,134,680	1,696,700	1,172,370	988,861	3,847,850	21,461,971
1992	6,892,860	3,837,010	2,642,250	1,784,850	1,579,200	1,277,920	895,898	3,779,880	22,689,868
1993	8,164,180	4,858,010	2,661,530	1,853,890	1,285,050	1,160,810	955,870	3,596,180	24,535,520
1994	8,869,350	5,733,500	3,275,310	1,802,190	1,290,810	916,410	845,323	3,429,360	26,162,253
1995	7,792,850	6,254,390	3,978,220	2,299,980	1,298,900	949,824	686,157	3,290,090	26,550,411
1996	5,777,920	5,491,280	4,357,370	2,804,670	1,662,790	958,186	712,635	3,065,870	24,830,721
1997	6,501,060	4,072,580	3,890,890	3,132,290	2,063,130	1,245,520	728,501	2,941,500	24,575,471
1998	4,329,440	4,578,310	3,026,080	2,866,990	2,248,900	1,477,660	900,923	2,713,550	22,141,853
1999	5,199,980	3,047,790	3,400,950	2,242,590	2,089,730	1,640,600	1,088,560	2,715,860	21,426,060
2000	7,121,890	3,665,960	2,271,570	2,511,400	1,608,250	1,492,780	1,183,170	2,800,790	22,655,810
2001	7,997,100	5,018,340	2,730,030	1,683,810	1,821,740	1,165,240	1,091,940	2,971,280	24,479,480
2002	3,289,270	5,643,200	3,758,590	2,054,470	1,253,450	1,358,840	876,698	3,107,830	21,342,348
2003	3,727,830	2,315,400	4,195,620	2,807,410	1,524,710	934,246	1,022,480	3,053,070	19,580,766
2004	4,365,900	2,621,790	1,717,040	3,127,630	2,084,610	1,138,330	704,371	3,128,630	18,888,301
2005	3,674,540	3,063,290	1,929,360	1,264,900	2,291,580	1,536,090	847,928	2,916,010	17,523,698
2006	7,192,910	2,588,070	2,283,480	1,454,060	954,828	1,741,690	1,178,120	2,933,320	20,326,478
2007	3,712,930	5,089,580	1,959,210	1,766,730	1,134,590	750,770	1,379,070	3,289,360	19,082,240
2008	3,080,320	2,626,440	3,846,850	1,506,400	1,361,550	879,353	586,128	3,687,640	17,574,681
2009	4,096,440	2,170,540	1,960,300	2,900,340	1,135,190	1,032,180	672,611	3,324,600	17,292,201
2010	4,436,160	2,883,560	1,614,470	1,469,600	2,170,510	854,546	784,335	3,091,750	17,304,931
2011	3,882,060	3,124,140	2,148,270	1,214,070	1,104,560	1,641,430	652,197	3,008,190	16,774,917
2012	2,948,750	2,709,310	2,262,490	1,556,780	883,378	812,281	1,222,570	2,791,900	15,187,459
2013	8,518,770	2,080,550	2,031,860	1,724,160	1,192,950	682,076	632,365	3,166,410	20,029,141
2014	4,257,170	6,021,540	1,567,620	1,547,570	1,306,150	906,719	522,479	2,953,630	19,082,878
2015	4,800,130	3,004,470	4,516,570	1,190,190	1,174,390	996,623	697,613	2,715,960	19,095,946
2016	3,360,150	3,387,770	2,254,690	3,440,100	909,530	903,530	773,065	2,685,500	17,714,335
2017	5,474,920	2,373,520	2,549,670	1,725,800	2,645,420	704,278	705,105	2,734,260	18,912,973
2018	4,846,400	3,841,690	1,749,160	1,896,520	1,291,800	1,999,310	537,869	2,675,470	18,838,219

Table 17: Annual total age-specific, apical, and average fishing mortality rates for sheepshead estimated from the ASAP base model.

Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Apical F	Avg. F
1982	0.00	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.01
1983	0.01	0.04	0.05	0.05	0.05	0.04	0.04	0.03	0.05	0.03
1984	0.00	0.03	0.04	0.04	0.03	0.03	0.03	0.02	0.04	0.03
1985	0.00	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.02
1986	0.00	0.03	0.04	0.04	0.03	0.03	0.03	0.02	0.04	0.02
1987	0.00	0.05	0.07	0.06	0.05	0.05	0.04	0.03	0.07	0.04
1988	0.00	0.05	0.06	0.06	0.05	0.05	0.04	0.03	0.06	0.04
1989	0.01	0.08	0.10	0.09	0.08	0.07	0.06	0.05	0.10	0.06
1990	0.01	0.08	0.10	0.09	0.08	0.07	0.06	0.05	0.10	0.06
1991	0.01	0.08	0.09	0.08	0.07	0.07	0.06	0.05	0.09	0.05
1992	0.01	0.10	0.12	0.11	0.10	0.09	0.07	0.06	0.12	0.07
1993	0.01	0.13	0.16	0.14	0.13	0.11	0.10	0.08	0.16	0.08
1994	0.01	0.10	0.12	0.11	0.10	0.09	0.07	0.06	0.12	0.07
1995	0.01	0.10	0.12	0.11	0.10	0.08	0.07	0.06	0.12	0.07
1996	0.01	0.08	0.10	0.09	0.08	0.07	0.06	0.05	0.10	0.06
1997	0.01	0.03	0.07	0.11	0.12	0.12	0.11	0.10	0.13	0.07
1998	0.01	0.03	0.07	0.10	0.11	0.10	0.09	0.09	0.11	0.06
1999	0.01	0.03	0.07	0.11	0.13	0.12	0.12	0.11	0.13	0.07
2000	0.01	0.03	0.07	0.10	0.11	0.11	0.10	0.09	0.12	0.06
2001	0.01	0.02	0.05	0.08	0.08	0.08	0.08	0.07	0.09	0.04
2002	0.01	0.03	0.06	0.08	0.09	0.08	0.07	0.07	0.09	0.05
2003	0.01	0.03	0.06	0.08	0.08	0.08	0.07	0.07	0.09	0.05
2004	0.01	0.04	0.07	0.09	0.10	0.09	0.08	0.07	0.10	0.06
2005	0.01	0.03	0.05	0.06	0.07	0.06	0.06	0.05	0.07	0.04
2006	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.02	0.03	0.02
2007	0.00	0.01	0.03	0.04	0.05	0.04	0.04	0.04	0.05	0.03
2008	0.01	0.03	0.05	0.06	0.07	0.06	0.06	0.05	0.07	0.04
2009	0.01	0.03	0.05	0.07	0.08	0.07	0.07	0.06	0.08	0.05
2010	0.01	0.03	0.05	0.07	0.07	0.07	0.06	0.05	0.07	0.04
2011	0.02	0.06	0.09	0.10	0.10	0.09	0.08	0.07	0.10	0.06
2012	0.01	0.02	0.04	0.05	0.05	0.05	0.04	0.04	0.05	0.03
2013	0.00	0.02	0.04	0.06	0.07	0.06	0.06	0.05	0.07	0.03
2014	0.01	0.02	0.04	0.06	0.06	0.06	0.05	0.05	0.06	0.03
2015	0.01	0.02	0.04	0.05	0.05	0.05	0.05	0.04	0.05	0.03
2016	0.01	0.02	0.03	0.04	0.05	0.04	0.04	0.04	0.05	0.03
2017	0.01	0.04	0.06	0.07	0.07	0.07	0.06	0.05	0.07	0.05
2018	0.01	0.02	0.05	0.06	0.07	0.07	0.06	0.05	0.07	0.04

Table 18: Limit and target reference point estimates for the Louisiana sheepshead stock. Spawning stock biomass units are pounds x 10^6. Fishing mortality units are $years^{-1}$.

Management Benchmarks		
Parameters	Derivation	Value
SPR_{limit}	Proposed Limit	20.0%
SSB_{limit}	Equation [24] and SPR_{limit}	5.47
F_{limit}	Equation [24] and SPR_{limit}	0.294
SSB_{target}	LAC 76: VII.385 (Geometric mean SSB 1982-2013)	21.4
SPR_{target}	Equation [24] and SSB_{target}	78.2%
F_{target}	Equation [24] and SSB_{target}	0.0337

Table 19: Sensitivity analysis table of proposed limit reference points. Current estimates are taken as the geometric mean of the 2016-2018 estimates. Yield and spawning stock biomass units are millions of pounds, and fishing mortality units are years^{-1}.

Model run	negLL	SPR_{limit}	$Yield_{limit}$	F_{limit}	SSB_{limit}	$SPR_{current}$	$F_{current}/F_{limit}$	$SSB_{current}/SSB_{limit}$
Base Model (h=1)	2,701.1	20.0%	6.29	0.29	5.47	68.9%	0.13	3.45
Model 1 (h=0.9)	2,701.0	20.0%	5.59	0.29	4.86	68.6%	0.13	3.82
Model 2 (h=0.8)	2,710.2	20.0%	4.65	0.29	4.05	68.4%	0.13	4.52
Model 3 (h=0.7)	2,700.5	20.0%	3.31	0.29	2.88	67.8%	0.13	6.14
Model 4 (Yield lambda*4)	5,501.7	20.0%	6.39	0.29	5.56	69.1%	0.12	3.46
Model 5 (IOA lambda*4)	2,595.4	20.0%	6.39	0.29	5.56	70.2%	0.12	3.51
Model 6 (Discard M=0.1)	2,696.2	20.0%	6.38	0.29	5.56	68.7%	0.13	3.44
Model 7 (Growth model ALK's 1982-2018)	2,683.7	20.0%	10.14	0.30	11.00	60.1%	0.08	3.00
Model 8 (ACAL MRIP hindcast)	2,700.9	20.0%	6.21	0.29	5.42	68.9%	0.13	3.45
Model 9 (MRIP Size with FES and APAIS)	2,691.4	20.0%	6.02	0.30	5.29	68.7%	0.13	3.44

Table 20: Sensitivity analysis table of MSY related reference points. Current estimates are taken as the geometric mean of 2016-2018 estimates. Yield and spawning stock biomass units are millions of pounds, and fishing mortality units are years^{-1}.

Model run	negLL	SPR_{MSY}	MSY	F_{MSY}	SSB_{MSY}	$SPR_{current}$	$F_{current}/F_{MSY}$	$SSB_{current}/SSB_{MSY}$
Base Model (h=1)	2701.1	--	--	--	--	68.9%	--	--
Model 1 (h=0.9)	2701.0	23.8%	5.63	0.25	5.92	68.6%	0.15	3.14
Model 2 (h=0.8)	2710.2	30.4%	5.04	0.20	7.11	68.4%	0.19	2.57
Model 3 (h=0.7)	2700.5	36.9%	4.45	0.16	8.12	67.8%	0.25	2.18

11. Figures

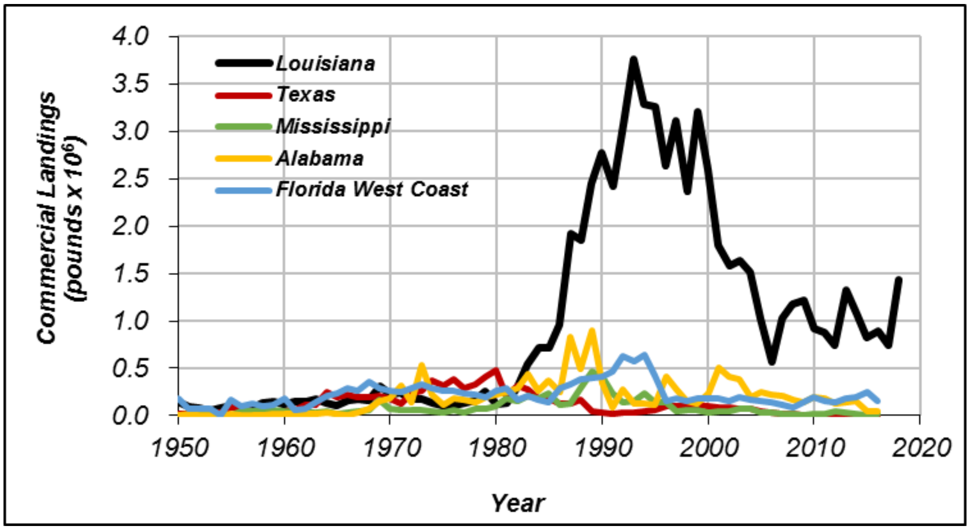

Figure 1: Reported commercial Gulf of Mexico sheepshead landings (pounds x 10^6) from NMFS statistical records and the LDWF Trip Ticket Program.

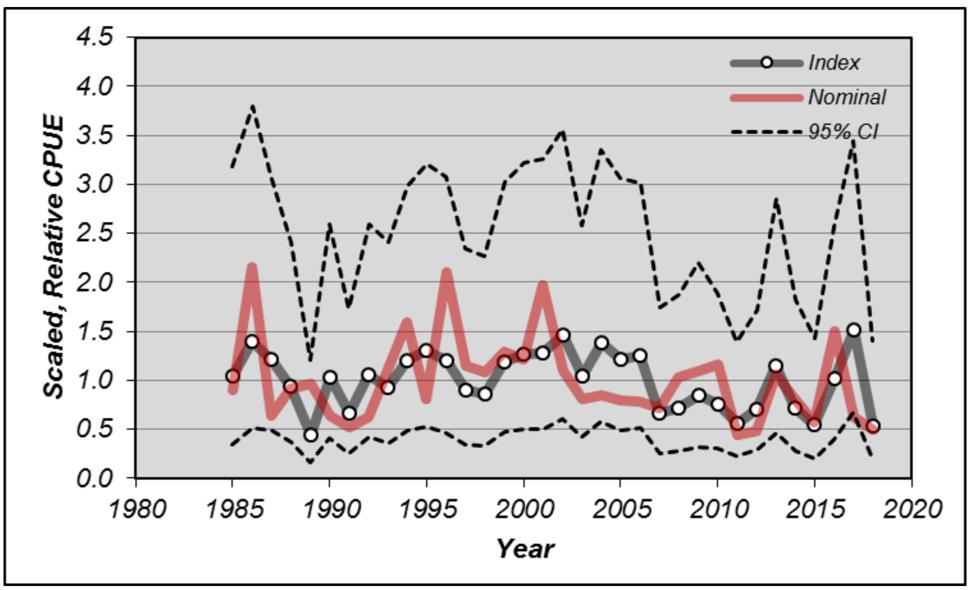

Figure 2: Standardized index of abundance, nominal catch rates, and 95% confidence intervals of the standardized index for sheepshead derived from the LDWF marine trammel net survey. Each time-series has been normalized to its individual long-term mean for comparison.

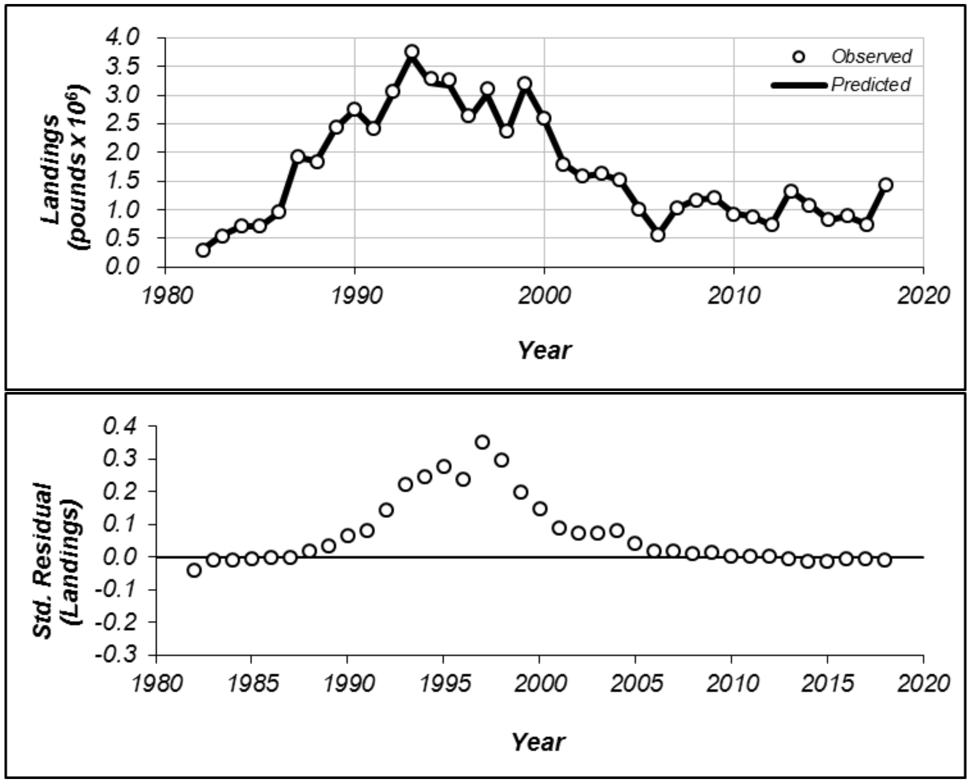

Figure 3: Observed and ASAP base model estimated commercial yield (top) and standardized residuals (bottom).

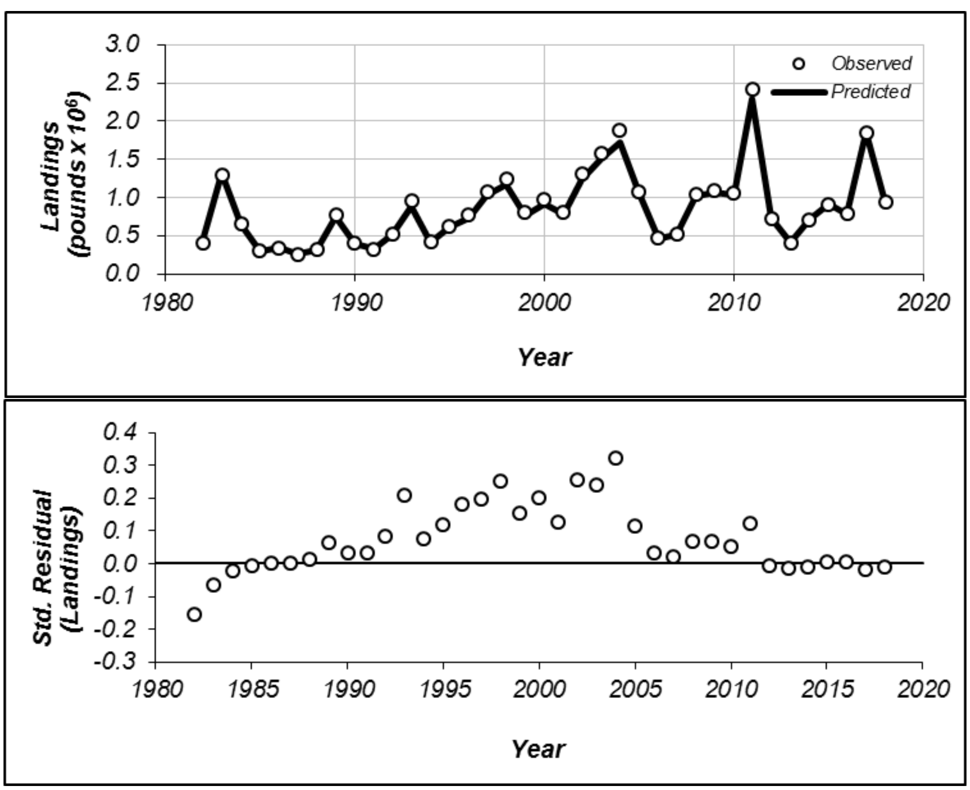

Figure 4: Observed and ASAP base model estimated recreational yield (top) and standardized residuals (bottom).

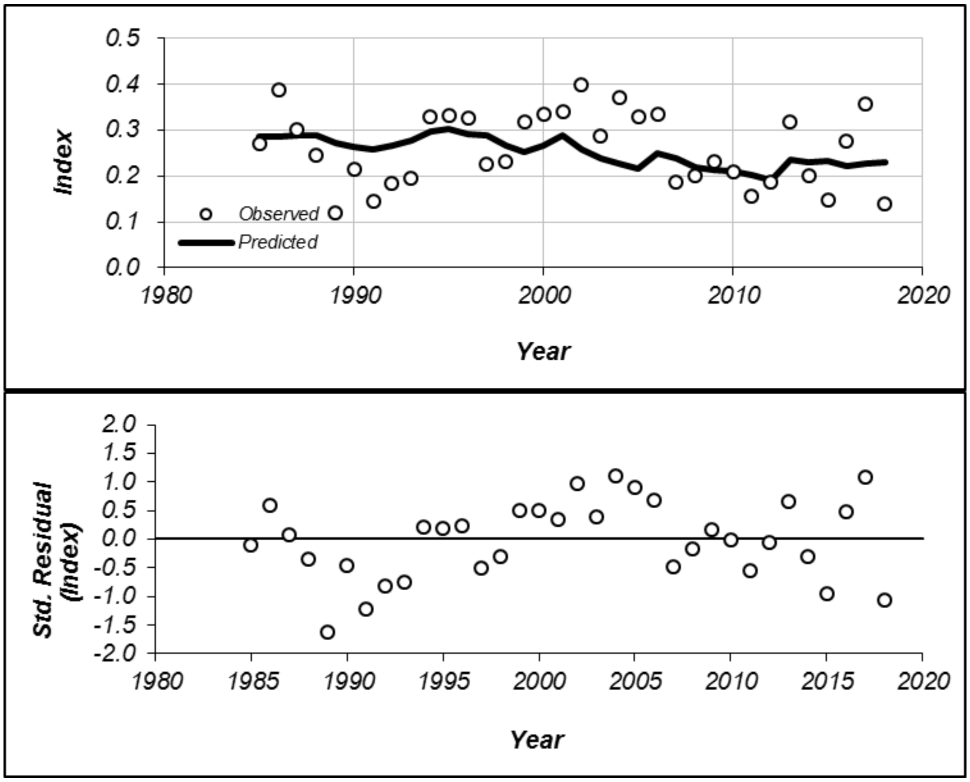

Figure 5: Observed and ASAP base model estimated survey CPUE (top) and standardized residuals (bottom).

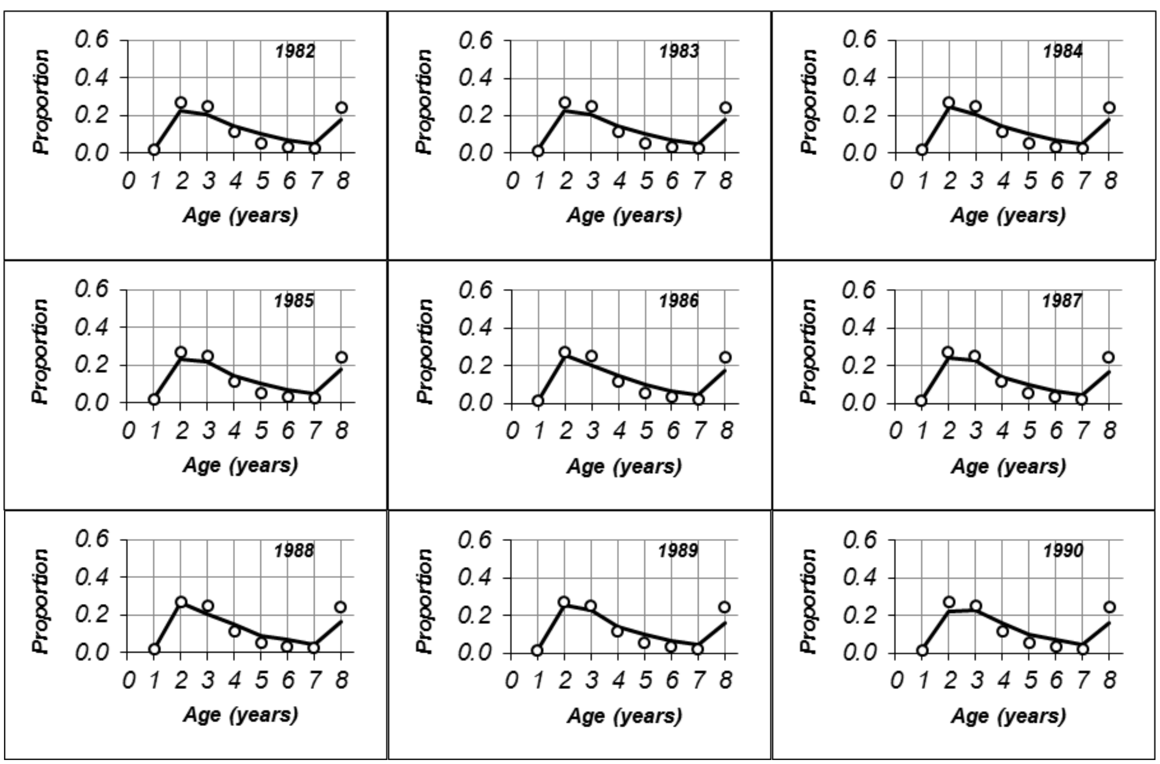

Figure 6: Annual input (open circles) and ASAP estimated (bold lines) commercial sheepshead harvest age compositions.

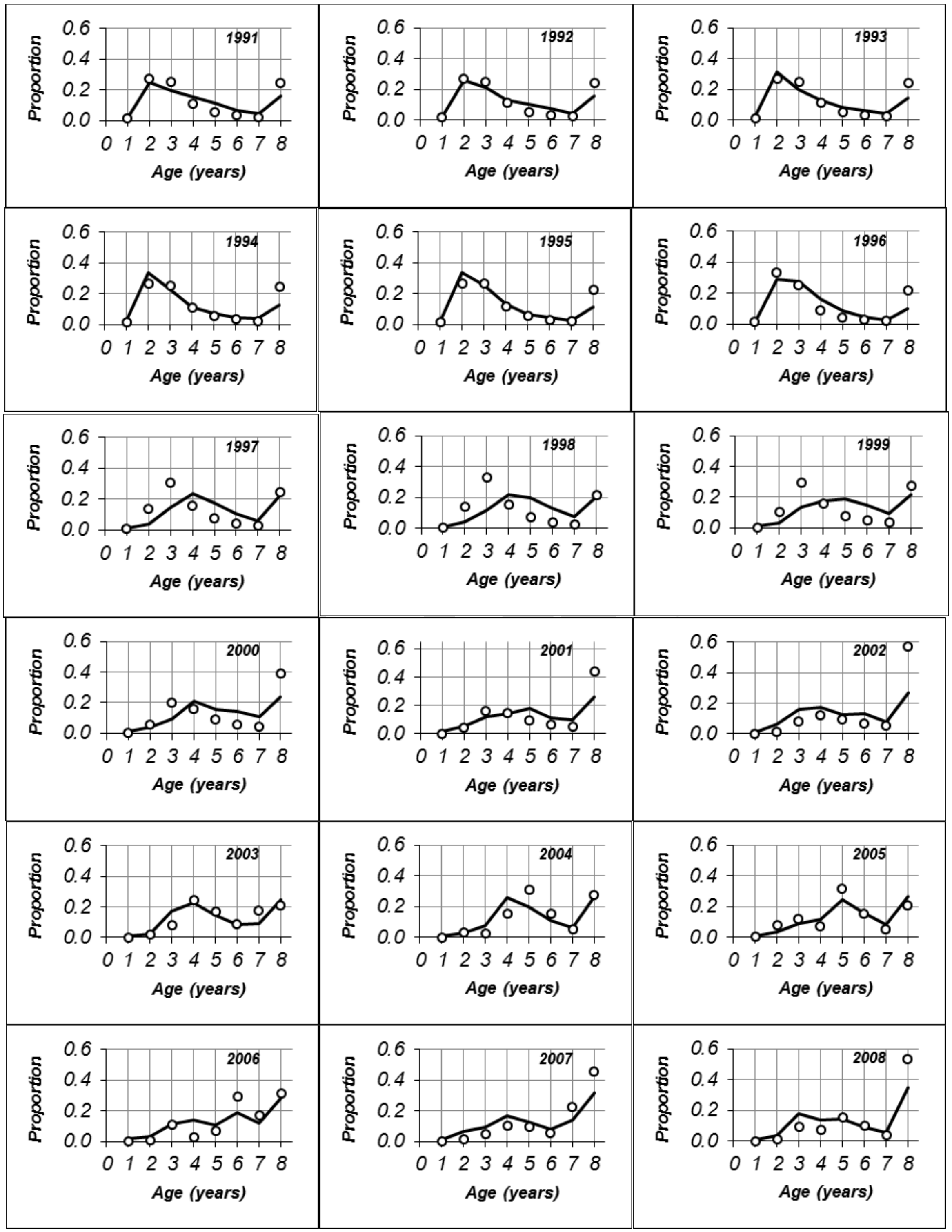

Figure 6 (continued):

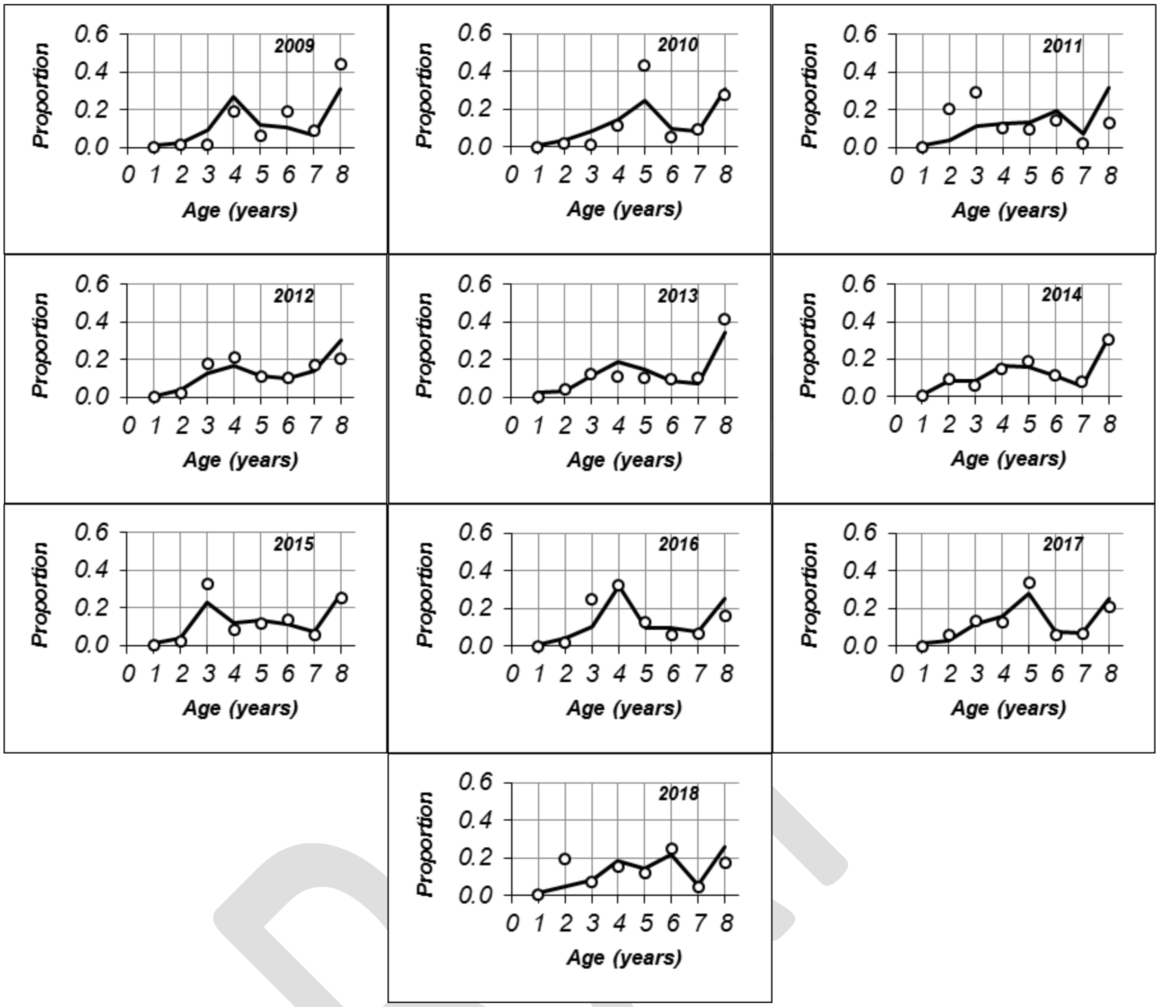

Figure 6 (continued):

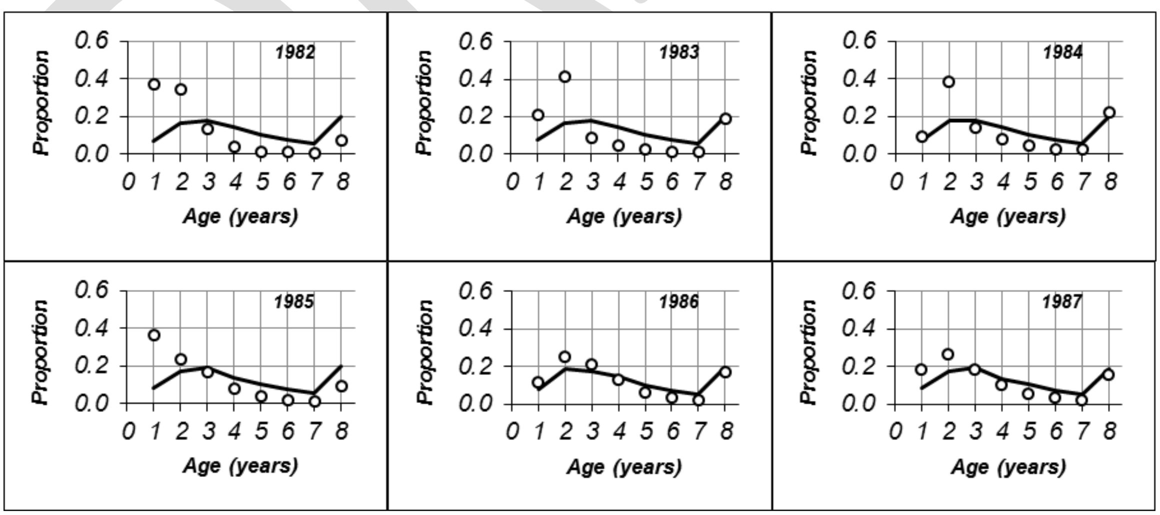

Figure 7: Annual input (open circles) and ASAP estimated (bold lines) recreational sheepshead harvest age compositions.

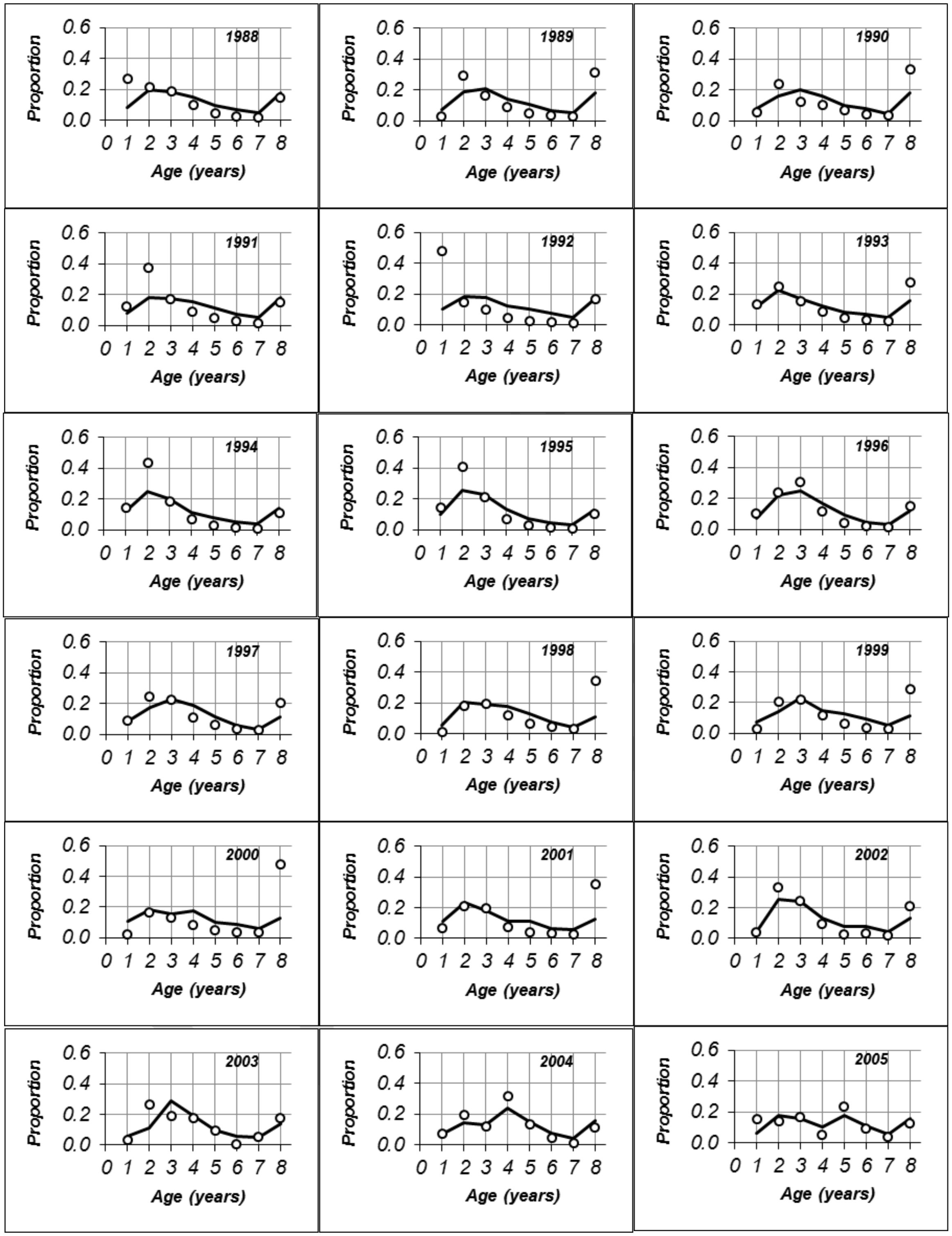

Figure 7 (continued):

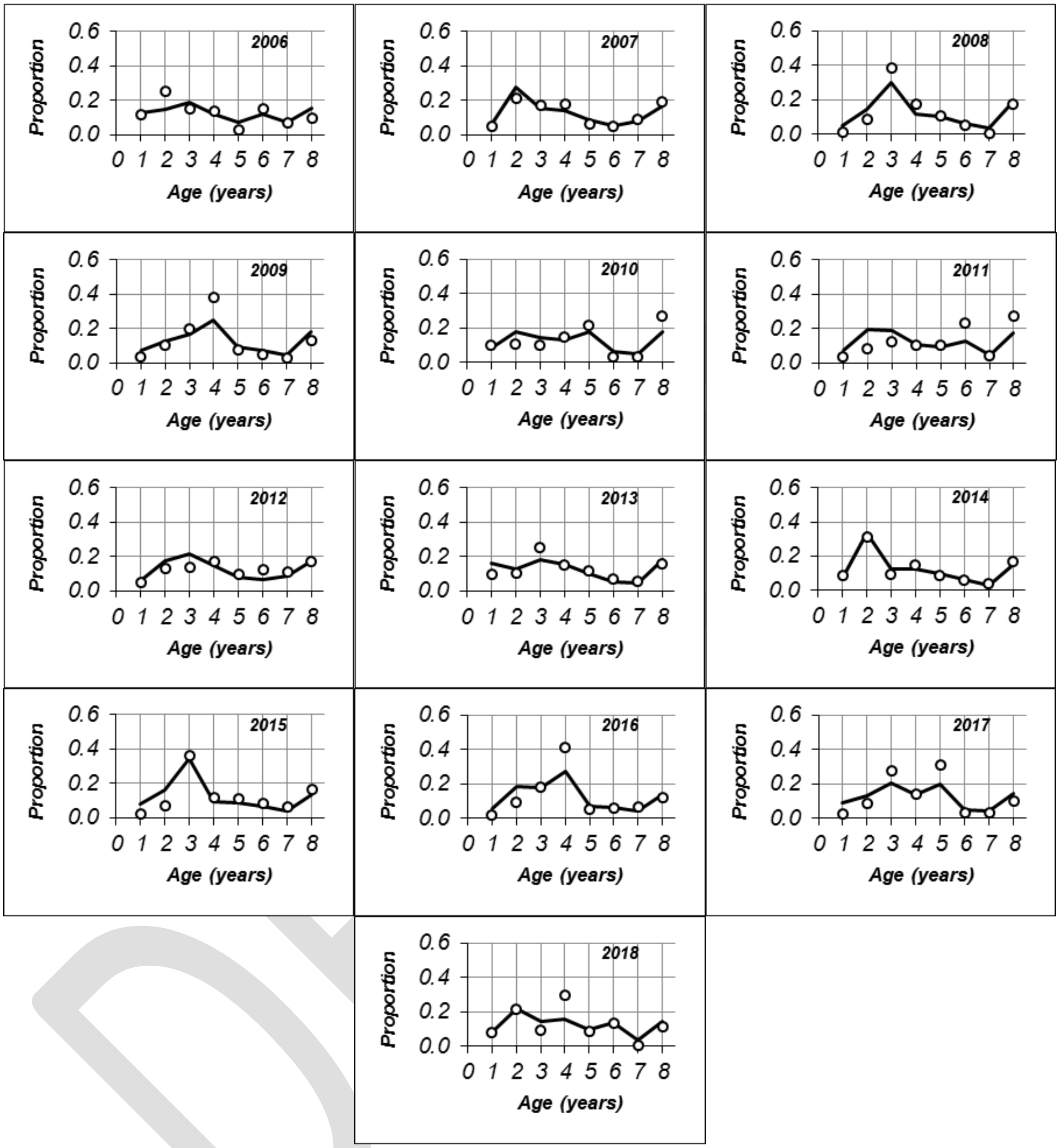

Figure 7 (continued):

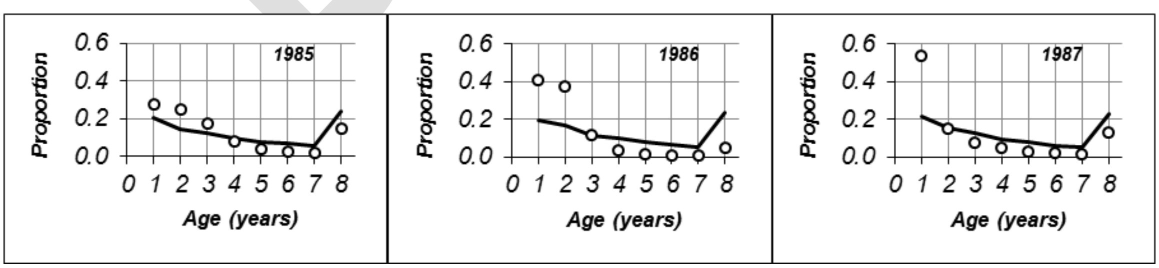

Figure 8: Annual input (open circles) and ASAP estimated (bold lines) survey age compositions.

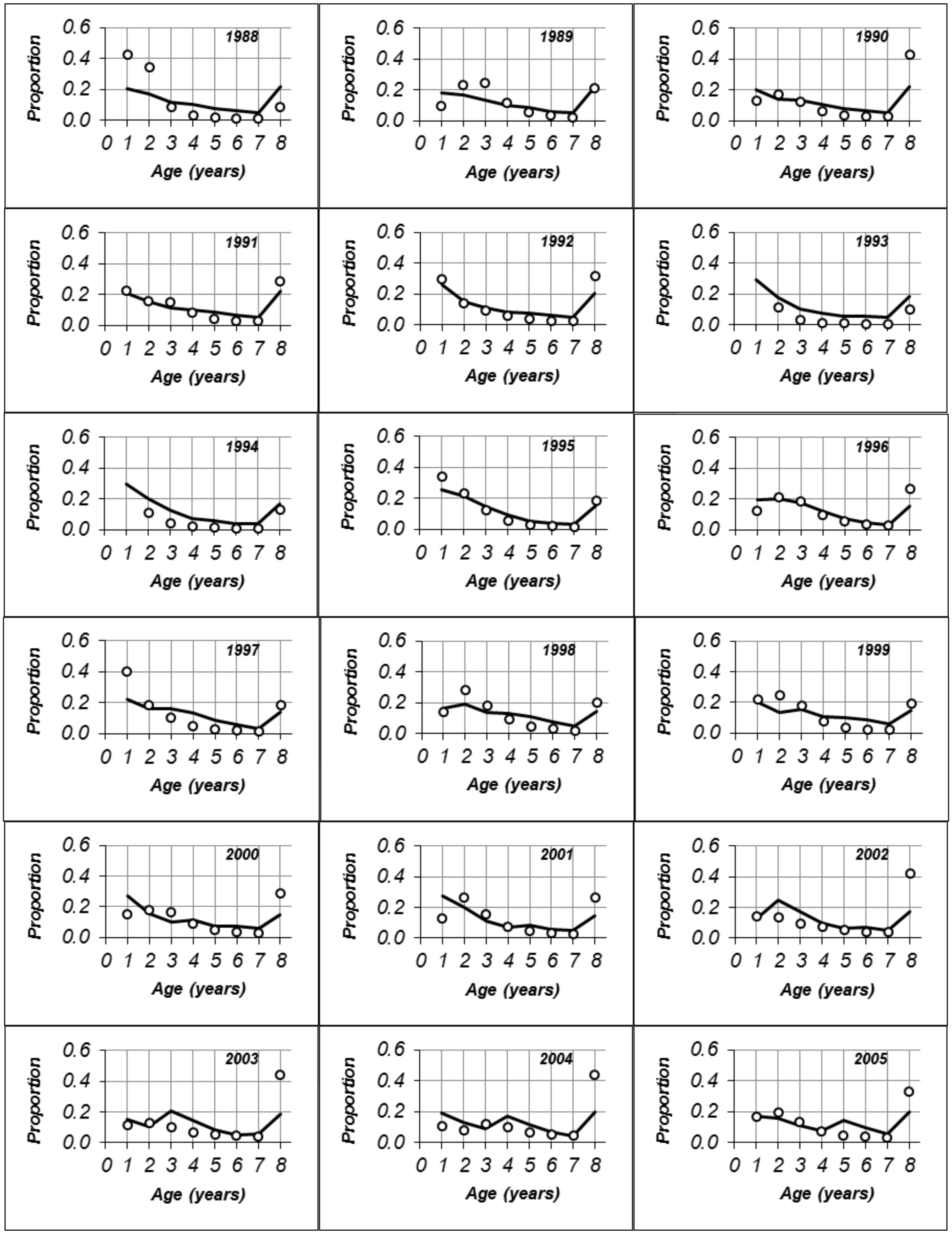

Figure 8 (continued):

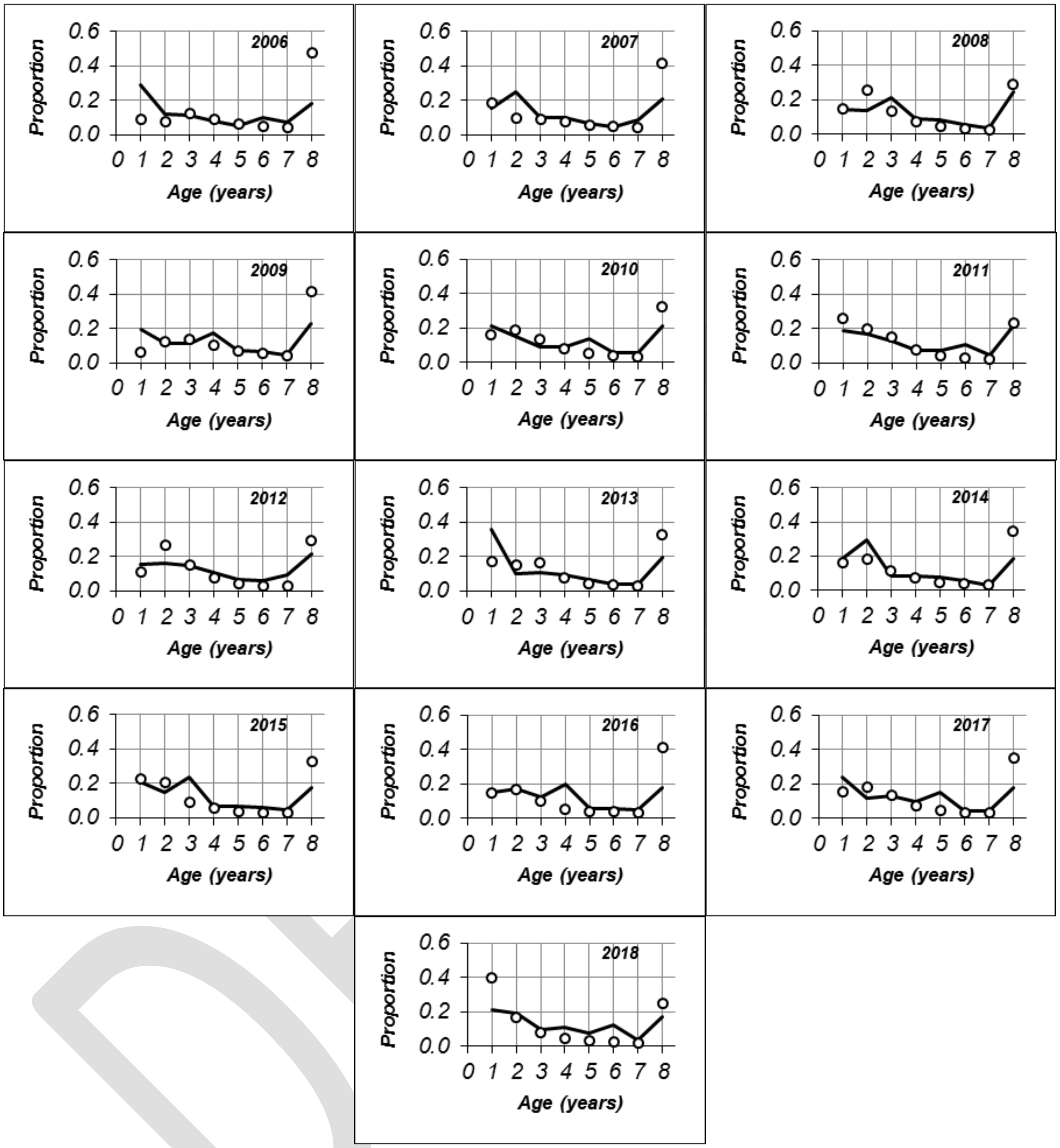

Figure 8 (continued):

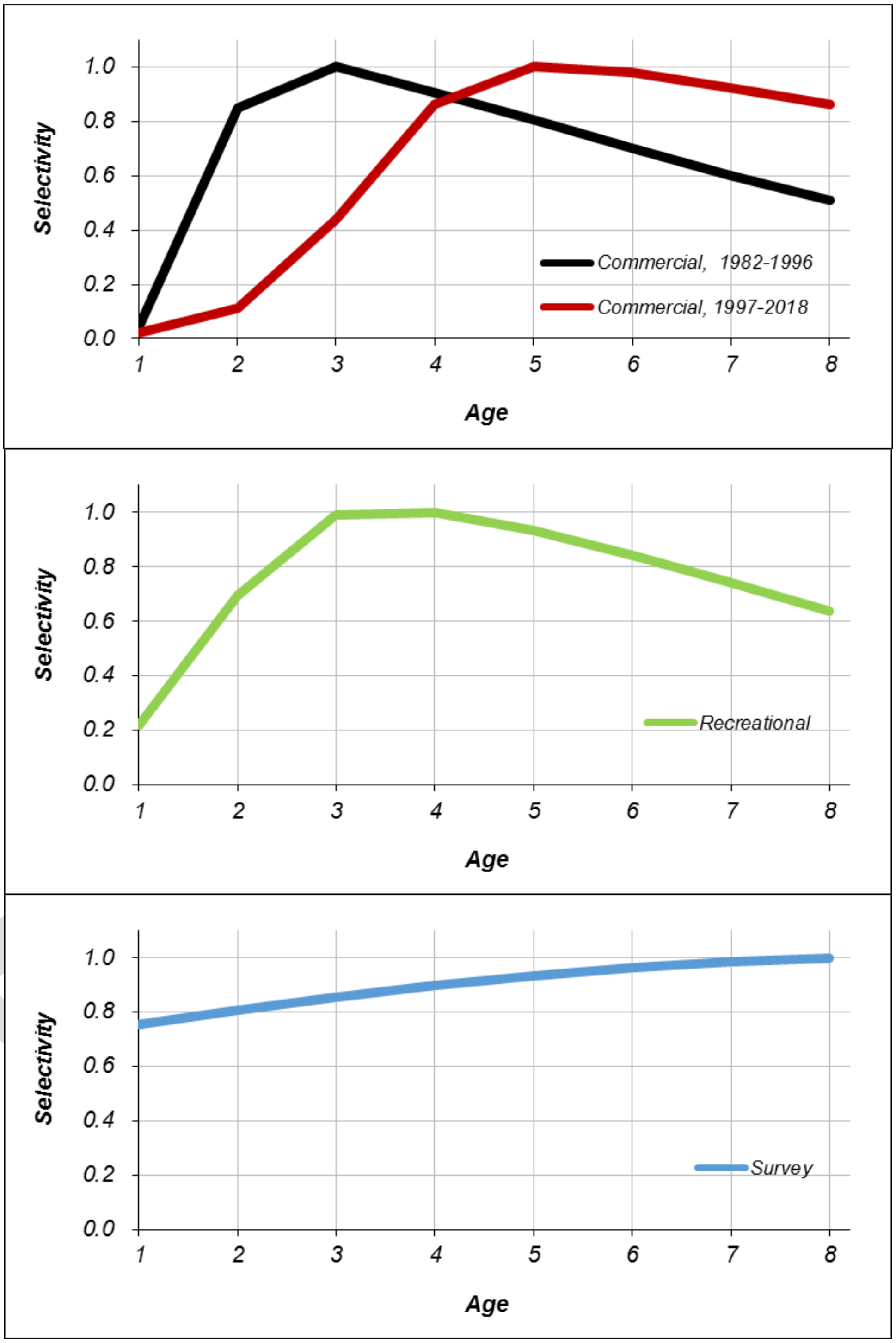

Figure 9: ASAP base model estimated commercial (top), recreational (middle), and survey selectivities (bottom, ages 1-8+).

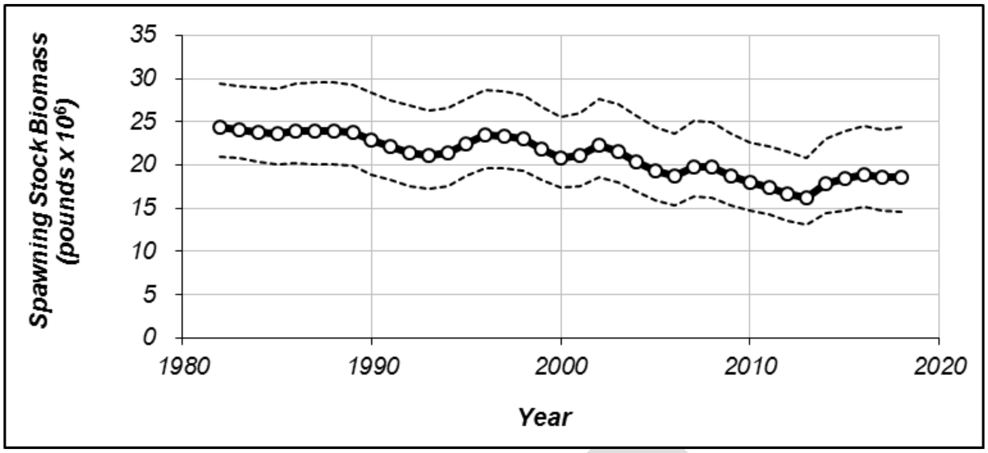

Figure 10: ASAP base model estimated female spawning stock biomass (MCMC median). Dashed lines represent 95% MCMC derived confidence intervals.

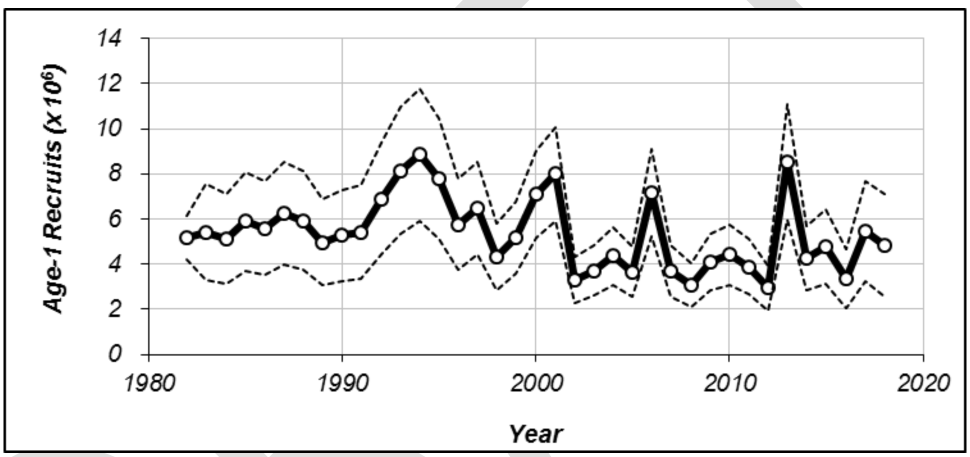

Figure 11: ASAP base model estimated recruitment. Dashed lines represent ± 2 asymptotic standard error.

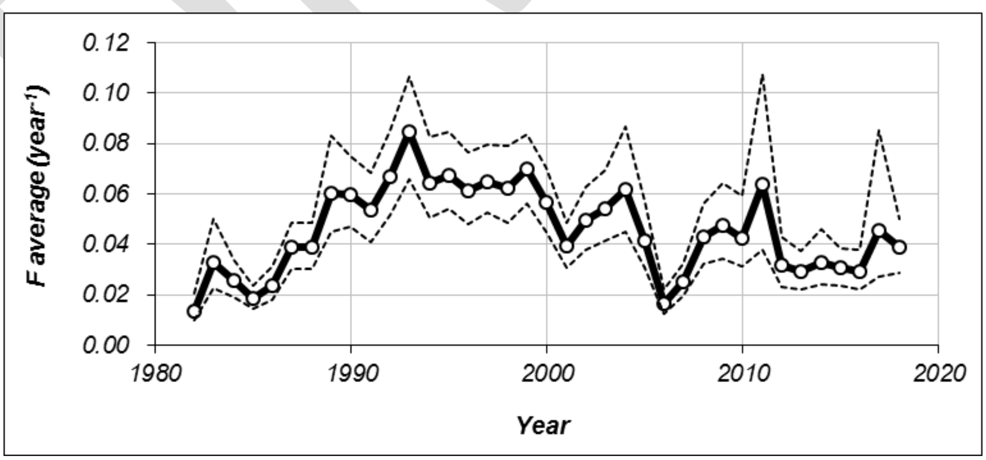

Figure 12: ASAP base model estimated average fishing mortality (MCMC median). Dashed lines represent 95% MCMC derived confidence intervals.

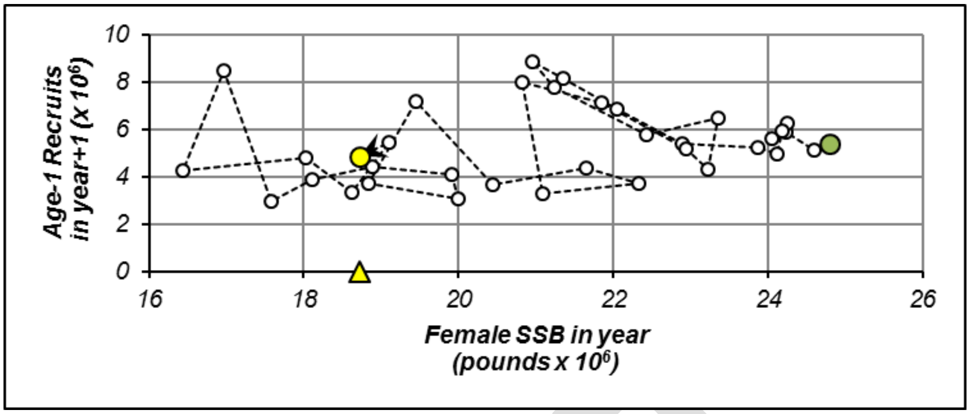

Figure 13: ASAP base model estimated age-1 recruits and female spawning stock biomass. Arrow represents direction of the time-series. The yellow circle represents the most current data pair (2018 age-1 recruits / 2017 female SSB) and the yellow triangle represents the 2018 SSB estimate. The green circle represents the first data pair (1983 age-1 recruits / 1982 female SSB).

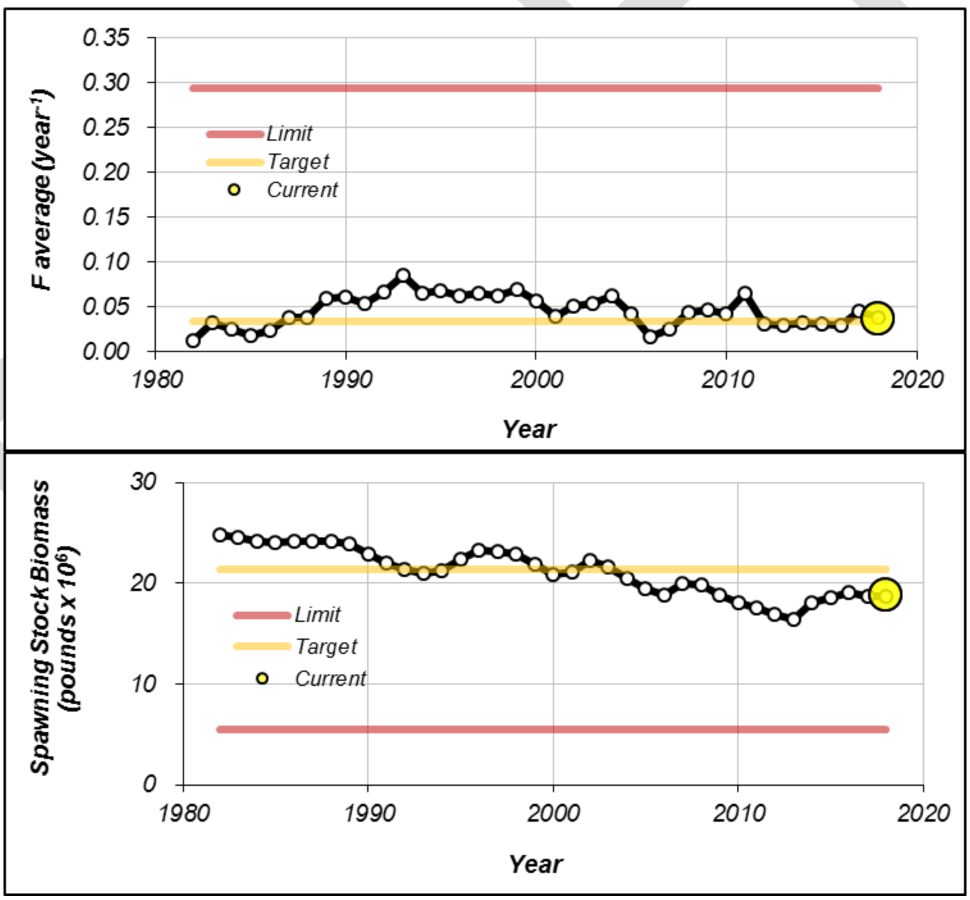

Figure 14: Time-series of ASAP base model estimated average fishing mortality rates, female spawning stock biomass, and spawning potential ratio relative to proposed limit and established target reference points. Current values represent the geometric mean of the 2016-2018 estimates.

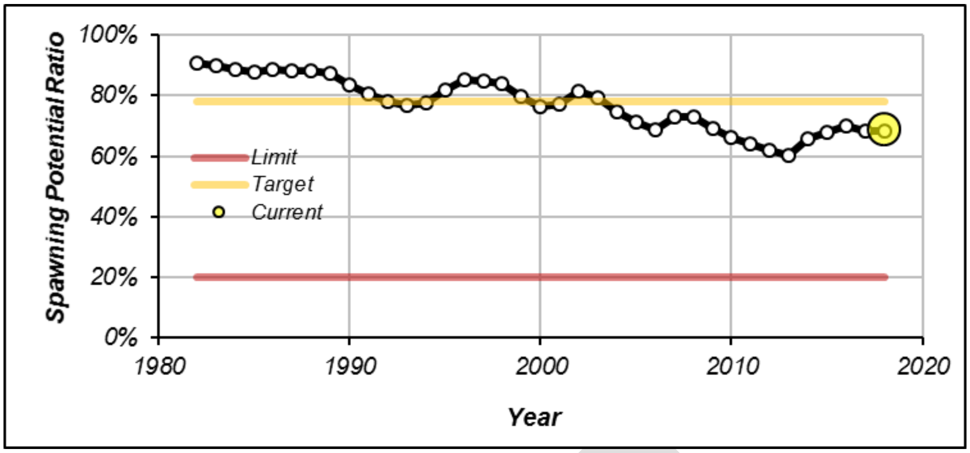

Figure 14 (continued):

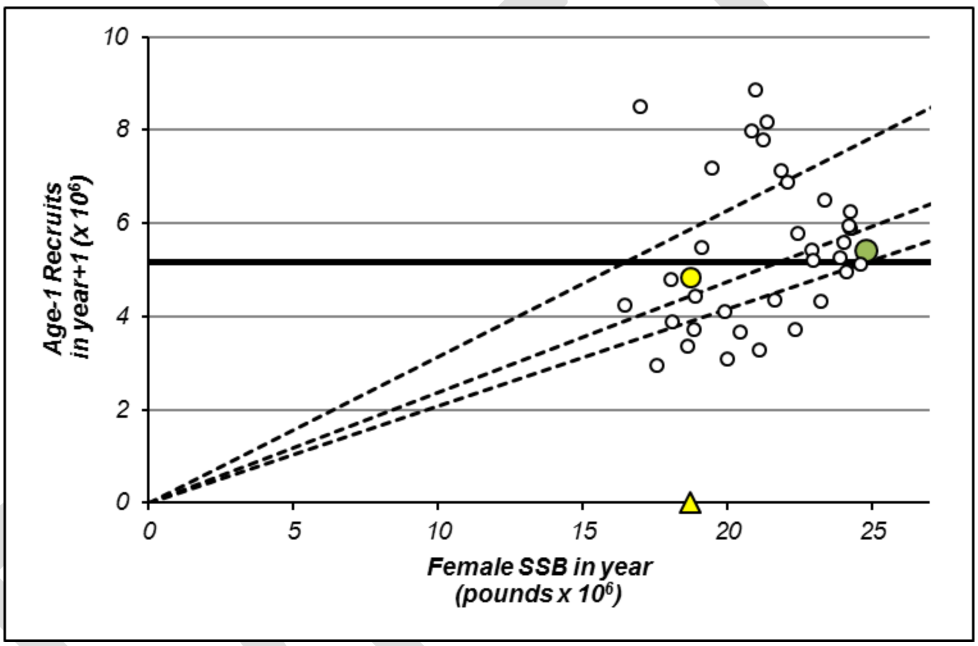

Figure 15: ASAP base model estimated age-1 recruits and female spawning stock biomass (open circles). Equilibrium recruitment is represented by the bold horizontal. The yellow circle represents the most current data pair (2018 age-1 recruits / 2017 female SSB) and the yellow triangle represents the 2018 SSB estimate. The green circle represents the first data pair (1983 age-1 recruits / 1982 female SSB). Equilibrium recruitment per spawning stock biomass corresponding with the target spawning stock biomass reference point estimate and the minimum and maximum spawning stock biomass estimates are represented by the slopes of the dashed diagonals (min. SSB=60% SPR; SSB_{target}=78%; max. SSB=91% SPR).

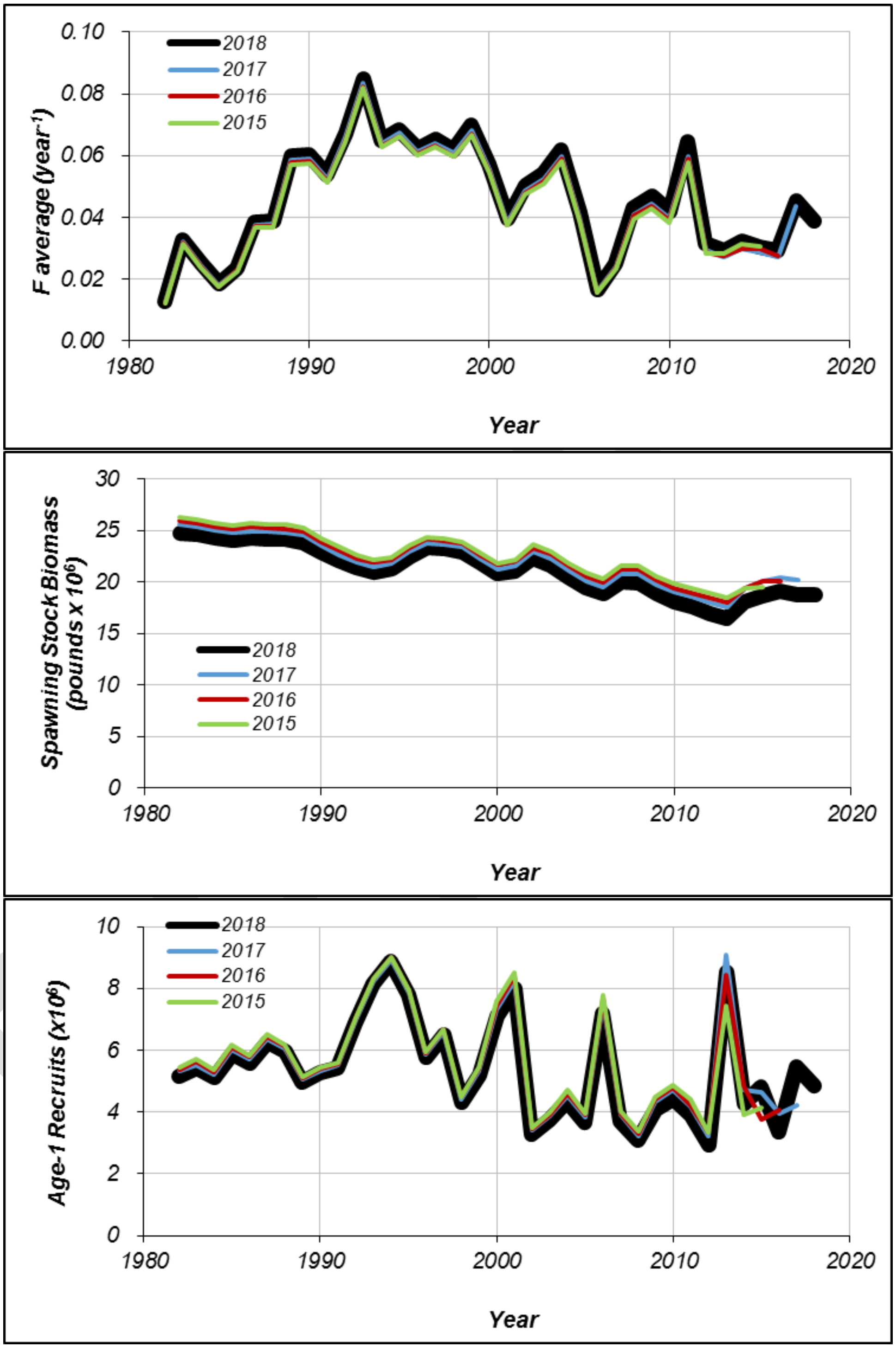

Figure 16: Retrospective analysis of ASAP base model. Top graphics depict annual average fishing mortality and female spawning stock biomass estimates. Bottom graphic depicts estimated age-1 recruits.

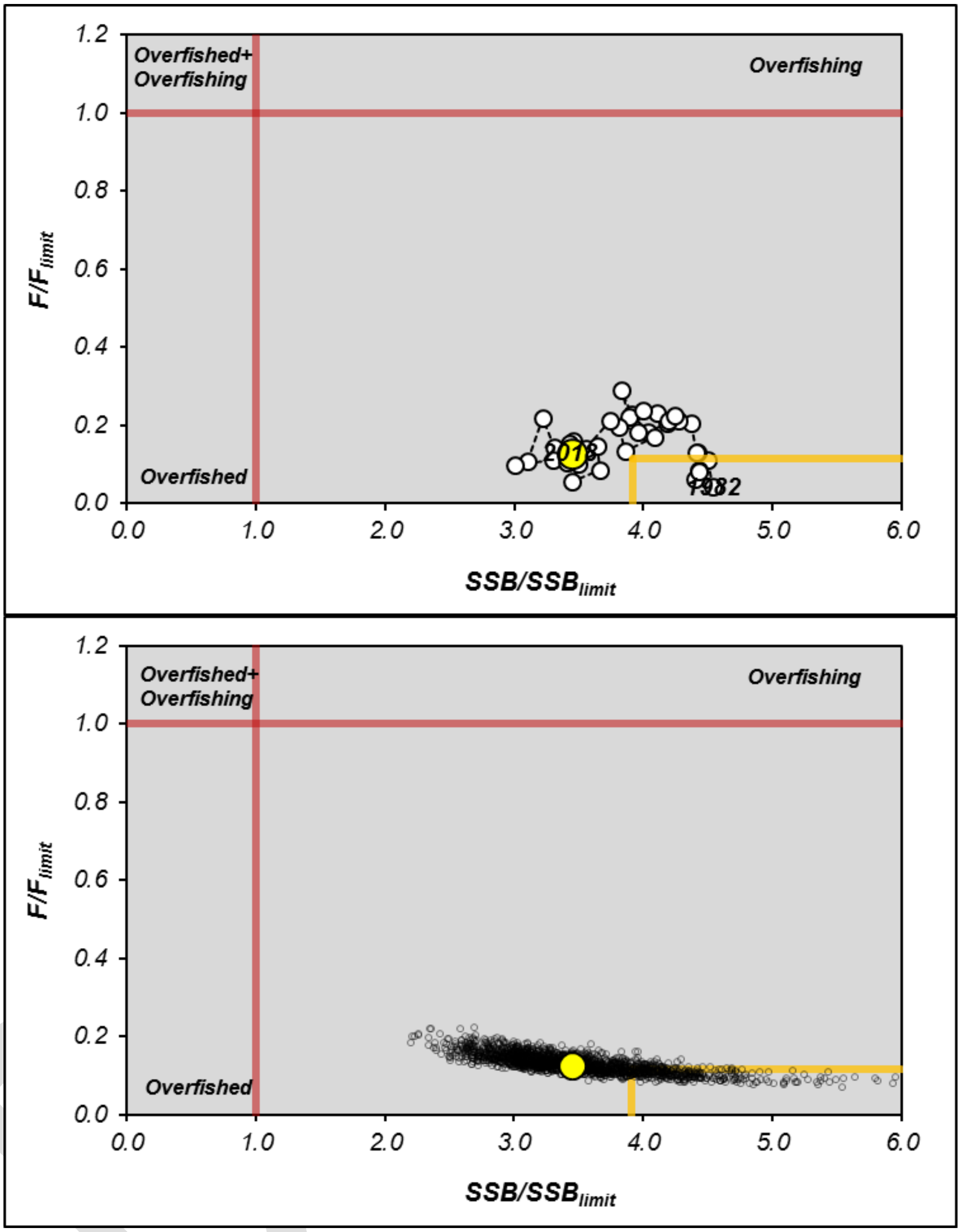

Figure 17: ASAP base model estimated ratios of annual average fishing mortality rates and female spawning stock biomass to the proposed limit reference points (F_{limit} and SSB_{limit}). Also presented are the target reference points (yellow lines). The first and last year of the time-series are identified. The yellow circle represents current status (geometric mean 2016-2018). Bottom graphic depicts current status and results of 2000 MCMC simulations relative to limit and target reference points.

Appendix 1:

LA Creel/MRIP Calibration Procedure

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Office of Fisheries
Louisiana Department of Wildlife and Fisheries
10/8/2018

Overview

The Louisiana Department of Wildlife and Fisheries (LDWF) conducts stock assessments on important recreationally and commercially landed species. Time-series of fishery removals are critical components of these stock assessments as they provide the level of depletion of the resource through time. Beginning in 2014, LDWF started its own creel survey (LA Creel) to provide recreational landings estimates for Louisiana-specific fishery management and stock assessment purposes. Prior to 2014 recreational landings estimates were taken from the National Marine Fisheries Service's Marine Recreational Intercept Program and the earlier Marine Recreational Fisheries Statistical Survey (MRIP/MRFSS). The MRIP and LA Creel surveys were conducted simultaneously in 2015 for benchmarking purposes. Methods are now needed to calibrate MRIP landings estimates to LA Creel landings estimates for species with upcoming LDWF stock assessments.

Calibration Methodology

A ratio estimator approach is described below allowing hind-casting of LA Creel recreational harvest estimates to 1982. The calibration procedure to hind-cast LA Creel discard estimates is presented in the Appendix of this document.

Concurrent harvest rate estimates of LA Creel and MRIP are only available for the single year (2015) both surveys were conducted simultaneously. Effort estimates, however, are available from both surveys for multiple years (2015-2017). The reliability of this calibration procedure could be greatly improved with more comparison years of the surveys.

Note: MRIP private fishing effort is distributed across the various fishing modes (shore, inshore, and offshore) by applying the observed distribution of those modes from the dockside survey. In 2016 and 2017, the MRIP effort estimation process required additional estimations, as the dockside portion of that survey was not conducted in Louisiana. NOAA Fisheries applied the proportions of trips by fishing mode observed in 2015 to the effort data collected in 2016 and 2017 to obtain estimates of angler trips by fishing mode. While this method is clearly not optimal, it does allow comparison of effort over additional years.

Abbreviations used in this document:

E - Fishing effort
FM - Fishing mode
- C - charter
- CI - charter inshore
- CO - charter offshore
- P - private
- PI - private inshore (LA Creel)
- PO - private offshore
- PR - private boat (MRIP)
- SH - shore (MRIP)

H - Harvest
HR - Harvest rate
D - Discards
DR – Discard rate
PSE - Percent standard error
R - Ratio
V - Variance
y – Year
w – Bimonthly period
wk – Week of year

The LA Creel survey provides estimates for four fishing modes (FM): private inshore (PI), private offshore (PO), charter inshore (CI), and charter offshore (CO). The MRIP survey provides estimates for five fishing modes: private boat (PR), shore (SH), PO, CI, and CO. For calibration purposes, LA Creel estimates are transformed into a fifth fishing mode equivalent to the MRIP surveys SH mode by separating the PI mode into PR and SH modes. Additionally, the inshore/offshore fishing modes of each survey are collapsed into overall private (P) and charter (C) fishing modes for the species included in this report that support predominantly inshore fisheries.

Fishing effort (E) estimates of the two surveys are calibrated separately by collapsed fishing mode (P and SH only) and bimonthly period (w). Because the charter fishing effort frame used by the LA Creel and MRIP surveys are functionally equivalent, charter fishing effort and corresponding variance estimates of the two surveys are assumed equivalent and not adjusted. Harvest rates and corresponding variance estimates of the MRIP and LA Creel surveys for the species included in this report are also assumed equivalent and not adjusted. Calibrated effort estimates of the shore and private fishing modes are then combined with unadjusted MRIP harvest rate estimates to provide time-series of recreational harvest estimates for species with upcoming LDWF stock assessments as described below.

Fishing Effort

To allow hind-casting of LA Creel effort estimates to the historic MRIP effort time-series, fishing effort calibration factors are calculated as the ratio of mean fishing effort (2015-2017) from each survey by fishing mode (P and SH only) and bimonthly period as:

$$\hat{R}_{E,FM,w} = \frac{\bar{E}_{LAcreel,FM,w}}{\bar{E}_{MRIP,FM,w}} \qquad [1]$$

Note: MRIP effort estimates in Equation [1] are based on the FES and APAIS methodologies.

Survey-specific mean fishing effort (angler trips) and calibration factors for the P and SH fishing modes by bimonthly period are presented below.

FM	w	$\bar{E}_{LAcreel}$	$\bar{E}_{MRIP}$	$\hat{R}_E$
P	1	141,988	683,741	0.208
P	2	229,436	539,929	0.425
P	3	425,433	913,075	0.466
P	4	349,345	1,131,685	0.309
P	5	284,077	898,045	0.316
P	6	277,228	865,312	0.320
SH	1	50,377	692,050	0.073
SH	2	80,580	588,099	0.137
SH	3	151,142	865,279	0.175
SH	4	73,203	1,056,573	0.069
SH	5	105,286	1,115,605	0.094
SH	6	64,342	902,530	0.071

The hind-cast LA Creel fishing effort estimates (1982-2013) are then calculated by fishing mode and bimonthly period as:

$$\hat{E}_{y,w,FM,\hat{R}} = \hat{R}_{E,FM,w}\hat{E}_{y,w,FM,MRIP} \quad [2]$$

Note: MRIP effort estimates in Equation [2] have been calibrated to the FES and APAIS design changes (FCAL).

Variances of the hind-cast LA Creel fishing effort estimates from Equation [2] are approximated by fishing mode and bimonthly period as:

$$\hat{V}\left(\hat{E}_{y,w,FM,\hat{R}}\right) = \hat{E}^2_{y,w,FM,MRIP}\hat{V}\left(\hat{R}_{E,FM,w}\right) + \hat{R}^2_{E,FM,w}\hat{V}\left(\hat{E}_{y,w,FM,MRIP}\right) - \hat{V}\left(\hat{R}_{E,FM,w}\right)\hat{V}\left(\hat{E}_{y,w,FM,MRIP}\right) \quad [3]$$

where

$$\hat{V}\left(\hat{R}_{E,FM,w}\right) = \hat{R}_{E,FM,w}{}^2\left[\frac{\hat{V}(\bar{E}_{LAcreel,FM,w})}{\bar{E}_{LAcreel,FM,w}{}^2} + \frac{\hat{V}(\bar{E}_{MRIP,FM,w})}{\bar{E}_{MRIP,FM,w}{}^2} - 2\frac{Cov(\bar{E}_{LAcreel,FM,w},\bar{E}_{MRIP,FM,w})}{\bar{E}_{LAcreel,FM,w}\bar{E}_{MRIP,FM,w}}\right]$$

Effort variances $\hat{V}\left(\hat{E}_{y,w,FM,MRIP}\right)$ in Equation [3] are post-calibration (i.e. after applying a mean fishing effort variance ratio estimator $\frac{\hat{V}(\bar{E}_{LAcreel,FM,w})}{\hat{V}(\bar{E}_{MRIP,FM,w})}$ to the MRIP variance estimates).

Harvest

The hind-cast LA Creel harvest estimates (1982-2013) by fishing mode (P and SH only) for the species included in this report are then calculated as:

$$\hat{H}_{y,FM,\hat{R}} = \sum_w \hat{E}_{y,w,FM,\hat{R}}\,\widehat{HR}_{y,w,FM,MRIP} \quad [4]$$

Note: MRIP harvest rate estimates in Equation [4] are FCAL estimates and represent A+ B1 landings only.

Variances of the calibrated harvest estimates are then calculated as:

$$\hat{V}\left(\hat{H}_{y,FM,\hat{R}}\right) = \sum_w \left[\hat{E}_{y,FM,w,\hat{R}}{}^2\hat{V}(\widehat{HR}_{y,FM,w,MRIP}) + \widehat{HR}_{y,FM,w,MRIP}{}^2\hat{V}\left(\hat{E}_{y,FM,w,\hat{R}}\right) - \hat{V}\left(\hat{E}_{y,FM,w,\hat{R}}\right)\hat{V}(\widehat{HR}_{y,FM,w,MRIP})\right] \quad [5]$$

Percent standard errors of the calibrated harvest estimates are then calculated as:

$$PSE\left(\hat{H}_{y,FM,\hat{R}}\right) = 100 \times \frac{\sqrt{\hat{V}\left(\hat{H}_{y,FM,\hat{R}}\right)}}{\hat{H}_{y,FM,\hat{R}}} \quad [6]$$

The MRIP (FCAL) and hind-cast LA Creel harvest estimate time-series and corresponding PSEs by fishing mode for species with upcoming LDWF stock assessments are presented below.

FM = Private																				
	Black Drum				**Red Drum**				**Sheepshead**				**Southern Flounder**				**Spotted Seatrout**			
	MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel	
Year	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE
1982	1,106,821	27.1	426,166	31.2	3,046,664	12.0	925,323	21.4	511,387	34.3	184,011	40.4	497,263	19.5	190,801	23.4	9,160,786	16.2	3,111,188	23.8
1983	1,659,509	34.3	595,673	38.8	4,758,470	32.7	1,542,955	41.7	1,064,824	38.1	334,974	43.8	1,929,817	51.4	610,002	58.6	7,402,179	20.0	2,660,990	25.0
1984	362,104	26.0	138,699	29.8	2,976,458	38.9	960,611	40.8	548,364	47.5	176,510	39.5	213,064	23.0	73,394	28.5	2,503,426	29.8	790,913	33.0
1985	356,406	30.0	115,179	34.5	2,563,074	14.5	865,588	21.9	340,142	32.1	114,127	35.8	431,284	24.5	150,115	27.3	5,947,072	15.2	2,109,649	22.2
1986	918,541	24.1	317,533	28.9	2,635,843	10.0	843,830	21.1	252,644	15.5	84,282	23.6	1,464,132	48.5	483,555	47.8	14,077,720	7.8	4,947,892	16.4
1987	683,049	25.6	237,415	30.7	2,602,974	23.0	876,900	30.6	270,702	33.7	87,926	33.0	147,601	25.2	52,016	27.6	11,023,715	10.1	4,035,139	15.6
1988	344,681	15.4	115,234	22.3	1,160,955	20.2	349,965	26.3	277,793	21.3	90,608	28.5	358,099	13.2	123,628	18.1	6,890,452	14.3	2,511,864	21.3
1989	227,336	20.4	76,002	25.3	2,015,801	12.6	676,453	24.5	789,892	49.3	254,087	50.2	341,489	25.9	111,900	29.0	8,082,318	11.9	2,753,203	18.0
1990	231,168	22.9	79,940	26.9	1,469,547	16.8	481,003	25.0	270,726	27.1	104,809	31.1	805,964	23.6	264,106	26.8	4,881,711	13.7	1,640,863	21.0
1991	183,005	19.4	62,265	26.3	1,824,768	20.0	582,125	33.1	402,935	32.6	138,862	35.4	694,466	16.1	248,442	20.6	13,468,560	9.9	4,744,596	18.2
1992	333,217	23.9	119,606	28.4	2,807,145	8.7	936,586	15.5	563,816	25.3	182,360	27.9	615,928	14.6	217,218	17.6	10,680,755	9.3	3,584,240	20.0
1993	246,588	17.6	88,970	24.2	2,581,130	9.9	880,530	16.3	885,380	26.7	320,661	35.5	500,023	14.8	175,907	18.0	7,757,436	12.1	2,655,102	18.2
1994	234,272	16.9	79,717	24.5	2,311,786	9.5	778,462	16.4	508,883	17.8	170,439	24.2	578,264	21.0	216,551	26.3	10,418,883	10.5	3,481,640	17.6
1995	335,507	18.4	109,385	22.1	3,842,177	8.7	1,269,660	19.6	920,809	20.4	274,232	26.3	398,528	14.0	146,807	19.4	12,135,672	13.2	3,937,329	27.0
1996	414,798	12.9	137,386	20.9	3,197,497	9.0	1,120,688	16.0	760,607	21.7	243,914	29.8	416,737	11.4	148,322	15.5	10,306,475	11.3	3,488,899	20.1
1997	477,705	16.1	161,196	20.3	2,861,918	9.6	987,223	16.3	1,005,406	18.2	318,972	22.9	445,579	11.7	155,574	18.2	10,415,118	11.9	3,599,696	17.9
1998	920,933	14.6	311,906	20.5	2,762,600	8.0	955,164	15.1	1,138,280	15.6	358,340	25.5	393,018	13.8	148,318	18.2	10,005,379	8.7	3,578,852	18.8
1999	681,905	11.9	236,111	18.6	3,459,681	6.9	1,208,361	14.4	793,093	16.2	246,697	26.4	758,946	10.4	272,110	16.0	14,037,235	8.5	4,731,081	18.3
2000	1,017,717	12.8	352,152	18.8	4,249,272	6.9	1,474,223	16.0	769,653	28.0	246,219	34.0	670,295	13.3	246,882	18.4	15,977,551	7.7	5,264,946	19.6
2001	765,815	13.7	259,288	20.5	4,322,843	7.7	1,456,752	14.4	567,945	15.8	193,751	22.4	427,914	12.2	155,260	16.0	12,618,114	8.0	4,269,752	15.9
2002	908,616	12.6	315,701	19.5	3,445,574	8.2	1,168,322	15.9	1,249,437	18.7	408,449	30.9	443,758	18.8	173,052	23.0	9,816,916	10.3	3,441,381	16.8
2003	659,209	14.7	229,521	22.3	2,977,090	7.4	1,014,320	17.2	1,257,175	23.2	396,409	28.7	647,034	15.7	250,097	18.7	10,528,223	9.6	3,662,095	20.0
2004	546,776	12.0	183,643	18.3	2,605,118	8.1	898,352	15.2	1,722,589	24.9	586,483	33.7	408,006	12.6	148,846	17.3	9,728,915	10.5	3,334,545	18.8
2005	461,775	13.0	156,509	21.3	2,236,920	9.4	772,472	15.8	962,130	23.6	302,340	30.7	286,521	12.9	108,654	15.8	10,699,116	8.5	3,616,229	17.8
2006	354,910	14.3	117,386	19.2	2,385,907	10.7	812,152	16.3	430,504	25.3	125,365	32.5	285,429	11.9	98,401	15.3	13,779,620	8.7	5,016,008	16.0
2007	415,104	15.7	142,698	18.7	3,049,990	8.3	1,045,909	15.6	320,952	21.9	95,855	25.9	355,606	19.0	123,052	23.8	11,790,003	8.3	3,967,935	18.2
2008	668,820	12.8	224,335	20.6	3,336,041	7.9	1,155,421	14.9	623,988	17.6	205,809	26.8	239,893	10.9	88,186	16.8	15,551,638	9.5	5,347,885	19.1
2009	908,297	13.6	308,638	19.6	3,414,547	8.2	1,187,696	16.4	1,055,358	22.6	315,386	32.0	398,573	14.6	140,011	19.7	15,667,348	8.8	5,452,613	16.8
2010	697,188	14.5	231,949	19.1	5,128,842	8.0	1,797,454	14.5	753,414	22.4	261,214	29.3	571,870	14.4	214,026	18.3	14,465,717	10.7	4,974,270	23.5
2011	679,614	15.1	232,721	20.6	4,548,266	8.3	1,584,573	14.9	1,425,042	35.5	525,042	44.9	544,173	14.7	198,755	17.6	17,697,003	9.6	5,977,076	18.1
2012	694,257	12.8	241,481	18.1	3,458,029	8.8	1,210,182	15.5	577,843	16.7	175,722	24.4	524,259	14.8	184,915	17.5	17,938,248	8.9	6,201,433	19.0
2013	528,084	14.3	172,534	20.4	4,523,043	8.7	1,512,033	15.4	311,155	16.9	95,381	24.0	930,394	13.1	317,618	25.0	12,928,606	9.4	4,374,563	17.4

FM = Shore

Year	Black Drum				Red Drum				Sheepshead				Southern Flounder				Spotted Seatrout			
	MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel	
	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE	Harvest	PSE
1982	880,444	22.8	113,540	38.2	2,388,907	23.1	293,698	36.1	676,628	29.0	66,012	30.5	834,940	21.4	103,180	36.3	2,787,818	23.5	296,866	35.0
1983	500,922	29.9	62,566	38.0	1,351,640	25.0	123,385	34.4	2,326,172	25.9	276,981	40.7	327,205	34.7	31,100	37.4	2,927,094	47.2	258,452	45.3
1984	536,866	34.1	51,163	46.2	660,866	35.0	57,459	34.8	987,229	41.9	85,083	40.5	112,657	45.9	9,755	45.9	331,308	40.5	32,117	42.3
1985	181,986	27.0	16,397	32.7	618,693	30.8	46,417	33.4	656,976	30.2	51,856	35.9	284,046	29.1	23,081	33.1	500,629	27.9	43,400	33.5
1986	469,638	52.0	39,289	48.9	243,647	45.9	18,934	47.8	782,112	81.2	57,566	79.5	189,325	42.5	18,019	48.7	1,815,727	55.4	142,905	52.4
1987	260,971	52.0	26,358	51.9	665,407	54.3	49,467	55.0	65,880	46.2	4,878	52.4	185,090	37.3	14,954	38.7	965,130	44.3	112,992	58.7
1988	429,974	36.6	48,607	46.1	237,418	45.6	18,170	48.4	662,260	57.5	57,664	53.5	90,283	40.5	8,305	40.6	398,803	39.6	41,221	48.1
1989	484,955	58.2	47,183	67.1	472,062	35.4	45,444	43.7	179,471	40.2	16,156	43.5	127,388	33.6	12,077	38.8	402,794	68.4	30,056	67.0
1990	122,352	47.4	15,821	63.4	627,617	29.6	54,607	36.3	80,673	46.7	7,631	52.3	238,834	24.9	22,144	31.2	1,178,966	28.6	120,340	42.6
1991	80,287	38.8	7,830	45.0	497,827	35.7	39,572	39.7	109,726	43.1	8,166	45.0	617,776	26.6	69,562	37.3	1,611,329	29.8	190,451	48.5
1992	266,722	39.0	24,559	43.7	535,731	21.7	57,486	31.8	1,470,811	61.9	111,109	64.6	197,948	31.2	17,703	32.4	1,622,752	18.8	160,534	25.9
1993	332,409	38.4	32,083	46.0	1,058,829	26.2	102,231	30.1	438,233	37.3	34,539	38.3	152,286	34.8	14,994	35.2	1,262,891	19.3	139,848	32.3
1994	111,090	26.4	12,000	35.3	973,065	30.5	86,198	33.8	339,821	55.8	27,751	51.7	245,182	26.2	26,246	30.4	2,585,733	32.7	225,016	34.0
1995	122,762	40.4	10,791	37.0	747,219	23.9	61,587	28.3	338,135	43.2	33,177	41.4	56,558	30.7	5,970	40.2	1,432,447	21.4	141,769	30.2
1996	529,054	58.3	42,278	55.7	864,227	22.6	85,059	27.2	682,583	41.1	54,497	42.0	134,402	31.1	14,417	42.1	2,327,551	27.4	272,968	42.0
1997	123,564	39.8	14,500	55.8	347,632	21.5	33,897	27.2	283,171	25.4	28,012	31.1	307,330	23.1	31,614	33.0	1,905,584	21.5	196,046	32.0
1998	86,575	34.3	11,850	53.2	397,083	31.2	39,546	33.4	450,254	36.2	34,658	37.6	128,645	26.4	15,533	39.9	2,415,887	30.1	316,704	52.1
1999	385,329	39.6	34,484	42.0	492,350	25.7	58,215	38.6	202,445	35.8	17,647	34.4	641,276	32.9	57,671	36.5	3,530,688	27.9	302,816	33.9
2000	625,217	26.3	55,444	30.4	822,698	21.3	74,515	25.1	202,744	52.7	18,710	49.9	136,953	43.0	13,647	44.9	2,697,901	36.0	235,416	36.6
2001	675,474	30.1	74,021	37.8	621,324	23.2	56,647	29.7	399,908	49.4	46,027	53.6	305,296	67.4	40,328	72.5	2,657,545	28.5	284,780	35.3
2002	399,178	23.6	39,488	28.7	945,520	31.8	86,759	37.0	872,663	35.4	77,666	40.1	323,826	31.2	35,596	40.3	923,988	31.5	104,622	40.0
2003	288,546	23.4	29,030	28.5	280,366	33.2	26,439	34.2	983,844	36.8	108,655	37.5	199,400	38.3	17,629	37.0	945,730	42.3	70,559	43.3
2004	137,240	36.0	13,664	36.9	559,991	19.0	53,877	26.8	603,693	36.9	49,237	39.0	395,552	36.1	39,848	47.2	1,303,971	45.1	186,126	62.8
2005	138,758	28.0	13,443	36.2	704,981	30.9	57,698	36.6	563,322	29.6	52,206	36.7	450,207	38.7	35,117	45.5	632,798	30.7	54,561	34.2
2006	261,544	30.8	25,308	39.5	389,280	25.4	35,566	35.1	593,305	31.2	44,987	35.3	335,766	29.1	34,011	31.9	788,193	22.7	75,533	29.7
2007	286,213	35.5	28,210	37.6	187,726	25.1	17,832	35.4	257,091	36.2	27,901	42.7	348,752	28.0	38,995	36.9	771,812	27.5	84,196	35.4
2008	247,234	25.5	22,539	32.8	374,463	27.9	30,507	30.4	1,396,084	30.3	113,710	33.3	260,865	36.4	23,363	33.9	1,140,758	33.3	131,023	47.6
2009	100,842	26.9	10,221	33.5	123,122	28.0	12,120	33.8	523,105	46.9	62,220	56.4	470,681	44.6	39,588	45.3	611,298	25.2	62,519	33.2
2010	184,668	41.2	16,865	42.9	531,708	32.4	50,704	34.5	561,648	40.1	46,001	39.1	94,348	29.4	8,854	31.9	584,064	43.3	45,383	43.2
2011	380,669	21.7	36,537	27.0	983,461	22.1	96,717	27.3	1,318,064	44.8	124,632	55.1	430,717	40.0	39,973	40.9	651,281	27.8	67,792	37.1
2012	283,508	22.6	26,638	30.9	279,299	36.1	23,109	38.3	695,553	42.6	54,144	43.8	155,170	30.6	15,176	33.3	727,577	29.5	80,824	39.4
2013	471,823	13.0	36,871	21.6	849,762	9.3	80,731	27.2	659,450	12.4	48,095	25.1	573,922	18.3	51,029	30.3	2,682,372	11.4	241,359	21.8

<u>Appendix (Discard Hindcast):</u>

A ratio estimator approach is described below allowing hind-casting of LA Creel recreational discard estimates to 1982. Concurrent discard estimates of the LA Creel and MRIP surveys are not available.

Analogous to the procedure to hind-cast LA Creel harvest estimates, the hind-cast LA Creel effort estimates of the shore and private fishing modes are combined with unadjusted MRIP discard rate estimates to provide time-series of recreational discard estimates for species with upcoming LDWF stock assessments as described below. Discard estimates of the charter fishing mode for the LA Creel and MRIP surveys are assumed equivalent and not adjusted.

Discards (1982-2013)

The hind-cast LA Creel discard estimates (1982-2013) are calculated by collapsed fishing mode (P and SH only) and bimonthly period as:

$$\hat{D}_{y,FM,\hat{R}} = \sum_{w} \hat{E}_{y,w,FM,\hat{R}}\, \widehat{DR}_{y,w,FM,MRIP} \quad [1a]$$

Note: MRIP discard rate estimates in Equation [1a] are FCAL estimates and represent B2 landings only. The calibrated effort estimates are taken from Equation [2].

Variances of the calibrated discard estimates from Equation [1a] are then calculated as:

$$\hat{V}\left(\hat{D}_{y,FM,\hat{R}}\right) = \sum_{w} \left[\hat{E}_{y,FM,w,\hat{R}}^{\;2}\, \hat{V}(\widehat{DR}_{y,FM,w,MRIP}) + \widehat{DR}_{y,FM,w,MRIP}^{\;2}\, \hat{V}\left(\hat{E}_{y,FM,w,\hat{R}}\right) - \hat{V}\left(\hat{E}_{y,FM,w,\hat{R}}\right) \hat{V}(\widehat{DR}_{y,FM,w,MRIP}) \right] \quad [2a]$$

Percent standard errors of the calibrated discard estimates are then calculated as:

$$PSE\left(\hat{D}_{y,FM,\hat{R}}\right) = 100 \times \frac{\sqrt{\hat{V}\left(\hat{D}_{y,FM,\hat{R}}\right)}}{\hat{D}_{y,FM,\hat{R}}} \quad [3a]$$

Discards (2014-2016)

Discard estimates of the LA Creel survey are only available from week 19 of 2016 to present. Discard estimates prior to week 19 of 2016 are imputed by fishing mode (P, SH, and C) and week of year (wk) by calculating discard to harvest ratios from the LA Creel estimates from week 19 of 2016 to week 18 of 2017 as:

$$\hat{R}_{D/H,FM,wk} = \frac{\hat{D}_{LAcreel,FM,wk}}{\hat{H}_{LAcreel,FM,wk}} \quad [4a]$$

The imputed LA Creel discard estimates are then calculated by fishing mode from week 1 of 2014 to week 18 of 2016 as:

$$\hat{D}_{y,wk,FM,\hat{R}_{D/H}} = \hat{R}_{D/H,FM,wk} \hat{H}_{y,wk,FM,LAcreel} \quad [5a]$$

Variances of the imputed LA Creel discard estimates from Equation [5a] are approximated by fishing mode and week of year as:

$$\hat{V}\left(\hat{D}_{y,wk,FM,\hat{R}_{D/H}}\right) = \hat{H}^2_{y,wk,FM,LAcreel}\hat{V}\left(\hat{R}_{D/H,FM,wk}\right) + \hat{R}^2_{D/H,FM,wk}\hat{V}\left(\hat{H}_{y,wk,FM,LAcreel}\right) - \hat{V}\left(\hat{R}_{D/H,FM,wk}\right)\hat{V}\left(\hat{H}_{y,wk,FM,LAcreel}\right) \qquad [6a]$$

where

$$\hat{V}\left(\hat{R}_{D/H,FM,wk}\right) = \hat{R}_{D/H,FM,wk}{}^2\left[\frac{\hat{V}(\hat{D}_{LAcreel,FM,wk})}{\hat{D}_{LAcreel,FM,wk}{}^2} + \frac{\hat{V}(\hat{H}_{LAcreel,FM,wk})}{\hat{H}_{LAcreel,FM,wk}{}^2}\right]$$

Harvest variances $\hat{V}\left(\hat{H}_{y,wk,FM,LAcreel}\right)$ in Equation [6a] are post-calibration (i.e. after applying a discard to harvest variance ratio estimator $\frac{\hat{V}(\hat{D}_{LAcreel,FM,wk})}{\hat{V}(\hat{H}_{LAcreel,FM,wk})}$ to the LA Creel harvest variance estimates).

The MRIP (FCAL) and hind-cast/imputed LA Creel discard estimate annual time-series and corresponding PSEs by fishing mode for species with upcoming LDWF stock assessments are presented below.

FM = Private

	Black Drum				Red Drum				Sheepshead				Southern Flounder				Spotted Seatrout			
	MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel	
Year	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE
1982	818,734	54.5	345,860	60.5	274,870	40.0	94,664	41.5	515,459	44.8	200,681	47.1	1,083,668	45.5	415,439	50.2	1,654,868	35.7	609,681	39.2
1983	671,251	47.1	224,549	50.1	793,805	34.3	265,412	40.0	833,079	71.7	268,324	76.4	145,644	54.4	50,553	55.2	2,092,864	42.4	754,795	47.4
1984	284,254	68.2	93,240	65.6	346,317	56.3	111,489	56.2	309,986	35.6	93,467	45.2	65,411	64.9	21,520	65.9	197,040	21.8	64,439	30.9
1985	291,106	38.5	95,314	41.4	243,413	40.1	91,863	46.5	317,951	28.8	109,302	37.0	61,785	68.0	19,987	66.6	1,709,137	23.1	579,765	29.5
1986	448,236	20.4	152,135	27.7	451,777	15.3	162,385	19.5	393,569	19.8	127,427	29.5	367,830	40.1	162,331	43.1	4,745,760	10.2	1,630,190	19.8
1987	300,153	41.9	93,694	44.6	2,360,122	24.5	759,753	32.9	210,127	21.2	74,868	25.8	10,809	42.4	4,341	46.5	6,980,249	12.7	2,367,280	21.1
1988	350,541	21.1	118,251	29.1	3,062,822	16.2	1,010,542	22.4	398,058	25.6	135,054	32.6	375,399	58.9	119,109	60.9	5,610,284	10.4	2,077,053	16.1
1989	228,012	35.0	75,276	40.5	2,998,273	20.9	986,135	30.8	483,464	37.6	174,497	44.9	260,401	93.8	84,574	91.5	5,656,036	14.2	1,879,166	20.3
1990	653,511	28.7	214,860	36.2	1,880,922	19.7	575,989	24.4	408,363	25.1	146,133	30.3	334,821	40.3	107,726	42.4	4,750,794	18.0	1,566,570	24.0
1991	389,398	26.0	130,884	32.2	7,412,013	11.2	2,413,187	27.7	272,267	26.1	100,654	28.7	114,636	37.5	35,343	33.6	12,341,402	9.3	4,316,171	17.6
1992	559,417	33.2	179,758	38.0	5,753,237	9.1	1,845,345	17.5	440,289	16.8	142,247	23.5	42,988	21.4	14,876	24.2	8,795,484	8.4	2,994,762	16.4
1993	710,873	18.2	235,327	23.6	4,143,002	11.2	1,394,760	19.0	758,778	20.8	261,093	28.4	45,686	33.2	16,234	35.7	6,905,906	11.3	2,294,599	17.5
1994	440,825	29.8	144,491	33.2	4,086,816	12.5	1,292,596	19.6	608,190	19.3	200,928	25.0	34,050	29.6	11,832	31.0	7,780,829	9.7	2,545,253	17.4
1995	816,070	17.5	288,067	20.8	4,248,542	15.4	1,356,682	22.3	558,424	25.6	180,589	31.0	59,357	34.4	21,731	33.3	7,603,172	11.0	2,469,940	22.8
1996	525,560	20.4	180,919	27.4	3,312,106	11.9	1,066,067	18.3	878,282	23.1	280,982	30.9	80,897	23.0	28,339	27.1	8,055,743	10.2	2,790,011	17.6
1997	1,057,203	18.5	357,381	27.0	5,150,476	11.3	1,623,792	20.9	1,138,193	23.4	388,364	33.4	98,494	29.1	33,249	32.9	10,917,063	19.7	3,714,497	25.0
1998	1,439,547	24.7	488,061	28.2	5,753,271	10.8	1,852,465	18.5	1,056,926	17.9	341,063	28.4	99,007	29.1	32,096	32.3	9,977,400	9.3	3,525,435	17.2
1999	820,371	13.6	272,222	19.4	5,477,613	9.4	1,855,481	17.3	699,825	18.9	218,048	29.4	84,447	20.8	29,392	26.0	11,688,515	8.8	3,900,534	18.2
2000	1,833,450	16.2	636,903	21.0	6,018,948	8.2	2,015,680	18.4	586,993	21.9	204,594	28.9	121,790	28.3	37,513	29.7	11,091,619	7.9	3,696,143	17.1
2001	1,781,293	17.4	641,432	22.0	6,184,966	9.5	1,893,106	18.7	816,650	16.4	289,672	22.4	88,936	21.8	33,827	26.2	7,365,829	11.2	2,385,033	19.6
2002	1,670,431	17.1	549,754	23.8	6,266,166	10.8	2,051,328	21.1	854,311	17.0	278,770	22.5	90,982	26.1	32,596	28.9	6,778,238	11.5	2,325,982	18.2
2003	1,172,837	17.8	408,312	22.5	5,286,909	10.2	1,707,282	22.5	930,576	20.8	286,148	31.2	172,327	23.4	67,664	27.1	10,682,302	9.5	3,656,768	20.8
2004	1,155,649	17.0	384,622	24.5	3,841,642	10.1	1,251,295	17.5	701,938	19.9	253,961	27.9	149,844	27.6	53,175	29.8	9,847,326	11.5	3,329,014	17.7
2005	954,552	24.2	324,774	29.3	3,505,968	11.8	1,125,035	19.3	770,173	15.0	252,100	25.9	87,557	25.3	31,613	26.7	10,903,988	9.7	3,699,324	17.6
2006	699,933	16.3	227,542	20.8	4,124,647	11.7	1,352,670	19.7	616,668	30.1	179,470	34.3	41,784	27.7	14,147	30.4	11,930,250	9.1	4,253,200	16.1
2007	818,643	15.4	279,976	19.3	4,630,404	11.5	1,534,744	20.7	308,039	21.2	101,638	25.6	78,231	25.8	28,165	30.1	9,924,934	8.4	3,345,776	18.0
2008	1,320,182	14.8	447,658	22.4	5,074,358	8.1	1,704,655	15.5	609,401	23.6	193,005	30.6	50,063	26.0	17,325	28.4	13,158,192	9.4	4,628,268	17.0
2009	1,788,575	14.5	598,396	22.8	6,242,208	9.6	2,046,201	20.1	744,464	19.5	224,182	27.5	89,961	28.4	32,910	34.0	13,919,234	10.0	4,655,798	17.8
2010	1,813,254	14.9	636,963	18.6	7,335,948	10.2	2,585,291	15.8	711,836	21.9	248,894	26.2	111,912	23.5	40,129	23.3	9,190,616	12.6	3,180,901	22.2
2011	1,390,360	14.9	475,469	19.2	4,744,947	9.7	1,532,673	16.4	259,735	17.7	86,064	22.2	85,027	24.1	31,745	26.9	10,091,732	9.5	3,443,856	16.2
2012	1,136,427	13.3	373,501	18.6	5,374,152	8.9	1,776,461	17.9	422,968	13.4	136,234	19.8	152,363	24.3	53,417	25.2	13,175,745	8.7	4,524,702	18.2
2013	1,709,164	12.2	586,398	18.1	6,088,863	9.9	2,013,792	17.0	398,767	14.8	130,785	21.7	197,844	21.3	72,578	23.8	13,404,945	10.3	4,608,071	16.5
2014			330,955	24.0			1,609,006	11.8			148,454	38.3			44,345	56.6			2,316,191	11.3
2015			295,893	21.4			1,486,227	10.3			98,800	30.3			30,296	41.4			3,440,509	12.3
2016			161,733	21.0			1,096,370	6.4			47,135	25.6			29,612	24.3			3,643,636	8.6

FM = Shore	Black Drum				Red Drum				Sheepshead				Southern Flounder				Spotted Seatrout			
	MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel	
Year	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE
1982	149,995	64.4	19,897	80.7	364,343	26.2	52,316	41.6	89,674	57.7	11,246	70.6	128,975	30.5	15,915	45.2	386,524	48.1	49,802	62.2
1983	69,276	40.0	6,493	59.5	15,283	79.9	1,470	73.4	25,959	61.6	2,914	58.8					7,794	83.8	1,361	89.1
1984	285,887	32.0	20,494	39.5	83,103	84.6	5,758	89.8	12,248	103.2	2,139	105.1	3,384	99.3	319	100.5	59,529	52.1	4,864	50.1
1985	138,851	42.9	12,304	55.2	32,336	53.0	2,919	51.6	155,985	38.0	11,628	41.9	12,292	79.8	881	80.3	603,943	44.5	47,922	44.9
1986	107,212	49.6	7,822	51.3	19,379	65.3	1,723	60.3	473,615	72.5	34,777	72.6	11,853	75.8	1,010	78.1	267,044	41.3	22,713	38.7
1987	102,949	71.9	8,596	74.4	352,180	47.9	26,897	48.2	36,133	89.7	3,410	94.8	13,517	87.5	1,198	89.8	642,898	37.9	64,120	42.0
1988	185,774	51.5	16,072	60.9	329,574	30.8	28,447	35.6	116,937	36.7	10,973	40.9	7,726	52.0	616	56.8	205,385	41.4	24,387	50.9
1989	61,484	38.9	5,723	46.1	1,080,247	72.5	128,194	83.5	115,300	39.3	11,720	45.4	49,549	66.9	3,586	66.6	311,869	36.9	27,571	40.1
1990	96,587	44.0	13,477	59.9	327,612	37.7	28,235	45.2	18,485	89.3	1,318	92.6	783,955	82.6	72,564	86.6	736,838	34.5	65,803	38.9
1991	237,878	30.6	24,906	36.8	1,544,560	43.0	124,239	43.5	207,958	30.7	14,829	39.1	91,471	44.6	10,241	47.2	1,902,261	22.7	219,559	37.7
1992	860,902	31.0	76,139	32.3	1,833,394	25.8	167,249	28.7	514,453	32.0	41,930	37.4	49,674	57.6	4,587	56.0	1,468,815	20.7	142,809	28.3
1993	1,345,395	39.9	110,604	41.5	1,630,396	23.1	171,511	31.8	1,109,224	51.0	86,564	51.4	51,220	62.5	3,860	64.5	2,544,151	26.7	323,743	45.9
1994	947,564	31.5	99,539	33.8	2,220,435	25.8	190,194	29.9	690,548	35.8	54,745	36.3	27,765	64.3	2,143	65.9	2,280,973	19.3	214,069	27.3
1995	602,888	40.5	48,383	40.0	942,643	25.9	86,408	28.5	72,571	30.1	8,839	38.7	18,216	63.3	1,309	62.8	1,617,673	19.6	162,345	29.9
1996	493,436	28.1	52,883	32.7	1,516,179	39.1	120,897	39.3	295,818	49.5	24,464	47.5	123,621	57.8	16,558	74.1	2,271,614	31.3	308,086	52.8
1997	1,032,761	51.8	90,230	49.3	1,179,933	27.3	100,418	31.4	199,864	33.2	17,257	35.4	71,388	41.3	8,442	48.4	2,076,029	22.6	207,557	32.1
1998	1,033,214	43.8	84,752	44.3	2,262,074	26.0	204,593	31.1	207,500	34.3	20,284	40.9	39,280	40.3	3,276	42.0	1,721,873	25.1	220,941	47.8
1999	532,125	37.2	45,165	42.1	1,281,413	23.5	130,179	31.6	51,091	32.2	4,474	39.5	68,459	49.6	7,292	57.3	4,103,241	23.1	371,893	29.8
2000	955,854	28.8	73,538	36.4	1,948,980	22.8	182,824	29.6	265,642	61.1	21,463	56.0	24,518	50.4	2,069	53.3	2,552,559	34.6	207,540	35.3
2001	1,404,055	37.8	143,215	44.1	1,702,671	23.4	159,705	28.0	627,865	66.9	49,516	64.4	267,359	75.6	37,792	76.1	2,252,160	31.5	187,174	32.3
2002	559,039	30.6	45,914	33.0	1,187,635	24.6	99,572	27.3	192,094	28.9	16,154	33.4	132,712	47.7	11,419	48.6	1,035,758	30.9	94,081	34.7
2003	1,024,308	33.3	104,601	38.7	744,196	31.1	73,392	36.7	114,932	46.8	11,660	47.4	299,436	63.4	31,155	65.2	1,546,106	34.1	119,188	35.8
2004	477,328	44.0	37,608	44.0	944,587	31.1	83,721	31.6	83,683	37.1	9,645	45.2	24,033	55.8	1,683	59.3	1,547,223	44.2	179,206	58.2
2005	793,236	24.4	78,009	30.6	1,986,884	22.7	197,746	37.7	322,768	29.1	27,129	33.4	127,575	57.7	10,772	59.1	895,780	34.2	88,581	36.9
2006	1,085,517	44.4	94,206	40.6	2,355,407	21.3	246,212	35.5	670,528	47.6	51,507	48.7	109,904	38.3	14,722	53.3	1,144,271	28.0	114,481	33.4
2007	464,018	30.3	53,814	41.9	1,109,367	20.9	108,758	29.6	256,654	49.1	23,186	43.8	96,680	53.7	16,221	68.5	929,550	25.0	101,536	36.6
2008	901,587	24.4	79,859	28.4	1,912,635	19.8	158,866	23.6	248,799	29.8	18,285	34.4	12,748	60.9	1,302	65.4	1,377,270	27.7	120,320	31.0
2009	417,567	31.0	39,805	30.9	1,414,008	28.6	126,475	32.2	384,706	30.4	37,443	32.7	87,082	93.5	6,332	93.7	927,737	30.0	109,736	43.9
2010	572,004	29.7	56,545	30.2	1,506,818	23.6	154,439	35.8	583,189	30.2	46,495	32.6	74,678	40.5	7,726	48.6	828,375	54.9	63,464	53.8
2011	1,434,105	21.3	134,468	28.0	1,860,121	22.2	162,394	25.3	249,435	48.1	22,119	43.9	103,717	65.2	7,384	66.2	719,286	25.7	64,218	31.8
2012	1,263,476	24.4	132,282	31.2	977,186	35.2	90,057	34.4	175,964	43.2	13,443	45.1	52,159	45.4	6,074	56.4	674,174	31.1	75,140	37.8
2013	2,271,755	9.7	195,413	19.6	3,675,890	9.3	327,093	18.3	939,354	18.9	77,379	32.1	41,427	37.2	3,162	40.7	5,525,367	8.1	504,444	24.1
2014			79,920	38.8			375,249	12.4			51,901	55.7			9,346	53.3			594,294	15.1
2015			76,780	21.4			378,245	11.5			23,835	34.1			9,300	45.9			727,719	12.3
2016			50,106	21.9			275,986	8.7			24,951	66.9			9,495	37.5			892,875	11.4

FM = Charter																				
	Black Drum				**Red Drum**				**Sheepshead**				**Southern Flounder**				**Spotted Seatrout**			
	MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel		MRIP		LA Creel	
Year	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE	Discards	PSE
1982																	7,252	32.4		
1983													352	57.8			121,816	54.1		
1984	182	112.8							1,166	78.8							116	101.5		
1985									587	107.7							42,739	26.9		
1986					25	55.4			266	97.1							16,514	42.5		
1987	2,752	45.9			2,597	42.5			2,484	64.6							64,522	30.1		
1988	5	106.1			1,561	59.4											59,254	37.7		
1989	298	63.1			26,854	45.6			1,199	62.5			1,401	106.9			190,285	38.2		
1990	6,449	56.2			30,305	40.5			16,177	94.7			445	57.1			39,578	32.1		
1991	3,258	52.2			46,366	44.7			1,641	52.5			280	82.8			144,689	30.9		
1992	7,421	46.7			63,966	35.7			3,664	55.2			225	61.5			91,373	31.5		
1993	410	71.7			58,230	19.2											155,919	30.0		
1994	329	100.1			70,705	32.6			1,123	61.4							243,186	36.3		
1995	2,606	72.8			198,687	34.0			1,654	110.7							300,673	31.6		
1996	4,776	74.9			113,101	28.6			406	56.1			843	103.1			223,999	36.0		
1997	20,581	37.1			157,816	23.0			19,422	46.2			490	68.4			260,983	23.5		
1998	18,161	43.4			138,650	25.5			8,030	44.8			647	48.0			199,955	31.8		
1999	12,980	33.2			105,462	22.3			5,944	40.9			520	57.8			277,771	21.3		
2000	10,335	28.4			108,340	13.2			1,739	48.3			259	59.4			175,694	15.8		
2001	13,566	28.8			203,577	19.3			12,615	31.6			1,224	72.4			211,516	15.0		
2002	9,657	30.9			138,601	17.2			4,954	29.6			1,248	50.0			104,977	25.3		
2003	25,831	34.0			129,125	18.5			16,306	53.2			982	53.9			170,658	26.6		
2004	13,050	32.7			105,936	14.2			10,370	38.8			503	55.6			221,275	16.5		
2005	5,692	45.0			53,333	25.0			3,190	61.4							263,044	26.2		
2006	30,916	38.8			144,300	48.0			10,206	71.3							464,015	26.8		
2007	13,350	37.3			178,892	21.5			23,101	34.4			486	60.6			238,335	19.0		
2008	31,830	33.1			198,411	16.5			30,031	55.1			1,197	59.3			323,315	17.3		
2009	62,094	27.2			332,961	19.7			16,588	52.9			98	71.3			356,216	17.4		
2010	38,261	33.5			151,250	23.0			10,938	36.4			69	107.9			167,473	21.6		
2011	29,517	38.0			203,917	17.0			5,021	34.4			640	62.2			149,933	27.4		
2012	21,344	30.0			153,584	17.6			5,844	46.6			2,353	48.7			205,441	22.7		
2013	83,501	7.5			281,131	7.2			48,342	11.3			12,017	15.1			222,879	7.6		
2014			14,093	31.5			353,243	19.2			2,706	40.6			442	53.7			316,892	29.4
2015			14,464	32.7			403,525	14.1			16,575	50.0			553	46.7			413,119	18.4
2016			16,975	33.3			338,910	7.4			10,778	23.1			497	31.4			439,247	9.6

Appendix 2:

Louisiana Sheepshead Growth

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Overview

In the previous assessment of the Louisiana sheepshead stock (West *et al.* 2015) sex-specific von Bertalanffy growth models (Beckman *et al*. 1991) were used to describe male and female sheepshead growth rates and develop sex-specific age-length-keys for age assignments of fishery and survey catches. Beckman *et al*. (1991) found significant differences between male and female sheepshead growth curves developed from a relatively small sample of Louisiana-specific data (n=752). While these differences were significant statistically, the differences between growth curves were minor and a non-sex-specific growth model was not described.

Methods

Sex-specific and non-sex-specific von Bertalanffy growth models were fit to LDWF sheepshead length-at-age observations. Due to the lack of a minimum size limit in the recreational fishery, the LDWF fishery-independent and recreational fishery-dependent data sets were combined for model fitting. Biological ages were assigned by assuming an April 1st birthdate. Additional length data for individuals ≤ 200 mm were also taken from the LDWF fishery-independent marine seine survey with ages assigned by assuming individuals as either young-of-the year or age-1 with visual assignment. The von Bertalanffy growth model is configured as:

$$L_t = L_\infty\left(1 - e^{-K(t-t_0)}\right) \quad [1]$$

where L_t is mean length-at-age in years (t), L_∞ is the asymptotic average maximum size, K is the rate at which length approaches L_∞, and t_0 is the theoretical age when length=0. Growth curves were fit to the data with the SAS nonlinear regression fitting procedure (PROC NLIN; SAS 2008) using the Newton iterative method. Growth curves were compared with an analysis of the residual sums of squares and Kimura's likelihood ratio tests (Haddon 2001).

Sex-specific and non-sex-specific length-weight regressions were also fit using only the fishery-independent dataset described above to the observations with weight records using the power model:

$$W = aL^b \quad [2]$$

where W is weight, L is length, a is the weight-length constant and b is the allometric exponent. The model, after common logarithmic transformation, was fit with the SAS linear regression procedure (PROC REG; SAS 2008). Sex-specific regressions were compared with an analysis of covariance.

Fish with only fork length (FL) measurements available were converted to total length (TL) from a relationship provided by the Florida Fish and Wildlife Research Institute for an earlier LDWF sheepshead stock assessment (Blanchet 2008):

$$TL = 4.233 + 1.090 \times FL \quad [3]$$

where FL is in units of mm.

Results

Parameter estimates of the sex-specific and combined growth curves are presented in Table 1. The analysis of residual sum of squares indicated the growth curves were not coincident (p<0.0001). Further analysis using Kimura's likelihood ratio test indicated only the L_∞ parameters as statistically different (p<0.0001). While statistically different, the difference in L_∞ between sexes was minor (i.e., 0.331 inches TL) and we consider the overall difference between male and female growth curves biologically insignificant. The combined sex growth curve and TL-at-age observations are presented in Figure 1.

Table 1: Parameter estimates and corresponding approximate standard errors of the combined and sex-specific von Bertalanffy growth models. Units are total length in inches and time in years.

Model	L_∞	SE
Combined	19.1	0.0519
Female	19.2	0.0672
Male	18.9	0.0770

Model	K	SE
Combined	0.460	0.00510
Female	0.460	0.00618
Male	0.468	0.00719

Model	t_0	SE
Combined	-0.0858	0.0143
Female	-0.0656	0.0141
Male	-0.0788	0.0150

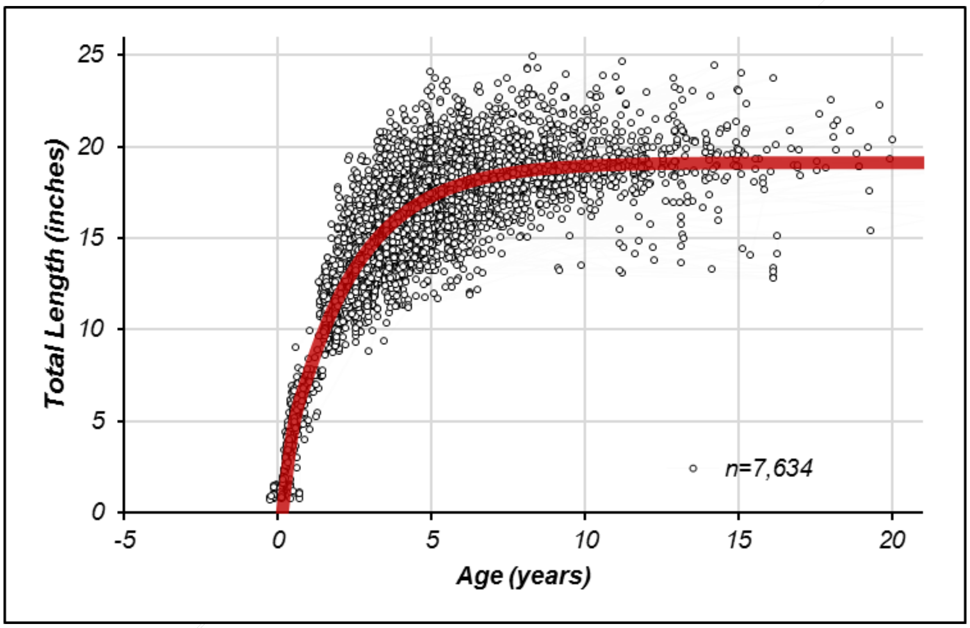

Figure 1: Sheepshead total length-at-age observations and predicted total length-at-age from the von Bertalanffy growth model.

Parameter estimates of the sex-specific and combined weight-length regressions are presented in Table 2. The analysis of covariance indicated the slope of the male and female regressions as not statistically different (p>0.05), whereas the male and female regression intercepts differed statistically (p<0.05).

Table 2: Parameter estimates, approximate standard errors of the allometric exponent, coefficients of determination, and sample sizes of the combined and sex-specific weight-length regressions. Units are total length in inches and weight in pounds.

Model	a	b	SE (b)	r^2	n
Combined	7.30E-04	2.96	0.0153	0.962	1488
Female	7.25E-04	2.97	0.0221	0.957	808
Male	8.37E-04	2.91	0.0248	0.955	643

Literature Cited

Beckman, D.W., A.L. Stanley, J.H. Render, and C.A. Wilson. 1991. Age and Growth-Rate Estimation of Sheepshead *Archosargus probatocephalus* in Louisiana Waters Using Otoliths. *Fishery Bulletin*. U.S. 89:1-8.

Blanchet, H. 2008. Assessment of sheepshead in Louisiana waters – 2008 report. Report to the Louisiana Legislature by the Wildlife and Fisheries Commission. February 2008. 26 pp.

Haddon, Malcolm. (2001). Modelling and Quantitative Methods in Fisheries. 1-406.

Porch CE, Wilson CA, Nieland DL (2002) A new growth model for red drum (Sciaenops ocellatus) that accommodates seasonal and ontogenic changes in growth rates. Fish Bull 100:149–152.

SAS Institute Inc. 2008. SAS/STAT® 9.2 User’s Guide. Cary, NC: SAS Institute Inc.

West, J., D. Davis, S. Beck, J. Adriance, and J.E. Powers. 2015. Assessment of sheepshead in Louisiana waters. 2015 Report of the Louisiana Department of Wildlife and Fisheries. 60 pp.