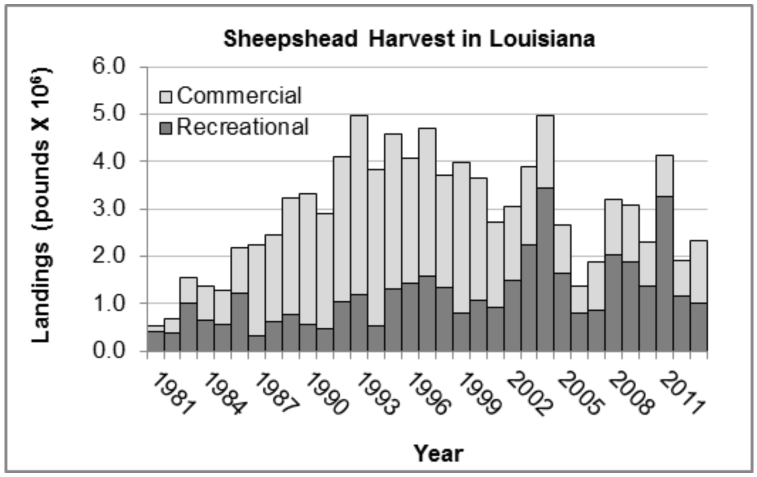
Assessment of Sheepshead *Archosargus probatocephalus* in Louisiana Waters
2015 Report

Executive Summary

Landings of sheepshead in Louisiana have averaged 2.9 million pounds per year in the most recent decade. The highest harvests on record occurred from1993-2004. After commercial gear restrictions were enacted in 1995, commercial landings substantially declined (40% average decrease from previous years). In the most recent years, recreational landings comprise approximately 60% 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 1981-2013. 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 Trip Ticket Program, National Marine Fisheries Service commercial statistical records, and the NMFS Marine Recreational Information Program. 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 von Bertalanffy growth functions.

The conservation threshold established by the Louisiana Legislature for sheepshead is a 30% spawning potential ratio. Based on results of this assessment, the Louisiana sheepshead stock is currently neither overfished or experiencing overfishing. The current spawning potential ratio estimate is 65%.

Summary of Changes from 2008 Assessment

In the prior assessment (Blanchet 2010), an untuned virtual population analysis and yield and spawner-per-recruit models were used to estimate the impact of fishing pressure on potential yield and spawning potential of sheepshead in LA waters. The status of the stock presented in the 2010 report was based on the last eight cohorts available for evaluation (2000-2008). In this assessment, a statistical catch at age model is used to estimate annual age-specific fishing mortality rates and population size from 1981-2013. Direct comparisons between the earlier and current assessments are not included in this report.

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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* (SH) occurring in Louisiana (LA) waters from 1981-2013. 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. Landings are taken from the Louisiana Department of Wildlife and Fisheries (LDWF) Trip Ticket Program, National Marine Fisheries Service (NMFS) commercial statistical records, and the NMFS Marine Recreational Fishing Information Program (MRFSS/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 (2003-2013) and von Bertalanffy growth functions (1981-2002).

1.1 Fishery Status

A comprehensive history of the SH resource and associated fishery within LA is described in Schexnayder et al. (1998) and for the Gulf of Mexico (GOM) in VanderKooy (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 upward to the saltwater line), including the Mississippi River, and state outside territorial waters (from the coastline seaward to the state water boundary). Some harvest also occurs from the federal waters of the Exclusive Economic Zone (EEZ). While SH are harvested year round as bycatch, the winter fisheries will target sheepshead opportunistically as they are encountered (VanderKooy 2006).

Recreational

The recreational fishery for SH operates primarily within state inside waters (from the coastline upward to the saltwater line) and state territorial waters (from the coastline seaward to the state water boundary), with very little harvest from the federal waters of EEZ. Sheepshead are infrequently targeted by LA anglers and comprised only 3% of the total 2013 LA recreational catch by weight (NMFS 2014b).

1.2 Fishery Regulations

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

Commercial

Commercial 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

Commercial

Commercial harvest of SH in LA was relatively light, between 0.05 and 0.31 million pounds, until the 1980s when commercial harvest expanded greatly (Figure 1). Commercial harvest rapidly increased in the early 1980s and into the 1990s, peaking at 3.76 million pounds in 1993. Landings remained high throughout the 1990s, averaging 2.99 million pounds. During the 2000s, commercial SH harvest declined from 2.60 million pounds in 2000 to 0.57 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 with the inshore and offshore trawl fleet. Commercial harvest of SH rebounded in the late 2000s with harvests around 1 million pounds. In 2013, 1.33 million pounds of sheepshead were commercially harvested in LA (Table 1).

Prior to commercial harvest regulation changes in 1995-97, the commercial SH fishery in LA was mainly an inshore gillnet and an offshore trawl fishery. In more recent years, hand lines, trawls, and skimmer nets became the main gears utilized in the fishery (Table 2). The commercial SH fishery had traditionally seen harvest peaks in the fall and early spring in and around larger bays, lakes and coastal offshore waters of LA (Pausina 2001). Timing of harvest peaks can vary depending on the availability of other target species, availability of sheepshead, and weather patterns. Monthly commercial landings of SH are generally greatest from November through April (Table 3). In 2013, the majority of SH were landed in

March and April. The Terrebonne, Barataria, Pontchartrain, and Mississippi River basins accounted for the majority of landings in 2013 (Table 4).

Recreational

From 1981 through 2013, LA recreational sheepshead harvest varied from a low of 0.33 million pounds in 1987 to a high of 3.45 million pounds in 2004 (Table 1). Recreational harvest generally increased from 1987 through 1997 followed by a several year decline (Figure 2). Recreational SH harvest increased again in 2002 through 2013, with peaks observed in 2004 (3.45 million pounds) and 2011 (3.26 million pounds). In 2013, 1.0 million pounds of SH were recreationally harvested in LA.

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 for use in ASAP. Below is a brief description of this survey's methodology. Complete details can be found in LDWF (2002).

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 – Atchafalaya Bay to western shore of Vermilion Bay (Vermilion/Teche/Atchafalaya Basins); CSA 7 – western shore of Vermilion Bay 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 beach 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' long and 6' depth net, consisting of 3 walls constructed of nylon. The inner wall has 1 5/8'' bar mesh wall, and the two outer walls have 6'' bar mesh wall. 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.

2.2 Fishery Dependent

Commercial

Commercial SH landings are taken from NMFS commercial statistical records (NMFS 2014a) and the LDWF Trip Ticket Program (Figure 1, Table 1). Commercial live releases of sheepshead are assumed to be insignificant relative to commercial harvest and not considered further in this assessment. Annual size compositions of commercial sheepshead harvest (Table 5) were developed from samples from the Trip Interview Program (TIPS; 1981-2002) and the Fishery Information Network (FIN; 2002-2013). Due to no length composition samples collected in early years of the commercial fishery, the 1994-1995 TIPS size composition data are pooled and used as a proxy for 1981-1995 size compositions. Due to low sample size in 2002, the available TIPS and FIN size composition samples were combined.

Ages of commercial sheepshead landings are derived from sex-specific von Bertalanffy growth functions (1981-2002) and otoliths collected directly from the commercial fishery (2003-2013; see *Catch at Age Estimation*).

Recreational

Recreational SH landings (1981-2013, Type A+B1 only; Table 1, Figure 2) and corresponding size distributions (Table 6) are taken from MRFSS/MRIP (NMFS 2014b). Recreational live releases (Type B2 catches) comprised 24% of the total recreational catch from 1981-2013 and are not considered further in this assessment (see *Research and Data Needs*).

Ages of recreational sheepshead landings are derived from sex-specific von Bertalanffy growth functions (1981-2001) and otoliths collected directly from the recreational fishery (2002-2013; see *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). While a unit stock is typically defined as that portion of the population which is genetically similar, for the purpose of this assessment, and to remain consist with the statewide management strategy, the unit stock is defined as those sheepshead occurring in LA waters.

3.2 Morphometrics

Weight-length regressions for LA sheepshead were developed by Beckman et al. (1991). 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:

$$W = 5.46{\times}10^{-5}(FL)^{2.86} \quad [1]$$

where W is whole weight in grams and FL is fork length in mm.

Fish with only TL measurements available are converted to FL in mm from the following relationship provided by the Florida Fish and Wildlife Research Institute (Blanchet 2008):

$$FL = 3.88 + \frac{TL}{1.09} \quad [2]$$

3.3 Growth

Beckman et al. (1991) found significant differences between male and female sheepshead growth curves developed from LA-specific data. For the purposes of this assessment, we use their sex-specific von Bertalanffy growth functions with size-at-age calculated from:

$$FL_{a,male} = 419{\times}(1 - e^{-0.417(a+0.901)}) \quad [3]$$

$$FL_{a,female} = 447{\times}(1 - e^{-0.367(a+1.025)}) \quad [4]$$

where FL_a is FL-at-age in mm and a is age in years.

3.4 Sex Ratio

The probability of being female at a specific size is estimated with an asymptotic function developed from sheepshead size and sex data collected from the LDWF FI marine trammel net survey (1986-2013) as:

$$P_{fem,FL} = 1 - e^{(-0.061(FL+0.020))} \quad [5]$$

where FL is in units of inches. The minimum sex ratio-at-size is assumed as 50:50. The probability of being male at a particular FL is then taken by difference. The function was fit to the data using the SAS nonlinear approximation procedure (PROC NLIN; SAS Institute 1994).

3.5 Maturity / Fecundity

An age-specific maturity vector (Render and Wilson 1992) is employed in this assessment where no female sheepshead age-0 to 1 spawn, 95% of age-2 females spawn, and 100% of age-3 females and greater spawn.

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).

3.6 Natural Mortality

Sheepshead can live to at least twenty years based on available age samples (Beckman et al. 1991; LDWF unpublished data). In the previous assessment (Blanchet 2010), the natural mortality rate was assumed constant across ages; however, an allometric relationship between natural mortality and fish size in natural ecosystems has been demonstrated (Lorenzen 1996). In this assessment, a value of constant M is assumed (M=0.21), but is allowed to vary with weight-at-age to calculate declining sex-specific natural mortality rates with age. This value of constant M (0.21) is consistent with a stock where approximately 1.5% of the stock remains alive to 20 years of age (Hewitt and Hoenig 2005). Following SEDAR 2006b, the value of M is rescaled for each sex where the average mortality rate over ages vulnerable to the fishery is equivalent to the constant rate over ages as:

$$M_a = M \frac{nL(a)}{\sum_{a_c}^{a_{max}} L(a)} \qquad [6]$$

where M is the constant natural mortality rates over exploitable ages a , a_{max} is the oldest age-class (age-8 in this case), 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:

$$L(a) = W_a^{-0.288} \qquad [7]$$

where -0.288 is the allometric exponent estimated for natural ecosystems (Lorenzen 1996) and W_a is weight-at-age. Resulting sex-specific M_a vectors are presented in Table 7. For modeling purposes, the sex-specific M_a vectors are averaged by weighting by the sex ratio at age. In this case, the sex ratio at age is derived from the annual sex-specific catch at age (see *Catch at Age Estimation*) by assuming sex ratios of the catches are representative of the population (see *Research and Data Needs*).

3.7 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.

Rose et al. (2001) summarize steepness estimates for periodic, opportunistic, and equilibrium life history strategists for freshwater, pelagic, and anadromous fish stocks from a meta-analysis of Ransom Myers spawner-recruit datasets (Myers et al. 1999). In SEDAR 2010, the periodic strategist steepness estimates included in the Rose et al. (2001) meta-analysis are refined to include only marine demersal species (mean and median steepness= 0.77 and 0.80, respectively). For purposes of this assessment, we further refine the list of marine demersal species in SEDAR 2010 to only include species with similar life history characteristics as discussed below.

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 2006a, 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 8). 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-high productivity. We further refine the list of marine demersal species in SEDAR 2010 to only include species with similar overall productivity scores (8 species: 2.3-2.7) (mean and median steepness= 0.75 and 0.77, respectively).

4. Abundance Index Development

An index of abundance (IOA) was developed from the LDWF FI marine trammel net survey for use as a tuning index in ASAP. Only those CSAs and months with ≥5% positive samples were included in index development. Stations not sampled regularly through time were also excluded. For purposes of this assessment, 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 (I_y) as:

$$I_y = c_y p_y \quad [8]$$

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 (e^x). The lognormal model considers only samples in which sheepshead are captured; the binomial model considers all samples. The IOA is then computed from equation [8] with variances approximated from a Monte Carlo resampling routine (2000 iterations) using the estimated least-squares means and standard errors.

Variables considered in model inclusion were:

Factor	Levels	Value
Year	29	1985-2013
Month	6	October-March
Area	5	CSA 1, 3, 5, 6, 7
Salinity	Continuous	--
Temperature	Continuous	--

January-March samples are grouped with the previous year's October-December samples for IOA development. This approximates survey timing at the end of the calendar year (December 31st).

To determine the most appropriate models, factors are selected using a forward step-wise approach where each factor is added to each sub-model individually and the resulting reduction in deviance per degree of freedom (Dev/DF) analyzed. The factor causing the greatest reduction in Dev/DF is then added to the base model. Criteria for model inclusion also include a reduction in Dev/DF ≥1% and a Chi-Square significance test ≤0.05. This procedure was repeated until no factor met criteria for model inclusion. We assume no significant interaction terms with year in this model and consider only the main effects.

The resulting sub-models are as follows:

$$c \sim Year + Area \quad [9]$$

$$p \sim Year + Area \quad [10]$$

Sub-models are estimated with the SAS generalized linear modeling procedure (PROC GENMOD; SAS 1994). Sample sizes, percent positive samples, nominal CPUE, the standardized index of abundance, and coefficients of variation of the standardized index are presented (Table 9, Figure 3). The standardized IOA and nominal CPUE time-series are also presented in Figure 3.

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.

5.1 Fishery

Sheepshead typically spawn February-April with annulus deposition occurring January-May. An April 1st birthday is typically assumed as a biological birthday. However, for purposes of this assessment, sheepshead 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.

1981-2002 Sex-specific s probabilities of age a given length l for recreational and commercial sheepshead landings are computed from:

$$P(a|l)_s = \frac{P(l|a)_s}{\sum_a P(l|a)_s} \quad [11]$$

where the probabilities of length given age are estimated from normal probability densities as:

$$P(l|a)_s = \frac{1}{\sigma_a\sqrt{2\pi}}\int_{l-d}^{l+d} exp\left[-\frac{(l-l_{as})^2}{2\sigma_a^2}\right] dl \quad [12]$$

where length bins are 1 inch FL intervals with midpoint l, maximum $l + d$, and minimum $l - d$ lengths. Mean sex-specific fork length-at-age l_{as} is estimated from Equations [3, 4]. 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 0.05 for both sexes). To approximate changes in growth and vulnerability to the fishery through the year, mean l_{as} are calculated at the mid-point of the calendar/model year. Thus, two sex-specific $P(a|l)_s$ matrices are developed to assign ages to SH fishery landings from 1981-2001 (Table 10) and also for instances discussed below.

2003-2013 Sex and fleet-specific (*i.e.,* commercial and recreational) probabilities of age given length are computed from:

$$P(a|l)_{yfs} = \frac{n_{layfs}}{\sum_a n_{layfs}} \quad [13]$$

where n_{layfs} are annual fleet and sex-specific sheepshead sample sizes occurring in each length/age bin (Tables 11 and 12). For length bins with sample sizes <10, the $P(a|l)$ for that length interval is taken from equation [11].

Annual fleet-specific catch-at-age is then taken as:

$$C_{ayf} = \sum_l \sum_s C_{lyfs} P(a|l)_{yfs} \quad [14]$$

where C_{lyfs} are annual sex and fleet-specific catch-at-size in FL, and $P(a|l)_{yfs}$ are taken from either equation [11] or [13]. For modeling purposes, catches ≥ age-8 are summed into a plus group. Resulting annual fleet-specific catch-at-age and corresponding mean weights-at-age are presented (Tables 13-16).

5.2 Survey

Probabilities of age given length for SH catches of the LDWF marine trammel net survey are computed from equations [11] and [12]. To approximate survey timing (i.e., a December 31st midpoint), mean l_a is calculated at the end of the calendar/model year. Resulting sex-specific $P(l|a)$ for SH catches of the marine trammel net survey are presented (Table 17).

Annual survey catch-at-age is taken from equation [14] with annual survey catch-at-size substituted for fishery catch-at-size. Survey catch-at-size is derived using only those samples included in IOA development. Annual survey catch-at-size and age composition are presented (Tables 18 and 19).

6. Assessment Model

The previous LDWF SH stock assessment (Blanchet 2010) estimated the impact of fishing pressure on female SH with an untuned VPA and yield and spawner-per-recruit analyses. The status of the stock presented in the 2010 report was based on the last eight cohorts available for evaluation (2000-2008). In this assessment, a statistical catch-at-age model is used to estimate annual age-specific fishing mortality rates and population sizes (1981-2013) of SH occurring in LA waters. Direct comparisons between the earlier and current assessments were not included in this report.

The Age-Structured Assessment Program (ASAP3; NOAA Fisheries Toolbox http://nft.nefsc.noaa.gov) is used to describe the dynamics of SH occurring in LA waters. Only the years 1981-2013 are modeled due to the absence of size/age information from earlier years of the fishery. ASAP is a statistical catch-at-age model that allows internal estimation of a Beverton-Holt stock recruitment relationship. Minimum data requirements are fishery catch-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 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 2012; NOAA Fisheries Toolbox 2013).

6.1 Model Configuration

Mortality

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

$$F_{ayf} = v_{af} Fmult_{yf} \quad [15]$$

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

Age and fleet specific fishery selectivities are modeled with double logistic functions as:

$$v_{af} = \left(\frac{1}{1+e^{-(a-\alpha_f)/\beta_f}}\right)\left(1-\frac{1}{1+e^{-(a-\alpha 2_f)/\beta 2_f}}\right) \quad [16]$$

Total mortality for each age and year is calculated from the annual age-specific natural mortality rates and estimated annual fleet-specific fishing mortalities as:

$$Z_{ay} = M_{ay} + \sum_f F_{ayf} \quad [17]$$

where M_{ay} are computed by averaging the sex-specific M_a vectors by weighting by the annual sex ratio at age (see *Natural Mortality*).

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

$$F_y = \frac{\sum_a F_{ay} N_{ay}}{\sum_a N_{ay}} \quad [18]$$

Population Abundance

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

$$N_{ay} = N_{a-1,y-1} e^{-Z_{a-1,y-1}} \quad [19]$$

Numbers in the plus group A are calculated from:

$$N_{Ay} = N_{A-1,y-1} e^{-Z_{A-1,y-1}} + N_{A,y-1} e^{-Z_{A,y-1}} \quad [20]$$

Spawning Stock Biomass

Annual female spawning stock biomass is calculated from:

$$SSB_y = \sum_{i=1}^{A} N_{ay} W_{SSB,a} p_{mat,ay}\, e^{-Z_{ay}(0.33)} \quad [21]$$

where $W_{SSB,a}$ are female spawning stock biomass weights-at-age (*i.e.,* on April 1st), $p_{mat,ay}$ 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, and $-Z_{ay}(0.33)$ is the proportion of total mortality occurring prior to spawning on April 1st.

Stock Recruitment

Expected recruitment, $\hat{R}_{y+1}$, is calculated from the Beverton-Holt stock recruitment relationship, reparameterized by Mace and Doonan (1988), with annual lognormal deviations as:

$$\hat{R}_{y+1} = \frac{\alpha SSB_y}{\beta + SSB_y} + e^{\delta_{y+1}} \quad [22]$$

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

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.

Expected Catch

Expected fishery catches by age, fleet, and year, are estimated from the Baranov catch equation as:

$$\hat{C}_{ayf} = N_{ay} F_{ayf} \frac{(1-e^{-Z_{ay}})}{Z_{ay}} \quad [23]$$

Expected fishery age compositions are then calculated from $\frac{\hat{\hat{C}}_{ayf}}{\sum_a \hat{C}_{ayf}}$. Expected yields for each age, year, and fleet are computed as $\sum_a \hat{C}_{ayf} \overline{W}_{ayf}$, where $\overline{W}_{ayf}$ are observed fleet-specific mean catch weights.

Survey Catch-rates

Expected annual survey catch-rates are computed from:

$$\hat{I}_{ay} = q \sum_a N_{ay} (1 - e^{-Z_{ay}(1.0)}) v_a \quad [24]$$

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).

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 tuning indices modeled. Parameters are estimated in log-space and then back transformed. In this assessment, 124 parameters are estimated:

1. 16 selectivity parameters (4 parameters per selectivity block: 2 blocks for the commercial fishery [1981-1996 and 1997-2013], 1 block for the recreational fishery [1981-2013], and 1 block for the survey [1985-2013]). Details of fishery selectivity blocks are provided in the *Model Assumptions/Inputs* Section below.
2. 66 apical fishing mortality rates (F_{mult} in the initial year and 32 deviations in subsequent years for 2 fleets)
3. 33 recruitment deviations (1981-2013)

4. 7 initial population abundance deviations (age-2 through 8-plus)
5. 1 survey catchability coefficient
6. 1 stock-recruitment parameter (unexploited spawning stock biomass; the steepness parameter is fixed at 0.80 for the base run).

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

$$-ln(L) = \sum_i \lambda_i(-ln\,L_i) + \sum_j(-ln\,L_j) \quad [25]$$

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:

$$-ln(L_i) = 0.5\sum_i \frac{[ln(obs_i) - ln(pred_i)]^2}{\sigma^2} \quad [26]$$

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:

$$-ln(L_j) = -ESS\sum_{i=1}^{A} p_i\,ln(\hat{p}_i) \quad [27]$$

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 vulnerabilities are dome-shaped, 5) abundance indices are proportional to absolute abundance, and 6) natural mortality, fecundity, growth and sex ratio at size 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 0.8, 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) 1981-1996 (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 fishery landings were specified with CV's of 0.2 for each year of the time-series; annual recruitment deviations were specified with CV's of 0.5. Input levels of error for the survey for each year of the time-series were specified with CV's calculated from the standardized index. All lambdas for lognormal components included in the objective function were equally weighted. Input effective sample sizes for estimation of fishery age compositions were specified as ESS=50 for years where annual ALKs were available (2003-2013) and down weighted to ESS=10 for years where von Bertalanffy growth functions were used (1981-2002).

6.3 Model Results

Objective function components, weighting factors, and likelihood values of the base model are summarized in Table 20.

Model Fit

The base model provides an overall reasonable fit to the data. Fits to the commercial and recreational landings are reasonable, but are generally underestimated towards the middle of each time-series (Figures 4 and 5). Model estimated survey catch-rates provide reasonable fits to the observations, but are also generally underestimated towards the middle of the time-series (Figure 6). Model estimated fishery and survey age compositions provide reasonable fits to the input age proportions (Figures 7-9).

Selectivities

Estimated fishery and survey selectivities are presented in Figure 10. Fishery estimates indicate full-vulnerability to the commercial fishery at age-2 during the 1981-1996 regulation block and age-6 during the 1997-2013 regulation block. Recreational estimates indicate full-vulnerability to the fishery at age-4. Survey estimates indicate full vulnerability to the FI marine trammel net gear at age-8+.

Abundance, Spawning Stock, and Recruitment

Stock abundance had fluctuated over the time-series (Table 21). Stock size estimates increased from 16.1 million fish in 1981 to a peak of 33.8 million fish in 2001. Since 2001, stock abundance decreased to16.3 million fish estimated in 2013.

Female spawning stock biomass (SSB) estimates increased from 17.7 million pounds in 1981 to 38.4 million pounds in 2002 (Figure 11). Since 2002, SSB estimates decreased to 23.5 million pounds in 2013.

Recruitment also has varied over the time-series (Figure 12). Estimates of age-1 abundance increased from 4.7 million fish in 1981 to a maximum of 11.5 million recruits in 2001. Since 2001, recruitment estimates decreased to a low of 2.8 million age-1 fish in 2013. It's important to note that recruitment estimates starting in 2002, when age data directly from the fisheries became available for catch at age development, are more variable and generally lower than earlier recruitment estimates. Prior to 2002, sheepshead ages were assigned to fishery catches with ALKs constructed from von Bertalanffy growth functions (see *Catch at Age Estimation*).

Fishing Mortality

Model estimated fishing mortality rates are presented in Table 22 (total apical, average, and age-specific) and Figure 13 (average only). Average F rates are weighted by population numbers at age. Average F rates have varied over the time-series. The lowest and highest estimates of average F are 0.02 yr^{-1} in 2006 and 0.09 yr^{-1} in 2011. The 2013 estimate of average F is 0.06 yr^{-1}.

Stock-Recruitment

No discernable relationship is observed between female SSB and subsequent age-1 recruitment (Figure 14). The ASAP base model was run with steepness fixed at 0.80. The estimated unexploited female SSB was 39.3 million pounds. When allowed to directly solve for steepness, the parameter was estimated as 1.0. Alternate model runs with steepness values fixed at 1.0, 0.9, and 0.7 are discussed in the *Model Diagnostics* Section below.

Parameter Uncertainty

In the ASAP base model, 124 parameters are estimated. Asymptotic standard errors for the recruitment time-series are presented in Figure 12. Markov Chain Monte Carlo (MCMC) derived 95% confidence intervals for the median female SSB and average F rates are presented in Figures 11 and 13. Uncertainty around female SSB has remained fairly constant across the time series, whereas uncertainty around recruitment has decreased over time. Uncertainty around average F rates has varied across the time-series.

6.4 Management Benchmarks

The conservation standard established by the LA Legislature for sheepshead (RS 56:325.4: http://www.legis.la.gov/Legis/Law.aspx?d=105210) is a 30% spawning potential ratio (SPR; Goodyear

1993). Methodology used in this assessment to estimate equilibrium yield, female spawning stock biomass, and average fishing mortality rates that lead to a 30% SPR are described below. Current conditions are derived by averaging estimates from the last three years of the assessment (2011-2013) as described below.

When the stock is in equilibrium, equation [21] can be solved, excluding the year index, for any given exploitation rate as:

$$\frac{SSB}{R}(F) = \sum_{i=1}^{A} N_a W_{SSB,a} p_{mat,a}\, e^{-Z_a(0.33)} \quad [28]$$

where total mortality at age Z_a is computed as $M_a + v_a Fmult$; vulnerability at age v_a is taken by rescaling the current F-at-age estimate (geometric mean 2011-2013) to the maximum.
Current natural mortality at age M_a is taken as the geometric mean of M_{ay} from the last three years of the assessment; the current proportion of mature females at age $p_{mat,a}$ is taken as the arithmetic mean of $p_{mat,ay}$ from the last three years of the assessment. 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 [23], 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 2011-2013). 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 [28] 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 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 average fishing mortality rate, female spawning stock biomass, and yield that lead to 30% SPR ($SSB_{30\%}$, $F_{30\%}$, and $Y_{30\%}$; Table 23). Also presented are a plot of the stock recruitment data, equilibrium recruitment, and diagonals from the origin intersecting R_{eq} at the minimum and maximum SSB estimates of the time-series, corresponding with a minimum equilibrium SPR of 47% and a maximum of 96% (Figure 15). The current estimate of equilibrium SPR is 65%.

6.5 Model Diagnostics

Sensitivity Analysis

A series of sensitivity runs are used to explore uncertainty in the base model's configuration as follows:

1. steepness parameter h fixed at 1.0, 0.9, and 0.7 (models 1-3)

2. fishery landings up-weighted ($\lambda \times$ 5; model 4)
3. survey catch-rates up-weighted ($\lambda \times$ 5; model 5)

Current conditions are taken as the geometric mean (SSB and average F) of the last three years of the assessment (2011-2013). Reference point estimates from all of the sensitivity runs indicate the stock is currently above $SSB_{30\%}$ and the fishery is currently operating below $F_{30\%}$ (Table 24). Estimates of $F_{30\%}$, $SSB_{30\%}$, and $Y_{30\%}$ from all sensitivity runs are similar in magnitude (0.24-0.25 yr^{-1}, 9.0-11.7 million pounds, and 3.9-5.1 million pounds, respectively).

Retrospective Analysis

A retrospective analysis is conducted by sequentially truncating the base model by a year (terminal years 2009-2013 only). Retrospective estimates of recruitment, $SSB/SSB_{30\%}$, and $F/F_{30\%}$ are presented in Figure 16, where $SSB_{30\%}$ and $F_{30\%}$ are computed from the base model run.

Estimated terminal year $SSB/SSB_{30\%}$, $F/F_{30\%}$, and recruitment from the 2011-2013 terminal year runs were similar to the base model run. Terminal year estimates for all runs indicate little bias in $F/F_{30\%}$, $SSB/SSB_{30\%}$, and age-1 recruits.

7. Stock Status

The history of the LA sheepshead stock relative to $F/F_{30\%}$ and $SSB/SSB_{30\%}$ is presented in Figure 17. Given the established conservation standard of 30% SPR, fishing mortality rates exceeding $F_{30\%}$ ($F/F_{30\%}$ >1.0) are defined as overfishing; spawning stock sizes below $SSB_{30\%}$ ($SSB/SSB_{30\%}$ < 1.0) are defined as the overfished condition. Current conditions (i.e., female SSB and average F) are derived as geometric means from the last three years of the ASAP base model run.

Overfishing Status

Using results of the ASAP model presented in this assessment, the 2011-2013 estimate of $F/F_{30\%}$ is 0.24, suggesting the stock is currently not undergoing overfishing. The current assessment model indicates that the stock never experienced overfishing during the time-series examined.

Overfished Status

The 2011-2013 estimate of $SSB/SSB_{30\%}$ is 3.58, suggesting the stock is currently not in an overfished state. The current assessment model indicates that the stock has never been considered overfished during the time-series examined.

Control Rules

As specified in RS 56:325.4, if the annual LDWF sheepshead stock assessment indicates current SPR<30%, the department shall close the season within two weeks for a period of at least one year, or shall provide, for the commission's consideration, management options derived from data that indicate that the spawning potential ratio is estimated to have at least a fifty percent chance of recovery to a thirty percent ratio within ten years or some other appropriate recovery period based on the biology of the stock of the fish, environmental conditions, and the needs of the fishing communities.

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.

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 samples collected directly from the survey in question would allow a more accurate representation of survey age composition in future assessments.

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 future use in sheepshead stock assessments.

Estimates of sheepshead batch fecundity and spawning frequency as a function of age/size are needed.

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. A new LDWF fishery-independent survey methodology was implemented in 2013. This methodology should be assessed for adequacy with respect to its ability to evaluate stock status, and modified if deemed necessary.

Stock losses due to discard mortality are not taken into account in this stock assessment. If data characterizing the size/age composition of recreational releases becomes available, future stock assessment efforts could account for this source of mortality.

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.

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10. Tables

Table 1: Louisiana annual commercial and recreational sheepshead landings (pounds x 10^6) derived from NOAA-Fisheries commercial statistical records, LDWF trip ticket program, and MRFSS/MRIP. Recreational landings are A+B1 catches only.

Year	Harvest		%_Commercial	%_Recreational
	Commercial	Recreational		
1981	0.13	0.41	24.2	75.8
1982	0.30	0.37	44.4	55.6
1983	0.54	1.01	35.1	64.9
1984	0.72	0.64	52.7	47.3
1985	0.72	0.56	56.1	43.9
1986	0.96	1.21	44.3	55.7
1987	1.92	0.33	85.5	14.5
1988	1.85	0.61	75.1	24.9
1989	2.45	0.77	76.1	23.9
1990	2.77	0.55	83.4	16.6
1991	2.43	0.48	83.6	16.4
1992	3.06	1.05	74.5	25.5
1993	3.76	1.20	75.9	24.1
1994	3.29	0.53	86.1	13.9
1995	3.27	1.31	71.3	28.7
1996	2.64	1.43	64.9	35.1
1997	3.11	1.58	66.3	33.7
1998	2.37	1.34	63.9	36.1
1999	3.19	0.79	80.1	19.9
2000	2.59	1.07	70.8	29.2
2001	1.80	0.93	65.8	34.2
2002	1.58	1.48	51.7	48.3
2003	1.64	2.25	42.1	57.9
2004	1.52	3.45	30.6	69.4
2005	1.02	1.63	38.6	61.4
2006	0.57	0.80	41.3	58.7
2007	1.02	0.85	54.5	45.5
2008	1.16	2.04	36.3	63.7
2009	1.21	1.87	39.3	60.7
2010	0.92	1.36	40.4	59.6
2011	0.88	3.26	21.3	78.7
2012	0.74	1.16	38.8	61.2
2013	1.33	1.00	56.9	43.1

Table 2: Percent contribution by gear of Louisiana commercial sheepshead landings from the LDWF Trip Ticket Program, 2000-2013.

% Commercial Landings by Gear						
YEAR	*HAND LINES*	*OTTER TRAWL, FISH*	*OTTER TRAWL, SHRIMP*	*SKIMMER NETS*	*TROT LINES*	*OTHER*
2000	25.11	15.84	50.37	4.64	2.12	1.93
2001	30.80	17.99	36.94	10.53	2.99	0.76
2002	18.75	16.09	44.98	13.45	5.72	1.02
2003	15.64	41.12	29.91	7.16	5.56	0.61
2004	35.40	20.12	22.85	14.58	6.23	0.82
2005	47.46	18.29	18.96	7.41	7.30	0.58
2006	1.58	36.19	21.62	26.44	13.79	0.38
2007	24.82	19.33	23.59	22.56	9.54	0.17
2008	29.46	1.85	22.01	42.86	3.38	0.45
2009	17.53	20.44	12.39	42.94	6.29	0.41
2010	20.07	18.85	12.52	38.54	8.99	1.04
2011	50.14	17.04	7.78	18.78	5.45	0.80
2012	43.32	12.10	20.90	16.69	5.79	1.20
2013	25.68	35.41	9.45	22.06	5.28	2.12

Table 3: Percent contribution by month of Louisiana commercial sheepshead landings from the LDWF Trip Ticket Program, 2000-2013.

% Commercial Landings by Month												
Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
2000	4.6	4.6	63.9	6.9	0.3	0.6	0.3	2.3	1.8	3.9	4.5	6.2
2001	13.2	10.4	34.3	16.9	0.4	0.7	0.4	4.7	3.5	5.3	3.1	7.1
2002	18.2	17.0	29.2	12.5	2.4	1.8	1.1	0.9	1.1	3.2	5.5	7.1
2003	14.1	8.3	26.0	13.0	0.9	2.3	5.8	2.8	3.3	6.6	4.6	12.3
2004	10.7	13.7	37.8	15.8	1.1	0.6	0.4	0.5	1.2	1.6	3.9	12.8
2005	19.9	12.3	40.9	17.0	2.3	4.5	0.3	0.8		0.2	0.4	1.4
2006	1.2	3.5	15.2	6.1	1.4	0.3	0.3	6.7	6.5	1.5	27.1	30.3
2007	15.2	17.3	29.0	15.4	0.7	0.5	0.3	2.1	2.3	3.4	8.3	5.6
2008	27.2	13.2	20.0	25.5	0.7	1.1	0.4	1.4	0.6	3.0	3.0	3.8
2009	15.8	9.4	16.9	13.5	0.5	1.6	0.2	12.3	3.6	5.7	10.1	10.4
2010	31.3	14.3	11.7	21.1	0.9	0.8	0.1	1.4	1.1	2.6	7.5	7.2
2011	4.2	6.6	39.3	17.6	2.9	0.9	1.3	1.3	2.3	4.0	8.1	11.4
2012	20.1	9.5	42.5	9.1	0.8	1.6	0.4	1.4	2.1	5.1	4.7	2.7
2013	7.9	7.4	20.4	44.4	0.7	0.6	0.4	1.0	1.1	2.2	7.4	6.5

Table 4: Percent contribution by basin of Louisiana commercial sheepshead landings from the LDWF Trip Ticket Program, 2000-2013.

% Commercial Landings by Area														
Basin/Year	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*
ATCHAFALAYA/VERMILION-TECH	0.1	0.2	0.1	0.2	0.3	1.7	2.2	1.8	1.7	1.7		1.8	4.5	3.3
BARATARIA	41.3	25.2	40.3	26.6	25.1	20.7	41.9	34.1	22.2	6.5	20.3	21.7	34.1	18.8
CALCASIEU RIVER	0.9	1.5	0.8	0.9	2.1	1.8	3.8	2.3	2.0	1.6	2.0	1.1	2.8	2.3
LAKE PONTCHARTRAIN	14.9	13.3	17.7	30.0	11.1	5.8	37.9	11.4	3.1	24.3	20.2	25.6	23.7	15.4
LOUISIANA GRID 13	16.0	20.7	20.0	1.3	1.5	8.5	0.7	1.1	1.0	0.9	3.1	1.9	2.8	8.2
LOUISIANA GRID 14	2.3	0.1		0.1			1.0	1.8	0.2					
LOUISIANA GRID 15	0.2	1.3	0.1			0.2						0.3		
LOUISIANA GRID 17		0.1												
MISSISSIPPI RIVER	22.7	36.8	19.7	39.6	57.8	59.3	10.6	45.5	69.3	63.3	52.3	46.2	30.6	16.2
TERREBONNE	1.4	0.8	1.3	1.4	2.2	2.0	2.0	1.9	0.3	1.7	2.1	1.4	1.4	35.8
UNKNOWN AREAFISHED	0.1													

Table 5: Annual size composition samples of Louisiana commercial sheepshead landings derived from the Trip Interview Program (TIPS; 1981-2002) and the Fishery Information Network (FIN; 2002-2013). Cumulative size distributions are presented for years where limited size composition data were available. FL_in is fork length in inches.

	Commercial, 1981-2013																		
FL_in	*1981-1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*
6		*1*																	
7																			
8	*6*																		
9	*26*	*10*	*4*																
10	*59*	*43*	*7*	*2*									*2*						
11	*181*	*132*	*21*	*6*	*1*	*5*	*2*	*2*			*3*		*2*		*2*			*5*	
12	*313*	*212*	*71*	*27*	*5*	*15*	*7*	*1*	*12*	*13*	*18*	*1*	*10*	*13*	*17*	*18*	*29*	*15*	*4*
13	*349*	*195*	*159*	*52*	*19*	*27*	*15*	*9*	*14*	*21*	*31*	*15*	*38*	*41*	*46*	*49*	*74*	*36*	*13*
14	*340*	*140*	*193*	*46*	*38*	*65*	*36*	*26*	*50*	*36*	*35*	*17*	*70*	*77*	*81*	*86*	*127*	*50*	*31*
15	*262*	*114*	*154*	*47*	*11*	*83*	*51*	*66*	*97*	*67*	*74*	*32*	*145*	*144*	*97*	*81*	*132*	*81*	*41*
16	*156*	*105*	*96*	*16*	*2*	*62*	*31*	*63*	*75*	*107*	*77*	*53*	*283*	*235*	*224*	*64*	*125*	*101*	*68*
17	*87*	*59*	*36*	*2*		*27*	*13*	*36*	*41*	*57*	*58*	*66*	*299*	*254*	*231*	*40*	*134*	*91*	*71*
18	*60*	*36*	*14*			*13*	*8*	*24*	*13*	*5*	*8*	*22*	*216*	*96*	*101*	*7*	*81*	*63*	*10*
19	*25*	*15*	*3*			*5*		*5*	*17*		*2*	*16*	*62*	*23*	*11*		*67*	*53*	*9*
20	*9*	*7*	*3*			*1*	*1*	*2*	*13*	*1*	*3*	*4*	*10*	*4*	*3*		*29*	*24*	*2*
21	*4*	*2*							*2*		*1*	*2*					*2*	*2*	
22								*1*	*1*			*1*					*6*		*2*
23																	*1*		
24																			
25																			
26									*1*										
Totals	*1877*	*1071*	*761*	*198*	*76*	*303*	*164*	*235*	*336*	*307*	*310*	*229*	*1137*	*887*	*813*	*345*	*807*	*521*	*251*

Table 6: Annual size distributions of Louisiana recreational sheepshead harvest taken from MRFSS/MRIP. FL_in is fork length in inches.

	Recreational, 1981-2013																
FL_in	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
5			0.00		0.02							0.10			0.01		
6			0.00		0.00	0.00	0.06					0.15	0.01	0.03	0.01	0.00	0.02
7		0.08	0.03		0.02	0.00	0.05	0.03	0.00		0.00	0.11	0.02	0.01		0.03	0.01
8	0.01	0.15	0.06	0.07	0.10	0.00	0.03	0.12	0.01	0.01	0.01	0.03	0.02	0.05	0.02	0.02	0.01
9	0.04	0.13	0.09		0.21	0.11	0.04	0.11	0.01	0.02	0.08	0.08	0.06	0.05	0.08	0.04	0.04
10	0.19	0.05	0.13	0.08	0.04	0.02	0.04	0.05	0.03	0.14	0.22	0.08	0.08	0.10	0.14	0.07	0.04
11	0.22	0.13	0.20	0.19	0.11	0.10	0.10	0.07	0.18	0.05	0.05	0.03	0.09	0.21	0.16	0.06	0.08
12	0.06	0.20	0.12	0.15	0.14	0.12	0.13	0.10	0.14	0.08	0.14	0.04	0.09	0.13	0.12	0.15	0.13
13	0.03	0.13	0.05	0.12	0.11	0.12	0.12	0.10	0.08	0.05	0.14	0.08	0.11	0.16	0.18	0.22	0.15
14	0.15	0.04	0.08	0.11	0.12	0.23	0.11	0.18	0.15	0.11	0.08	0.06	0.09	0.09	0.11	0.17	0.16
15	0.29	0.03	0.05	0.11	0.05	0.11	0.20	0.11	0.12	0.18	0.14	0.07	0.13	0.09	0.07	0.11	0.12
16	0.00	0.03	0.03	0.04	0.02	0.18	0.08	0.07	0.11	0.19	0.11	0.06	0.13	0.04	0.04	0.04	0.16
17		0.02	0.01	0.05	0.01	0.00	0.01	0.00	0.07	0.06	0.01	0.04	0.05	0.02	0.01	0.06	0.04
18		0.02	0.11	0.07	0.02	0.01	0.02	0.04	0.11	0.05	0.01	0.03	0.06	0.01	0.02	0.01	0.02
19		0.01	0.02	0.00	0.00	0.00			0.00	0.04	0.01	0.02	0.02	0.01	0.01	0.00	0.01
20			0.00			0.00		0.01	0.00		0.01	0.01	0.01	0.01	0.01	0.01	0.00
21												0.00	0.00	0.00	0.00	0.00	
22												0.00		0.00			
23														0.00			0.00
24																	
25								0.00									
26																	
27																	
28																	
29						0.00											

FL_in	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
5											0.00					
6							0.01	0.04				0.00				
7	0.00	0.01		0.01		0.00	0.00	0.00		0.00	0.00	0.00	0.02			0.05
8		0.01		0.01	0.02	0.01	0.01	0.03	0.06	0.05	0.00	0.00	0.02	0.01	0.02	0.01
9	0.00	0.01	0.01	0.05	0.01	0.02	0.03	0.08	0.05	0.02	0.01	0.02	0.06	0.02	0.03	0.00
10	0.02	0.05	0.06	0.01	0.06	0.03	0.02	0.04	0.04	0.03	0.04	0.04	0.07	0.06	0.05	0.02
11	0.07	0.07	0.06	0.10	0.11	0.13	0.04	0.09	0.05	0.03	0.08	0.08	0.06	0.01	0.08	0.20
12	0.08	0.11	0.08	0.11	0.13	0.13	0.15	0.07	0.13	0.09	0.09	0.15	0.04	0.06	0.09	0.06
13	0.12	0.14	0.06	0.14	0.13	0.11	0.15	0.11	0.10	0.07	0.16	0.15	0.07	0.05	0.07	0.14
14	0.18	0.16	0.11	0.09	0.20	0.10	0.20	0.11	0.13	0.13	0.16	0.12	0.15	0.09	0.15	0.04
15	0.18	0.19	0.11	0.09	0.14	0.14	0.18	0.17	0.20	0.13	0.18	0.18	0.08	0.09	0.18	0.20
16	0.17	0.11	0.22	0.17	0.10	0.17	0.09	0.12	0.14	0.19	0.12	0.14	0.14	0.29	0.17	0.17
17	0.07	0.08	0.12	0.09	0.07	0.10	0.05	0.09	0.05	0.12	0.05	0.07	0.14	0.18	0.08	0.06
18	0.06	0.01	0.14	0.03	0.01	0.02	0.03	0.02	0.01	0.09	0.07	0.01	0.07	0.11	0.05	0.04
19	0.02	0.02	0.02	0.04	0.01	0.03	0.03	0.02	0.02	0.05	0.02	0.01	0.07	0.01	0.01	
20	0.00	0.01	0.00	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.03	
21	0.00	0.01	0.01	0.01	0.00		0.00	0.01	0.01	0.00	0.00	0.01				
22		0.00		0.02			0.00		0.01			0.00	0.01	0.01		
23		0.00														
24			0.01													
25																
26																
27																
28																
29																

Table 7: Sex-specific sheepshead natural mortality at age.

	M	
Age	*Female*	*Male*
1	*0.30*	*0.29*
2	*0.26*	*0.25*
3	*0.23*	*0.23*
4	*0.22*	*0.22*
5	*0.21*	*0.21*
6	*0.21*	*0.21*
7	*0.20*	*0.20*
8+	*0.20*	*0.20*

Table 8: 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*	***0.37***	*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 (medium-high)***	

Table 9: 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*	*% Positive*	*Nominal CPUE*	*Index*	*CV*
1985	*85*	*17.65*	*0.95*	*1.28*	*0.48*
1986	*95*	*27.37*	*2.09*	*1.36*	*0.36*
1987	*186*	*25.81*	*0.44*	*0.77*	*0.26*
1988	*171*	*28.07*	*0.84*	*0.88*	*0.27*
1989	*207*	*16.91*	*1.07*	*0.43*	*0.29*
1990	*196*	*20.41*	*0.65*	*0.73*	*0.28*
1991	*218*	*16.06*	*0.60*	*0.55*	*0.30*
1992	*229*	*22.27*	*0.49*	*0.65*	*0.24*
1993	*236*	*20.76*	*0.51*	*0.52*	*0.24*
1994	*220*	*26.36*	*0.92*	*0.97*	*0.24*
1995	*220*	*28.64*	*0.70*	*1.02*	*0.22*
1996	*222*	*22.97*	*2.38*	*1.15*	*0.24*
1997	*225*	*23.11*	*0.90*	*0.99*	*0.24*
2005	*221*	*27.15*	*0.82*	*1.47*	*0.23*
2006	*223*	*28.25*	*0.87*	*1.28*	*0.22*
2007	*232*	*22.41*	*0.75*	*0.77*	*0.24*
2008	*225*	*24.00*	*1.11*	*1.00*	*0.23*
2009	*228*	*23.25*	*1.16*	*0.93*	*0.24*
2010	*225*	*20.89*	*1.00*	*0.97*	*0.25*
2011	*229*	*22.71*	*0.43*	*0.68*	*0.23*
2012	*223*	*24.22*	*0.40*	*0.73*	*0.25*
2013	*263*	*24.33*	*1.11*	*0.94*	*0.22*

Table 10: Sex-specific probabilities of age given length used in age assignments of sheepshead fishery landings, 1981-2002.

	Female									Male								
FL_in	Age_0	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	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	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	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	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.99	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.86	0.14	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	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	0.00	0.99	0.01	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.70	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.65	0.01	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.95	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.11	0.01	0.00	0.00	0.00	0.00
13	0.00	0.00	0.48	0.47	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.21	0.59	0.15	0.03	0.01	0.00	0.01
14	0.00	0.00	0.02	0.53	0.31	0.09	0.03	0.01	0.02	0.00	0.00	0.00	0.21	0.28	0.16	0.08	0.05	0.22
15	0.00	0.00	0.00	0.06	0.27	0.22	0.13	0.07	0.25	0.00	0.00	0.00	0.01	0.07	0.10	0.10	0.08	0.64
16	0.00	0.00	0.00	0.00	0.03	0.09	0.11	0.10	0.67	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.06	0.86
17	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.06	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.95
18	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.98
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	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	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	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Table 11: Annual length-at-age samples used in age assignments of commercial sheepshead landings 2003-2013.

Female - 2003									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12		1		2				2	5
13		1	2	2	1			1	7
14			5	7	3	2	2	2	21
15			4	20	7	5	5	4	45
16			1	3	6	4	9	7	30
17			2	2	2	3	3	4	16
18				1	1			3	5
19			1	3	1	1	2	1	9
20			1	2			2		5
21								2	2
22								1	1
23									
24									
25									
26								1	1
Total		2	16	42	21	15	23	28	147

Male - 2003									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12		1	1			1			3
13			1	1	1		1		4
14		1	5	8	3	1	1	3	22
15		1	1	11	7	3	3	4	30
16			1	5	7	1	6	3	23
17				2	2	1	2	3	10
18				1		2	1	2	6
19				1	1			3	5
20				1			1	4	6
21									
22									
23									
24									
25									
26									
Total		3	9	30	21	9	15	22	109

Female - 2004									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12		1	3		1				5
13				6					6
14				4	4	1		1	10
15			1	9	11	4	2	1	28
16				1	19	11	2	14	47
17					11	5	5	8	29
18						1			1
19									
20									
21									
22									
23									
24									
25									
26									
Total		1	4	20	46	22	9	24	126

Male - 2004									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12		1		1					2
13			3	5	2				10
14			1	6	10	2		3	22
15			1	3	9	5		6	24
16				1	15	4	1	14	35
17					1	3		10	14
18									
19									
20									
21									
22									
23									
24									
25									
26									
Total		1	5	16	37	14	1	33	107

Table 11 (continued):

Female - 2005									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11		1							1
12		4	1			1			6
13		5	2	1	1	1			10
14			4	3	8				15
15			4	6	8	2		1	21
16			3	1	11	5	1	8	29
17			1		5	6	2	9	23
18							1	5	6
19									
20								1	1
21									
22									
23									
Total		10	15	11	33	15	4	24	112

Male - 2005									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11		1							1
12		1	1						2
13		1			2	1			4
14			3	1	6				10
15			4	3	13	5	4	2	31
16				2	6	5	4	7	24
17					2	5	1	2	10
18								1	1
19							1		1
20									
21									
22									
23									
Total		3	8	6	29	16	10	12	84

Female - 2006									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12									
13			3						3
14		1	4			1			6
15				1	2	7	3	1	14
16			1	1	3	14	7	8	34
17					2	17	11	12	42
18						6		7	13
19							3	2	5
20								2	2
21								2	2
22									
23									
Total		1	8	2	7	45	24	34	121

Male - 2006									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12			1						1
13		1	4	1			1		7
14			3	2	1	2			8
15					4	6	3	4	17
16					2	6	3	4	15
17						6	2	8	16
18			1			1	3	3	8
19								8	8
20								2	2
21									
22								1	1
23									
Total		1	9	3	7	21	12	30	83

Female - 2007									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10		1							1
11									
12		1	2	1					4
13			8	1	1		1		11
14		1	7	4	2	1		1	16
15			2	13	8		5	5	33
16			1	5	11	5	18	25	65
17				5	5	5	26	59	100
18				1	3	5	12	56	77
19				1	3	6	5	17	32
20						2		6	8
21									
22									
23									
Total		3	20	31	33	24	67	169	347

Male - 2007									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12				1					1
13		3	8	3	2				16
14			6	14	3		1		24
15		1		13	7	4	11	12	48
16			1	6	9	7	26	24	73
17				3	3	2	14	28	50
18				1	2		2	9	14
19				1		1	1	2	5
20								1	1
21									
22									
23									
Total		4	15	42	26	14	55	76	232

Table 11 (continued):

Female - 2008									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12		2	1	1					4
13			1	1	1				3
14		1	14	2	6	1		2	26
15			10	11	13	6	2	16	58
16			3	6	20	15	3	42	89
17				2	21	14	4	110	151
18					1	6	6	36	49
19					1	1	1	11	14
20								3	3
21									
22									
23									
Total		3	29	23	63	43	16	220	397

Male - 2008									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12			2						2
13			7	2	6	1		1	17
14			11	5	4	1		2	23
15			2	9	14	3	3	20	51
16			3	9	15	16	6	59	108
17					5	5	1	62	73
18					1	1	2	17	21
19								3	3
20									
21									
22									
23									
Total			25	25	45	27	12	164	298

Female - 2009									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12			2	6					8
13			1	9	1				11
14			1	18	3	4		2	28
15			1	9	3	8	3	10	34
16				5	3	19	11	27	65
17				1	2	19	10	48	80
18					1	4	6	42	53
19								2	2
20						1		1	2
21									
22									
23									
Total			5	48	13	55	30	132	283

Male - 2009									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11				1					1
12		1		2					3
13			2	12					14
14				15		1		1	17
15				8	5	6	3	2	24
16				5	4	20	7	38	74
17				2	6	14	5	43	70
18					1		1	15	17
19								1	1
20									
21									
22									
23									
Total		1	2	45	16	41	16	100	221

Female - 2010									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12				1	2				3
13				7	6				13
14				5	22	1		2	30
15			2		19	4	4	9	38
16					5	2	5	13	25
17					1		5	18	24
18								4	4
19									
20									
21									
22									
23									
Total			2	13	55	7	14	46	137

Male - 2010									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12				1	3				4
13			1	3	7				11
14				2	11	1		1	15
15				2	11	6	3	6	28
16					4		4	18	26
17							2	5	7
18								1	1
19									
20									
21									
22									
23									
Total			1	8	36	7	9	31	92

Table 11 (continued):

Female - 2011									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12		15							15
13		21	7		2	2			32
14		23	26	4	4	5		2	64
15		15	21	9	6	14		2	67
16		8	20	8	6	17	2	6	67
17		5	17	7	9	20	3	14	75
18		1	11	6	7	7	1	9	42
19		1	13	5	8	3	1	7	38
20		1	2	2	3	2		9	19
21						1		1	2
22				2	1			1	4
23						1			1
Total		90	117	43	46	72	7	51	426

Male - 2011									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12		8				2			10
13		24	9			1			34
14		9	19	8	1	1	2		40
15		11	21	6	6	5	1	1	51
16		3	17	5	5	8		8	46
17			17	6	3	9	4	9	48
18			8	6	4	1	2	5	26
19		1	3	3	5	5	1	10	28
20				1	1	2	1	5	10
21									
22					1				1
23									
Total		56	94	35	26	34	11	38	294

Female - 2012									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11		3	1						4
12		1	9				1		11
13		1	16	3			1		21
14			9	7	1	2	1	1	21
15			12	14	6	8	2	4	46
16			4	7	9	5	9	6	40
17			1	11	6	2	19	10	49
18				11	9	6	3	9	38
19				3	1	5	5	14	28
20				1	1		4	9	15
21								1	1
22									
23									
Total		5	52	57	33	28	45	54	274

Male - 2012									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11		1							1
12		2	2						4
13		1	7	4	1				13
14			12	9	2	1	1		25
15			12	6	2	3	4	1	28
16			4	7	6	2	15	8	42
17				10	2	6	7	10	35
18				3	5	4	3	5	20
19					1	5	4	11	21
20							1	6	7
21								1	1
22									
23									
Total		4	37	39	19	21	35	42	197

Female - 2013									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12		1		1					2
13			1		1				2
14			7	3	1		2	1	14
15		4	3	3	2	3		1	16
16			2	4	4	4	5	11	30
17				3	2	4	5	19	33
18						1		2	3
19								2	2
20				1		1			2
21									
22				1					1
23									
Total		5	13	16	10	13	12	36	105

Male - 2013									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
10									
11									
12			1						1
13			1	2	2		1		6
14			2	1			1		4
15		1	1	2	2	1	2	6	15
16			1	2	5	4	2	13	27
17			1		3	4	2	16	26
18								3	3
19						1		2	3
20									
21									
22							1		1
23									
Total		1	7	7	12	10	9	40	86

Table 12: Annual length-at-age samples used in age assignments of recreational sheepshead landings 2002-2013.

Female - 2002									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8									
9									
10		4							4
11		1							1
12		4						1	5
13		4	1	1				1	7
14			5			1			6
15			3	3	2	1	1		10
16				3		1	1	1	6
17		1	2				1	2	6
18						1			1
19						1			1
20									
21									
22									
23									
Total		14	11	7	2	5	3	5	47

Male - 2002									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8									
9									
10	1	1							2
11									
12		1							1
13		2	1	1					4
14				1					1
15			2	1		1			4
16			1			1			2
17								1	1
18			2					1	3
19						1		1	2
20									
21									
22									
23									
Total	1	4	6	3		3		3	20

Female - 2003									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8			1						1
9	3	1	1						5
10	1	1	3						5
11			4		1			1	6
12		1	6	1					8
13			2	6				1	9
14			4	3	5				12
15			3	4	4		1		12
16			2	5	1			1	9
17				5		1	1	1	8
18				1					1
19					1				1
20									
21									
22									
23									
Total	4	3	26	25	12	1	2	4	77

Male - 2003									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8		1							1
9									
10			1						1
11		3	1	1					5
12			2						2
13			1	2	1			1	5
14		2	3	1				1	7
15			3	2	1	1	1	1	9
16			2		1		2		5
17				3				1	4
18					1			2	3
19				2					2
20			1				1		2
21									
22									
23									
Total		6	14	11	4	1	4	6	46

Female - 2004									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8									
9	1	1							2
10	2								2
11		1	1						2
12	1	1	1	1	2				6
13	2	1	4	9	1			1	18
14			3	7	2	1			13
15			1	7	5	2	1	2	18
16			2	6	6	1	2	1	18
17				3	2	2		5	12
18					1	2			3
19								1	1
20				1				1	2
21									
22									
23									
Total	6	4	12	34	19	8	3	11	97

Male - 2004									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8									
9									
10									
11	1								1
12		1	1	2					4
13			1	5	1				7
14		3	1	8	1	1			14
15		1	5	10	9			1	26
16			1	4	4	2		6	17
17		3	1	3	2	1		1	11
18				2					2
19								1	1
20									
21									
22									
23									
Total	1	8	10	34	17	4		9	83

Table 12 (continued):

Female - 2005									
FL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*	*Total*
8									
9		2							2
10	2	4	1	1					8
11	1	9	5		1				16
12		4	5		1			2	12
13		5	7		3	2	1	1	19
14		1	8	6	12	1		1	29
15			1	1	15	7	6		30
16				2	15	7	2	5	31
17					7	3	3	4	17
18				1		2		2	5
19						1	2	1	4
20									
21									
22									
23									
Total	3	25	27	11	54	23	14	16	173

Male - 2005									
FL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*	*Total*
8									
9									
10		2							2
11		5	1						6
12		6	11	1	1				19
13		1	9	4	3			1	18
14			9	6	11	6		2	34
15		1	2	1	16	7	2	2	31
16				3	13	2	3	4	25
17			1		2	2		5	10
18						1			1
19									
20					1				1
21									
22									
23									
Total	0	15	33	15	47	18	5	14	147

Female - 2006									
FL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*	*Total*
8	3								3
9		2							2
10	1	4							5
11	1	4	1						6
12		10	1						11
13		5	5	3		1			14
14		1	4	5	1	2	2	1	16
15		1	6	6		9	4	3	29
16			3	5	2	11	5	1	27
17				1	2	2	5	4	14
18					1	2	2		5
19									
20								2	2
21									
22									
23									
Total	5	27	20	20	6	27	18	11	134

Male - 2006									
FL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*	*Total*
8	4								4
9	1								1
10	2	1							3
11		2	1						3
12		4	5						9
13		2	6	1					9
14		5	5	5	1	1	2	1	20
15			3	4		7			14
16			1	2	1	1	2	3	10
17				2		3	1	4	10
18					1		1		2
19					1		1		2
20					1				1
21						1			1
22					1			1	2
23									
Total	7	14	21	14	6	13	7	9	91

Female - 2007									
FL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*	*Total*
7	1								1
8	6	2							8
9	2	3							5
10	2	13	1						16
11		33	1						34
12		23	6					1	30
13		12	8	1	1				22
14		3	15	12	1	2	1		34
15		1	12	16	3		1	1	34
16			4	7	2	3	12	3	31
17			1	6		1	2	15	25
18				1	1	2	3	4	11
19						1	1		2
20								1	1
21								1	1
22								1	1
23						1			1
Total	11	90	48	43	8	10	20	27	257

Male - 2007									
FL_in	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*	*Total*
7	1								1
8	3	2							5
9	3	6							9
10	1	13							14
11		5	1					1	7
12		11	5						16
13		9	6	3					18
14		3	4	3	2				12
15		1	5	6	4	1		4	21
16			2	6	3	1	2	8	22
17			3	2	1	1	5	1	13
18			1		1	1		3	6
19				1		1		3	5
20						1		1	2
21									
22								2	2
23									
Total	8	50	27	21	11	6	7	23	153

Table 12 (continued):

Female - 2008									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
7									
8	2	4	1						7
9	2	1							3
10		6	8	1					15
11	2	8	15					3	28
12		9	24	1		1		2	37
13		4	24	3	1			1	33
14			23	14	2			1	40
15		1	6	11	10	6		4	38
16			3	6	7	6		10	32
17			1	2	7	1		14	25
18				2	2			5	9
19					1			7	8
20					1			2	3
21					1			1	2
22									
23									
Total	6	33	105	40	32	14		50	280

Male - 2008									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
7									
8	1	3							4
9	1	7	2						10
10		9	10		1				20
11	2	4	13	3					22
12	1	4	31	3	1			2	42
13			37	7	2				46
14		3	15	8	3		1		30
15		2	6	14	7	2		3	34
16				3	4	3	1	18	29
17			2		2	3		5	12
18			1	1	3	3		2	10
19				1	2	1		1	5
20								1	1
21									
22					1				1
23									
Total	5	32	117	40	26	12	2	32	266

Female - 2009									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
7									
8	1								1
9	3	3							6
10	3	3		1					7
11	1	6	3	4					14
12		5	8	7	1	1		2	24
13		4	12	21	1			2	40
14			7	17	4	1			29
15			2	21	8	6		1	38
16			1	11	8	7	6	7	40
17			2	4	2	4		17	29
18			2	2	1	2		2	9
19			2			2		4	8
20						1		4	5
21								1	1
22									
23									
Total	8	21	39	88	25	24	6	40	251

Male - 2009									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
7									
8	1	1							2
9	1	2	1						4
10	1	3	5	3					12
11	1	5	5	2					13
12		7	12	13				1	33
13		1	10	28	1				40
14		3	11	30	3	1			48
15		1	5	18	6	3	3	3	39
16		1	1	6	5	2	5	15	35
17			2	1			1	10	14
18			2	1	1	1	1	4	10
19								2	2
20						1			1
21					1			3	4
22								2	2
23									
Total	4	24	54	102	17	8	10	40	259

Female - 2010									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
7		1							1
8									
9	1								1
10	2	7			1				10
11		3	5	1					9
12	1	3	7	5					16
13		2	8	18	4				32
14			6	12	10				28
15		1	3	10	7	2			23
16			1	3	7	1	4	10	26
17				1	3		1	4	9
18					3	1		5	9
19								2	2
20								3	3
21									
22									
23									
Total	4	17	30	50	35	4	5	24	169

Male - 2010									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
7									
8	1								1
9	1								1
10		8		2					10
11		6	4	1					11
12		9	9	6	1				25
13		5	6	14	8				33
14		2	2	10	13			1	28
15			3	3	18	2	2	3	31
16		1	4	1	4	2		10	22
17					3	1		6	10
18			1	1	1		1	4	8
19					1		1		2
20							1	1	2
21							1	3	4
22									
23									
Total	2	31	29	38	49	5	6	28	188

Table 12 (continued):

Female - 2011									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1	2							3
9		3							3
10		1							1
11		1	5						6
12		1	6	6	2				15
13		2	4	4	2	2		1	15
14		1	6	6	6	4		1	24
15			8	4	5	7		2	26
16		1		3	4	17	5	9	39
17			1	1	4	6	2	10	24
18				1	1	4	1	9	16
19						2			2
20				1		1		2	4
21					1				1
22									
23									
Total	1	12	30	26	25	43	8	34	179

Male - 2011									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8									
9	2								2
10		1	4						5
11		3	8						11
12		8	5	1		1			15
13		7	7	6	5	5			30
14		1	9	4	5	3			22
15			4	4	4	8		2	22
16			1	3	5	10	1	11	31
17			1	2		4	1	10	18
18			1		1	1		3	6
19							2	1	3
20					1		1	1	3
21									
22									
23									
Total	2	20	40	20	21	32	5	28	168

Female - 2012									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1	1							2
9		2							2
10		3							3
11	1	4	2	1					8
12		3		6	2	1			12
13		8	1	3	2	1			15
14			4	8	3	2	1		18
15		1	4	6	4	3	4	2	24
16				2	3	7	7	7	26
17				1	2	5	9	8	25
18				1	2		1	3	7
19								2	2
20									
21									
22									
Total	2	22	11	28	18	19	22	22	144

Male - 2012									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8									
9		2							2
10		3		1					4
11		3	4						7
12		6	7	2	1				16
13		1	6	5		2			14
14			11	12	3	3	3		32
15			4	11	8	7	4	3	37
16			2	1	1	12	14	6	36
17						3	1	7	11
18							1	3	4
19									
20									
21									
22									
Total		15	34	32	13	27	23	19	163

Female - 2013									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1	1							2
9									
10	3	1							4
11		2	4						6
12			3	3	1				7
13		3	9	3	1	1			17
14			10	8	5	1	2	2	28
15		2	8	11	11	6	3	2	43
16			4	7	10	8	6	21	56
17			1	3	5	1	5	13	28
18				1	1		3	7	12
19								5	5
20								1	1
21							1		1
22									
Total	4	9	39	36	34	17	20	51	210

Male - 2013									
FL_in	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Total
8	1								1
9	6								6
10		2	3						5
11	2		5	1					8
12		4	5	4					13
13		2	9	3				1	15
14		2	7	10	12	3	2	3	39
15			9	10	14	3	3	3	42
16			1	7	7	12	7	18	52
17				3	5	3	2	12	25
18				1	1	1		6	9
19								1	1
20							1	1	2
21									
22									
Total	9	10	39	39	39	22	15	45	218

Table 13: Annual commercial sheepshead catch-at-age and yield (pounds).

Commercial Catch-at-age									
Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Yield (lbs)
1981	4,774	13,278	9,323	4,981	2,720	1,723	1,284	11,457	129,526
1982	10,930	30,402	21,347	11,404	6,227	3,946	2,940	26,232	296,566
1983	20,015	55,672	39,091	20,883	11,403	7,225	5,383	48,035	543,064
1984	26,396	73,423	51,555	27,541	15,039	9,529	7,099	63,351	716,222
1985	26,516	73,756	51,789	27,666	15,107	9,572	7,132	63,638	719,470
1986	35,457	98,627	69,252	36,995	20,201	12,800	9,536	85,097	962,075
1987	70,640	196,491	137,968	73,704	40,246	25,501	18,999	169,537	1,916,712
1988	68,089	189,394	132,985	71,042	38,792	24,580	18,313	163,413	1,847,483
1989	90,241	251,012	176,251	94,155	51,413	32,577	24,271	216,579	2,448,554
1990	101,913	283,479	199,047	106,334	58,063	36,791	27,410	244,592	2,765,256
1991	89,320	248,451	174,452	93,195	50,889	32,245	24,023	214,369	2,423,569
1992	112,848	313,895	220,405	117,743	64,293	40,738	30,351	270,836	3,061,960
1993	138,624	385,594	270,749	144,637	78,979	50,044	37,284	332,699	3,761,361
1994	121,153	336,995	236,625	126,408	69,025	43,737	32,585	290,767	3,287,298
1995	120,308	334,645	234,974	125,526	68,543	43,431	32,357	288,739	3,264,369
1996	116,898	314,260	170,830	80,972	45,247	30,674	24,301	240,643	2,639,002
1997	32,107	195,147	249,344	151,258	85,642	54,465	39,756	299,730	3,114,532
1998	24,119	217,956	230,227	130,117	72,486	43,670	29,633	175,252	2,371,614
1999	8,765	202,697	426,702	252,087	112,157	56,158	33,617	163,668	3,192,626
2000	6,907	69,376	116,806	102,407	70,565	50,075	39,212	338,487	2,591,871
2001	3,585	44,538	84,272	76,458	52,798	36,740	28,164	230,193	1,797,963
2002	1,873	9,599	32,085	40,331	34,553	27,903	23,934	250,336	1,583,357
2003	3	13,926	39,901	103,666	65,200	36,606	56,739	118,716	1,637,948
2004	4	9,481	15,355	67,943	147,474	64,865	19,139	110,578	1,519,027
2005	1,505	25,603	41,072	27,885	85,242	44,699	14,953	56,057	1,022,232
2006	1	4,510	10,795	3,293	8,527	43,174	19,473	47,201	566,597
2007	657	3,652	12,780	27,722	26,091	13,447	50,628	109,518	1,024,224
2008	7	8,230	27,893	19,932	45,456	28,891	11,303	154,510	1,163,763
2009	402	3,020	4,547	59,104	17,360	58,599	29,184	139,348	1,213,414
2010	24	14,111	5,090	30,915	119,248	16,691	22,566	86,354	923,824
2011	0	46,461	66,462	23,825	21,730	32,512	5,409	28,232	881,635
2012	904	3,937	31,583	37,041	20,849	18,816	30,601	36,302	738,358
2013	9	19,928	37,037	39,077	36,357	35,323	33,699	143,107	1,325,636

Table 14: Annual mean weights at age (pounds) of commercial sheepshead landings.

Commercial Mean Weight-at-age								
Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+
1981-1995	1.17	1.77	2.33	2.71	2.98	3.21	3.42	4.45
1996	1.20	1.74	2.28	2.69	3.03	3.30	3.53	4.58
1997	1.16	1.89	2.39	2.74	3.00	3.20	3.36	4.10
1998	1.24	1.88	2.35	2.73	2.98	3.12	3.21	3.63
1999	1.36	1.97	2.44	2.65	2.78	2.88	2.95	3.29
2000	1.36	1.87	2.50	2.86	3.12	3.32	3.50	4.30
2001	1.36	1.89	2.51	2.87	3.11	3.30	3.46	4.21
2002	1.36	1.96	2.59	2.99	3.25	3.47	3.66	4.59
2003	1.72	2.06	2.95	3.16	3.46	3.58	3.70	5.35
2004	1.72	1.72	2.23	2.71	3.53	3.73	4.02	4.92
2005	1.36	1.88	2.82	3.03	3.40	3.85	3.91	4.61
2006	1.72	2.20	2.48	2.86	3.58	4.02	3.95	5.37
2007	1.15	2.02	2.56	3.44	3.87	4.39	4.23	5.00
2008	1.72	1.97	2.73	3.26	3.63	4.02	4.36	4.78
2009	1.36	1.68	2.25	2.75	3.67	3.93	4.14	4.64
2010	1.72	1.72	2.50	2.38	2.80	3.19	3.77	4.33
2011	0.00	2.68	3.74	4.17	4.50	4.09	4.50	6.02
2012	1.36	1.72	2.74	3.85	4.24	4.43	4.46	5.65
2013	1.72	2.56	2.89	3.32	3.56	3.88	3.81	4.67

Table 15: Annual recreational sheepshead catch-at-age and yield (pounds).

	Recreational Catch-at-age								
Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	Yield (lbs)
1981	61,750	30,624	16,671	18,403	12,277	7,352	4,729	24,055	361,959
1982	76,398	87,036	29,734	9,007	4,130	2,637	2,086	23,024	439,162
1983	254,050	172,671	56,359	30,879	16,404	10,698	9,176	155,541	1,637,386
1984	53,784	76,783	34,622	18,775	10,661	6,955	5,479	59,459	653,063
1985	108,141	77,209	40,917	19,854	9,294	5,209	3,612	30,782	557,507
1986	116,311	128,787	105,969	66,552	38,091	25,589	19,304	139,536	1,557,346
1987	25,169	37,666	22,817	15,071	9,770	6,409	4,616	32,139	371,817
1988	66,447	53,392	44,564	27,761	14,993	9,167	6,571	55,943	669,661
1989	41,249	77,049	37,806	24,752	15,106	10,671	8,888	100,601	886,443
1990	33,108	20,672	15,350	13,731	10,470	8,015	6,606	65,421	507,024
1991	70,787	45,536	26,291	14,234	9,419	6,653	5,097	41,090	482,788
1992	105,421	51,044	42,898	23,940	15,187	10,967	9,061	105,547	957,060
1993	94,911	83,270	53,297	32,538	22,231	16,603	13,801	149,000	1,280,179
1994	75,122	81,180	38,509	17,092	8,971	5,519	3,956	36,037	577,075
1995	196,427	162,055	96,771	40,670	19,476	11,507	8,217	80,674	1,295,404
1996	86,009	148,985	119,210	56,408	27,831	16,491	11,849	98,587	1,352,205
1997	87,685	144,747	106,204	59,620	35,701	25,103	19,777	166,937	1,689,433
1998	29,727	74,686	72,132	49,704	31,893	22,701	18,251	177,235	1,459,320
1999	31,020	60,658	49,735	32,647	20,447	13,839	10,606	98,293	916,749
2000	40,535	47,456	31,765	24,681	19,095	16,293	15,076	193,661	1,345,299
2001	34,695	65,124	40,136	20,627	13,791	11,040	9,707	125,027	1,021,548
2002	82,476	142,833	139,234	67,193	17,371	40,336	20,800	88,153	1,049,597
2003	15,913	22,376	273,421	202,949	102,661	2,550	13,478	165,013	2,140,652
2004	149,583	67,399	161,115	413,146	229,147	62,756	27,236	156,701	2,565,104
2005	61,899	81,424	89,820	26,363	164,784	63,988	41,466	72,566	1,441,124
2006	23,286	77,245	47,375	43,212	8,220	49,107	28,366	30,429	651,048
2007	13,294	54,088	47,940	50,915	10,580	12,810	31,350	48,726	636,523
2008	13,000	60,292	261,963	109,107	71,614	40,272	1,209	144,603	1,463,517
2009	24,054	77,287	112,222	260,283	68,070	50,964	14,962	91,402	1,452,806
2010	33,887	36,234	48,521	73,066	57,025	7,449	13,309	147,476	1,241,328
2011	66,720	21,344	92,005	96,421	106,032	215,766	51,933	214,088	2,487,680
2012	34,121	43,799	34,691	77,999	41,591	44,736	44,985	69,150	1,391,054
2013	9,094	37,499	110,314	52,672	43,995	23,596	20,927	47,921	1,566,084

Table 16: Annual mean weights at age (pounds) of recreational sheepshead landings.

Recreational Mean Weight-at-age								
Year	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+
1981	1.11	1.53	2.57	2.91	3.03	3.08	3.11	3.13
1982	0.97	1.71	2.16	2.54	2.93	3.26	3.55	4.37
1983	1.06	1.61	2.33	2.70	2.97	3.30	3.76	4.86
1984	1.19	1.67	2.31	2.73	3.01	3.26	3.55	4.29
1985	0.92	1.71	2.32	2.64	2.86	3.06	3.29	4.04
1986	0.98	1.73	2.42	2.73	3.03	3.26	3.41	3.71
1987	1.08	1.73	2.35	2.82	3.07	3.22	3.34	3.65
1988	0.95	1.75	2.41	2.72	2.96	3.16	3.34	4.21
1989	1.25	1.65	2.39	2.77	3.07	3.35	3.64	4.32
1990	1.05	1.72	2.46	2.91	3.19	3.41	3.59	4.20
1991	1.01	1.78	2.28	2.79	3.12	3.31	3.45	3.94
1992	0.95	1.81	2.32	2.77	3.10	3.37	3.62	4.57
1993	1.03	1.74	2.33	2.81	3.15	3.40	3.62	4.34
1994	1.12	1.68	2.26	2.67	2.96	3.17	3.34	4.61
1995	1.05	1.72	2.27	2.62	2.90	3.13	3.35	4.49
1996	1.04	1.82	2.31	2.65	2.91	3.14	3.35	4.00
1997	1.05	1.77	2.35	2.73	3.07	3.32	3.50	3.99
1998	1.22	1.77	2.41	2.80	3.10	3.34	3.55	4.17
1999	1.14	1.78	2.38	2.79	3.07	3.28	3.46	4.27
2000	1.11	1.71	2.42	2.87	3.25	3.55	3.80	4.62
2001	1.08	1.75	2.29	2.75	3.18	3.48	3.71	4.82
2002	0.68	0.95	1.70	2.20	2.15	2.07	2.53	3.08
2003	0.44	0.80	1.29	2.00	1.87	3.95	2.78	4.82
2004	0.82	0.92	1.64	1.89	1.94	2.38	2.62	4.06
2005	0.44	0.96	1.28	1.90	2.35	2.48	2.55	5.02
2006	0.42	0.97	1.69	1.97	2.49	2.27	2.41	4.98
2007	0.32	0.95	1.86	2.42	2.62	3.08	3.00	4.03
2008	0.53	1.02	1.43	2.07	2.48	2.49	4.52	3.50
2009	0.56	0.87	1.42	1.80	2.28	2.46	2.83	4.10
2010	0.44	0.73	1.36	1.73	2.03	2.84	3.04	4.78
2011	0.50	1.65	1.60	1.97	2.41	2.73	2.93	4.21
2012	0.50	1.05	1.56	1.61	1.92	2.31	2.62	5.91
2013	0.51	1.01	1.22	2.97	3.42	2.29	6.45	6.10

Table 17: Probabilities of age given length for age assignments of sheepshead catches from the LDWF fishery-independent marine trammel net survey.

	Female									Male								
FL_in	Age_0	Age_1	Age_2	Age_3	Age_4	Age_5	Age_6	Age_7	Age_8+	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	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	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	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	0.86	0.14	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	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.25	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.01	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.99	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.65	0.01	0.00	0.00	0.00	0.00	0.00
12	0.00	0.66	0.33	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.11	0.01	0.00	0.00	0.00	0.00
13	0.00	0.01	0.81	0.16	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.58	0.15	0.03	0.01	0.00	0.01
14	0.00	0.00	0.24	0.50	0.17	0.05	0.02	0.01	0.02	0.00	0.00	0.00	0.21	0.28	0.15	0.08	0.05	0.23
15	0.00	0.00	0.01	0.18	0.26	0.16	0.09	0.06	0.24	0.00	0.00	0.00	0.01	0.06	0.10	0.09	0.08	0.66
16	0.00	0.00	0.00	0.01	0.06	0.10	0.10	0.08	0.65	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.06	0.87
17	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.06	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.95
18	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.99
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	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	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	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Table 18: Annual sheepshead catch-at-size from the LDWF fishery-independent marine trammel net survey.

FL_in	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
5				2		1	3	10	4	3	2	2		1	3	3			2		1				1	1			1
6	6		4	4	5	26	19	51	14	11	8	8		9	8	14	1	10	2	10	6	3		1	3	2		2	2
7	1	5	10	11	1	18	9	19	56	3	13	10	27	6	8	8	26	2	3	7	2	10		1	4	2	2		1
8	3	20	52	17	5	1	1	7	96	273	42	20	59	6	14	7	32	8	13	6	7	12	11	10	6	7	6		7
9	9	46	17	30	3	4	4	11	54	27	24	15	29	12	28	14	11	14	8	14	9	8	6	16	6	8	7	1	28
10	4	40	9	19	4	8	11	16	15	22	15	20	11	7	25	18	10	17	8	5	14	3	10	9	3	7	3	5	20
11	7	26	11	41	5	8	9	6	11	36	20	26	30	22	25	19	25	22	3	10	14	4	14	30	5	13	7	4	10
12	6	53	16	48	13	8	5	9	15	22	24	58	24	42	41	24	76	29	14	10	23	5	8	31	12	17	6	6	17
13	12	60	10	26	32	12	12	13	11	34	37	73	34	29	65	46	87	22	26	12	27	15	11	42	27	23	6	13	41
14	17	37	11	15	52	17	15	10	6	20	24	127	26	66	65	53	95	32	22	34	32	32	13	42	39	38	20	16	67
15	10	10	16	12	43	16	23	15	4	17	40	123	31	54	58	64	88	72	41	76	43	63	37	41	81	45	20	21	51
16	4	11	14	11	15	10	5	15	8	25	15	94	26	27	37	71	81	91	71	70	35	57	54	44	78	37	19	13	49
17	4	4	1	4	10	13	11	19	8	26	11	24	15	11	20	25	50	62	51	49	29	62	33	26	39	27	13	15	43
18			1	1	3	18	7	6	3	17	10	18	7	6	7	7	14	13	17	16	11	11	4	9	6	15	6	7	25
19					1	11	1	3	6	5	3	9	2	1	2	4	2	4	1	2	3	2		1	1	1	1	3	6
20					1	1		2					1	1				1				2			1		1		
21						1																							
Totals	83	310	172	242	192	173	135	212	311	542	288	627	322	300	407	377	599	399	282	322	256	288	201	305	312	243	117	106	368

Table 19: Annual sheepshead survey age composition and sample sizes derived from the LDWF fishery-independent marine trammel net survey.

Year	*Age_1*	*Age_2*	*Age_3*	*Age_4*	*Age_5*	*Age_6*	*Age_7*	*Age_8+*	*n*
1985	*0.222*	*0.217*	*0.177*	*0.096*	*0.051*	*0.032*	*0.023*	*0.182*	*68*
1986	*0.368*	*0.298*	*0.150*	*0.057*	*0.025*	*0.015*	*0.010*	*0.077*	*259*
1987	*0.332*	*0.200*	*0.105*	*0.066*	*0.044*	*0.031*	*0.024*	*0.198*	*100*
1988	*0.407*	*0.301*	*0.098*	*0.041*	*0.023*	*0.015*	*0.012*	*0.102*	*192*
1989	*0.075*	*0.190*	*0.202*	*0.122*	*0.069*	*0.044*	*0.032*	*0.265*	*179*
1990	*0.140*	*0.132*	*0.104*	*0.064*	*0.040*	*0.030*	*0.027*	*0.464*	*124*
1991	*0.197*	*0.143*	*0.130*	*0.086*	*0.053*	*0.037*	*0.030*	*0.324*	*100*
1992	*0.231*	*0.134*	*0.090*	*0.055*	*0.039*	*0.032*	*0.029*	*0.389*	*118*
1993	*0.502*	*0.163*	*0.063*	*0.027*	*0.017*	*0.014*	*0.013*	*0.202*	*120*
1994	*0.331*	*0.181*	*0.089*	*0.044*	*0.028*	*0.022*	*0.021*	*0.285*	*255*
1995	*0.243*	*0.213*	*0.134*	*0.071*	*0.043*	*0.030*	*0.024*	*0.241*	*211*
1996	*0.120*	*0.155*	*0.155*	*0.107*	*0.068*	*0.047*	*0.036*	*0.312*	*578*
1997	*0.239*	*0.215*	*0.124*	*0.066*	*0.041*	*0.030*	*0.025*	*0.259*	*224*
1998	*0.141*	*0.213*	*0.165*	*0.110*	*0.065*	*0.041*	*0.029*	*0.236*	*270*
1999	*0.167*	*0.227*	*0.165*	*0.089*	*0.051*	*0.034*	*0.026*	*0.239*	*355*
2000	*0.127*	*0.150*	*0.145*	*0.088*	*0.059*	*0.045*	*0.037*	*0.349*	*332*
2001	*0.107*	*0.215*	*0.144*	*0.091*	*0.058*	*0.041*	*0.033*	*0.310*	*534*
2002	*0.120*	*0.115*	*0.080*	*0.070*	*0.057*	*0.048*	*0.043*	*0.468*	*370*
2003	*0.062*	*0.092*	*0.094*	*0.070*	*0.056*	*0.049*	*0.045*	*0.531*	*257*
2004	*0.078*	*0.075*	*0.088*	*0.080*	*0.066*	*0.055*	*0.048*	*0.509*	*293*
2005	*0.143*	*0.170*	*0.117*	*0.082*	*0.055*	*0.041*	*0.034*	*0.359*	*235*
2006	*0.050*	*0.060*	*0.095*	*0.089*	*0.068*	*0.054*	*0.048*	*0.537*	*260*
2007	*0.126*	*0.087*	*0.067*	*0.067*	*0.061*	*0.053*	*0.048*	*0.491*	*186*
2008	*0.180*	*0.197*	*0.133*	*0.072*	*0.045*	*0.034*	*0.029*	*0.311*	*286*
2009	*0.044*	*0.111*	*0.103*	*0.083*	*0.066*	*0.054*	*0.047*	*0.491*	*294*
2010	*0.115*	*0.132*	*0.142*	*0.087*	*0.057*	*0.044*	*0.037*	*0.386*	*225*
2011	*0.133*	*0.110*	*0.111*	*0.089*	*0.062*	*0.046*	*0.039*	*0.409*	*107*
2012	*0.105*	*0.128*	*0.138*	*0.088*	*0.056*	*0.041*	*0.035*	*0.410*	*104*
2013	*0.125*	*0.117*	*0.134*	*0.084*	*0.053*	*0.040*	*0.035*	*0.411*	*340*

Table 20: Summary of objective function components and likelihood values of the ASAP base model.

Objective function = 2,277			
Component	*Lambda*	*ESS*	*Obj_fun*
Catch_Fleet_Total	*2*		*877.84*
Index_Fit_Total	*1*		*-1.19*
Catch_Age_Comps		*4732*	*661.09*
Index_Age_Comps		*916*	*212.55*
Recruit_devs	*1*		*526.75*

Table 21: 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
1981	4,688,720	2,475,580	1,426,790	1,021,070	756,284	633,704	573,127	4,572,050	16,147,325
1982	4,842,930	3,473,410	1,895,810	1,110,610	803,842	600,465	506,282	4,149,910	17,383,259
1983	5,403,520	3,582,760	2,643,040	1,467,990	869,752	634,853	477,283	3,739,210	18,818,408
1984	5,165,030	3,940,660	2,641,020	1,962,170	1,098,910	657,520	484,426	3,270,860	19,220,596
1985	5,717,320	3,800,630	2,950,510	2,009,590	1,510,190	853,542	514,534	2,974,260	20,330,576
1986	5,601,870	4,213,560	2,853,680	2,253,540	1,552,910	1,177,690	670,364	2,771,430	21,095,044
1987	5,475,980	4,081,210	3,082,470	2,106,410	1,678,950	1,168,920	894,890	2,656,760	21,145,590
1988	5,537,890	4,009,390	2,974,400	2,292,840	1,588,340	1,279,300	898,081	2,762,990	21,343,231
1989	4,416,580	4,047,390	2,914,720	2,201,380	1,719,060	1,203,470	977,703	2,835,810	20,316,113
1990	5,181,740	3,206,090	2,879,210	2,108,870	1,613,710	1,274,690	901,272	2,900,740	20,066,322
1991	5,776,850	3,765,510	2,272,130	2,082,490	1,547,610	1,198,120	955,606	2,893,820	20,492,136
1992	6,758,010	4,208,610	2,694,050	1,658,540	1,541,680	1,158,540	905,245	2,950,350	21,875,025
1993	8,635,820	4,882,490	2,937,150	1,912,600	1,193,530	1,123,040	853,178	2,889,640	24,427,448
1994	9,140,380	6,198,120	3,338,830	2,039,500	1,345,810	850,960	810,487	2,755,780	26,479,867
1995	9,082,970	6,639,480	4,389,080	2,412,270	1,494,900	998,048	637,195	2,711,890	28,365,833
1996	8,258,190	6,573,840	4,683,310	3,143,440	1,749,510	1,097,070	740,166	2,527,680	28,773,206
1997	7,865,220	6,003,460	4,718,330	3,411,860	2,317,230	1,304,010	825,665	2,498,300	28,944,075
1998	5,120,050	5,771,310	4,492,430	3,481,830	2,455,170	1,653,670	936,104	2,430,930	26,341,494
1999	6,951,910	3,766,050	4,348,020	3,362,590	2,562,990	1,799,100	1,218,910	2,521,400	26,530,970
2000	10,404,900	5,128,800	2,847,840	3,255,150	2,456,610	1,855,240	1,308,130	2,762,290	30,018,960
2001	11,493,800	7,663,430	3,872,380	2,137,550	2,404,530	1,806,520	1,372,060	3,056,080	33,806,350
2002	3,103,420	8,491,730	5,831,940	2,952,710	1,617,370	1,817,750	1,373,220	3,408,850	28,596,990
2003	3,848,600	2,287,420	6,436,830	4,429,830	2,231,960	1,224,120	1,384,480	3,691,100	25,534,340
2004	5,293,490	2,815,950	1,708,200	4,788,650	3,277,080	1,655,630	915,202	3,857,920	24,312,122
2005	4,076,190	3,847,480	2,076,440	1,248,420	3,474,330	2,385,260	1,216,160	3,576,960	21,901,240
2006	8,205,650	2,994,630	2,896,030	1,567,180	941,148	2,630,400	1,819,200	3,708,460	24,762,698
2007	4,177,480	6,076,160	2,290,760	2,241,740	1,219,820	736,629	2,071,020	4,395,480	23,209,089
2008	3,434,090	3,092,560	4,644,520	1,766,480	1,730,950	945,081	574,005	5,093,350	21,281,036
2009	4,817,580	2,518,000	2,318,040	3,481,460	1,319,910	1,297,470	713,824	4,353,730	20,820,014
2010	4,286,990	3,529,380	1,884,400	1,731,300	2,587,170	983,370	974,015	3,870,290	19,846,915
2011	4,596,020	3,147,940	2,653,300	1,417,830	1,298,470	1,946,520	745,299	3,728,190	19,533,569
2012	3,645,740	3,328,440	2,302,450	1,925,080	1,024,820	943,873	1,429,740	3,356,450	17,956,593
2013	2,778,030	2,672,600	2,495,980	1,729,740	1,446,270	773,813	718,341	3,696,130	16,310,904

Table 22: 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	Fmult_total	Avg. F
1981	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01
1982	0.01	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.03	0.02
1983	0.02	0.05	0.07	0.07	0.07	0.06	0.06	0.05	0.07	0.05
1984	0.01	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.03
1985	0.01	0.03	0.04	0.04	0.04	0.03	0.03	0.03	0.04	0.03
1986	0.02	0.06	0.07	0.07	0.07	0.07	0.06	0.06	0.08	0.05
1987	0.02	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.07	0.05
1988	0.02	0.07	0.07	0.07	0.07	0.06	0.06	0.05	0.07	0.05
1989	0.03	0.09	0.09	0.09	0.09	0.08	0.08	0.07	0.10	0.07
1990	0.03	0.09	0.09	0.09	0.09	0.08	0.08	0.07	0.10	0.07
1991	0.02	0.08	0.08	0.08	0.08	0.07	0.07	0.06	0.09	0.06
1992	0.03	0.11	0.11	0.11	0.10	0.10	0.09	0.09	0.12	0.08
1993	0.04	0.13	0.13	0.13	0.13	0.12	0.11	0.10	0.14	0.09
1994	0.03	0.09	0.09	0.09	0.09	0.08	0.08	0.07	0.10	0.07
1995	0.03	0.10	0.10	0.10	0.10	0.09	0.09	0.08	0.11	0.07
1996	0.02	0.08	0.08	0.09	0.08	0.08	0.07	0.07	0.09	0.06
1997	0.02	0.04	0.07	0.11	0.13	0.12	0.12	0.11	0.13	0.06
1998	0.01	0.03	0.06	0.09	0.10	0.10	0.09	0.09	0.10	0.06
1999	0.01	0.03	0.06	0.09	0.11	0.11	0.11	0.10	0.11	0.06
2000	0.01	0.03	0.05	0.08	0.10	0.09	0.09	0.08	0.10	0.05
2001	0.01	0.02	0.04	0.06	0.07	0.07	0.06	0.06	0.07	0.03
2002	0.01	0.02	0.04	0.06	0.07	0.07	0.06	0.06	0.07	0.04
2003	0.02	0.04	0.06	0.08	0.09	0.08	0.08	0.07	0.09	0.06
2004	0.03	0.05	0.08	0.10	0.11	0.10	0.09	0.09	0.11	0.08
2005	0.01	0.03	0.05	0.06	0.07	0.06	0.06	0.06	0.07	0.05
2006	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02
2007	0.01	0.02	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.03
2008	0.02	0.04	0.06	0.07	0.08	0.07	0.07	0.06	0.08	0.05
2009	0.02	0.04	0.06	0.08	0.08	0.08	0.07	0.07	0.08	0.06
2010	0.02	0.03	0.05	0.07	0.07	0.07	0.07	0.06	0.07	0.05
2011	0.03	0.06	0.09	0.11	0.11	0.10	0.09	0.09	0.11	0.07
2012	0.02	0.04	0.05	0.07	0.07	0.07	0.06	0.06	0.07	0.05
2013	0.02	0.04	0.06	0.08	0.09	0.09	0.08	0.08	0.09	0.06

Table 23: Limit reference point estimates for the Louisiana sheepshead stock. Spawning stock biomass and yield units are pounds x 10^6. Fishing mortality units are yr^{-1}.

Reference Points		
Parameter	Derivation	Value/Estimate
SPR_{limit}	RS 56:325.4	30%
$F_{30\%}$	Equation 28 And SPR_{limit}	0.24
$SSB_{30\%}$	Equation 28 And SPR_{limit}	10.21
$Yield_{30\%}$	Equation 28 And SPR_{limit}	4.41

Table 24: Sensitivity analysis table: current estimates are taken as the geometric mean of the last three years of the assessment (2011-2013). Spawning stock biomass units are pounds x 10^6. Fishing mortality units are yr^{-1}.

Model run	negLL	$Yield_{30\%}$	$F_{30\%}$	$SSB_{30\%}$	$F_{current}/F_{30\%}$	$SSB_{current}/SSB_{30\%}$
Base Model (h=0.8)	2,277	4.41	0.24	10.21	0.24	3.58
1 (h=1.0)	2,277	5.05	0.24	11.68	0.24	3.13
2 (h=0.9)	2,283	4.87	0.25	11.31	0.24	3.36
3 (h=0.7)	2,277	3.88	0.24	8.98	0.24	4.07
4 (Yield lambda (X5))	5,786	4.57	0.24	10.58	0.23	2.47
5 (Survey lambda (X5))	2,259	4.34	0.24	10.06	0.23	2.54

11. Figures

Figure 1: Reported commercial sheepshead landings (pounds x 10^6) for the Gulf of Mexico derived from NOAA-Fisheries statistical records and the LDWF trip ticket program.

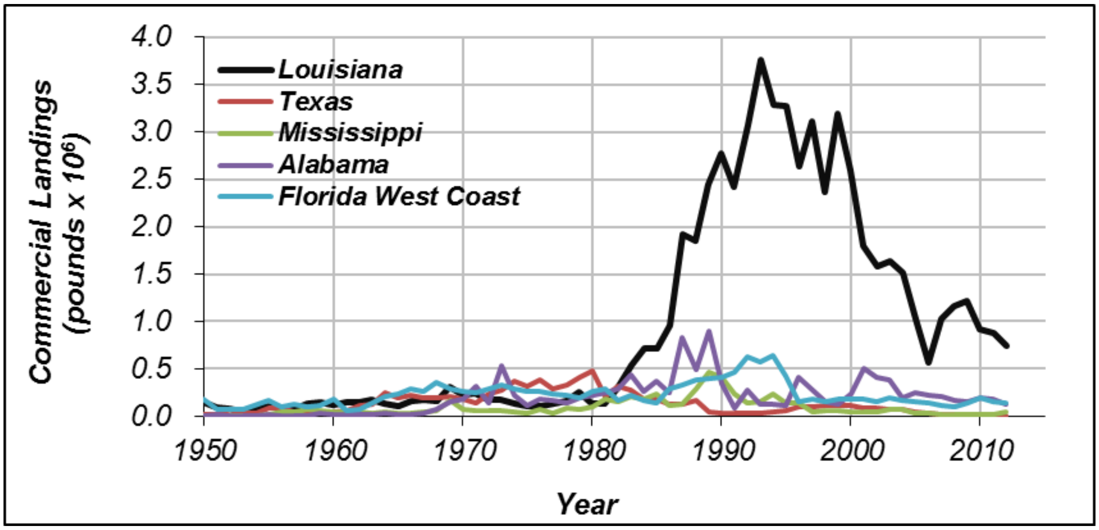

Figure 2: Estimated recreational sheepshead landings (pounds x 10^6) of the Gulf of Mexico derived from MRFSS/MRIP.

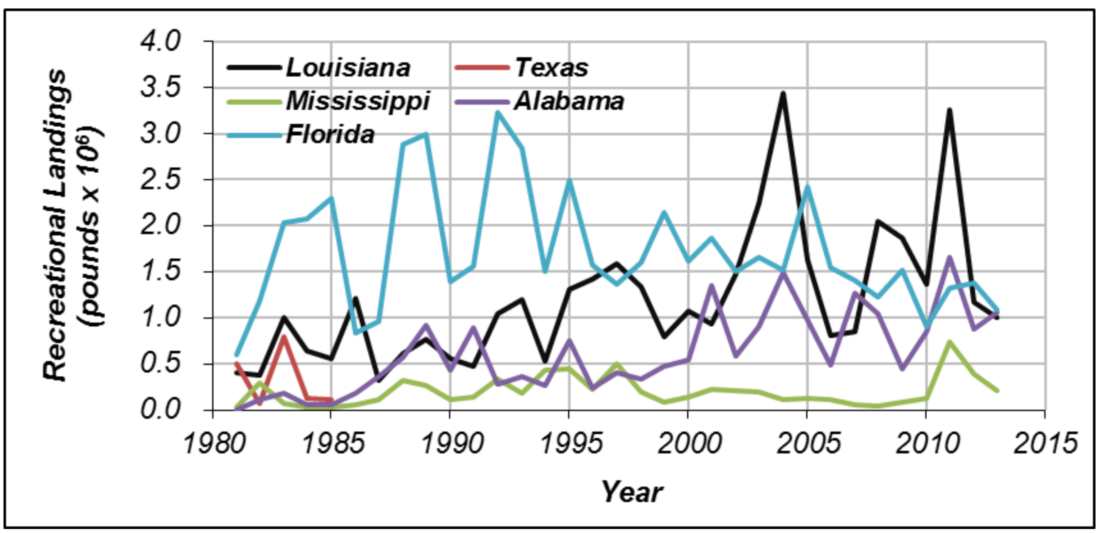

Figure 3: Standardized index of abundance, nominal catch rates, and 95% confidence intervals of the standardized index for sheepshead derived from the LDWF marine trammel net survey. Each time-series has been normalized to its individual long-term mean for comparison.

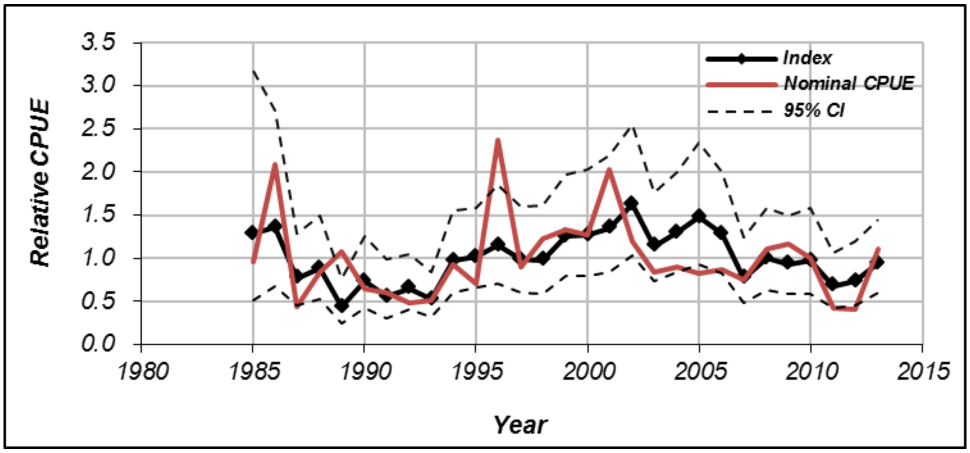

Figure 4: Observed and ASAP base model estimated commercial yield (top) and standardized residuals (bottom).

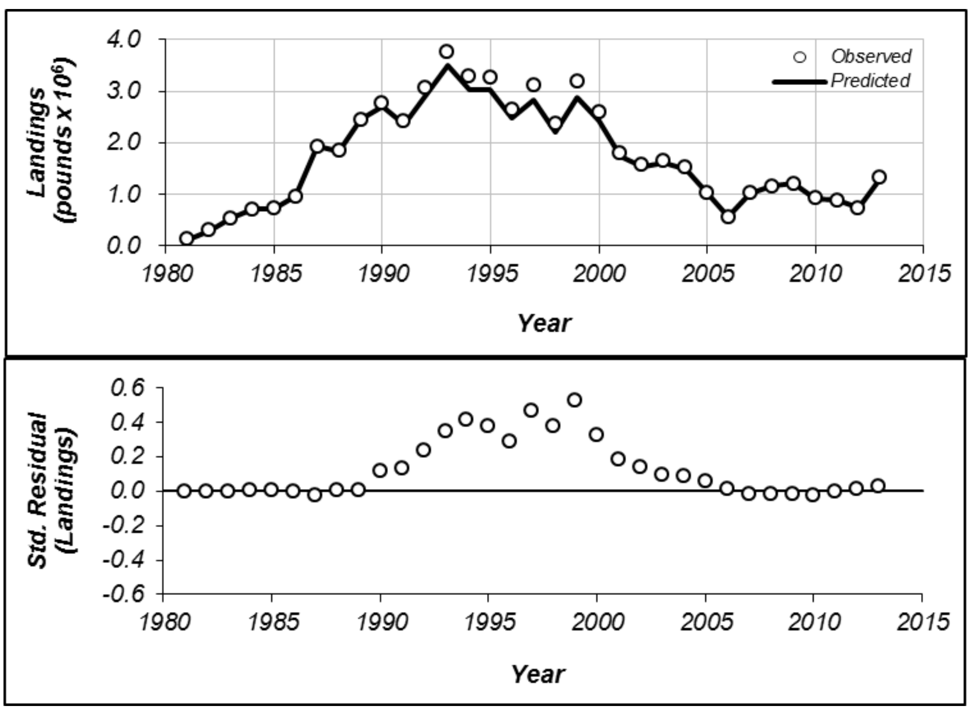

Figure 5: Observed and ASAP base model estimated recreational yield (top) and standardized residuals (bottom).

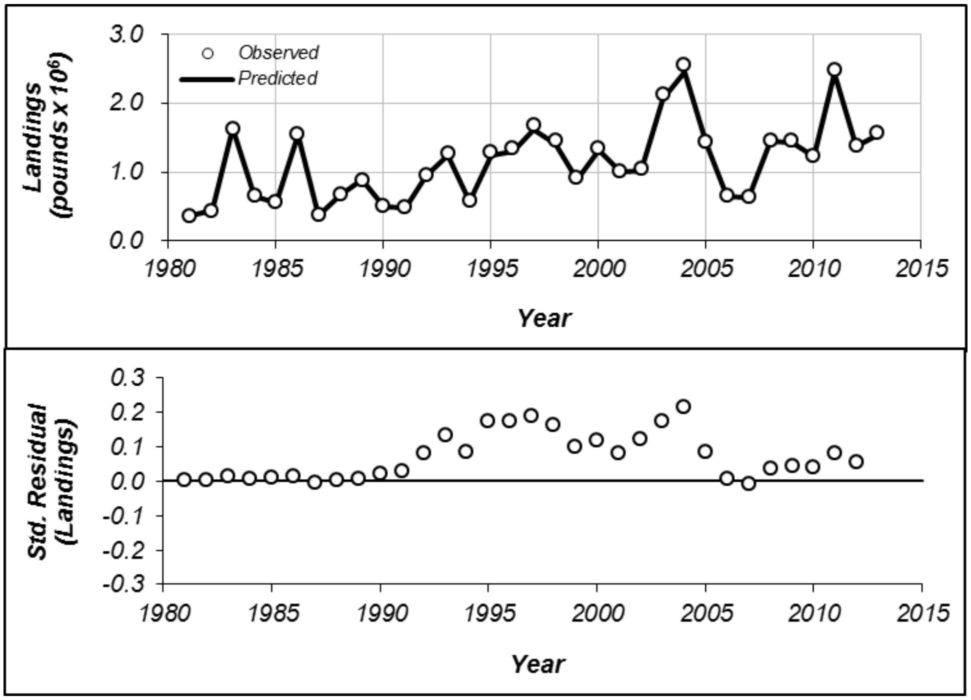

Figure 6: Observed and ASAP base model estimated survey CPUE (top) and standardized residuals (bottom).

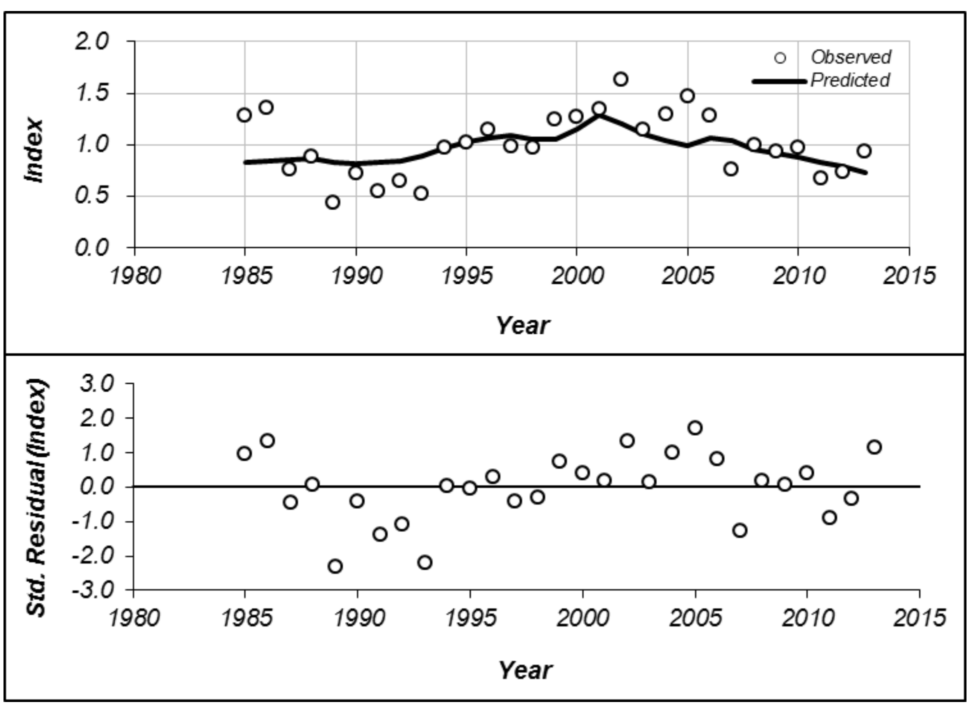

Figure 7: Annual observed (open circles) and ASAP estimated (bold lines) commercial sheepshead harvest age compositions.

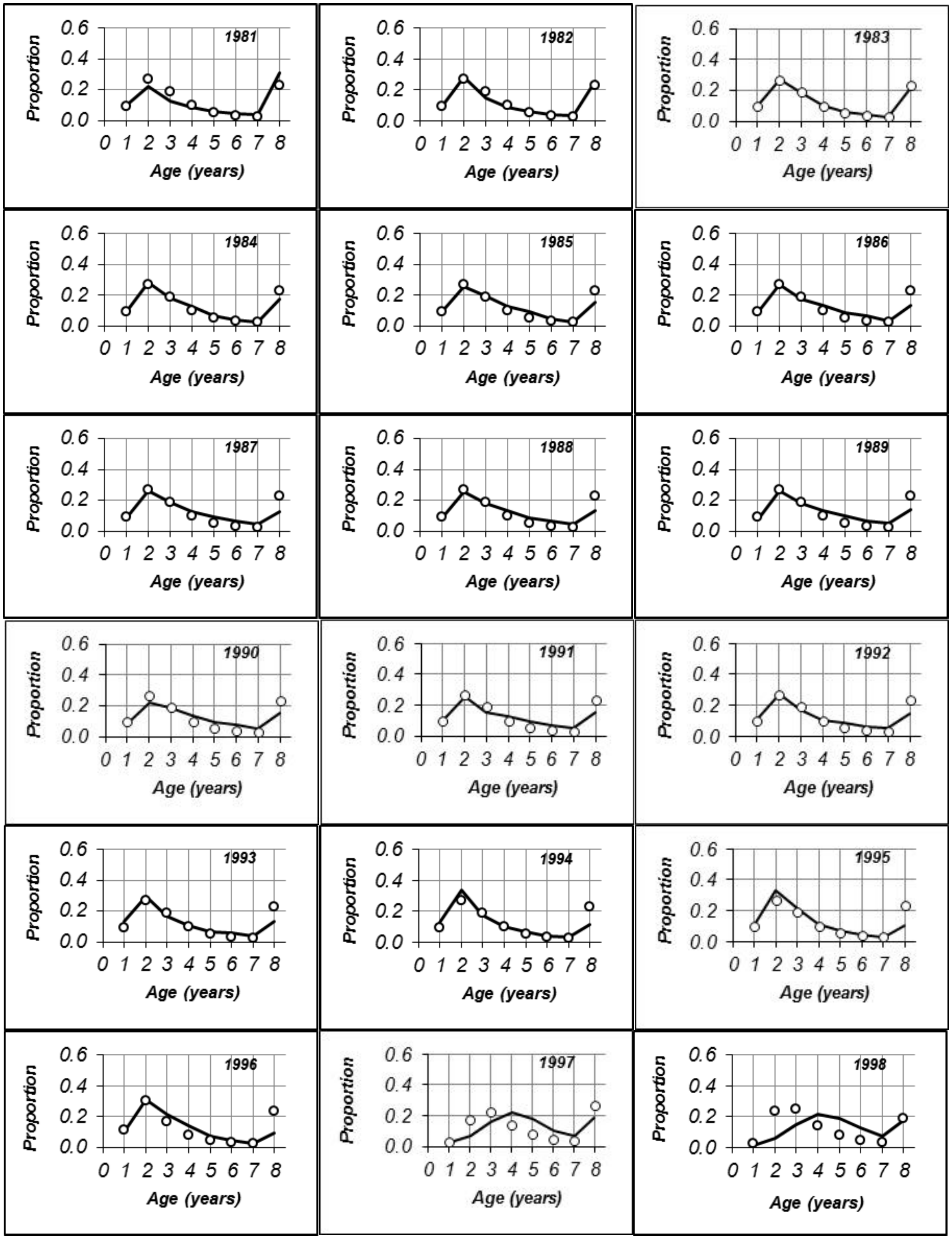

Figure 7 (continued):

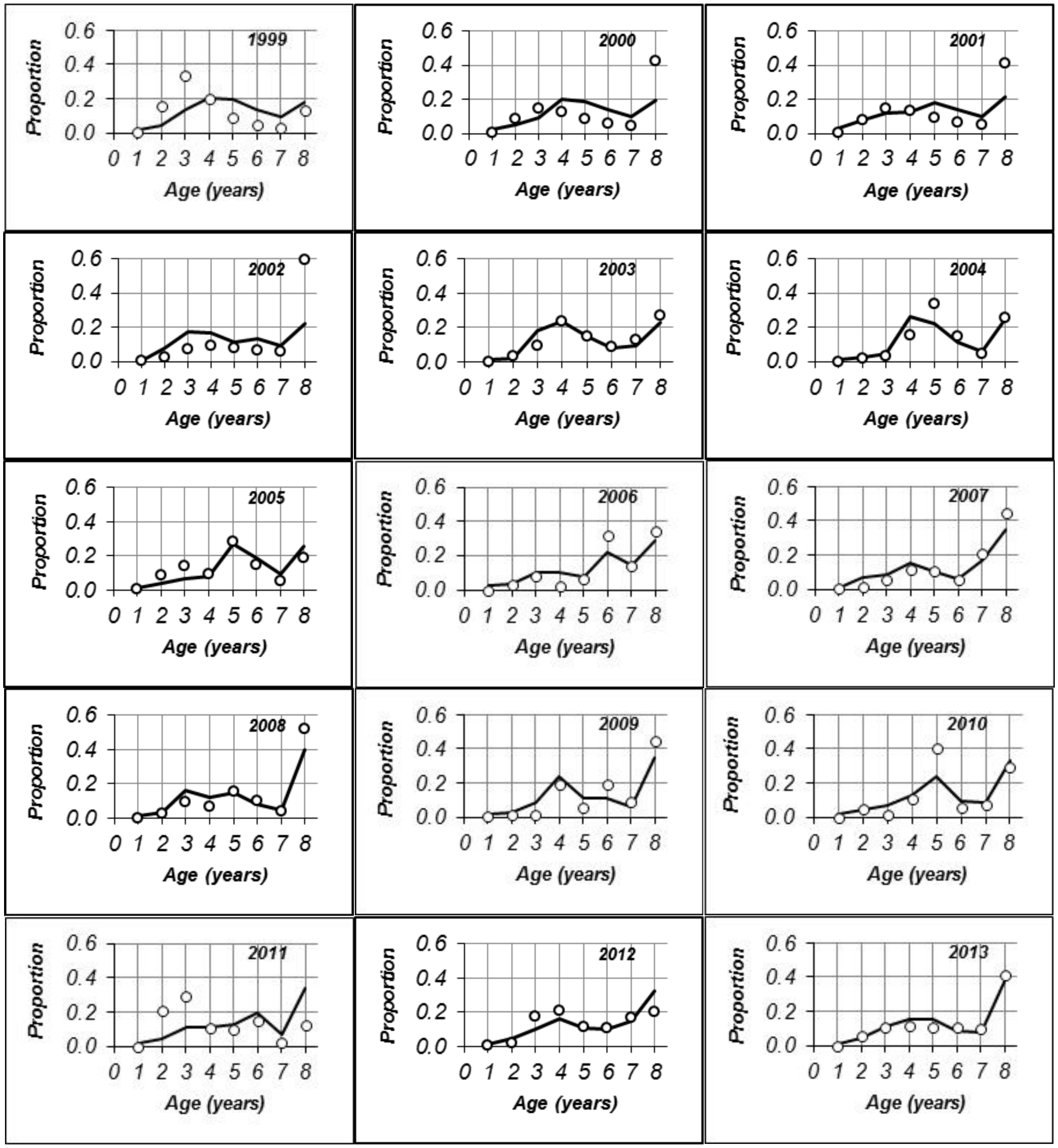

Figure 8: Annual observed (open circles) and ASAP estimated (bold lines) recreational sheepshead harvest age compositions.

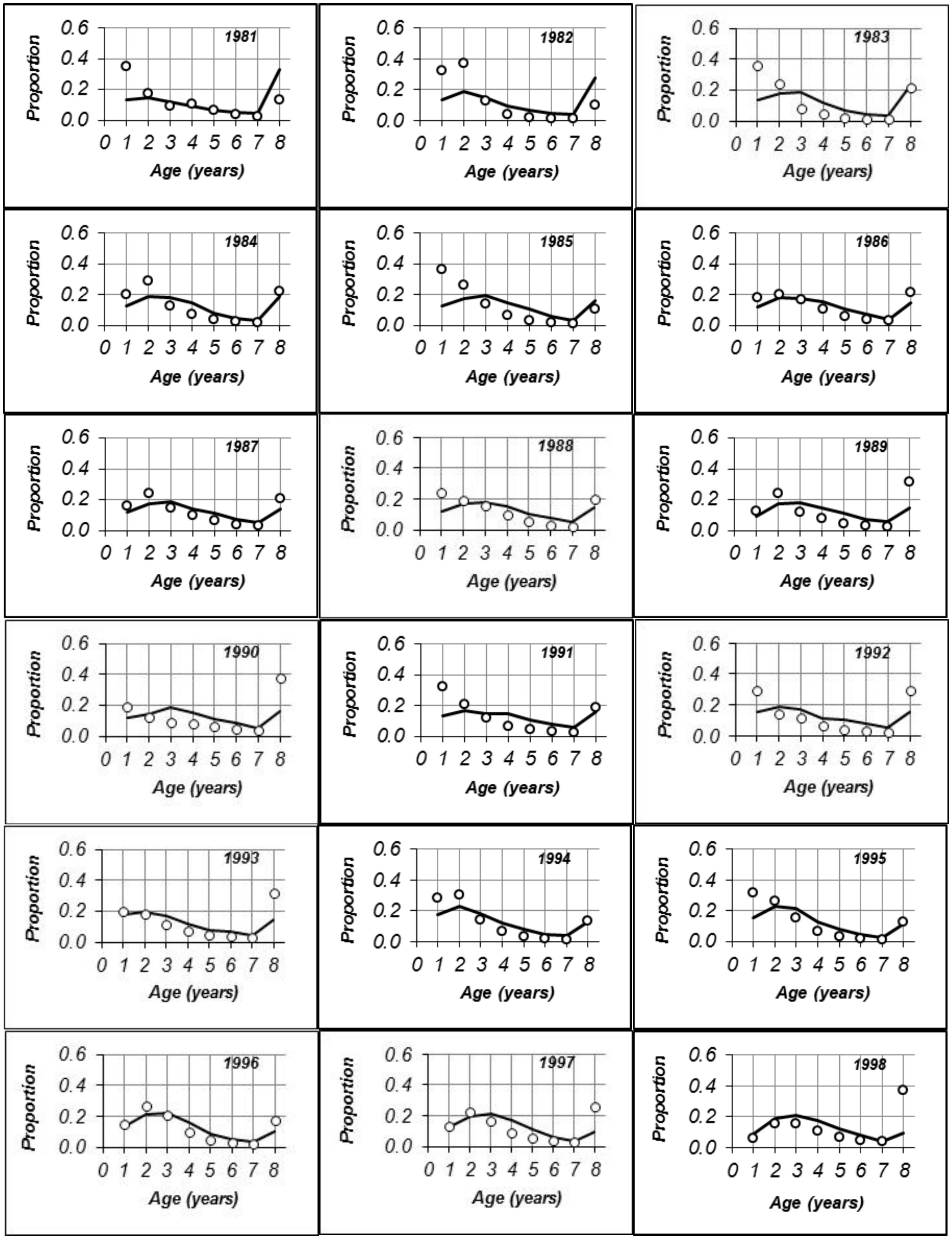

Figure 8 (continued):

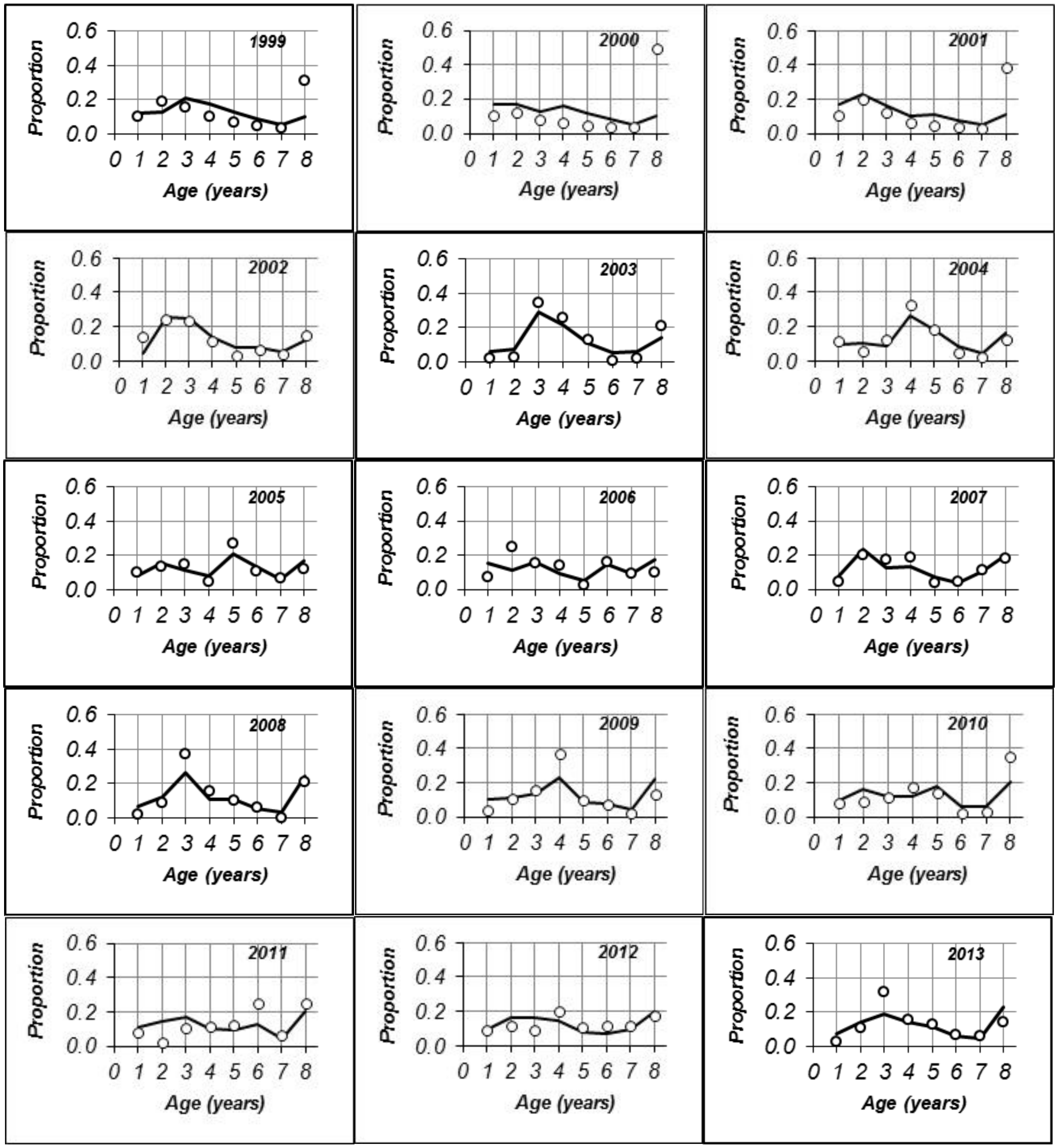

Figure 9: Annual observed (open circles) and ASAP estimated (bold lines) survey age compositions.

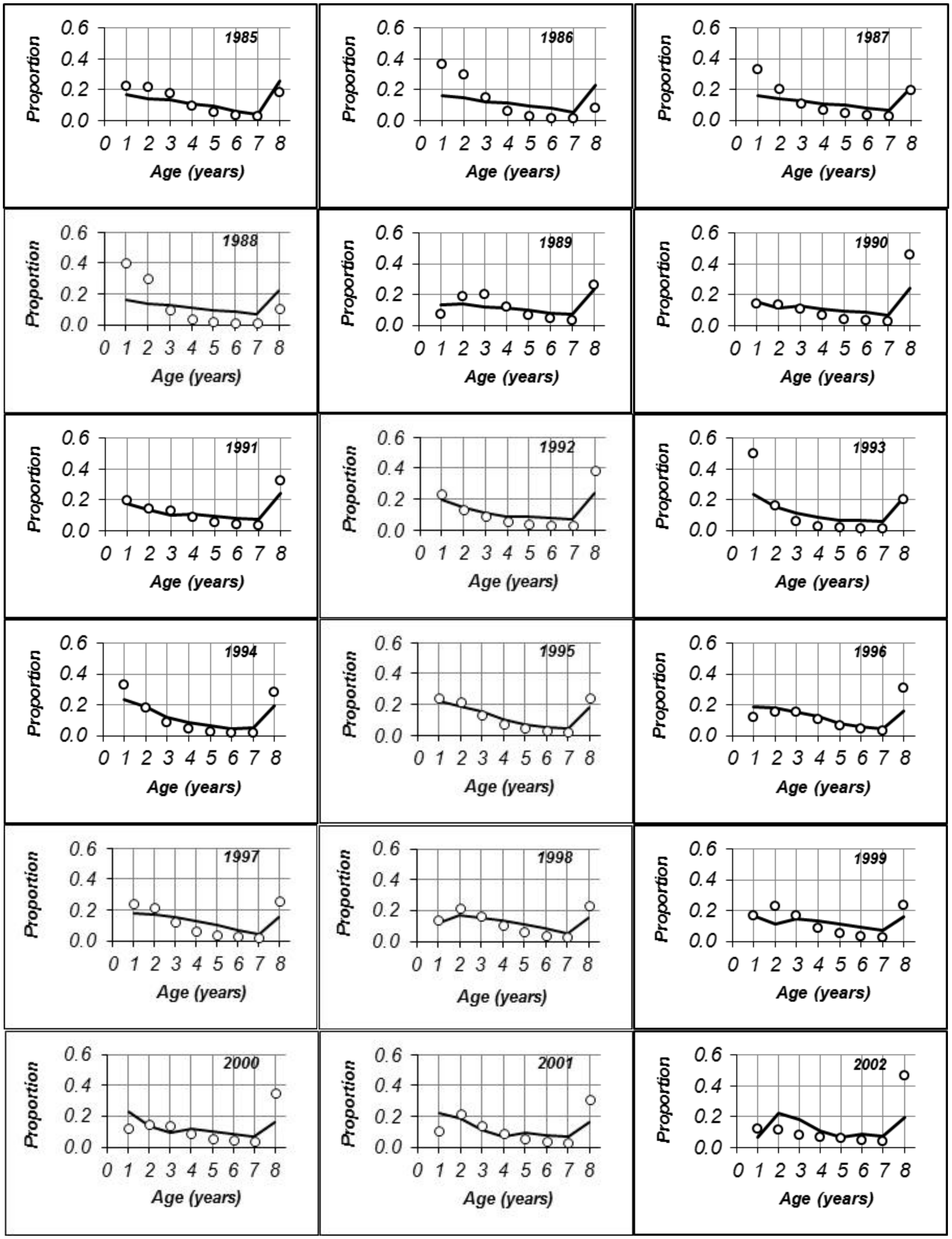

Figure 9 (continued):

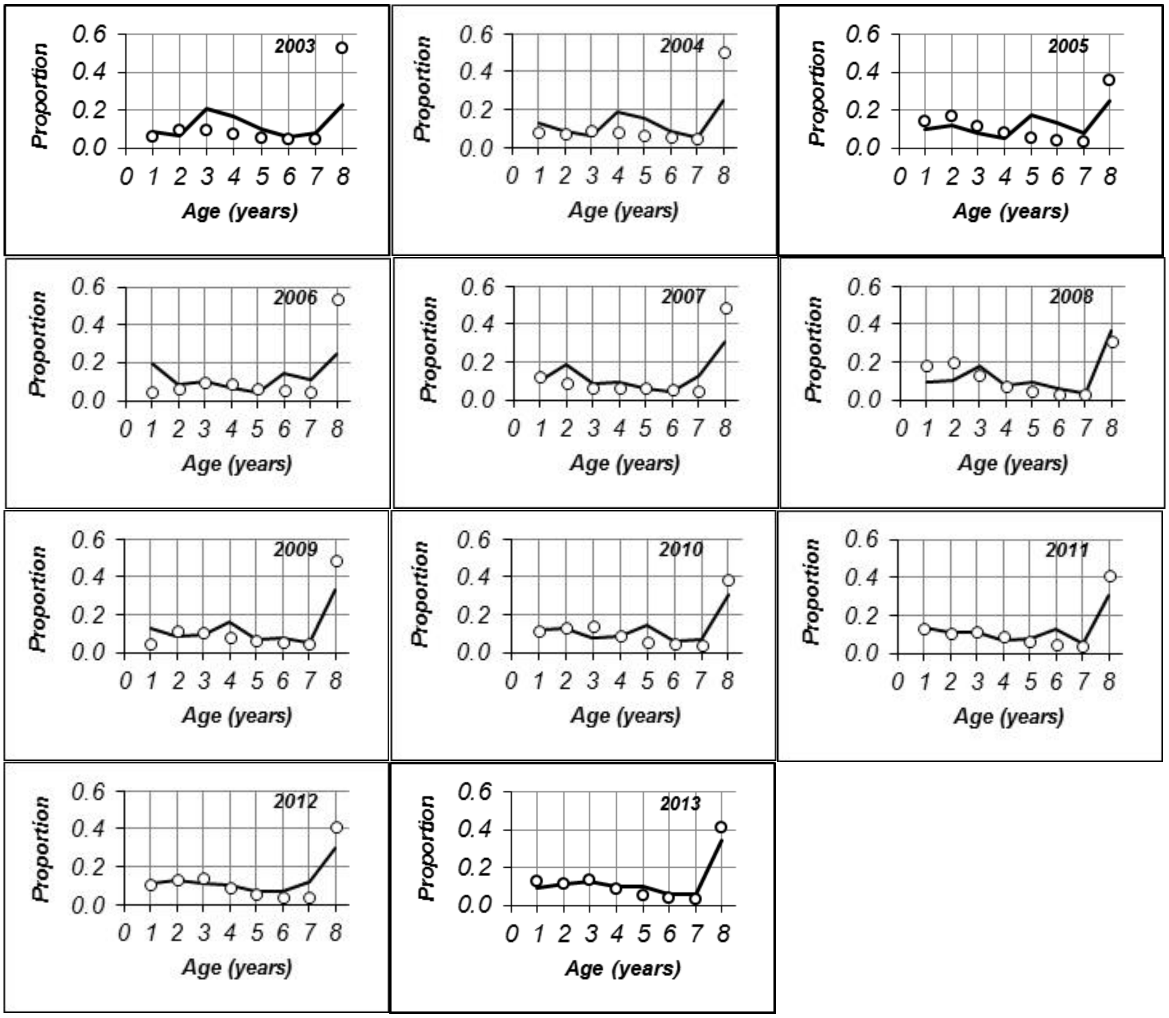
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Proportion
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8
Age (years)

Figure 10: ASAP base model estimated commercial and recreational fleet selectivities (top), and survey selectivities (bottom, ages 1-8+).

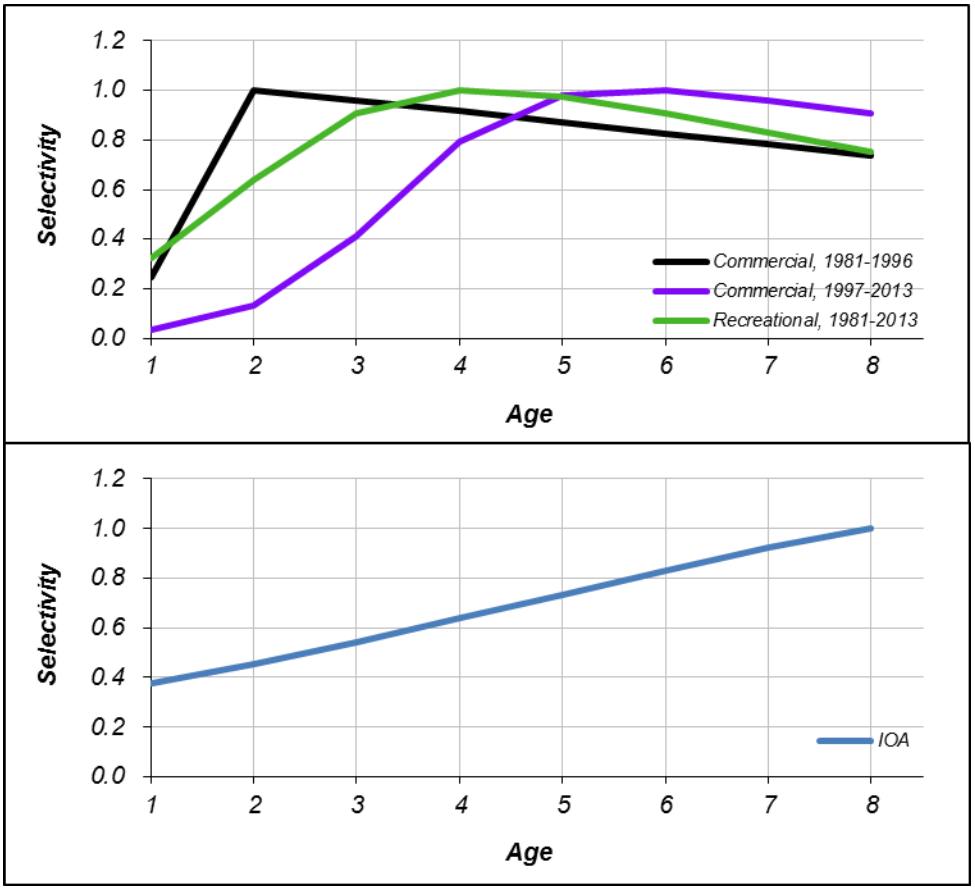

Figure 11: ASAP base model estimated spawning stock biomass (top). Bottom graphic depicts ASAP base model estimated spawning stock biomass (MCMC median) and dashed lines represent 95% MCMC derived confidence intervals.

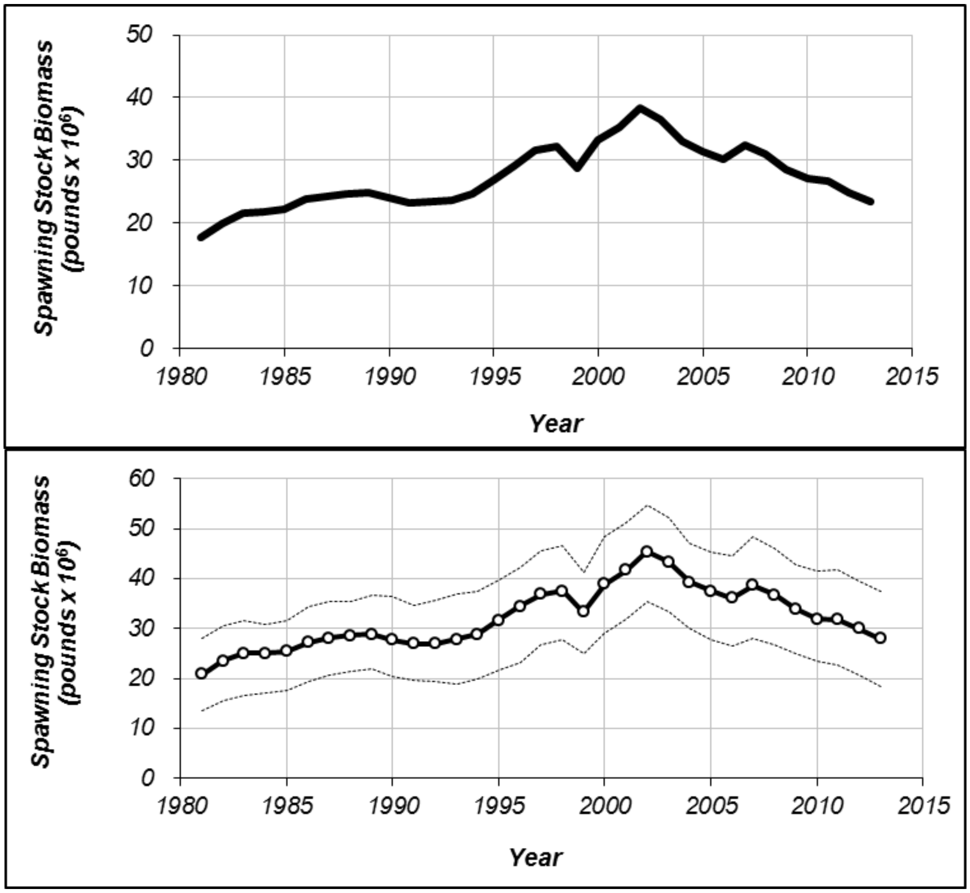

Figure 12: ASAP base model estimated recruitment. Dashed lines represent ±1 asymptotic standard error.

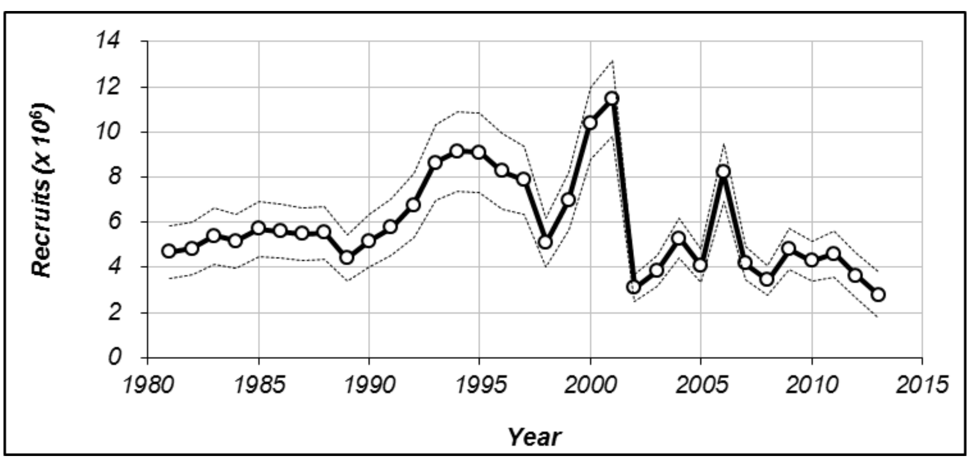

Figure 13: ASAP base model estimated average fishing mortality (top). Bottom graphic depicts ASAP base model estimate average fishing mortality (MCMC median) and dashed lines represent 95% MCMC derived confidence intervals.

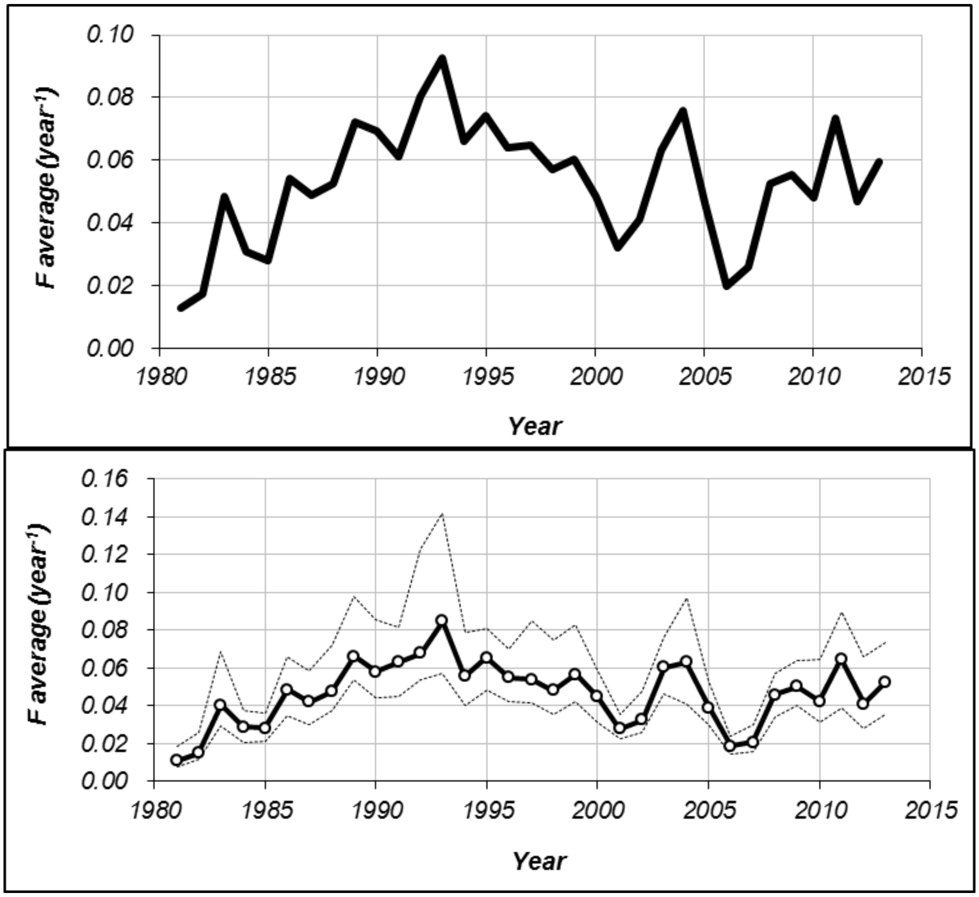

Figure 14: ASAP base model estimated age-1 recruits and female spawning stock biomass. Arrows represent direction of the time-series. The yellow circle represents the most current data pair.

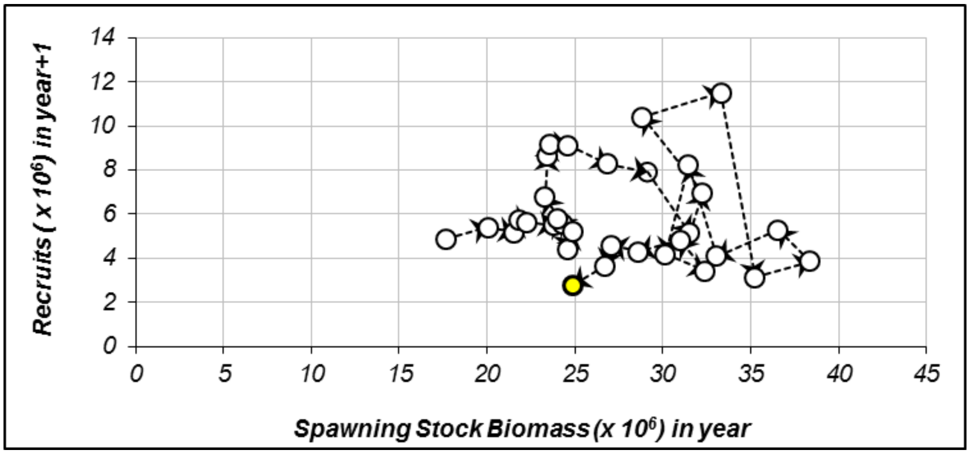

Figure 15: ASAP base model estimated age-1 recruits and spawning stock biomass (open circles). Equilibrium recruitment is represented by the bold line. The yellow circle is the 2013 spawning stock biomass estimate. Equilibrium recruitment per spawning stock biomass corresponding with the minimum and maximum spawning stock biomass estimates are represented by the slopes of the dashed diagonals (min. spawning stock=47% SPR; max. spawning stock=96% SPR).

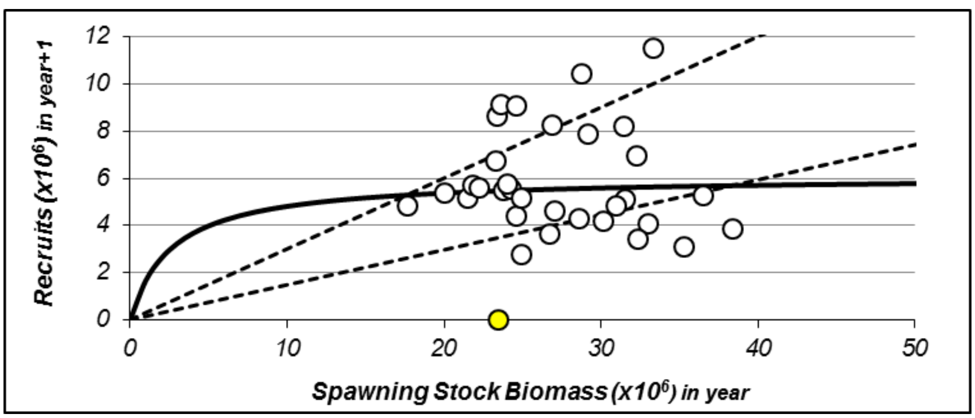

Figure 16: Retrospective analysis of ASAP base model (2009-2013). Top graphics depict estimated ratios of annual average fishing mortality to $F_{30\%}$ and spawning stock biomass to $SSB_{30\%}$ (dashed line). Bottom graphic depicts estimated age-1 recruits.

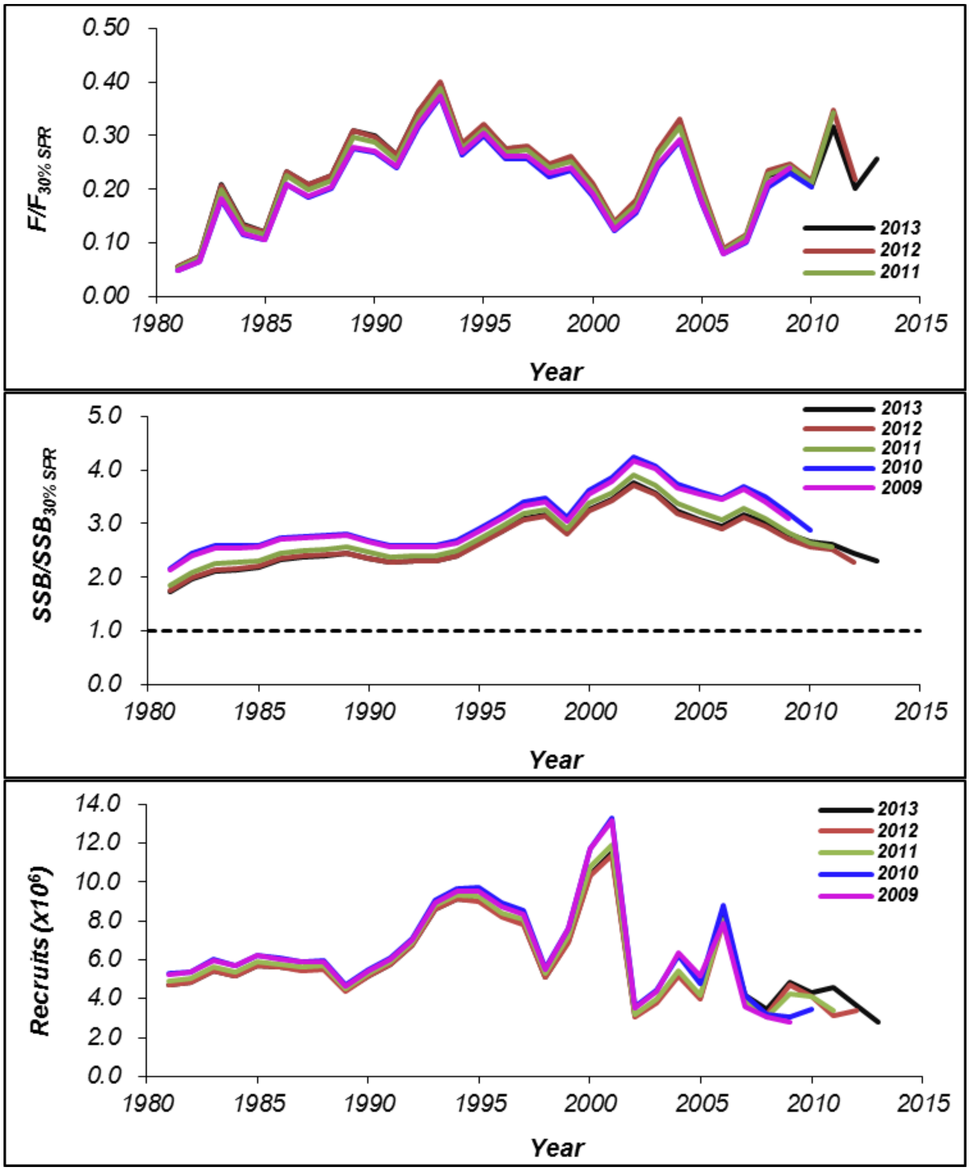

Figure 17: ASAP base model estimated ratios of annual average fishing mortality to $F_{30\%}$ and female spawning stock biomass to $SSB_{30\%}$. In the top graph, arrows and dashed line represent direction of time-series. The yellow circle is the 2013 estimate and the red circle is current status (geometric mean of average F and female SSB 2011-2013). Bottom graphic depicts current status and results of 2000 MCMC simulations relative to limit reference points.