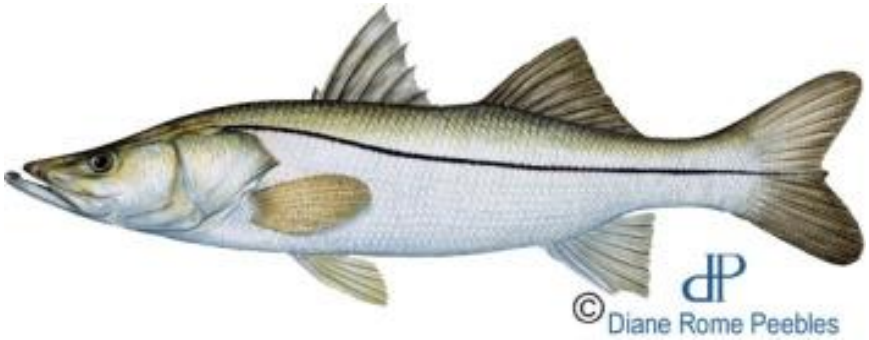

THE 2015 STOCK ASSESSMENT UPDATE OF COMMON SNOOK, *Centropomus undecimalis*

Robert G. Muller, Alexis A. Trotter, and Philip W. Stevens

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Fish and Wildlife Conservation Commission
Fish and Wildlife Research Institute
100 Eighth Avenue Southeast
St. Petersburg, Florida 33701-5020

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Florida Fish and Wildlife Research Institute
St. Petersburg, FL 33701

EXECUTIVE SUMMARY

- The Commission closed the snook fishery by executive order after a severe cold spell in January 2010. The fishery on the Atlantic coast reopened in September 2010 and the fishery on the gulf coast remained closed until September 2013. An objective of this assessment, which includes data through 2014, was to evaluate the effects that the cold kill had on Common Snook populations.

- The peak recreational harvest (those fish that were landed or died after being released alive) occurred on the Atlantic coast in 1997 (60,900 fish), averaged 32,000 fish from 1998 through 2004, and then declined to 6,500 fish harvested in 2010; the total harvest in 2014 on the Atlantic coast was 17,900 snook. The gulf harvest peaked at 149,000 fish in 1997 then declined before rising to 117,000 fish in 2004. Very low numbers of fish were harvested each year after 2009 with the closure of the gulf fishery. The fishery on the gulf coast reopened in September 2013 and the total harvest in 2014 on the gulf coast was 47,500 snook.

- Common Snook is a popular recreational species even though it only occurs in peninsular Florida. In 2014, based on recreational interviews with anglers who indicated the type of fish that they were targeting, snook were the fourth most targeted species on the Atlantic coast and the third most targeted on the gulf coast. In the 2013 assessment, snook was the tenth most targeted species on both coasts.

- Catch rates from the FWRI Fishery Independent Monitoring program (FIM), the federal Marine Recreational Information Program (MRFSS/MRIP) and the Everglades National Park creel survey (ENP) were used to provide guidance on stock trends to the assessment model.

- The haul seine catch rates in numbers of snook per set from FWRI's FIM program on the Atlantic coast decreased from 1997 to 2001, then stabilized until the drop in 2010, and then increased slightly. Catch rates on the gulf coast during 1996 to 2008 were mostly stable and then dropped in 2009 and 2010 to their lowest catch rates in the series. The gulf catch rates increased after 2010 with 2014 having the highest catch rate in the series. We used length data by coast for age-1 fish from the fishery independent samples to identify age-1 fish in the seine hauls and then repeated the standardization process to generate indices just for age-1 fish by coast. The catch rates for age-1 fish resembled the catch rates for adults.

- On the Atlantic coast, recreational MRFSS/MRIP total-catch rates were flat from 1996 through 2009 then dropped in 2010 and 2011 before increasing to levels higher than the 1996-2009 levels. The catch rates on the gulf coast were generally increasing until a drop after the 2005 red tide event. The drop was followed by increases until the severe drop in 2010 and large increases since.

- Total catch rates from the ENP showed similar increases in recent years as did the MRFSS/MRIP index on the gulf coast except with higher rates in 2007-2009. The ENP index showed the same sharp drop in 2010 followed by increases afterwards although only back to the levels seen in the early 2000s.

- The sizes of fish that anglers released were estimated from angler interviews, angler logbooks, the Snook and Gamefish Foundation's Angler Action Program, and a fishery independent catch-and-release fishing program. Data from the first two programs were available beginning in 2002 and the Angler Action Program beginning in 2010. The fishery independent catch and release fishing program operated from 2002 through 2005. We used the average lengths from 2002-2005 by coast from logbooks and the catch and release program to assign lengths to the released fish in the years 1999 to 2002. For the earlier years, we pro-rated these fish lengths after accounting for differences in size regulations.

- As with the assessments since 2006, we determined the condition of the stocks using the National Marine Fisheries Service's Age-Structured Assessment Program (ASAP) because ASAP is a flexible model especially in terms of numbers of indices, years with age data for estimating selectivity, linking discards to their fisheries, differential weighting of population parameters, estimating uncertainty, and other technical details.

- Estimated fishing mortality rates on the Atlantic coast increased until 1998 (although the peak was 0.99 per year in 1995) and then the rates dropped with the implementation of more restrictive regulations (26-34 inch slot in 1999; one-fish bag limit and 28-32 slot limit in 2007). Fishing mortality rates were below 0.06 per year from 2010 until 2012 and then returned rates similar to those seen in 1999-2007. The fishing mortality rate in 2014 on the Atlantic coast was 0.16 per year. Fishing mortality rates also increased on the gulf coast before declining sharply after the min-max size limits were implemented in 1999 (the estimates of fishing mortality rate in 1996 was 1.48 per year and dropped to levels of around 0.20 per year after 1999). The fishing mortality rates during the closure attributed to the deaths of live-released fish were 0.03-0.04 per year during 2010-2012 and rose upon the fishery reopening. The fishing mortality rate in 2014 was 0.09 per year on the gulf coast.

- The estimated recruitment on the Atlantic coast has generally declined since 1991-1992 and recruitment levels in 2007 and 2009 through 2011 were the lowest over the 29-year time period. Recruitment since 2012 has been higher at levels similar to those seen during the mid-1990s. Recruitment on the gulf coast has been mostly stable with a few years with high recruitment (2000, 2003, 2012, 2013, and 2014) and a few years with low recruitment (2005-

2009). Low numbers of recruits on the gulf coast often occurred in years when there were high spawning biomass levels indicating that environmental effects were important determinants of year class strength.

- The spawning biomass of snook on the Atlantic coast was generally flat until the late 1990s and then was flat at a lower level until 2011 when the biomass began to increase. While spawning biomass on the Atlantic coast was 345 mt (0.76 million lb) in 2014, one should expect lower spawning biomasses in the future when the fish from the low recruitment years (2009-2011) mature. The spawning biomass on the gulf coast has generally increased over the time series except for a decline beginning in 2008 that dropped to a low in 2010. The spawning biomass in 2014 (1,404 mt, 3.10 million lb) was the highest of the 29 years of data included in the assessment.

- In July 2007, the Commission implemented the Snook Work Group's recommendations to adopt a one-fish bag limit statewide and to reduce the min-max limits to 28-32 inches total length (TL) on the Atlantic coast and 28-33 inches TL on the gulf coast. Based upon the average lengths of kept fish recorded by recreational samplers for the 2008-2014 time period, anglers on the Atlantic coast had reasonable compliance with the new size limits: 79% of the kept fish were within the 28–32 in length limits, 4% were undersized, and 17% were oversized. Anglers on the gulf coast showed similar compliance with 73% of the kept fish within the 28-33 in length limits, 22% undersized and 5% oversized. Bag limit adherence was high on both coasts. During 2008–2014, only three out of 2,540 anglers intercepted on the Atlantic coast (two out of 1,609 trips) kept more than one fish per angler. On the gulf coast, twenty out of 21,052 anglers that were intercepted (12 out of 10,733 trips) kept more than one fish per angler during the period 2002-2014.

- The Commission's management objective for snook is to maintain the spawning potential ratio (SPR) at or above 40%. However, because SPR was devised to evaluate the effect of fishing mortality on a stock, natural mortality events, such as red tides or cold kills are not accounted for in SPR model results. Therefore, results of this assessment are being presented both in terms of SPR as well as the equivalent spawning stock biomass (SSB). For the 'base' model (i.e., the model that does not incorporate the impact of environmental events), the transitional SPR (tSPR) values in 2014 approached the Commission's objective on the Atlantic coast (39%) and exceeded the objective on the gulf coast (61%). Results from the model that incorporated the impact of environmental events (red tides and cold kills) indicated that in 2014 SSB in the Gulf was still at 90% of the SSB expected at $SSB_{40\%SPR}$ ($SSB_{2014}/SSB_{SPR40\%}$=0.90). Also, for the Atlantic SSB in 2014 was only at 60% of the SSB expected at $SSB_{40\%SPR}$ ($SSB_{2014}/SSB_{SPR40\%}$=0.60).

1.0. INTRODUCTION

Common Snook, *Centropomus undecimalis,* is one of Florida's most popular gamefish even though snook only occur in the southern portion of the peninsula. The snook species that occur in Florida are located at the northern extent of their geographical distribution and snook can experience thermal stress when water temperatures decline in winter months. Prolonged cold conditions in January 2010 produced many reports of fish cold-kills and many of the dead fish were snook. Responding to the fish kill, the Commission closed the fishery statewide in January 2010; they reopened the fishery on the Atlantic coast in September 2010 while keeping the fishery on the gulf coast closed until September 2013. The 2013 assessment update primarily examined how snook on each coast responded after 2010 but only included data from the 2013 fall open season on the gulf coast. This assessment update includes another 12 months of data, i.e., through 2014.

Evaluating the condition of a stock involves combining life history and fishery characteristics to provide managers with information on how anglers and the stocks interact and whether the stocks are increasing, decreasing, or stable. We provide summaries of harvest patterns, changes in effort, standardization of catch rates, and develop population and recruitment estimates from age-structured, separable population analyses. Because regulations change how anglers interact with the underlying stocks, we evaluated regulatory compliance as well. The effects of cold kills and red tides on snook were also explored.

This assessment used the same primary analytical assessment model as was used in the 2012 and 2013 assessments (Muller and Taylor 2012, 2013) and continues to benefit from improvements in the analytical procedures employed in the National Marine Fisheries Service's (NMFS) Southeast Data, Assessment, and Review (SEDAR) process for other species.

2.0. BIOLOGICAL CHARACTERISTICS

2.1. Data Sources

The biology and population dynamics of Common Snook in Florida have been investigated for populations statewide (Taylor et al. 1993, 1998, 2000, Tringali and Bert 1996; Tringali et al. 2008, Winner et al. 2010); in southwest Florida (Fore and Schmidt 1973, Bruger unpublished manuscript, Thue et al. 1982, Blewett et al. 2006, 2009, Stevens et al. 2007, Brennan et al. 2008, Adams et al. 2009, Trotter et al. 2012); in the Indian River Lagoon and Southeast Florida (Gilmore et al. 1983; Tucker and Campbell 1988; Lowerre-Barbieri et al. 2003, Dutka-Gianelli et al. 2011, Young et al. 2014, Young et al. 2016), and in Tampa Bay (McMichael et al. 1989; Lowerre-Barbieri et al. 2014, Brame et al. 2014). Much unpublished data on snook population dynamics were made available by R. Taylor (Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute, FWC-FWRI, personal communication).

2.2. Stock Distribution

Common Snook are found in estuaries, adjacent rivers, and in nearshore waters of

the tropical and subtropical western Atlantic (Gilmore et al. 1983; Rivas 1986). Fishes in the genus *Centropomus* occur in coastal waters bounded by the August 24 ˚C water isotherm in the North Atlantic and the February 24 ˚C water isotherm in the South Atlantic (Rivas 1986). Common Snook are the most widely distributed species within the genus. Common Snook have been reported from as far north as New York along the Atlantic seaboard (Schaefer 1972), and throughout the Gulf of Mexico. Common Snook are most abundant on the Atlantic coast of Florida from Cape Canaveral south through the Florida Keys and on the Gulf coast from Cedar Key south to the Dry Tortugas. Common Snook occur infrequently along the rest of the gulf coast until Galveston, Texas where they again become abundant through Rio de Janeiro, Brazil (Gilmore et al. 1983; Rivas 1986).

In Florida, Common Snook from the Atlantic and gulf coasts have different life history patterns and are genetically isolated from one another (Tringali and Bert 1996; Taylor et al. 1993). Nearly all Common Snook from the gulf coast inhabit a single estuary for their entire lives, while most Atlantic Common Snook stray or emigrate much greater distances. The genetic diversity and genotype frequencies of Common Snook from the gulf coast of Florida, the Atlantic coast of Florida, and islands in the Caribbean differ and are evidence of reproductive isolation and unique stock structure among these populations (Tringali and Bert 1996). A robust microsatellite DNA analysis 1,396 specimens confirmed the genetic distinctiveness of gulf and Atlantic stocks (Fig. 2.2) and that an individual Common Snook selected at random can be assigned to its respective stock although not to its natal estuary (Tringali et al. 2008). Due to these differences, the Atlantic and gulf coast populations of Common Snook in Florida are managed separately.

Advances in otolith microchemistry have further delineated differences between the Florida coastal populations of Common Snook. A linear discriminate function analysis on the otolith chemistries from fish collected on the Atlantic coast and the gulf coast was highly effective in identifying the source coast of juvenile fish and juvenile otoliths were never misclassified by coast. When the function derived from juvenile fish was applied to adult fish from Florida Bay, the adult fish were identified as having come from both coasts in roughly equal proportions (Patterson et al. 2005), similar to results of genetic studies in Florida Bay (Tringali and Bert 1996).

2.3. Habitat Requirements and Distribution Pattern

2.3.1. Eggs and larvae

Eggs and larval Common Snook are found in polyhaline and euryhaline waters near estuarine passes or adjacent river mouths (Tolley et al. 1987; Peters et al. 1998a, 1998b; R. Taylor, FWC-FWRI personal communication). The lengths and distribution of larvae suggest that Common Snook eggs hatch near the mouths of estuaries and that the larvae remain near the bottom where flood tides transport them into the bay. Extensive estuarine sampling of Naples Bay, Florida, produced 14 larval Common Snook (Tolley et al. 1987). Later sampling at four sites around Tampa Bay and three sites around Naples produced 981 larvae, with sizes ranging from 1.9 mm to 9.7 mm SL, though densities of larval collections were similar to Tolley et al. (1987; Peters et al. 1998a). While relatively few larval Common Snook have been collected, it has been documented that newly hatched larvae spend

about 2.5 weeks in the upper few meters of the water column in high-salinity open or nearshore waters prior to their arrival in shallow-water nursery sites (Peters et al. 1998 b). Larvae have been found in euryhaline and oligohaline waters and apparently settle out of the plankton near mangrove prop roots. Larvae have been successfully reared between 25 ˚C and 32 ˚C, with maximum yolk utilization efficiency and larval growth at 26 ˚C (Limouzy 1993). Below 25 ˚C and above 33 ˚C larval Common Snook did not survive long after hatching.

2.3.2. Young-of-the-year (YOY) and juveniles

Small juvenile Common Snook prefer low-energy, shallow waters, often near overhanging shoreline vegetation or seagrass meadows. Primary nursery habitat has been described as brackish, shallow, warm-water streams or dredged canals with slow currents, unvegetated bottoms, and overhanging or submerged mangrove prop roots (Fore and Schmidt 1973). Gilmore et al. (1983) identified three distinct nursery habitats for Common Snook on the Florida Atlantic coast, including freshwater tributaries, salt marshes and impoundments, and seagrass beds. McMichael et al. (1989) described the habitat for small juvenile Common Snook in Tampa Bay as including quiet creeks, canals, and lagoons in riverine, mangrove, and saltmarsh habitats.

Recent work has focused heavily on ontogenetic habitat shifts. Brame et al. (2014), working in YOY habitat in Tampa Bay, illustrated how a pond and creek system supports various life stages in sequence. In that study, the smallest Common Snook were found in tidal ponds before moving to tidal creeks around 40 mm SL. Similarly, in Charlotte Harbor, the smallest juveniles were found in coastal wetland ponds and creeks, and then moved to secondary habitats with more connectivity to the open estuary around 150 mm SL (Stevens et al. 2007). These remote habitats provide three critical requirements for these diminutive Common Snook: 1) a low-energy environment, 2) abundant quantities of the proper-sized prey to accommodate their developing mouth gape, and 3) a safe respite from larger predators. At 150 mm SL, Common Snook lose their ability to tolerate low dissolved oxygen (Peterson and Gilmore 1991) which may prompt movement towards the open estuary. Another factor prompting this movement may include the pursuit of larger prey. By 320 mm SL, Common Snook have left the juvenile habitat and occupy open estuarine shorelines (Stevens et al. 2007; Winner et al. 2010; Barbour et al. 2014).

Preliminary investigations that quantify elemental signatures from juvenile Common Snook otoliths may provide a qualitative measure of the relative importance of different juvenile habitats as sources of new juvenile recruitment to the adult standing stock. Juveniles collected from six watershed regions within Tampa Bay showed moderate distinctions in elemental fingerprints as cross validation from Canonical Discriminate Analysis resulted in ~ 63% classification success (H. Rolls, FWC-FWRI personal communication).

2.3.3. Adults

The distribution of adult Common Snook closely approximates the distribution of mangroves that are thought to be their principal habitat (Marshall 1958; Gilmore et

al. 1983). Winner et al. (2010) analyzed fisheries-independent monitoring data to describe the distribution, habitat use, and seasonality of adult Common Snook in Florida estuaries. Common Snook were most abundant in shoreline habitats with overhanging vegetation and the presence of seagrass and were commonly found in high salinity (> 25 ppt) near deeper inlets, passes, or mouths of bays possibly reflecting aggregations of pre-spawning fish. Freshwater rivers also serve as habitat for adult Common Snook (Blewett et al. 2009; Dutka-Gianelli et al. 2011; Trotter et al. 2012; Young et al. 2016). Blewett et al. (2009) found that Common Snook, while present in three Charlotte Harbor rivers year-round, peaked in abundance during fall, sometimes tripling in numbers compared to other seasons. This movement of Common Snook into rivers occurred 2-3 months before any risk of cold events. These results suggest that Common Snook at these southerly latitudes are not moving to rivers for overwintering purposes as previously suspected. More recent data from the large floodplain rivers of Charlotte Harbor shows strong relationships between freshwater inflow and the abundance and condition of Common Snook, suggesting these fish may be taking advantage of floodplain resources as prey concentrates into the main stem of rivers as waters recede (Blewett et al. in review). In smaller rivers along the Atlantic coast, however, Common Snook abundance remained relatively constant throughout the year and showed no distinct seasonal trends (Dutka-Gianelli et al. 2011). Preliminary analysis of data from four rivers around Tampa Bay also showed no seasonal trends (A. Trotter, FWC-FWRI, personal communication). These studies suggest that smaller rivers may simply provide an extension of the estuarine habitat, while larger rivers provide trophic subsidies to Common Snook. Catadromous movements of Common Snook, in turn, highlight a pathway for energy transfer from freshwater floodplains to estuarine and marine habitats.

Behavioral contingents, segments of the population that use divergent migration tactics, have been recently described for Common Snook (Blewett et al. 2009; Lowerre-Barbieri et al. 2014). Acoustic monitoring in a large river found that a portion of the tagged population resided in the river year after year, except for a seasonal movement out of the river during the summer spawning season (Trotter et al. 2012). An estuary contingent was evident in an acoustic monitoring study that tracked spawning-related movements near passes and in the interior of a large estuary (Lowerre-Barbieri et al. 2014). A portion of the tagged population remained in the estuary year-round, and did not exhibit catadromy. Variation in seasonal, annual, and cross-system catadromy by Common Snook during winter can be an important factor during cold events because water temperatures in these habitats (rivers vs. estuary) vary enough (2 ˚C) to influence survivorship when temperatures drop near the Common Snook lethal limit (Blewett at al. 2014; Stevens et al. in review). The lower lethal limit water temperature is around 10 ˚C (9 ˚C–14 ˚C [48 ˚F–57 ˚F] for juveniles, and 6 ˚C–13 ˚C [43 ˚F–55 ˚F] for adults, Shafland and Foote 1983).

2.4. Food Habits

Tolley et al. (1987) posit that larval Common Snook probably eat copepods although the few larval Common Snook that they collected had empty stomachs. McMichael et al. (1989) and Gilmore et al. (1983) found that small juveniles fed mainly on micro-crustaceans (including copepods and mysids) until large enough to

take paleomonid shrimp and cyprinodontiform fishes. A transition from intake of crustaceans to an intake of fishes occurs at a length of approximately 45 mm SL (1.8 in). Large juveniles fed mainly on the abundant fishes found in seagrass beds and most prey items reported for adult Common Snook are species associated with the water column.

Adult Common Snook are opportunistic feeders that feed on prey that are abundant in their environment. In Charlotte Harbor, the dominant estuarine prey were Pinfish (*Lagodon rhomboides*), anchovies (*Anchoa* spp.), and Pink Shrimp (*Farfantepenaeus duorarum*), while the dominant riverine prey were crayfish (*Procambarus* spp.), sunfishes (*Lepomis* spp.), Brown Hoplo (*Hoplosternum littorale*), and grass shrimp (*Palaemonetes* spp.) (Stevens et al. 2010; Blewett et al. 2013). In a study of riverine Common Snook conducted along the east coast, silversides (*Menidia* spp.), Brown Hoplo, mojarras (Gerreidae), and blue crabs (*Callinectes* spp.) were common prey items (Dutka-Gianelli et al. 2011).

Adams and Wolfe (2006) documented cannibalism in Common Snook in the winter when the juvenile Common Snook were in the creeks and tidal ponds and the larger Common Snook were seeking thermal refuges. Cannibalism has since been documented in the coastal rivers along the east coast (Dutka-Gianelli et al. 2011) and in the rivers around Tampa Bay (A. Trotter, FWC-FWRI, personal communication).

2.5. Reproductive Life History

Histological evidence shows that Common Snook are protandrous hermaphrodites; i.e., Common Snook begin life as males and then, after maturation, the fish become mature females (Taylor et al. 2000). Observed transitional fish ranged from 240 to 824 mm (9.4-32.4 in) fork length (FL) and were from 1 to 7 years old. However, not all Common Snook change sex because the oldest individual sampled was a 21 years old fish, identified as a male in the field, from the east coast stock (Taylor et al. 2000). Unfortunately, a gonad sample was not taken from this fish and the sex could therefore not be confirmed by histological analysis. There are, however, other confirmed instances of very old male Common Snook (see section 2.6). Gonads of Common Snook undergoing sex-reversal simultaneously contain sex cells of both sexes: ovigerous lamellae and remnants of dorsal sperm ducts containing sperm. Protandrous hermaphrodism and differences in growth and mortality between sexes result in significantly skewed sex ratios such that the majority of small Common Snook are male and most large Common Snook are female. Sex ratios reported from southwest Florida Common Snook were similarly skewed (Volpe 1959; Thue et al. 1982).

Males reach sexual maturity during their first year when they are 150–200 mm FL (5.9-7.9 in) which is smaller and younger than previously suspected (Taylor et al. 2000). Mature females arise directly from mature males after the transitional gonadal tissue has reorganized shortly after spawning. If all males have the capacity to become female at some point in their lives, then the maturation schedule for females would simply reflect the schedule of transition from male to female or the sex ratios.

The probability that a snook of a particular size will be a female increases with length or age and is closely approximated by coast-specific logistic regressions (Taylor et al. 2000). On the Atlantic coast, the probability of a snook being female, *P(fem)*, for a particular sized fish (fork length (FL) in mm) was:

$$P(fem) = \frac{e^{(-7.208+0.0094FL)}}{(1+e^{(-7.208+0.0094FL)})} \qquad (2.5.1)$$

and the probability of being female at a particular age

$$P(fem) = \frac{e^{(-2.283+0.307Age)}}{(1+e^{(-2.283+0.307Age)})} \quad . \qquad (2.5.2)$$

The probability on the gulf coast of a snook being female for a particular sized fish was

$$P(fem) = \frac{e^{(-5.713+0.0094FL)}}{(1+e^{(-5.713+0.0094FL)})} \qquad (2.5.3)$$

and the probability of being female at a particular age

$$P(fem) = \frac{e^{(-1.578+0.307Age)}}{(1+e^{(-1.578+0.307Age)})} \quad . \qquad (2.5.4)$$

These equations predict that 50% of the fish of a given year class will be females by the time they reach 7.4 years and a total length of 34.4 inches (819 mm FL) on the Atlantic coast and younger (5.1 years) and smaller (27.2 inches TL or 641 mm FL) on the gulf coast.

For snook at the current minimum size, 28 in TL (711 mm), the sex ratio is significantly skewed towards males on the Atlantic coast with about 0.4 females for each male and the reverse on the gulf coast with approximately 1.7 females for each male. The sex ratio is equal on the Atlantic coast by the maximum slot size, 32 in TL (813 mm) while it is skewed in favor of females on the gulf coast at the maximum slot size (33 in TL [838 mm]) with 5.4 females for each male.

The reproductive season for Common Snook on both coasts of Florida extends over at least six months: on the gulf coast, from April through September and on the Atlantic coast, from April through October (Taylor et al. 1998). Marshall (1958) found Common Snook from southwest Florida spawning from May to November with peak activity during May and June. Volpe (1959) determined that the spawning season for Common Snook from Lee and Collier Counties was June and July based on specimens with flowing gametes. In September, he found no Common Snook extruding gametes and concluded that peak spawning had passed. Based on observations of running-ripe male Common Snook, Fore and Schmidt (1973) reported the spawning season in the Ten Thousand Islands area of southwest

Florida was from the first of May to about the middle of November. Gilmore et al. (1983) used back-calculated hatching dates of recruiting juveniles to identify an extended spawning season of April to December for Common Snook along the east-central coast of Florida. Using oocyte diameters and gonadosomatic indices, Tucker and Campbell (1988) showed that spawning along the east-central coast of Florida occurred from early May until early October. McMichael et al. (1989) used back-calculated dates from otoliths collected from juvenile Common Snook to determine that Common Snook spawn from April until December in Tampa Bay. Using acoustic telemetry to determine the period of time spent at coastal spawning sites, Young et al. (2014) determined that peak spawning along the Atlantic coast from Ponce Inlet to Palm Beach Inlet occurs in July and August and Lowerre-Barbieri et al. (2014) found that peak spawning in the Tampa Bay area occurred during June and July. These variations are expected because environmental conditions vary from one location to the next, especially temperature, which appears to mediate spawning (Gilmore et al. 1983; Bye 1984).

Spawning occurs only after the water temperature warms to 24 ˚C from winter minima. Taylor et al. (1998) found that, out of physical factors of moon phase, tide, amplitude, velocity, and time of day, the only variable significantly correlated to maximum oocyte diameters was time of day and that spawning occurred between 14:00 and 20:00 hours. Lowerre-Barbieri et al. (2003) tagged Common Snook in spawning aggregations and recaptured them on the following day to determine whether the fish had spawned in spite of being captured and released; they found that the stress of being caught did not cause the fish to leave the spawning aggregation. Spawning frequency of Common Snook was inferred from the proportion of females found to contain post-ovulatory follicles or hydrated oocytes. The estimated interval between spawning events ranged between 1.1 and 2.5 days based upon the proportion of females with post-ovulatory follicles. In Tampa Bay, the average spawning frequency for Common Snook using hydrated oocytes was estimated as about once every 1.4 days (Taylor et al. 1998).

Recent advances in passive acoustic research have revealed new information regarding the variability of individual reproductive dynamics. Trotter et al. (2012) estimated individual spawning season duration by tracking fish that left a tidal river. Mean time away from the river, and assumed to be spawning, was 78 days (range 40 – 120 days). Unfortunately, that study did not track fish once they had left the river array and joined the spawning aggregations. Young et al. (2014) updated many reproductive parameters for Atlantic coast Common Snook using acoustic telemetry and showed that individual dynamics are highly variable. By tracking 271 Common Snook, they documented that over the course of the entire spawning season, an individual Common Snook had a mean spawning duration of 38.6 days, made an average of 7.7 trips to a spawning aggregation during that period, and remained within the aggregation for an average of 3.28 days during each trip. Lowerre-Barbieri et al. (2014) tracked 31 Common Snook in Tampa Bay and also found fish moving into and out of the spawning aggregation throughout the spawning season, with a mean spawning duration for an individual of 112 days. Further, both Lowerre-Barbieri et al. (2014) and Young et al. (2016) found that Common Snook on both coasts demonstrate strong site fidelity to spawning locations, moving to a specific aggregation for multiple years.

Mean annual fecundity was determined for 35 fully developed female snook with a mean length of 754 mm (29.7 in) TL, mean age of 6.3 yr, and mean weight of 4,615g (10.2 lb). Mean annual fecundity was 966,000 (SE = 115,000) hydrated oocytes (R. Taylor, FWC-FWRI, personal communication).

Common Snook maturity schedules, used in the calculation of spawning potential ratios (SPR), were based on sex-ratio because all females are mature. We assume that the mature, male Common Snook that transition to females after the spawning season will spawn as females in the following spawning season. However, Milton and Chenery (2005) used $^{87}Sr/^{86}Sr$ and Sr/Ca ratios to infer migratory patterns in barramundi (*Lates calcarifer*), a species closely related to snook, and found some of the fish in Papua New Guinea did not show the isotopic ratio changes associated with a fish moving from freshwater to marine waters. They concluded that as many as half the barramundi did not spawn annually. Investigating whether Common Snook may also exhibit skip spawning, we now have results from two, multi-year acoustic studies: the first was conducted along approximately 50 km of the Caloosahatchee River in Charlotte Harbor during 2005-2007 (Trotter et al. 2012) and the second study was conducted along the east coast from Ponce Inlet south to Palm Beach Inlet, including the rivers, estuaries, and offshore reefs, during 2008-2010 (Young et al. 2014). Results from the Caloosahatchee study found that 40% of the Common Snook monitored remained within the freshwater portions of the rivers, suggesting that they were skip spawning (Trotter et al. 2012). On the Atlantic coast, approximately 24% of the Common Snook were not recorded in the inlet aggregations and were considered to have exhibited skipped spawning (Young et al. 2014). In both cases, the fish that did not participate in spawning had a mean length that was smaller than those that did spawn. Secor (2008) evaluated the management implications of skip spawning and noted that skip spawning had a small to moderate effect on SPR. He further noted if the proportion of fish that skipped spawning was constant across all mature ages then there was no effect of skip spawning on the SPR; however, if the proportion of fish that skipped spawning increased with age then the SPR would increase because of the reduced number of spawning fish in the unfished state. If only the smaller fish skipped spawning, then the tSPR would be about 2% less.

2.6. Growth Patterns

Common Snook on the Atlantic coast of Florida attain larger sizes than do Common Snook on the gulf coast of Florida. The average observed sizes at age-1 for Atlantic and gulf coast male Common Snook were 231 and 264 mm (9.1 and 10.4 in) FL, respectively (Taylor et al. 2000). At age-2, Atlantic coast males were also smaller than gulf coast males but Atlantic coast males continue to grow at a relatively rapid rate and surpass the average gulf coast male size-at-age by age-4. Predicted sizes at age for females are larger for all ages on the Atlantic coast than on the gulf coast.

Common Snook can reach about 20 years old and exceed 1,100 mm FL (45 in TL). On the Atlantic coast, the oldest Common Snook sampled from the fishery, that had sex determined, were 19 years old (three females between 1,000 and 1,036 mm TL [39.4-40.8 in TL] and three males between 931 mm and 998 mm TL [36.7-39.3 in TL]). The largest Common Snook was a female (1,145 mm or 45.1 in TL), but she

was aged at 16 years. The largest male was 1,035 mm (40.7 in TL) and 13 years old. On the gulf coast, the oldest Common Snook was a 16-year-old male (730 mm or 28.7 in TL). The largest Common Snook was a female (1,110 mm or 43.7 in TL), and her age was determined to be just nine years. The largest male on the gulf coast was 986 mm (38.8 in TL) and 11 year old. These observations reinforce the idea that Common Snook size is a poor indicator of age (Fig. 2.6).

Volpe (1959) reported a maximum age for combined sexes of seven years, while Thue et al. (1982) reported eight years for southwest Florida Common Snook. The maximum observed age for Common Snook in Taylor et al. (2000) was 21 years for both coasts. The differences in age among these studies can probably be attributed to the different age determination methodology—scale ages by Thue et al. (1982), whole otoliths by Volpe (1959), and otolith sections by Taylor et al. (2000)—and to the different methods of capture. Hook and line was the primary gear in the older studies while seines were used by Taylor et al. (2000). Maximum observed sizes of 1,105 and 1,032 mm (46.1 in and 43.3 in TL), for Atlantic and gulf coast females (Taylor et al. 2000) were larger than those reported previously by Volpe (1959, 970 mm or 38.2 in TL) or Thue et al. (1982, 950 mm or 37.4 in TL). These differences may also be the result of the now larger sample sizes, different sampling gear, or the effects of having stricter harvest regulations on the fishery than during the time of the earlier research. In addition, the extended time series for some projects may lead to new maximum ages. For instance, a dart tagged Common Snook was reported recaptured in the St. Lucie River in the spring of 2014. It was originally tagged 21 years previously (in August 1993) in Jupiter Inlet and was 880 mm TL (34.6 in) when tagged. The average age for an 850-900 mm TL Common Snook on the Atlantic coast is 6 years (range 3-13 years), suggesting a maximum age for Common Snook of more than 25 years.

Coast-specific, von Bertalanffy growth equations for fork length at age from Taylor *et al.* (2000) were

$$\text{Fork length (mm)} = 989.3\,(1 - e^{-0.235(\text{Age} + 0.0976)}) \text{ on the Atlantic coast and}$$
$$\text{Fork length (mm)} = 947.3\,(1 - e^{-0.175(\text{Age} + 1.352)}) \text{ on the gulf coast.}$$

2.8. Morphometrics

Coast-specific length-length and weight-length relationships were developed by Taylor et al. (2000) using measurements from Common Snook collected during the period 1986–1991. The estimated length-length and length-weight relationships for Atlantic coast Common Snook were:

$$\text{Fork length (mm)} = 0.9526\ \text{Total length (mm)} - 10.8259,$$
$$\text{Fork length (mm)} = 1.1109\ \text{Standard length (mm)} + 7.1198,$$
$$\text{Total length (mm)} = 1.0490\ \text{Fork length (mm)} + 11.826, \text{ and}$$

$$\text{Weight (g)} = 8.2775\ 10^{-6}\ \text{Fork length(mm)}^{3.0434}.$$

The estimated length-length and length-weight relationships for gulf coast snook were

Fork length (mm) = 0.9512 Total length (mm) - 14.8606,
Fork length (mm) = 1.0630 Standard length (mm) + 20.0876,
Total length (mm) = 1.0502 Fork length (mm) + 16.2241, and

Weight (g) = $4.4014\ 10^{-6}$ Fork length(mm) $^{3.1117}$.

These relationships predict that the average weight of a 28-in TL snook would be 7.2 lb on the Atlantic coast and 5.8 lb on the gulf coast. Conversely, the average weight of a 32-in TL snook on the Atlantic coast would be 10.8 lb and on the gulf coast, the average weight of a 33 in TL snook would be 9.8 lb.

3.0. FISHERY CHARACTERISTICS

2.7. Natural mortality

The instantaneous natural mortality rates were based on the longevity of Common Snook being 15-20 years and were the same rates as those used in previous Common Snook analyses: 0.20 per year on the Atlantic coast and 0.25 per year on the gulf coast. A possible explanation for the coastal difference in maximum ages and natural mortality rates was that Common Snook on the gulf coast are exposed to more cold kills, such as occurred in December 1983, December 1989, January 2001 or in January 2010, and red tides, such as occurred in September 2001 or July 2005. A re-analysis of the tag returns, including updated information on reporting rates and angler behavior, produced estimates of natural mortality of 0.34 per year (Atlantic coast) and 0.41 per year (gulf coast) suggesting that the currently used rates are low (B. Pine, University of Florida, personal communication). Then et al. (2015) reexamined the question of natural mortality rates and derived an equation that predicts higher natural mortality rates. However as mentioned earlier (Section 2.6), there was a tag return in 2014 from a fish that was tagged in Jupiter Inlet on the Atlantic coast in August 1993 (21 years at liberty) and this fish's age was estimated at more than 25 years. The analyses of the tagging data suggests that natural mortality should be higher while the recapture of a fish 25 or more years old suggests that natural mortality should be lower. With this equivocal information, we continue to use the same average rates as in previous assessments in the base run with sensitivity runs that used higher and lower natural mortality rates.

3.1. Commercial Harvest

There has been no legal commercial harvest of snook in Florida after the Florida Legislature declared snook a gamefish in 1957 and prohibited the sale of snook. For historical perspective, we present the statewide commercial landings of snook from 1918 through 1957 in Fig. 3.1.

3.2. Recreational Harvest

The FWC obtains estimates of recreational landings and releases from two National Marine Fisheries Service programs: the Southeast Region Headboat Survey (SRHS) and the Marine Recreational Fisheries Statistics Survey which has recently undergone a major revamp and has been renamed the Marine Recreational

Information Program (MRFSS/MRIP). We did not include headboat landings in these analyses because SRHS reported only 81 snook landed in the southeast United States during 1986-2014; thus, MRFSS/MRIP was the sole source of our snook landings and releases **(http://www.st.nmfs.noaa.gov/recreational-fisheries/index)**.

MRFSS/MRIP began sampling in 1979 but the first two years can be considered a sampling pilot study because changes in the survey's estimation methodology in 1994 precluded the calculation of estimates in the first two years; hence MRFSS/MRIP uses 1981 as the start of the program. Information collected during angler interviews includes the types of fish anglers catch; how many fish are caught, kept and released; the lengths and weights of landed fish; and demographic information on the anglers. In 1986, extra interviews in the private and rental boat mode were conducted in Florida to improve the estimates for king mackerel and in 1987 MRFSS/MRIP adjusted their sampling allocations by reducing the number of interviews with anglers fishing from shore and increasing the interviews of anglers fishing from private or rental boats. In the 1992, Congress allocated more funding such that the overall numbers of interviews were increased by approximately 250%. The annual number of recreational interviews increased from approximately 12,000 interviews on each coast of Florida to a maximum of 22,000 on the Atlantic coast in 2002 and a maximum on the gulf coast of 31,000 interviews in 2004 (Fig. 3.2.1) after FWC/FWRI personnel began conducting the creel survey interviews for MRFSS/MRIP in 1998. The implementation of the MRIP estimation procedures required more night and early morning interviews and that has resulted in fewer interviews conducted in recent years. While we present recreational landings information from 1981, we confine the stock analyses to the period 1986–2014 with the more comparable data. The 2014 data were downloaded from MRFSS/MRIP on 16 Mar 2015 and are considered preliminary and subject to change.

Catch and landings estimates were calculated for the Atlantic and gulf coasts of Florida separately for each stratum: six two-month waves of the year, three fishing modes (e.g., from shore, charterboat/guide boats, or private/rental boats), and three areas along each coast (inshore waters, state territorial waters, and federal offshore waters). Thus, the annual estimates of catch, landings and releases, are aggregates of the individual stratum estimates.

The catch estimates in this assessment do not match those from earlier assessments because NMFS/MRIP recommended that the new MRIP methods and estimates be used where possible and to adjust the estimates for the years prior to MRIP, i.e., data prior to 2004, using the procedures developed by the Ad Hoc Recalibration Working Group (NOAA 2012). The MRIP adjustment factors were calculated using 2004-2014 data. While the patterns remain similar, the magnitude of the landings and releases were different (Fig. 3.2.2).

To evaluate the variability in catch and landings estimates, we used a Monte Carlo approach to calculate 10,000 values within each stratum using the stratum's mean estimate and variance (each of the 10,000 values was calculated as the stratum mean estimate plus a random, normal deviate (μ=0, σ=1) times the square root of the stratum variance), and then combined the different stratum estimates by coast

and year to identify the mean, median, quartiles, and 95% confidence limits. We used the mean estimated number of fish kept (Types *a* and *b1* fish in MRFSS/MRIP) as landings and the mean estimated number of fish released alive (Type *b2* fish) as releases in the subsequent analyses. This is the same approach that was adopted in previous snook stock assessments.

Recreational angler interviews indicated that anglers in Florida released more than 95% of the snook they caught (Table 3.2.1, Fig. 3.2.3). In 2014, the total catch, including the number of fish released, was 431,000 fish on the Atlantic coast and 1,592,000 fish on the gulf coast. On the Atlantic coast, the total catch of snook peaked at 683,000 fish in 1995 and, on the gulf coast, at 2,343,000 fish in 2005. The estimated total harvest of snook, meaning those snook that were retained by the angler plus those snook that were estimated to have died after being released alive, was around 32,000 fish from 1998 through 2004 on the Atlantic coast and has been lower since then, with only 6,500 fish harvested in 2010, when the fishery was only open during the delayed fall season (September 17 through December 14, 2010). The total harvest in 2014 on the Atlantic coast was 17,900 snook. The gulf harvest peaked at 149,000 fish in 1997 then declined and then rose to about 117,000 fish in 2004 before dropping to very low levels after 2009 with the closure of the gulf fishery until September 2013 (Fig. 3.2.4). The total harvest in 2014 on the gulf coast was 47,500 snook. The variability in the harvest estimates is shown in Fig. 3.2.5; the harvest on the Atlantic coast in 1997 was poorly estimated as were the total harvests on the gulf coast in 1996 and 1999. The low harvests from 2010 to 2012 reflect fish that died following catch and release during the gulf coast snook closure.

As mentioned above, the term 'harvest' includes the estimated number of fish that died after being released as well as the number of snook that were landed. Taylor *et al.* (2001) estimated the overall, average release mortality rate, which is the percentage of snook that die after having been released alive, as only 2.13 % for snook. Although this rate is low, because anglers release most of the snook they catch, the number of deaths due to hooking injuries or catch-and-release stress can be appreciable (Table 3.2.1). Release mortality accounted for about 9,000 out of the 17,900 fish harvested (50%) in 2014 on the Atlantic coast. On the gulf coast the proportion of total harvest that was attributed to live-release deaths was 33,600 fish out of 47,500 total snook harvested (71%) in 2014 (Table 3.2.1, Fig. 3.2.4). The percentage of harvest attributed to release mortality has increased significantly since 1981 on both coasts (t-test that the slope is zero, $t = 8.12$, $df = 32$, $P < 0.05$ on the Atlantic coast and $t = 10.87$, $df = 32$, $P < 0.05$ on the gulf coast).

The two coasts differ as to when landings and releases occur. During the period of 2008-2014, the Sep–Oct wave accounted for 55% of the annual landings of snook on the Atlantic coast (Fig. 3.2.6). On the gulf coast in the same period, landings were almost evenly split between Mar-Apr (41%) and Sep-Oct (35%). On a finer, multi-year temporal scale, i.e., the periods 2008-2012 and 2013-2014, the landings on the Atlantic coast show a shift from Mar-Apr to Sep-Oct such that in 2013-2014 65% of the landings were taken in Sep-Oct (Table 3.2.2.). On the gulf coast, there was a similar shift from Mar-Apr to Sep-Oct such that 45% of the landings were taken in Sep-Oct. Releases on the Atlantic coast also showed an intensification of

proportion of releases during Jul-Aug (38%) and releases on the gulf coast shifted from May-Jun to Sep-Oct (27%).

3.3. Recreational effort

Recreational trips are not classified by species; therefore, we have to estimate the number of trips that were directed towards a particular species. MRFSS/MRIP developed a program to estimate directed fishing trips for a particular species by prorating the total number of trips in each stratum by the number of trips that caught the species of interest and then adding up the trips across strata. Directed trips for snook generally increased on the Atlantic coast until 2007 and then declined (Fig. 3.3.1a). The decline in 2008 coincided with the weakening of the U.S economy and peak in gasoline prices (Fig. 3.3.2). The number of trips on the gulf coast also increased until 2007 and then declined (Fig. 3.3.1b). Although snook anglers on the gulf constituted a higher proportion of the total trips than did snook anglers on the Atlantic coast, the patterns were similar (Fig (3.3.1b).

Total harvest increased as the number of trips by year increased on the Atlantic coast until 1998 and then, while effort continued to increase until 2008, the total harvest of snook declined, probably in response to the regulatory changes (Fig. 3.3.3). On the gulf coast, total harvest tracked effort until 2005 and then declined through 2010 before increasing again. Coincident with these two sharp declines in effort were an extensive red tide in 2005 and the cold temperatures in January 2010.

Changing popularity on snook with anglers can possibly be considered as another indicator of changes in effort. Based on MRFSS/MRIP interviews with anglers who indicated preferences for catching a particular species during their fishing trips, snook was the fifth most targeted fish on the Atlantic coast from 2000 to 2009, dropped to tenth place in 2012, and was the fourth most targeted in 2014 (Table 3.3.1). Snook was the third most targeted species on the gulf coast in 2009 but also dropped to tenth place in 2012 and has since returned to third place in 2014. As noted in earlier assessments, anglers did not rank snook in the top five target species on either coast in 1987. In the Everglades National Park Creel Survey, the top three species sought by anglers have been snook, spotted seatrout and red drum.

The number of snook permits also can be considered as a possible measure of recreational effort for snook. With the addition of five-year snook permits, lifetime, Gold Sportsman, and Saltwater shoreline licenses, we had to combine the annual sales of resident snook permits with these other licenses to arrive at the total number of snook permits in a given year. This process estimates the number of licenses and permits even though some of the multi-year license holders may not be active. Resident snook permits were initially required beginning in 1990, the statewide number of active permits has increased from 113,500 stamps in fiscal year (FY) 1990–91 to 282,000 stamps in FY 2006–07. It has remained at close to that level until a drop from FY 2010-11 through FY 2012-13, followed by an uptick in 2014 (Fig. 3.3.4a). The number of resident snook stamps in FY 2013/14 was 179,000 stamps. We combined resident Saltwater Fishing licenses in a manner similar to what we did for snook permits. The number of active Saltwater Fishing

licenses has increased significantly since 1989–90 (*t*-test for slope equals zero, $t = 9.41$, $df = 21$, $P < 0.05$), reaching 985,000 licenses in FY 2013–14 (Fig. 3.3.4b). The ratio of snook permits to resident licenses increased peaking at 46% in 2007-08 and then decreased to lows during the gulf coast closure years (Fig. 3.3.4c).

3.4. Lengths of fish caught by anglers

Size limits for snook in Florida have been revised several times since the Marine Fisheries Commission was established in 1983. The minimum size was increased from 18 in (457 mm) to 24 in total length (610 mm, TL) in 1985 with the provision that anglers could keep one snook longer than 34 in (864 mm) total length. In January 1999, the size limits were changed to a slot limit with a minimum size of 26 in (660 mm) TL and a maximum size of 34 in TL and no allowance for keeping larger snook. The Commission narrowed the slot an inch in July 2006 by raising the minimum size to 27 in (686 mm) TL to account for measuring length as maximum total length (tail squeezed) as opposed to measuring total length with the tail relaxed. Based upon the recommendations of the 2007 Snook Work Group, the Commission established slot limits by coast in July 2007 which reduced the allowable harvest slot limits to 28-32 in (711-813 mm) TL on the Atlantic coast and to 28-33 in (711-838 mm) TL on the gulf coast.

Lengths of fish caught by anglers came from MRFSS/MRIP interviews (1986–2014), Everglades National Park Creel Survey (1986–2014), snook carcasses that anglers voluntarily supplied to FWRI (1997–2014), FWRI interviews targeting snook anglers (1998–2014), logbook records including the Angler Action data from the Snook and Gamefish Foundation (AnglerAction.org, 2010-2014). Although snook length regulations are in total length, MRFSS/MRIP and ENP samplers record fish lengths in millimeters fork length, thus we converted the fork lengths to maximum total lengths (defined below) using the length-length equations in Taylor et al. (2000). Logbook data, for the most part, is reported in inches total length. When FWC samplers measured total length, they squeezed the tail; thus, all of the subsequent analyses will use the term 'total length' to mean total length with the tail squeezed or maximum total length. For evaluating the effectiveness of regulations, we converted the length measurements into integer inches total length (TL).

Lengths of snook landed by anglers and sampled by creel clerks or reported in logbooks in 2008-2014 on the Atlantic coast (3,887 fish) ranged from 10 in to 37 in TL (Table 3.4.1). Fish on the gulf coast during the same period (1,693 fish) ranged in length from 8 in to 35 in. The maximum lengths of recreationally caught snook measured over the assessment period were 44 in on the Atlantic coast and 46 in on the gulf coast (Fig. 3.4.1). The lengths of snook measured by samplers showed that snook landed on the Atlantic coast were larger than those landed on the gulf coast (Fig. 3.4.1, Kolmogorov-Smirnov two-sample test, max difference = 0.29, test difference = 0.01, reject the null hypothesis).

We assigned sampled length frequencies to the landings estimates to create the estimated landings-at-length by year and coast. When sufficient length data were available, we assigned lengths to landings by coast, year and season (spring: Jan-Jun and fall: Jul-Dec).

Given that anglers release many snook, we had to assign lengths to fish that were not available to the samplers for measurement (MRFSS/MRIP catch Type *b1* and Type *b2*). The fish that anglers reported landing but that were unavailable for inspection by the creel clerk (Type *b1*) were assumed to have the same lengths as the landed fish measured by the samplers (Type *a*). As in the previous snook stock assessment (Muller and Taylor 2013), the fish that were released alive (Type *b2*) were assigned the lengths based on logbook data, the FWC Catch-and-Release program, and the Snook and Gamefish Foundation's Angler Action data set. For the years 2002-14, the lengths were assigned directly to the numbers of fish that were released alive by coast, year, and season. For the 1999-2001 years, the average lengths from 2002-2005 were applied and for the years prior to 1999, the lengths of fish less than 24 in were applied to the released fish. The length composition of the fish that were believed to have died after being released fish are presented in Table 3.4.2.

Therefore, the final total catch-at-length is a composite of the sampler-observed lengths assigned to the directed fishery and the lengths assigned to the estimated numbers of snook that were released alive tallied by length and year (Table 3.4.3).

3.5. Ages of fish caught by anglers

The ages of snook were determined from sectioned otoliths (ear bones) that were collected from fish captured by fishery dependent and fishery independent programs (Table 3.5.1). Because the spawning season of snook is in the summer and snook form their annulus (ring) on the otoliths in the spring, fish were assigned to their year class based on the number of annuli and for those fish collected from January to June, age was determined by whether the annulus was on the margin of the otolith. Because landings are by calendar year, young of the year fish become age-1 fish on January 1 of the year following their hatching. Fishery dependent ages were used to assign ages to the catch-at-length by coast and year. Seventy percent of the length-specific landings on the Atlantic coast and 64% of the length-specific landings on the gulf coast were matched directly by coast and year. The remaining length-specific landings were assigned ages from fishery-dependent ages that had been grouped across years by regulatory period. However, approximately 1% of the lengths on the gulf coast were either small (less than 18 in or large >43 in and these were either aged from fish collected by fishery-independent sampling (0.7%) or by a stochastic aging process (0.3%) that was derived from the von Bertalanffy growth curve and the root-mean-square error (Muller and Taylor 2012). The years that had ages assigned with fishery-independent ages were down-weighted in the stock assessment analysis by assigning an effective sample size of one. The ages of released fish were derived from age-length keys by coast and year that came from fishery dependent sampling, life history studies and fishery-independent sampling.

The estimated numbers of harvested fish by age, year, and coast are shown in Table 3.5.2. Fish older than 12 years old were not consistently harvested on either coast and so we combined all snook that were 12 years old and older into a 12^+ age category. Using a 12+ category on the gulf coast was a departure from previous assessments that used a 10+ as the oldest age category on the gulf coast.

3.6. Bycatch

The main source of bycatch in the snook fishery is the recreational fishery for snook and the fish that are caught and released because they are not within allowable slot limits or bag limits. Fish that are released alive are estimated as MRFSS/MRIP Type-*b2* fish and are included in the assessment. Historically, snook were occasionally caught as bycatch to the inshore gill-net fishery (Motta 1993). However, the constitutional net ban implemented in July 1995 (Article X, Florida Constitution, Section 16) eliminated the use of entangling nets from inshore waters and from use in all likely snook habitats. There is potential for snook to be caught by commercial hook-and-line or cast net fishers but FWC does not have observer data from these fisheries to determine the extent of this bycatch.

3.7. Combined Harvest

The harvest from the recreational fishery is the only legal harvest because Florida's legislature eliminated the commercial fishery by making snook a gamefish in 1957. Bycatch of snook in commercial gear became apparently minimal after 1995 when a constitutional amendment in Florida eliminated entangling gear from state waters and restrictions were placed on other nets.

4.0. ASSESSMENT

4.1. Trends in availability

An underlying assumption in stock assessments is that the availability of fish, as measured by catch rates, reflects abundance or population size. The National Research Council (1998) recommended using fishery-independent indices and, whenever possible, indices by specific ages. In this snook assessment, we used the catch rates from FWC's FIM program's stratified-random seine hauls as well as total catch rates from the fishery to tune the model.

4.1.1. Fishery Independent Indices

The 183 m (600 ft) haul seine deployed by FIM is an ideal gear for sampling snook because the seine catches snook a wide range of sizes, from 10 in on either coast to a maximum of 45 in on the Atlantic coast and to 43 in on the gulf coast. To account for various sources of uncertainty in the observed number of snook per seine haul that was not related to their abundance, we standardized the estimated mean number of snook per seine haul with hurdle models by coast that involved two generalized linear models (GLIM) per index. One model estimated the probability that a haul seine set would catch a snook and assumed a binomial distribution (logit link) and the other model estimated the number of snook caught in successful hauls using a gamma distribution (log link). The annual index is the product of these two terms by year after they each have been back-calculated from their linear forms (for the logit link, the transform was $\Pr op = \frac{e^{f(x1+x2+..)}}{1+e^{f(x1+x2+...)}}$ and for the gamma, the transform was $Y = e^{g(x1+x2+...)}$ where the x1, x2,… refer to the variables included in the respective linear models). Potential variables to be

included in the GLIM models were bay, year, month, presence/absence of bottom vegetation, bottom type (mud or sand), shore type (mangrove, emergent, terrestrial, or structure), water temperature, and salinity. Temperature and salinity were subdivided into several categories to handle any non-linearity in the catch-rate response. For a variable to be included in the final model, the variable had to meet two criteria: the variable had to be statistically significant at the 0.05 level (chance of observing a value if its actual value was zero) and it had to reduce the deviance (a measure of the variability) by at least 0.5%. To calculate the year-specific index and its variability, we used a Monte Carlo simulation approach with 10,000 iterations that used the least-squares mean estimates and their standard errors from the GLIM models. Each iteration used the annual least-squares mean catch rate and added uncertainty that was calculated by multiplying the standard error by a random normal deviate (μ=0, σ=1). As described above, these values were converted back from their linear scale and multiplied together.

On the Atlantic coast, the GLIM reduced the mean deviance of the proportion of positive seine hauls by 30% (11,024 seine hauls) and the mean deviance of the positive hauls model (3,093 hauls) by 12%. The number of snook per set on the Atlantic coast reached a low in 2002 and then varied without trend before it dropped in 2010. It increased in 2012 and again in 2013 but the catch rates have yet to regain their 2002-2009 levels (Fig. 4.1.1.1a). On the gulf coast, the GLIM reduced the mean deviance of the proportion of positive seine hauls by 21% (12,193 seine hauls) and the mean deviance of the positive hauls model (3,628 hauls) by 7%. Catch rates on the gulf coast generally increased until 2001-2003 then leveled off until declining in 2009 and 2010 and increasing afterwards reaching a peak in 2014. (Fig. 4.1.1.1b).

To provide the model guidance on recruitment (age-1 fish), we incorporated data from the 21-m seines as well from the 183-m haul seine. Based on FIM age samples, the interquartile length range for age-1 fish was from 210 – 302 mm TL (8.3 to 11.9 in) on the Atlantic coast and from 235 – 353 mm TL (9.3 to 13.9 in) on the gulf coast. Therefore, instead of the number of snook per haul seine as was used before, we used the number of age-1 snook per seine set based on the interquartile lengths as a measure of the number of recruits. We used the same GLIM approach as for the FIM index and gear type was added as a potential variable. On the Atlantic coast, the GLIM for age-1 snook reduced the mean deviance of the proportion of positive seine hauls by 22% (22,585 seine sets) and the mean deviance of the positive seine set model (701 sets) by 4%. Age-1 fish on the Atlantic coast increased until 1999 and then declined to a low in 2002 then another increase to 2004 followed by a decrease until 2010, with the exception of 2008 (Fig. 4.1.1.2a). The Atlantic catch rates since 2012 have been at a level similar to those of 2004-2005. On the gulf coast, the GLIM reduced the mean deviance of the proportion of positive seine sets by 14% (48,540 sets) and the mean deviance of the positive seine set model (958 sets) by 8%. Age-1 fish on the gulf coast increased until 2000 and then dropped in 2001 and 2002, possibly in response to a cold water event in January 2001. The catch rates increased and then were level until 2012 when they increased again reaching their highest value in 2014 (Fig. 4.1.1.2b).

4.1.2. Fishery Dependent Indices

Because recreational interviewers collect information on the number of fish released as well as the number landed, we developed a fishery dependent index for the Atlantic coast using MRFSS/MRIP's total catch per intercept. On the gulf coast, we developed two fishery dependent indices, one from MRFSS/MRIP intercepts and a similar index from Everglades National Park's creel survey. While there were some night interviews, the majority of the MRFSS/MRIP interviews were conducted during the daytime; for example, during the years 1999-2014, 97% of the interviews on the Atlantic coast and 99% on the gulf coast were conducted between 9:00 AM and 7:00 PM (Fig.4.1.2.1). We do not assume that the nighttime catch rates are equal to the day time catch rates but only that the overall trends between daytime and nighttime fishing have not changed systematically through time. For the indices, the actual total number of fish caught per intercept is not as important as the inter-annual trends.

If more than one interview was conducted on the same recreational trip, beginning in 1991, MRFSS/MRIP has a data field that allows linking these ancillary trips to the primary interview; therefore, catch rates were determined from the 1991 to 2014 MRFSS/MRIP data and the measure for the catch rate was the total number of fish caught by all of the anglers on the recreational trip identified by the primary interview.

We ran cluster analyses (Krebs 1989, Shertzer and Williams 2008) to identify which MRFSS/MRIP interviews had the potential to catch snook, this was the same procedure that was used in the 2012 and 2013 stock assessments. The cluster that included Common Snook on the Atlantic coast included Red Drum and Spotted Seatrout while the cluster on the gulf coast included Common Snook and Red Drum (Fig. 4.1.2.2). Thus, the selection criterion was to include any trip that caught any species in the cluster as a potential snook trip.

As with the fishery-independent indices, we used a generalized linear model with a binomial distribution (logit link) for the proportion of positive trips and a second GLIM with a gamma distribution (log link) for the number of snook caught on successful trips. Comparisons between the log-normal and gamma distributions for the modeling the number of snook caught per positive trip demonstrated that the gamma distribution reduced the deviance more than the log-normal distribution did. For example, on the Atlantic coast, the gamma reduced the deviance by 10.0% and the log-normal distribution was only 4.4%. Similarly on the gulf coast, the gamma reduced the deviance by 10.6% and the log-normal distribution reduced it by 6.1%. The indices by coast were the product of the annual proportion of positive trips times the annual mean number of snook caught on positive trips. Potential variables for the analyses included year, the two-month wave during which the trip was conducted, the number of anglers on a fishing trip, the length of the fishing trip in hours, area fished (bay or nearshore), the mode of fishing (shore, charter, private/rental boat), and avidity (the number of fishing trips that the angler made in the previous two-months). Again, variables were included in the final model if they were statistically significant and they reduced the null mean deviance by at least 0.5%.

On the Atlantic coast, the GLIM with the binomial distribution reduced the mean deviance of the proportion-positive by 24% (26,106 trips) and GLIM with the gamma distribution reduced the mean deviance of the number of Common Snook on positive trips (6,429 trips) by 10%. The estimated number of snook per trip from MRFSS/MRIP intercepts generally declined reaching a low in 2010 followed by an increase with the estimated mean catch rate in 2014 (1.74 fish per trip; Fig. 4.1.2.3a). The 2014 mean catch rate was similar to the levels seen during the early 1990s. The GLIM for the gulf coast with the binomial distribution reduced the mean deviance of the proportion-positive model by 5% (30,451 trips) and GLIM with the gamma distribution reduced the mean deviance of the positive-trips model (15,555 trips) by 11%. The estimated MRFSS/MRIP catch rates on the gulf coast were more variable but generally increased until the sharp drop in 2010; however, the highest value was in 2014 (Fig. 4.1.2.3b).

A cluster analysis of catch rates from Everglades National Park's Creel Survey (ENP) for the years 1999–2014 was calculated in the same manner as the MRFSS/MRIP catch rates. The ENP data also grouped Common Snook with Red Drum. Potential variables for ENP were year, month, interview location (Flamingo or Everglades City), area fished (areas 1-6), hours fished, and the number of anglers. The final model reduced the deviance by 13% for the proportion of positive trips (63,288 trips) and 17% for the number of snook caught on positive trips (41,245 trips). The ENP index (Fig.4.1.2.3.c.) increased more than the MRFSS/MRIP index before a sharp drop in 2010 and then a more gradual increase afterwards.

4.1.3. Comparison of Indices

On the Atlantic coast, there was one fishery independent index, FIM, and one fishery dependent index, MRFSS/MRIP that provided guidance to the assessment model on population abundance. While these two indices provide different looks at the population because one was sampled with a 183-m haul seine (FIM) and the other was sampled by anglers, their selectivity patterns link the indices to the corresponding ages in the population. When the two indices are superimposed (Fig. 4.1.3a), they show similar patterns ($r = 0.72, df = 16, P < 0.05$): a decline from 1995 (MRFSS/MRIP) or 1997 (FIM) until 2002, then flat or an increase in the FIM index in 2008 followed by a sharp drop in 2010 and an increase after 2011. On the gulf coast, there was one fishery-independent index, FIM, and two fishery-dependent indices, MRFSS/MRIP and ENP. As on the Atlantic coast, the fishery-independent gear was the FIM 183-m haul seine and the fishery-dependent indices used anglers and their hook-and-line gear. The FIM index was significantly correlated to the MRFSS/MRIP index ($r = 0.85, df = 17, P <0.05$) but the ENP index was not correlated to either the MRFSS/MRIP index ($r = 0.38, df = 22, P = 0.067$) nor the FIM index ($r = 0.31, df = 17, P = 0.20$; Fig. 4.1.3b). The ENP's lack of correlation to the other indices could be due to its very high values 2007-2009.

4.2. Assessment models

As in the 2013 assessment, we used the Age-Structured Assessment Program (ASAP, Legault and Restrepo 1998) from NMFS's Northeast Fisheries Science Center's Assessment Toolbox as the main analytical tool. However to get a rough idea of the levels of expected total mortality rates, we calculated catch curves by

coast using the numbers of fish harvested by age by the FIM haul seines over the period 2008-2014.

4.2.1. Catch Curves

At several of the SEDAR workshops and reviews, reviewers have asked for some simple analyses as checks on more complex population models. One of the simplest models for estimating total mortality rates is a catch curve, which can be determined from just a plot of the number of fish by age (Ricker 1975). When plotted on a log-scale, this curve becomes linear, provided that the total mortality and recruitment are constant, and its slope is an estimate of the total mortality. This model is rarely used as a final analysis because of assumptions of constant recruitment, all ages being equally vulnerable, and constant mortality; however, a catch curve provides a rough estimate of the expected magnitude of total mortality.

4.2.1.1. Model Configuration and Equations

The basic data for a catch curve is numbers of fish by age. The size slot limits that were implemented in 1999 and narrowed in 2007 preclude using fishery dependent data for estimating total mortality because mortality is confounded with the upper size limit. Therefore to get an idea of recent mortality rates, we used the 2008-14 numbers of fish by age and coast collected with the FIM program's 183 m (600 ft) haul seine. Instead of simply taking the logarithms of the number of fish and calculating a linear regression on age, we used the Chapman and Robson approach because it is less sensitive to missing ages and to sampling error (Chapman and Robson 1960, Ricker 1975, Murphy 1997). Using the equations from Ricker (1975), survival, *S*, is:

$$S = \frac{T}{\Sigma N + T - 1} \qquad (4.2.1.1.1)$$

where $T = 0N_0 + 1N_1 + 2N_2 + 3N_3 + \ldots + AN_A$, $\Sigma N = N_0 + N_1 + N_2 + \ldots + N_A$, N_0 is the abundance of the first age considered to be fully available, and *A* is the oldest age. Annual survival can be converted to an instantaneous estimate of total mortality, *Z*, by

$$Z = -\ln(S) \qquad (4.2.1.1.2)$$

where ln() refers to taking the natural logarithm.

4.2.1.2. Parameters estimated

A catch curve estimates a single parameter, survival, which in turn can be expressed as total mortality per year.

4.2.1.3. Uncertainty and Measures of Precision

The variance of survival from a catch curve is calculated using:

$$V = S\left(S - \frac{T-1}{\Sigma N + T - 2}\right) \qquad (4.2.1.3)$$

However we have found that the variance tends to be under-estimated and we know that the haul seine data do not meet the equilibrium assumptions. Hence these rates are only to be used as ball park estimates.

4.2.1.4. Model Results

We calculated catch curves by coast using the 2008-2014 numbers of snook caught at age from the haul seines and determined the starting age as the next older age after the modal-abundance age. The catch curve calculations for the Atlantic coast included ages 4 through 19 and the annual survival rate was 0.75 (Fig. 4.2.1.4a), which was equivalent to an instantaneous total mortality rate of 0.29 per year. The standard error of the annual survival rate ($\sqrt{V}$) was 0.0050 and the 95% confidence interval for the total mortality was 0.28 – 0.31 per year). On the gulf coast, the calculations included ages 4 through 15 and the annual survival rate on the gulf coast was 0.56 (SE = 0.0082; Fig. 4.2.1.4b) which was equivalent to an instantaneous total mortality rate of 0.58 per year (95% confidence interval 0.55 – 0.61 per year). This rate was the same value as was calculated in the last assessment for the gulf coast. Because of the underlying assumptions of constant recruitment, constant mortality, and constant selectivity across ages, it must be remembered that these estimates from catch curves provide only rough numbers.

4.2.2. Age-Structured Assessment Program (ASAP)

The Age-Structured Assessment Program (ASAP) has been used extensively in the southeast US for the red snapper stock assessment (Schirripa and Legault 1999), the red grouper stock assessment (NOAA 2002, SEDAR, 2006), the mutton snapper assessment (SEDAR 2008, O'Hop et al. 2015), the black grouper assessment (SEDAR 2010), and the 2012 and 2013 snook assessments (Muller and Taylor 2012, 2013). ASAP is a statistical catch-at-age model that allows for multiple fisheries, discards, and tuning indices. The model estimates a stock- recruit relationship and biomass-based benchmarks internal to the model. ASAP estimates the population numbers by age in the first year of the time series and recruitment of age-1 fish in all years and then works towards older and more recent years (forward projection). This assessment used ASAP version 3.0.17 which was released in April 2014.

4.2.2.1. Model Configuration and Equations

Although the 2013 base model for the gulf coast included two fisheries: the recreational fishery and the removals from red tide and cold kills, the number of snook killed by either the red tides or the cold temperatures is very poorly estimated. Therefore, we prefer to use the approach that was originally used in the 2012 assessment with only the recreational fishery in the base model and then make sensitivity runs with different approximations of the numbers of snook killed by the environmental factors to demonstrate the importance of environmental effects on snook stocks.

The basic equations for ASAP are similar to those found in any statistical catch-at-age model and recruitment is determined from a Beverton-Holt stock-recruit relationship (Beverton and Holt 1957) with annual deviations. Fishing mortality, in the absence of discards, was considered to be the product of selectivity for a particular age and the annual fishing mortality for fully recruited fish ($Fmult_{f,,y}$, selectivity = 1.0). The annual fishing mortality deviations were multiplicative meaning that the fishing mortality multiplier for a given year depended upon the prior year's fishing mortality multiplier, i.e. $Fmult_{f,y} = Fmult_{f,y-1}*Fmult_dev_{f,y}$. The equation for the fishing mortality at age, *a*, in year, *y*, for fleet, f was:

$$F_{f,a,y} = Sel_{f,a} Fmult_{f,y} \qquad (4.2.2.1.1)$$

where $Sel_{f,a}$ was the selectivity for a given age. In prior assessments, we applied different selectivity patterns when the size limits changed but, since the minimum size has been 24 in TL (610 mm) or greater for the entire time series and because ASAP allows the linkage of the discards to the fish that were kept, it was deemed more appropriate to use a single, flat-topped selectivity pattern and then account for the different retention size limits with the proportion of fish that were released by age and year. Because $Fmult_{f,y}$ predicts the total catch and some of the fish are discarded, $Fmult_{f,y}$ is a capture rate not a mortality rate. Separate selectivity patterns were used for the recreational fishery and for the MRFSS/MRIP index. Discards in the snook fishery were those snook that anglers released alive (Type *B2* fish) because the fish were either not in the allowable slot limit, or the angler had already filled his bag limit, or the snook season was not open, or the angler practiced catch-and-release fishing. When discards were linked to the kept fish, the equation for the fishing mortality of the directed fishery at age, *a*, in year, *y*, for fleet, *f*, $F_{f,a,y}$, became:

$$F_{f,a,y} = Sel_{f,a} Fmult_{f,y} (1 - prop_rel_{f,a,y}) \qquad (4.2.2.1.2)$$

where $prop_rel_{f,a,y}$ was the proportion of fish that were discarded by each age and year and the corresponding discard mortality, $F_disc_{f,a,y}$, was:

$$F_disc_{f,a,y} = Sel_{f,a} * Fmult_{f,y} * prop_rel_{f,a,y} * rel_mort \qquad (4.2.2.1.3)$$

where *rel_mort* was the release mortality on the discarded fish. The release mortality rate on snook was 0.0213 per year (Taylor et *al.* 2001).

The number of snook at age and year, $N_{a,y}$, was projected forward from the earliest year using the total fishing mortality by age and year, $F_tot_{f.a.y}$ ($F_tot_{f,a,y} = F_{f,a,y}+F_disc_{f,a,y}$), and the natural mortality rate, $M_{a,y}$, from

$$N_{a+1,y+1} = N_{a,y} \exp(-F_tot_{f,a,y} - M_{a,y}) \qquad (4.2.2.1.4)$$

The predicted catch-at-age, $\hat{C}_{a,y}$, was calculated from the Baranov catch equation (Murphy 1965, Ricker 1975):

$$\hat{C}_{a,y} = N_{a,y} \frac{F_tot_{f,a,y}}{(F_tot_{f,a,y} + M_{a,y})}(1 - \exp(-F_tot_{f,a,y} - M_{a,y})). \quad (4.2.2.1.5)$$

Predicted index values were calculated from the estimated number of snook of the appropriate ages, the appropriate selectivity pattern, and the index's catchability coefficient, q_j. For an aged index, I_j, the number of snook at age was summed across the ages for the index and multiplied by the catchability, q_j, or

$$\hat{I}_{y,j} = q_j \sum_a N_{a,y} \quad (4.2.2.1.6)$$

The Beverton-Holt stock-recruit equation was fit with annual log-normal recruitment deviations (Hilborn and Walters 1992). The formulation of the Beverton-Holt equation in ASAP for the calculation of recruitment in year, *y* (R_y), from the spawning biomass in year, *y-1* (SSB_{y-1}), was:

$$R_y = \frac{\alpha SSB_{y-1}}{\beta + SSB_{y-1}} \quad (4.2.2.1.7)$$

where

$$\alpha = \frac{4hR_0}{5h-1} \quad (4.2.2.1.8)$$

and

$$\beta = \frac{S_0(1-h)}{(5h-1)} \quad (4.2.2.1.9)$$

and *h* was the steepness (Francis 1992), S_0 was the unfished spawning biomass and R_0 was the unfished recruitment. Steepness is the ratio of the predicted recruitment at a spawning biomass level of 20% of the spawning biomass without fishing to the recruitment with no fishing and provides a simple, direct way of comparing the productivity associated with stock-recruit curves – higher steepness values indicate higher recruitment per unit spawning biomass at low spawning biomass levels.

4.2.2.2. Parameters Estimated

There were 80 parameters estimated in the Atlantic coast ASAP model and 83 parameters in the gulf coast model (Table 4.2.2.2). The estimated parameters on the Atlantic coast were: two selectivity parameters for the fishery, 29 fishing mortality estimates (F_{mult} in the initial year (1986) and 28 F_{mult} deviations), 29 recruitment deviations, initial abundances of 11 ages in 1986, three catchability coefficients for the indices, two selectivity parameters each for the FIM index and the MRFSS/MRIP index, the unfished spawning biomass, and steepness. The estimated 83 parameters on the gulf coast were: two selectivity parameters for the fishery, 29 fishing mortality estimates for the recreational fishery (F_{mult} 1986 and 28 F_{mult} deviations), 29 recruitment deviations, initial abundances of 11 ages in 1986, four catchability coefficients for the indices, two selectivity parameters each for the

FIM, MRFSS/MRIP and ENP indices, the unfished spawning biomass, and steepness. The sensitivity case with the environmental factors being treated as a fishery on the gulf coast, solved for 114 parameters instead of 83 parameters because that model added two selectivity parameters and 29 F_{mult} deviations for the "environmental fishery".

4.2.2.3. Uncertainty and Measures of Precision

Process error was partly evaluated through sensitivity runs with higher and lower natural mortality rates, a run with a high emphasis on the FIM age-1 recruitment index, and a run on the gulf coast that included the environmental effects of cold kills and red tides. Observation error, i.e., the precision of the ASAP estimated parameters, was evaluated with Markov Chain Monte Carlo (MCMC) simulations. The MCMC simulations were initialized with the parameter standard errors (Table 4.2.2.2) that came from the successful inversion of the Hessian which produced variance-covariance matrices. We generated eight chains of MCMC simulations, each with a different initial seed to initialize the random number generator, of 5.045 million simulations with a thinning rate of 1,009 producing 5,000 unique solutions per chain for a total of 40,000 outcomes from 40.4 million simulations. We applied a burn-in of 1 to eliminate the first record in each chain because the MCMC simulations started with ASAP output and hence the first records were the same. Autocorrelation and convergence were evaluated with the 'boa' package (Smith 2015) in R (R-Core Team 2015).

4.2.2.4. Model Results

4.2.2.4.1. Model Fits

The fits to the index age composition were reasonable for both coasts even though there were some years with poor fits (Table 4.2.2.4.1, Fig. 4.2.2.4.1.1). The fit of the age composition of the landings and dead discards was also close (Fig. 4.2.2.4.1.2 and Fig. 4.2.2.4.1.3). The fits to the index values were also reasonably close (Fig. 4.2.2.4.1.4) as were the fits to the discards (Fig. 4.2.2.4.1.5). Based on the mean square errors (MSE, essentially the variance of the individual model components), the ASAP fit the MRFSS/MRIP index the closest on the Atlantic coast followed by the FIM age-1 index, the discards, the FIM adult seine (183-m) index, and finally the recreational direct fishery (Table 4.2.2.4.1). On the gulf coast, the model fit the discards the closest, followed by the MRFSS/MRIP index, the Everglades National Park index, FIM adult seine (183-m) index, the recreational fishery, and finally, the FIM Age-1 index. ASAP fits the parameters on a logarithmic scale but we also show how the harvest and discards were fit on an arithmetic scale together with the 95% confidence interval from the MCMC simulations (Fig. 4.2.2.4.1.6).

4.2.2.4.2. Fishery Selectivity

The realized selectivities (the ratio of the population number weighted average age-specific fishing mortality to the maximum weighted fishing mortality rate) varied as size limits changed. Prior to 1999, the statewide minimum size was 24 in TL (609 mm) with an allowance for one fish longer than 34 in (863 mm) and the resulting

selectivity on the Atlantic coast was dome-shaped with a maximum at an age of 7 years old (Fig. 4.2.2.4.2.a). In 1999, statewide slot limits were implemented with a 26-34 in (660-863 mm) retention slot with no allowance for keeping a snook longer than 34 in. The selectivity generally increased up to age-11 and then dropped off. In July 2006, the minimum size was raised to 27 in (685 mm) and in July 2007 slot limits changed again by coast. On the Atlantic coast, the slot was reduced to 28-32 in (711 -812 mm) which lowered the age of maximum selectivity to age-6. On the gulf coast, the changes in selectivity were similar to those on the Atlantic coast with the age of maximum selectivity in the 1986-1998 period of age-7, followed by a general increase in selectivity up to age-11 when the slot limits were introduced in 1999 (Fig. 4.2.2.4.2.b). The reduction in the width of the slot limit to 28–33 in (711 – 838 mm) on the gulf coast shifted the maximum selectivity back down to age-6. The similarity in the resulting selectivities by coast and time period was surprising given the differences in growth rates by coast.

4.2.2.4.3. Fishing mortality rates

The estimated fishing mortality rates by coast, year, and age are presented in Table 4.2.2.4.3 and Fig. 4.2.2.4.3.1). Because of the different size limits through the years, the age that snook became fully selected has varied; therefore for historical comparisons, we will focus on a single age (age-7). The large error bars prior to 1997 reflect the lack of fishery dependent length and age samples. In previous snook assessments, as a holdover from using Integrated Catch at Age, we filled the missing data from neighboring data but this is not necessary in ASAP and the result was large error bars in years with missing data.

Looking at a trajectory of fishing mortality rates on age-7 fish on the Atlantic coast, we see that fishing mortality rates reached a peak 0.99 per year in 1995 and then the rates dropped markedly with the implementation of the 26-34 in slot limit in 1999 to levels near 0.20 per year except for 2007 when the rate spiked to 0.61 per year followed by a return to 0.17 per year in 2008 (Fig. 4.2.2.4.3.1a). The fishing mortality rates declined even further in 2010 with the cancellation of the spring opening. The rates remained low in 2011 and 2012 but rose to 0.22 per year in 2013 and then decreased slightly in 2014 (0.16 per year, 95% credible interval: 0.12-0.19 per year). The geometric mean of the fishing mortality rates from 2012 through 2014 was 0.12 per year.

On the gulf coast, the peak fishing mortality rate on age-7 fish was higher at 1.48 per year in 1996 and dropped sharply with the implementation of the slot limit in 1999 to levels around 0.20 per year and remained low (Fig. 4.2.2.4.3.1b). When the fishery was closed in 2010, the fishing mortality rates were very low (0.03 – 0.04 per year); however, the fishery reopened in September of 2013 and the fishing mortality rate increased to 0.24 per year but was back to 0.09 per year in 2014. The geometric mean of the fishing mortality rates from 2010 through 2014 on the gulf coast was 0.10 per year.

When fishing mortality rates from the current stock assessment were compared to those from the 2006 (Muller and Taylor, 2006), 2012 (Muller and Taylor 2012), and 2013 stock assessments (Muller and Taylor 2013) using age-7, the rates on the Atlantic coast were very similar in the three earlier assessments until 1999. This

assessment estimated higher fishing mortality rates than the previous three assessments prior to 1999 and then lower or similar rates except for the spikes in the 2007 rate in this assessment and in the 2011 rate in the 2013 assessment (Fig. 4.2.2.4.3.2a). On the gulf coast, the fishing mortality rates from this assessment also were higher until 1999 when they dropped to rates lower than the earlier assessments (Fig. 4.2.2.4.3.2b). A possible explanation for the difference in mortality rates is that in this assessment, we made an extra effort to ensure that only aged fish that were collected with hook-and-line gear were included in the assignment of ages to lengths. Further, because ASAP does not require a complete catch-at-age matrix, we did not fill any years that lacked length samples.

4.2.2.4.4. Stock Abundance and Recruitment

The estimated total number of snook has varied across years and by coast. On the Atlantic, the number of snook increased from 450,000 fish in 1986 to 751,000 fish in 1992 and then declined to 273,000 fish in 2009 and has increased to 404,000 fish in 2014 (Table 4.2.2.4.4, Fig. 4.2.2.4.4.1a). On the gulf coast, the number of snook increased from 558,000 fish in 1986 to 2,118,000 in 2003 and then declined to a low of 928,000 fish in 2009 and increased sharply to 3,581,000 fish in 2014 (Table 4.2.2.4.4, Fig. 4.2.2.4.4.1b).

Estimated recruitment of age-1 snook on the Atlantic coast increased from 200,000 fish in 1986 to 305,000 in 1991 then declined to a low of 69,000 fish in 2009 and has increased to 157,000 snook in 2014 (Table 4.2.2.4.4, Fig. 4.2.2.4.4.2a). On the gulf coast, recruitment was more variable with 238,000 fish in 1986 increasing to 782,000 fish in 2000 before declining to 344,000 fish in 2001 (the January 2001 cold kill, Fig. 4.2.2.4.4.2b). There was a large recruitment year in 2003 (1,167,000 fish) followed by lower levels of recruitment to a low of 182,000 in 2008 and a slight increase until 2012 when recruitment was estimated at 1,165,000 fish. The 2014 estimate was the highest in the time series (1,757,000 fish). Note the recent large recruitments also have large error bars around the estimates.

When estimated recruitment after 1995 was compared to the recruitment estimates in the earlier assessments, the 2006, 2013, and this assessment had similar trajectories while the 2012 assessment estimated higher values on the Atlantic coast (Fig. 4.2.2.4.4.3a). On the gulf coast, the 2012, 2013, and this assessment were similar and higher than the recruitment in the 2006 assessment (Fig. 4.2.2.4.4.3b). The differences within a coast were a matter of scale because the recruitment patterns in this assessment on both coasts were correlated with those in the earlier assessments (on the Atlantic coast, the correlation coefficients were *0.72, 0.78,* and *0.84*, $df = 25, 23,$ *and 16*, $P < 0.05$ and on the gulf coast the correlation coefficients were *0.44, 0.85* and *0.73*, $df = 25, 23,$ *and 16*, $P < 0.05$). The recruitment on the gulf coast showed a severe drop in 2005 which coincided with the 2005 red tide.

4.2.2.4.5. Stock Biomass (total and spawning stock)

The total biomass on the Atlantic coast increased from 780 mt (1,721,000 lb) to a peak of 1,238 mt (2,730,000 lb) in 1994 and then declined such that the total biomass was 737 mt (1,625,000 lb) in 2014 (Fig. 4.2.2.4.5.1a). The peak biomass

reflected the earlier 1991-1992 increases in recruitment. The total biomass on the gulf coast increased from 549 mt (1,211,000 lb) to a peak total biomass of 2,165 mt (4,773,000 lb) in 2005 and then decreased to 1,645 mt (3,628,000 lb) in 2010. Total biomass increased to 2,958mt (6,521,000 lb) in 2014 (Fig. 4.2.2.4.5.1b).

Spawning biomass on the Atlantic coast increased from 375 mt (827,000 lb) in 1986 to 459 mt (1,013,000 lb) in 1994, then decreased to 270 mt (595,000 lb) in 2001, then increased slightly before a decrease to 266 mt (587,000 lb) in 2008 and a rise to 351 mt (773,000 lb) in 2013 (Fig. 4.2.2.4.5.2a). The spawning biomass in 2014 was 345 mt (762,000 lb). Overall the spawning biomass on the Atlantic coast is slightly below the 1986 level. On the gulf coast, the spawning biomass has increased from 260 mt (572,000 lb) in 1986 to 1,404 mt (3,095,000 lb) in 2014 (Fig. 4.2.2.4.5.2b).

Comparing spawning biomass from the more recent assessments and the 2006 assessment is complicated because the 2006 assessment used an early, less capable, version of ASAP (version 1.4.2). For example, that version calculated spawning biomass at the beginning of the year while the current versions of ASAP (versions 3.09 for the 2012 and 2013 assessments and 3.0.17 for this assessment) accounts for the mortality from the beginning of the year to the spawning season (summer) and uses a separate average spawning biomass-weight-at-age matrix. Another difference is that the 2006 assessment used a constant natural mortality rate for all ages and separate selectivity patterns for each change in regulations while the recent analyses including this assessment used age-specific natural mortality rates (Lorenzen 2005) and a single selectivity for catching snook with different release rates depending up the regulations. However setting aside the differences in calculation methods, the estimated spawning biomass on the Atlantic coast reported in the 2006 assessment had the highest values and the 2013 assessment had the lowest values (Fig. 4.2.2.4.5.3a). The resulting patterns were similar among the three recent assessments, i.e. significantly correlated ($r = 0.83, 87, \text{ and } 0.88, df = 25, 23, \text{ and } 16, P < 0.05$). On the gulf coast, the spawning biomass estimates from the 2012 assessment and the 2013 update were higher than the estimates from this assessment and the 2006 had the lowest values (Fig. 4.2.2.4.5.3b). However, all three of the earlier assessments were significantly correlated with this assessment ($r = 0.96, 0.99, \text{ and } 0.85; df = 25, 23, \text{ and } 16; P < 0.05$).

4.2.2.4.6. Stock-Recruitment Parameters

As is frequently the case in species with high SPR values, the relationship between spawning stock and subsequent recruitment in snook was poorly defined (Fig. 4.2.2.4.6). In other words, much of the variability in recruitment is not explained by variations in the spawning biomass which indicates environmental influences on recruitment. In this assessment, we let ASAP solve for steepness from a starting value of 0.70 (CV=0.127). The estimated steepness values were 0.67 ($sd = 0.086$) on the Atlantic coast and 0.73 ($sd = 0.079$) on the Gulf coast and these values are consistent for a fish that lives about 20 years (Myers, et al. 1999; Rose, et al. 2001. The magnitude of these values is similar to the corresponding steepness values in the 2013 assessment (0.66 Atlantic coast and 0.71 on the gulf coast).

The estimated recruitment on the Atlantic coast ranged from a high of 305,000 age-1 fish in 1991 to a low of 69,000 fish in 2009 (Table 4.2.2.4.4 and Fig. 4.2.2.4.6a). Spawning biomass explains some of that range but the uncertainty in recruitment, on a log-normal scale, had a coefficient of variation (CV) = 0.39. The range of recruitment estimates on the gulf coast was wider than that on the Atlantic coast; from a low of 182,000 age-1 fish in 2008 to a high of 1,757,000 age-1 fish in 2014 (Table 4.2.2.4.4, Fig. 4.2.2.4.6b). The CV on the gulf coast was 0.60.

4.2.2.4.7. Measures of Parameter Uncertainty

The ASAP model evaluated uncertainty stemming from the input data. In fitting the model, ASAP estimated 80 parameters and their standard deviations on the Atlantic coast and 83 parameters and their standard deviations on the gulf coast (Table 4.2.2.2). These parameter estimates and their standard deviations were used to initiate a Markov Chain Monte Carlo approach. We ran eight chains of 5,045,000 simulations on each coast with a thinning rate of 1,009 producing 5,000 outcomes per chain and combined the outcomes from the eight chains. The MCMC results were used to develop the box-whisker plots of fishing mortality on age-7 fish on both coasts (Fig. 4.2.2.4.3.1), recruitment (Fig. 4.2.2.4.4.2) and spawning biomass (Fig. 4.2.2.4.5.2). The box-whisker plots only indicate observation error because ASAP does not capture the underlying uncertainty in the model configuration; hence process error was explored with alternative sensitivity runs (see Section 4.2.2.4.8).

4.2.2.4.8. Management Benchmarks

Given the Commission's objective of maintaining the SPR at or above 40% for snook, transitional SPR (tSPR) is used to determine whether the stock and fishery meet the Commission's objective. The tSPR values for 2014 were 39% on the Atlantic coast and 61% on the gulf coast; thus, the stock is near the Commission's objective on the Atlantic coast and exceeds the objective on the gulf coast (Fig. 4.2.2.4.8.1). It is important to compare the recent fishing mortality rates to the fishing mortality rate corresponding to 40%SPR, $F_{40\%SPR}$. Because fishing mortality rates in the last year of an assessment are poorly estimated due to the lack of information beyond the last year to provide scaling and balance, we followed the SEDAR process and used the geometric mean of the last three years' fishing mortality rates ($F.gm = \left(F_{y-2} * F_{y-1} * F_y\right)^{1/3}$) as a measure of the current fishing mortality rate. On the Atlantic coast, the F_{gm} value was 0.12 per year, which was the slightly below $F_{40\%}$ (0.13 per year). On the gulf coast, the F_{gm} value was 0.10 per year which also was less than $F_{40\%SPR}$ (0.24 per year; Table 4.2.2.4.8). Thus, the recent fishing mortality rates on both coast in 2014 met the Commission's management objectives. The spawning biomass corresponding to $F_{40\%SPR}$ ($SSB_{40\%SPR}$) was 571 mt on the Atlantic coast and the estimated spawning biomass in the base run was 346 mt. The $SSB_{40\%SPR}$ was 854 mt on the gulf coast and the estimated spawning biomass in the base run in 2014 was 1,404 mt. The apparent mismatch between the fishing mortality rates on the Atlantic coast meeting the Commission's objective and the spawning biomass being below their goal means that the recent low fishing mortality rates have not been in place long enough to allow all of the ages in the spawning stock to rebuild. Yield per recruit, static SPR and the 2014 point tSPR are shown in (Fig. 4.2.2.4.8.2).

Examining the uncertainty in the benchmarks, when the ratio of F_{gm} to $F_{40\%SPR}$ is plotted on the ratio of the spawning biomass in 2014 to $SSB_{40\%SPR}$, none of the MCMC simulations on the Atlantic coast estimated spawning biomass values in 2014 were greater than $SSB_{40\%SPR}$ and 48% of the F-ratios were <= 1.0 (Fig. 4.2.2.4.8.3a). All of the F-ratios were less than 1.0 on the gulf coast and all of the spawning biomass ratios were greater than 1.0 (Fig. 4.2.2.4.8.3b).

4.2.2.4.9. Retrospective and Sensitivity Analyses

4.2.2.4.9.1. Retrospective Analyses

We conducted two types of retrospective analyses for each coast. The first retrospective analyses used the same data sets that were used in the base runs by coast but then ASAP was rerun with terminal years of 2004 through 2014 for both coasts. ASAP did not converge when 2010 was the terminal year on the Atlantic coast and it did not converge when 2009 was the terminal year on the gulf coast. The estimated fishing morality rates on the Atlantic coast for years that converged had a significant retrospective bias of -11% (*paired t = --2.71, df = 42, P < 0.05)*, recruitment had a significant average retrospective bias of 13% (*paired t = 2.14, df = 42, P < 0.05)*, and spawning biomass had a significant retrospective bias of 36% (*t =2.80, df =42, P < 0.05;* Fig.4.2.2.4.9.1a, c, and e*).* The gulf fishing mortality rates had a significant retrospective bias of -5.1% *(t =-2.20, df = 42, P < 0.05*), recruitment did not have a significant retrospective bias (*paired t = 1.77, df = 42, p = 0.085*), spawning biomass had a significant retrospective bias of 7.1% (*t =3.33, df = 42, P < 0.05;* Fig.4.2.2.4.9.1b, d, f).

A simpler way of determining whether retrospective bias exists is to compare the results from previous stock assessments to the current assessment. In effect, this approach is more a comparison of the status advice that was provided with the data and methods available at the time of the different assessments. Age-structured stock assessments have been conducted for snook since 1997 and the results for average fishing mortality rates for ages 6-10, transitional SPR values and the number of snook age 6^+ from the different stock assessments are shown in Table 4.2.2.4.9.1 by coast. Assessments prior to 2006 used Integrated Catch-at-Age (ICA, Patterson 1997) and the assessments for 2006 and later used ASAP, albeit different versions of ASAP. As above, we tested for retrospective bias with paired t-tests comparing the proportional difference between the estimates for the successive assessments. Because the ICA results are unchanged from what was reported in the 2013 assessment, we only discuss the estimates from ASAP, i.e., the 2006 – 2015 assessments. Trajectories of fishing mortality rates (Fig. 4.2.2.4.3.2), recruitment (Fig. 4.2.2.4.4.3), spawning biomasses (Fig. 4.2.2.4.5.3) and transitional spawning potential ratios (Fig. 4.2.2.4.8.1) were plotted for the four ASAP assessments. On the Atlantic coast, there was retrospective bias in the average fishing mortality rates that were estimated with ASAP (15%, *t = 2.50, df = 66, P < 0.05*). This value is similar to that previous assessment's finding of 18% for the fishing mortality rates estimated by ASAP (*t = 3.27, df = 40, P < 0.05*). The bias means that new estimates of fishing mortality rates for a given year from ASAP are likely to be underestimates. There was not retrospective bias with the

transitional spawning potential ratios (*t = -0.29, df = 66, P = 0.78)* nor with the number of age-6+ fish (*t = -0.95, df = 66, P = 0.34)*. On the gulf coast, the average fishing mortality estimates from ASAP did not show a significant retrospective bias (*t = 1.95, df = 66, P = 0.055*), the transitional spawning potential ratios had a significant retrospective bias of 10% (*t = 5.89, df = 66, P < 0.05),* as did the number of age 6+ fish *(19%; t = 4.69, df = 66, P < 0.05*). The retrospective biases on the gulf coast were not surprising given how poorly the model recruitment index fit (Fig. 4.2.2.4.1.4e).

4.2.2.4.9.2. Sensitivity runs

Several sensitivity runs were conducted including higher and lower natural mortality rates, emphasizing the age-1 fit on the gulf coast, and including environmental effects. To explore the uncertainty surrounding natural mortality, runs were made with natural mortality rates of 0.15 per year and 0.34 per year on the Atlantic coast and 0.20 per year and 0.41 per year on the gulf coast. The higher natural mortality rates came from a re-analysis of early snook tagging data that partitioned the mortality rates (Dr. B. Pine, University of Florida, personal communication) and the lower natural mortality rates were based upon plausible maximum ages. Predictably because the catches-at-age did not change, higher natural mortality rates estimated lower fishing mortality rates (Fig. 4.2.2.4.9.2.1a and b) and, conversely, recruitment was higher with higher natural mortality rates (Fig. 4.2.2.4.9.2.1c and d) to account for the greater removals from natural causes; and the spawning biomass followed recruitment although offset by a few years (Fig. 4.2.2.4.9.2.1e and f). Transitional SPR values are not equilibrium values but depend on the estimated fishing mortality rates and the tSPR increased with higher natural mortality rates because of smaller unfished spawning biomass (Fig. 4.2.2.4.9.2.1g and h).

In the retrospective discussion (Section 4.2.2.4.9.1), we mentioned that the model did not fit the FIM age-1 index on the gulf coast very well (Fig. 4.2.2.4.1.4e). To improve the fit, we added emphasis ($\lambda = 50$) to the FIM age-1 recruitment index. The resulting measures of the management objectives, $F_{40\%SPR}$ and $SSB_{40\%SPR}$, were similar to those in the base run but the geometric mean fishing mortality rate was lower than in the base run (0.055 per year compared to 0.096 per year) and the spawning biomass was higher (1,861 mt as compared to 1,404 mt; Table 4.2.2.4.8). The transitional spawning potential ratio (0.70) was higher than the tSPR in the base run (0.61).

The sensitivity run that estimated the extra mortality from the environmental factors did so by creating another 'fishery' consisting of the snook that are believed to have died due to either cold kills or red tides. The years with cold kills were identified on the gulf coast by calculating the proportion of hours per year that the water temperature was below 14°C, the temperature at which sub-adult snook cease feeding (Howells et al. 1990) using hourly temperature readings from NOAA's National Data Buoy Center's C-MAN station off Venice, FL (Station VENF1, 27°4'12"N 82°27'0"W). However on the Atlantic coast, there were no long term water temperature recording stations north of Lake Worth in operation prior to 2005 and Lake Worth's water temperatures from the C-Man station did not include any water temperatures of 14°C or below. Monthly sampling for harmful algal

blooms, including red tides, along the gulf coast began in 1994. Years with red tides were identified as years with the probability of cells counts greater than 100,000 cells per liter exceeding 0.10.

The challenge of including deaths from environmental factors is that the number of fish that died due to these factors is unknown. Therefore as a first approximation, Muller and Taylor (2012) used the proportional change in the FIM index on the gulf coast between the year with the event and the subsequent year and the numbers of fish from the 2012 base run in the ages affected by the environment. For example, the FIM index dropped 28% between 2001 and 2002 and there was an estimated total of 654,000 fish for ages 3 through 10 which were the ages that were affected based upon the sampling of the 2001 cold kill for an estimated kill of 184,000 snook (0.28 x 654,000). Since the FIM-index showed only increases after 2010, we used the dead snook estimates from Muller and Taylor (2012) for 1986-2010 and no deaths for 2011-2014 (Fig.4.2.2.4.9.2.2). By extending the range of ages affect to 3-10 years old from of 3 to 7 years old, we included 95% or more of the aged fish. Due to data availability, this exercise was confined to the gulf coast.

Using the mean-square-error (MSE) as a measure of the goodness of fit, the model with the environmental effects had lower MSE values (better model fit) in five of the six components used to fit ASAP than did the model that without the environmental effects (Table 4.2.2.4.9.2). The landings were fit slightly better in the base model (MSE = 0.099) as compared to the run with environmental effects (MSE = 0.108). The extra mortality in years with cold kills was higher than in the years with red tides. The fit of the model with the environmental effects to the tuning indices was better than with the base model (Table 4.2.2.4.9.2), especially in 2010 (Fig. 4.2.2.4.9.2.3). The model estimated similar but slightly lower fishing mortality rates, higher recruitment and higher spawning biomass (Fig. 4.2.2.4.9.2.4). The spawning biomass estimated with environmental effects exhibited declines in the years with environmental impacts especially the 2010-2012 period. The additional mortality was 0.53 per year from the cold kill in 2001, 0.16 per year in 2003, 0.17 per year in 2005 and 0.21 per year in 2006 from red tide and 1.50 per year in 2010 from the cold kill. When the tSPR was recalculated with the additional 'natural' mortality, the tSPR increased slightly to 0.63 in 2014 from 0.61 in the base run (Fig. 4.2.2.4.9.2.5c, Table 4.2.2.4.8). The trajectory of tSPR was similar to that of the base run except for a very high tSPR value in 2010 that was due to the reduced unfished spawning biomass per recruit (Fig. 4.2.2.4.9.2.5b) which inflated the ratio. That high tSPR value should be interpreted as evidence that the snook population took a severe hit in 2010. The retrospective analysis in the sensitivity run with environmental effects did not converge in 2005 and 2009. There was not significant retrospective bias in the fishing mortality rates ($t = 1.75, df = 39, P = 0.088$) nor in recruitment ($t = -1.49, df =39, P = 0.14$) but there was with spawning biomass ($t = -2.45, df = 39, P < 0.05$). The aberrant trajectories in the 2010 run for fishing mortality rates and spawning biomass vanished with the inclusion of the environmental effects (Fig. 4.2.2.4.9.2.6). When the environmental effects were considered, then the gulf spawning biomass ratio was at 0.90 with 35% of the MCMC outcomes at or greater than 1.0 (Fig. 4.2.2.4.9.2.7) indicating that the spawning biomass on the gulf also is rebuilding after receiving the hit from the 2010 cold kill.

Given the uncertainty of the magnitude of the removals, another sensitivity run was made that reduced the number of fish that were killed by half. When the environmental impacts were reduced, the spawning biomass in 2014 was 18% less than the spawning biomass in the base run and the tSPR was slightly lower at 0.60 (Table 4.2.2.4.8), but still above the Commission's objective.

4.3. Comparison of models

Two models were presented in this assessment update: catch curves from fishery independent ages only and the age-structured statistical model, ASAP. As noted in Section 4.2.1, the upper slot limit nullifies the use of catch curves with fishery dependent ages because the larger, and presumed older, fish cannot be retained and the catch curve would be biased because the technique would consider these older fish dead when they are merely unavailable.

4.3.1. Fishery Selectivities

There are no age-specific selectivities in a traditional catch curve; i.e., all of the included ages are considered equally vulnerable to fishing which is a weakness of catch curves. For the snook catch curves with fishery independent ages, ages 4 through 19 on the Atlantic coast were considered equally vulnerable as were ages 4 through 15 on the gulf coast. The age-structured model was able to capture the changes in the selectivities for different ages of fish that were harvested (directly or indirectly) reflecting the changes in the slot limits even though the capture selectivity on a coast remained the same during the 29-year time series. Also, the changes in realized selectivities calculated from the estimated fishing mortality rates confirmed that older fish were less vulnerable to harvest after the slot limits were implemented than before (Fig.4.2.2.4.2).

4.3.2. Fishing mortality rates

As noted in Section 4.3.1, catch curves estimate total mortality and assume that all fish in the included ages are equally vulnerable to being kept by anglers. The assumption of constant vulnerability across ages is inconsistent with the slot limits used to partly manage snook in Florida; hence, the catch curves were calculated from the aged fish collected with the fishery independent haul seines only. The assumption of constant recruitment also was not met because during 2008-2014, recruitment was estimated by ASAP to vary 39% (CV) on the Atlantic coast and 60% on the gulf (Section 4.2.2.4.6). ASAP total mortality estimates were the sum of the average age-specific natural mortality rates for ages 6+ weighted by age-specific population numbers from ASAP and the weighted average fishing mortality rates including discards for ages 6+. The estimated total mortality per year on the Atlantic coast for this period from a catch curve was 0.29 per year and ASAP estimated the total mortality on age-6^+ fish at 0.36 per year. Similarly on the gulf coast, the catch curve estimated an average total mortality rate of 0.58 per year and ASAP estimated a total mortality of 0.32 per year for ages-6^+. It must be remembered that the catch curves were based on ages from fishery independent seine sets and the ASAP estimates were based on model estimates of the fishery. More importantly as discussed in Sections (4.2.2.4.2 and 4.3.1), there were marked differences in the selectivity of different aged fish to capture and retention and the

ASAP results reflect these differences.

4.4. Present and possible future condition of the stock

The stricter regulations for snook that were implemented in 2007, coupled to the closures in 2010 on the Atlantic coast and 2010-2013 on the gulf coast reduced the fishing mortality rates in recent years. As noted in Section 4.2.2.4.8, the tSPR values increased on the Atlantic coast and are approaching the Commission's objective of 40% while the SPR values on the gulf coast continue to be above 40%. Furthermore, if the current levels of fishing effort continue, then the tSPR values should increase because the static SPR value associated with the F_{gm} was 54% on the Atlantic coast and 74%, on the gulf coast. In addition, if the higher natural mortality rates estimated from the tagging data are more appropriate, then the fishing mortality rates would be lower and the tSPR would be even higher (Fig. 4.2.2.4.9.2.1 g and h). However, there is concern because the lowest recruitment on the Atlantic coast in the past 29 years occurred in 2009-2012 and when those year classes enter the fishery, the vulnerable population will be lower such that the same harvest by anglers would have higher fishing mortality rates that, in turn, could drop the tSPR below the Commission's objective. The gulf experienced low recruitment in 2005-2009; but the effects of the low recruitment on the gulf were damped because of the gulf's years of closure coincided with when those year classes entered the fishery. Further, the lowest recruitment on the gulf, occurred when the spawning biomasses were high suggesting that the low recruitment levels stemmed from environmental effects. For example in 2005, there were many comments from anglers regarding dead snook on the gulf coast after exposure to red tide, and in January 2010, there were reports on both coasts regarding cold killed snook. Given that there will continue to be cold kills and red tides in the future, management should continue to strive to maintain high stock levels as a buffer against environmental effects.

4.5. Regional considerations

This section of the snook stock assessment examines snook populations on a finer scale than by coast. Although there is no biological basis for splitting populations of snook at the regional level (i.e. bay system), there may be local depletion issues that can be detected with this examination. In this section, we examine recreational catch and effort and FIM catch rates for indications of regional differences.

Catch rates from the recreational survey (MRFSS/MRIP) were used to compare the regional snook relative population abundance. Intercepts from MRFSS/MRIP 1991-2014 data were selected using the same cluster analysis that was used in the coastal indices. The intercepts were grouped by county into five regions: Volusia – St. Lucie, Martin – Miami-Dade, Monroe – Collier, Charlotte – Lee, and Pasco – Sarasota. Estimates of the annual recreational catch rates by region were standardized with generalized linear models that potentially included year, two-month wave, mode of fishing, area (nearshore and estuary or bay), number of anglers, avidity (number of fishing trips in the previous two months), and time of day category (day vs. night). As with the coastal models, not all of the coefficients for these variables were significant in the different models.

Except for the Volusia—St. Lucie region, the regional recreational catch rate patterns were similar: generally flat (Martin–Miami-Dade, $t = -0.43, df = 17, P = 0.68$ and Collier-Monroe, $t = 1.76, df = 17, P = 0.10$) or slightly increasing (Charlotte-Lee, $t = 2.92, df = 17, P < 0.05$ and Pasco-Sarasota, $t = 2.16, df = 17, P < 0.05$; Fig. 4.5.1a,c-e) until the sharp drop from the 2010 cold kill and then an increase afterward. The catch rates Volusia-St. Lucie were much lower than the other regions and slightly decreasing ($t = -2.40, df = 17, P < 0.05$, Fig. 4.5.1b) until 2010 and then increasing. As a consistency check, the Collier-Monroe catch rates were compared to the Everglades National Park index for the same years and the correlation between the two indices was significant ($r = 0.62, df = 22, P< 0.05$)

If we compare the regions using just data from the 2008-2014 time period combined across years, the Collier-Monroe had the highest recreational catch rates, Martin--Miami Dade and Charlotte--Lee had the next highest, followed by Pasco–Sarasota, and Volusia-St. Lucie had the lowest catch rates (Fig. 4.5.2a).

The FWC FIM 183-m haul-seine catch data were also used to investigate snook abundance within regions of Florida. There are four regional FIM laboratories that sample snook: Indian River and Tequesta on the Atlantic coast and Tampa Bay and Charlotte Harbor on the gulf coast. These regions are roughly geographically similar to the MRFSS/MRIP regions except for there is no Collier-Monroe region equivalent with FIM haul seine sampling.

When the regional FIM catch rates are compared using generalized linear models in a similar manner as with the MRFSS/MRIP data above, Tequesta had the highest catch rates and the Indian River had the lowest catch rates with the two gulf regions in between (Fig. 4.5.3). Omitting the Florida Keys because there is no FIM equivalent, the two sources of catch rates agreed on the Atlantic coast and the gulf catch rates were intermediate. FIM had higher catch rates on the Gulf in Tampa Bay and MRFSS/MRIP had higher catch rates in Charlotte-Lee (Fig. 4.5.2b).

Anglers frequently ask or comment about the lengths of snook in different regions; therefore, we calculated the annual mean number of snook caught per set by length categories by region using the same generalized linear model approach that was used for calculating the FIM catch rates. The length categories were: snook less than 24 in TL, snook between 24 and 34 in TL, and snook longer than 34 in TL. These length categories do not match the current legal slot limits because of the changes in the slot limits. The full GLIM models by region and length category adjusted the number of fish per set for year, month, depth, temperature, salinity, shore type, and bottom type; however, not all of these terms were significant in each region and length category and; therefore, a reduced model with just the significant terms was used to estimate the adjusted number of snook per haul seine set for each year. In all cases, region explained a significant portion of the variability.

The number of snook per set less than 24 in TL and those 24-34 in TL were variable but mostly flat in the Indian River region until 2009 and then it declined to almost zero (mean = 0.019 snook per haul, 95% confidence interval: 0.009 – 0.033 snook per haul; Fig 4.5.4.a and c) while the number of snook longer than 34 in TL was

gradually increasing until the drop in 2010 and then has been variable afterwards (Fig. 4.5.4.e). The catch of snook less than 24 in TL and the 24-34 in TL snook were declining in the Tequesta region from 1997 until 2008 when there was an increase. Then there was a sharp drop in 2010 with an increase afterwards (Fig 4.5.4.b and d). The catch rates of larger snook (TL > 34 in) in the Tequesta region were variable without trend ($t = 0.34$, $df = 16$, $P = 0.74$; Fig 4.5.4.f). Catch rates in Tampa Bay for all size categories have shown increases after the drop in 2010 (Fig 4.5.4.g, i, and k). The Charlotte Harbor catch rates were similar to Tampa Bay with general increases until 2008, declines in 2009 and 2010 and increases afterwards (Fig 4.5.4h, j, and k). The Tequesta region had the highest, overall average catch rate on either coast for all three size categories. Charlotte Harbor had the second highest in the 24-34 in category and in the over 34 in category and Tampa Bay region had the second highest in the less than 24 in category.

5.0. MANAGEMENT

5.1. History of management

Snook are managed under Chapter 68B-21 of the Florida Administrative Code. As noted earlier, the Florida Legislature made snook a gamefish in 1957. In July 1985, the FWC (then known as the Florida Marine Fisheries Commission) established statewide regulations including a minimum size of 24 in; a maximum size of 34 in with an allowance to keep one fish over 34 in; closed season of January, February, June, July, and August in 1985 and 1986; a bag limit of two fish; and restricted gear to hook-and-line gear. In July 1987, management under this rule was extended to all fish of the genus *Centropomus*, August was permanently added to the summer closed season; all fish were required to be landed in whole condition; and the use of treble hooks with natural bait while harvesting snook was prohibited. In March 1994, the management goal was adopted to maintain snook stocks above 40% SPR, the January–February closure was changed to December 15 to January 31; the definition of total length was clarified, and the possession of snook was allowed on a vessel with cast nets aboard provided that such nets were secured and stowed away. In December 1998, the Commission implemented a slot limit of 26 in to 34 in with no allowance for fish larger than 34 in to be retained. Additional regulations include a prohibition on spearing (July 2000); removal of the "species of special concern" designation (February 2001); and reduced the bag limit to one fish on the Gulf coast and Monroe county, adding May to the closed months on the Gulf coast, and prohibiting landing snook in the Gulf that were harvested north and east of the Dade–Monroe county line (January 2002). In July 2002, the Commission allowed for the sale of snook by facilities with a special activities license for brood stock in culturing and for aquariums and for use in other displays. In July 2006, the length measurement was clarified for purposes of determining the legal size of snook, "total length" was defined as the straight line distance from the most forward point of the head with the mouth closed, to the farthest tip of the tail with the tail compressed or squeezed, while the fish is lying on its side. In accordance with that clarification, the Commission increased the minimum size from 26 in to 27 in. In July 2007, the Commission established a statewide bag limit of one fish; added December 1-14 and the month of February to the closed season in Florida's Gulf, Everglades National Park and Monroe County waters; allowed for carrying more than one cast net aboard while fishing for snook; and established a snook slot

limit of 28-32 in total length in Atlantic waters and 28-33 in total length in Florida's Gulf, Everglades National Park and Monroe County waters. In response to the 2010 cold kill, an executive order (10-03, effective 16 January 2010) prohibited the harvest and possession of snook in state and federal waters through 31 August 2010. Another executive order (10-39, effective 1 September 2010) extended the closure statewide until 16 September 2010 and a third executive order (10-45, effective 17 September 2010) extended the closure only on the gulf coast, Monroe County, and Everglades National Park, through 31 August 2011. Additional executive orders (11-16, 1 September 2011 and 12-11, 1 September 2012) extended the closure on the gulf coast through 31 August 2013.

5.2. Size limit compliance

Angler compliance with the different allowable harvest slot limits was evaluated using the total lengths of fish measured by MRFSS/MRIP, ENP, and FWC's snook program samplers plus lengths for harvested snook reported to the Angler Action Program (Section 3.4). On the Atlantic coast, two percent of the fish measured during 1986–1998 (1,646 fish) were less than the 24-in minimum size and there was not a maximum size at this time other than that an angler could not keep more than one fish greater than 34 in; three percent of the fish measured during 1999-2005 (5,416 fish) were less than the 26-in minimum size and 9% were greater than the 34 in maximum size; and 4% of the fish measured during 2008-2014 (3,887 fish) were below the 28 in minimum size and 17% were greater than the 32-in maximum size (Table 5.2). On the gulf coast, seven percent of the snook measured during 1986–1998 (10,209 fish) were less than 24 in and there was not a maximum size at that time. Seven percent of the fish measured during 1999-2005 (10,250 fish) were less than the 26-in minimum size and only 2% were greater than the 34 in maximum size; compliance was less with the narrower slot limits implemented in 2007 with 22% of the fish measured during 2008-2014 (1,693 fish) being less than the 28-in minimum size and 5% were greater than the 33 in maximum size. Anglers on the Atlantic coast tended to keep snook at the upper end of their slot (around 32 in) and anglers on the gulf coast tended to keep snook at the smaller end of the slot (around 28 in).

5.3. Bag limit compliance

Snook angler compliance with the bag limits was high. The bag-limit analyses included only interviews conducted during times when the snook fishery was open from 1986 through 2014. On the Atlantic coast, there was a two-fish bag limit in effect from 1985 until July 2007 when the bag limit was reduced to one fish. Only nine anglers on eight trips out of 11,748 anglers on 8,033 trips in the 1986-2006 period kept more than two fish per angler and the excess fish accounted for 3% of the harvested fish on the sampled trips (Table 5.3). In the later period, 2008-2014, there were only three anglers on two trips out of 2,540 anglers on 1,609 trips on the Atlantic coast that exceeded the one-fish bag limit and excess fish kept by those anglers accounted for 5% of the harvested fish on the trips that were sampled. On the gulf coast, the one-fish bag limit was implemented earlier in 2002. Twelve anglers on nine trips out of 11,108 anglers on 6,701 trips in the period 1986-2001 kept more than two fish per angler and the excess fish accounted for 6% of the harvested fish on the sampled trips. In the later period (2002-2014)

with a one-fish bag limit, twenty anglers on 12 trips out of 10,733 trips with 21,052 anglers kept more than one fish per angler and their excess fish accounted for 4% of the harvested fish on the sampled trips.

5.4. Overall Effectiveness of the regulations

A simple way of comparing the effectiveness of the regulations is to examine the catchability of the recreational fishery. While ASAP does not explicitly use catchability in calculating fishing mortality rates, we can easily estimate the recreational fishery's catchability using the directed effort (Table 3.2.1, Fig. 3.3.1) and the fishing mortality rates on age-7 fish (Table 4.2.2.4.3) because the fleet catchability, q, is the fishing mortality (*F*) exerted by one unit of effort (*E*) or $q_t = F_t / E_t$ for each year, *t*. The average fishing mortality rates for the combinations of coast and period were determined from the Baranov catch equation using the estimated population numbers and catches. The combination of reduced bag limits to one fish and the narrowing of the slot limits since 2007 have reduced the catchability by an average of 60% on the Atlantic coast and an average of 64% on the gulf coast (Table 5.4). In other words, the regulations have been effective in reducing fishing mortality.

6.0. RESEARCH and DATA NEEDS

In addition to the fishery information on harvest, releases, and catch rates, there continues to be a need for the collection of age, sex, and length information for future assessments of snook populations. Access to snook is complicated because most of the fish are released. Since 1998, FWRI interviewers have been visiting sites where anglers typically fish for snook and ask if they can measure the anglers' fish, if they can take biological samples, and whether they can collect the ear bones for age determination. This effort was enhanced in 2002; however, the most appropriate method for collecting this type of information would be to supplement MRFSS/MRIP intercepts with an emphasis on shore and private boat modes.

On a biological level, we need to understand how snook interact with their habitat throughout their lives. In this assessment, we ran a sensitivity analysis on the gulf coast that included the colds kills in 2001 and 2010 and red tide kills in 2003, 2005, and 2006 but it would be valuable to understand why some snook go offshore while other go up rivers to avoid these lethal factors. Young *et al.* (2014 and 2016) has made some initial strides along these lines but there is much left to learn. Because the management objective is measured with tSPR, learning the characteristics of the snook that skip spawning would let us refine the tSPR estimate. Acoustic tagging shows that fish on the Atlantic coast move easily between rivers, estuaries, and the nearshore reefs. Lowerre-Barbieri et al. (2003) investigated whether catch and release fishing on spawning aggregations affects reproduction but a more basic question is how many times does an individual snook get caught and released. The current estimation methodology assumes that every release is a unique fish which seems unlikely especially when anglers fish upon aggregations in the summer.

7.0 ACKNOWLEDGEMENTS

The most important people that make this assessment possible continue to be the field samplers who collect the essential information on anglers, catches, lengths, and ages. These people work incredible hours and in all kinds of weather to ensure that we have the best possible data for the assessments. We want to thank the Snook Team and their critical research conducted on the biology of the snook. Our special thanks go out to the samplers and biologists at Everglades National Park for providing their creel survey data as well as lengths and otoliths. Thanks also to the Snook and Gamefish Foundation for their providing the Angler Action program data on the sizes of fish caught and released. These data, especially the sizes of released fish, are vital for assessing the stocks.

8.0. LITERATURE CITED

Adams, A.J., R.K. Wolfe, N. Barkowski, D. Overcash. 2009. Fidelity to spawning grounds by a catadromous fish, *Centropomus undecimalis*. Marine Ecology Progress Series 389:213-222.

Adams, A.J. and R.K. Wolfe. 2006. Cannibalism of juveniles by adult *Centropomus undecimalis*. Gulf of Mexico Science. 2006 (1/2): 11-13.

Barbour, A.B., A.J. Adams, and K. Lorenzen. 2014. Size-based, seasonal, and multidirectional movements of an estuarine fish species in a habitat mosaic. Marine Ecology Progress Series 507:263-274.

Beverton, R. J. H. and S. J. Holt. 1957. On the dynamics of exploited fish populations. Ministry of Agriculture, Fisheries and Food. Fishery Investigations Series II Volume XIX. London: Her Majesty's Stationery Office. 533 p.

Blewett, D. A., R. A. Hensley, and P. W. Stevens. 2006. Feeding habits of common snook, *Centropomus undecimalis*, in Charlotte Harbor, Florida. Gulf Caribbean Research 18:1-13.

Blewett, D. A., P. W. Stevens, T. R. Champeau, and R.G. Taylor. 2009. Use of rivers by common snook *Centropomus undecimalis* in southwest Florida: a first step in addressing the overwintering paradigm. Florida Scientist 4:310 -324.

Blewett, D.A., P.W. Stevens, and M.E. Call. 2013. Comparative ecology of euryhaline and freshwater predators in a subtropical floodplain river. Florida Scientist 76:166-190.

Blewett D.A. and P.W. Stevens. 2014. Temperature variability in an estuary and implications for Common Snook *Centropomus undecimalis*, a cold sensitive fish. Gulf of Mexico Science 32:44-54.

Blewett, D.A., P.W. Stevens, and J. Carter. In review. River flooding affects abundance and body condition of a large, euryhaline fish.

Brame, A.B., C.C. McIvor, E.B. Peebles, and D.J. Hollander. 2014. Site fidelity and condition metrics suggest sequential habitat use by juvenile common snook. Marine Ecology Progress Series 509:255-269.

Brennan, N. P., C. J.Walters, and K. M. Leber. 2008. Manipulations of stocking magnitude: addressing density-dependence in a juvenile cohort of common snook (*Centropomus undecimalis).* Reviews in Fishery Science 16:215–227.

Bruger, G. E. unpublished manuscript. Population dynamics of adult snook in the Naples-Marco Island region of southwest Florida, 1976–1982, with a reanalysis of age and growth using otoliths and tag-recapture data. Florida Marine Research Institute, St. Petersburg, FL.

8.0. LITERATURE CITED continued

Bye, V. J. 1984. The role of environmental factors in the timing of reproductive cycles. *In* Potts, G. W. and R. J. Wooten, eds., Fish Reproduction. Academic Press. London.

Chapman, D. G. and D. S. Robson. 1960. The analysis of a catch curve. Biometrics 16:354-368.

Dutka-Gianelli, J, R. Taylor, E. Nagid, J. Whittington, and K. Johnson. 2011. Habitat utilization and Resource partitioning of apex predators in coastal rivers of southeast Florida. Fish and Wildlife Research Institute, Fish and Wildlife Conservation Commission. St. Petersburg, FL. IHR F2771-07-11-F

Fore, P. L. and T. W. Schmidt. 1973. Biology of juvenile and adult snook, *Centropomus undecimalis*, in the Ten Thousand Islands. Pp. XVI 1-18. *in* Ecosystems analysis of the Big Cypress Swamp and estuaries. U.S. Environmental Protection AGENCY Region IV, Atlanta, Georgia. Publication Number EPA 904/9-74-002.

Francis, R. I. C. C. 1992. Use of risk analysis to assess fishery management strategies: a case study using orange roughy (*Hoplostethus atlanticus*) on the Catham Rise, New Zealand. Canadian Journal of Fisheries and Aquatic Science 49:922-930.

Gilmore, R. G., C. J. Donahoe and D. W. Cooke. 1983. Observations on the distribution and biology of the common snook, *Centropomus undecimalis* (Bloch). Florida Scientist 46:313–336.

Hilborn, R. and C. J. Walters. 1992. Quantitative fisheries stock assessment: choice, dynamics, and uncertainty. Chapman and Hall, Inc. New York. 570 pp.

Howells, R. G., Sonski, A. J., P. L. Shafland, and B. Hilton. 1990. Lower temperature tolerance of snook, *Centropomus undecimalis*. Northeast Gulf Science 11:155-158.

Krebs, C. J. 1989. Ecological methodology. HarperCollinsPublishers, Inc. New York. 654 pp.

Legault, C. M. and V. R. Restrepo. 1998. A flexible forward age-structured assessment program. ICCAT Working Document SCRS/98/58. Sustainable Fisheries Division Contribution SFD-98/99-16.

Limouzy, C. B. 1993. Effect of incubation temperature on efficiency of yolk utilization by snook (*Centropomus undecimalis*) larvae. Abstract from a presentation made at the Snook Symposium, April 15–16, Sarasota, Florida.

Lorenzen, K. 2005. Population dynamics and potential of fisheries stock enhancement: practical theory for assessment and policy analysis. Philosophical Transactions of the Royal Society of London. Fisheries Theme Issue 2004

8.0. LITERATURE CITED continued

Lowerre-Barbieri, S. K., F. E. Vose, and J. A. Whittington. 2003. Catch-and-release fishing on a spawning aggregation of common snook: does it affect reproductive output. Transactions of the American Fisheries Society 132:940-952.

Lowerre-Barbieri, S.K., D. Villegas-Rios, S. Walters, J. Bickford, W. Cooper, R. Muller, and A. Trotter. 2014. Spawning site selection and contingent behavior in common snook, Centropomus undecimalis. PLoS ONE 9(7): e101809.

Marshall, A. R. 1958. A survey of the snook fishery of Florida, with studies of the biology of the principal species*, Centropomus undecimalis* (Bloch). Florida Board of Conservation Marine Research Laboratory Technical Series Number 22.

McMichael, R. H., Jr., K. M. Peters and G. R. Parsons. 1989. Early life history of the snook, *Centropomus undecimalis* in Tampa Bay, Florida. Northeast Gulf Science 10:113–126.

Milton, D. A. and S. R. Chenery. 2005. Movement patterns of barramundi, *Lates calcarifer*, inferred from 87Sr/86Sr and Sr/Ca ratios in otoliths, indicate non-participation in spawning. Marine Ecology Progress Series 301:279-291.

Motta, P. 1993. Tampa Bay gill-net fishing study. Final report to the Florida Department of Natural Resources, Contract No. C-7498.

Muller, R. G. and R. G. Taylor. 2006. The 2005 stock assessment update of common snook*, Centropomus undecimalis*. Florida Marine Research Institute. Fish and Wildlife Conservation Commission. St. Petersburg, FL. IHR 2006-003. 135 pp.

Muller, R. G. and R. G. Taylor. 2012. The 2012 stock assessment update of common snook*, Centropomus undecimalis*. Florida Fish and Wildlife Research Institute. Fish and Wildlife Conservation Commission. St. Petersburg, FL. IHR 2012-002. 156 pp.

Muller, R. G. and R. G. Taylor. 2013. The 2013 stock assessment update of common snook*, Centropomus undecimalis*. Florida Fish and Wildlife Research Institute. Fish and Wildlife Conservation Commission. St. Petersburg, FL. IHR 2013-004. 157 pp.

Murphy, G. I. 1965. A solution of the catch equation. Journal of Fisheries Research Board Canada 22:191-202.

Murphy, M. D. 1997. Bias in Chapman-Robson and least-squares estimators of mortality rates for steady-state populations. Fishery Bulletin 95: 863-868.

Myers, R.A., K.G. Bowen, and N.J. Barrowman. 1999. Maximum reproductive rate of fish at low population sizes. Canadian Journal of Fisheries and Aquatic Science 56:2404-2419.

8.0. LITERATURE CITED continued

NOAA. 2002. Draft status of red grouper in the United States waters of the Gulf of Mexico 1986-2001 revised. NMFS, Southeast Fisheries Science Center. Sustainable Fisheries Division Contribution No. SFD-01/02-175rev.

MOAA. 2012. MRFSS/MRIP Calibration workshop ad hoc working group report. May 16, 2012.

National Research Council. 1998. Improving fish stock assessments. National Academy Press. Washington, D. C. 177 p.

O'Hop, J. R. G. Muller, and D. T. Addis. 2015. Stock Assessment of Mutton Snapper (*Lutjanus analis)* of the U.S. South Atlantic and Gulf of Mexico through 2013. SEDAR Update Assessment. FWC Report IHR2014-005. Dated 23 February 2015.

Patterson, H. M., R. G. Taylor, and R. S. McBride. 2005. Coastal origin of common snook, *Centropomus undecimalis,* in Florida Bay. Gulf and Caribbean Research 17:25-30.

Patterson, K. R. 1997. Integrated catch at age analysis. Version 1.4. User's manual. FRS Marine Laboratory. Aberdeen Scotland.

Peters, K. M., S. D. Giordano, J. M. Adams, R. W. Fenwick, R. W. McWilliams, and N. J. Berill. 1998a. Factors influencing the distribution of larvae of the common snook, (*Centropomus undecimalis* (Bloch), in southwest Florida. Florida Marine Research Institute Publ. 53, 33p.

Peters, K. M., R. E. Matheson, Jr., and R. G. Taylor. 1998b. Reproduction and early life history of common snook, *Centropomus undecimalis* (Bloch), in Florida. Bulletin of Marine Science 62:509–529.

Peterson, M. S., and R. G. Gilmore, Jr. 1991. Eco-physiology of juvenile snook *Centropomus undecimalis* (Bloc): life-history implications. Bulletin of Marine Science 48:46–57.

R Core Team. 2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin 191. Bulletin of the Fisheries Research Board of Canada.

Rivas, L. R. 1986. Systematic review of the perciform fishes of the genus *Centropomus*. Copeia 1986:579–611.

Rose, K. A., J. H. Cowan, Jr., K. O. Winemiller, R. A. Myers, and R. Hilborn. 2001. Compensatory density dependence in fish populations: importance, controversy, understanding, and prognosis. Fish and Fisheries 2:293-327.

8.0. LITERATURE CITED continued

Schaefer, R. H. 1972. First record of a snook from New York waters. New York Fish and Game Journal 19(2):182–183.

Schirripa, M. J. and C. M. Legault. 1999. Status of the red snapper in U.S. waters of the Gulf of Mexico updated through 1998. NMFS, Southeast Fisheries Science Center. Sustainable Fisheries Division Contribution No. SFD-99/00-75.

Secor, D. H. 2008. Influence of skipped spawning and misspecified reproductive schedules on biological reference points in sustainable fisheries. Transactions of the American Fisheries Society 137:782–789.

SEDAR. 2006. Gulf of Mexico red grouper, SEDAR12, Stock assessment report. Charleston, SC. 358 p.

SEDAR. 2008. South Atlantic and Gulf of Mexico mutton snapper, SEDAR15A, Stock assessment report 3. North Charleston, SC. 410 p.

SEDAR. 2010. Gulf of Mexico black grouper, SEDAR19, Stock assessment report. North Charleston, SC. 661 p.

Shafland, P. L. and K. J. Foote. 1983. A lower lethal temperature for fingerling snook, *Centropomus undecimalis*. Northeast Gulf Science 6:175–178.

Shertzer, K. W. and E. H. Williams. 2008. Fish assemblages and indicator species: reef fishes of the southeastern United States. Fishery Bulletin 106:257-269.

Smith, B. J. 2015. Bayesian output analysis program for MCMC. URL: http://www.jstatsoft.org/v21/i11.

Stevens, P.W., D.A. Blewett, and G.R. Poulakis. 2007. Variable habitat use by juvenile common snook, *Centropomus undecimalis* (Pisces:Centropomidae): applying a life-history model in a southwest Florida estuary. Bulletin of Marine Science 80:93–108.

Stevens, P.W., D.A. Blewett, T.R. Champeau, and C.J. Stafford. 2010. Posthurricane recovery of riverine fauna reflected in the diet of an apex predator. Estuaries and Coasts 35:59-66.

Stevens, P.W., D.A. Blewett, R.E. Boucek, J.S. Rehage, B.L. Winner, J.M. Young, J.A. Whittington, and R. Paperno. In review. Resilience of a tropical sportfish (Common Snook) to a severe cold event varies across five estuaries in southern Florida.

Taylor, R. G., H. J. Grier, and J. A. Whittington. 1998. Spawning rhythms of common snook in Florida. Journal of Fish Biology. 53:502–520.

8.0. LITERATURE CITED continued

Taylor, R. G., J. A. Whittington, and H. J. Grier. 1993. Biology of common snook from the east and west coasts of Florida. Study 3, Sect. 1. In Investigations into nearshore and estuarine gamefish distributions and abundance, ecology, life history, and population genetics in Florida. Edited by R. E. Crabtree, T. M. Bert, and R. G. Taylor. FDNR/FMRI Rep. No. F0165-F0296-88-93-C. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. pp 1–51.

Taylor, R. G., J. A. Whittington, H. J. Grier, R. E. Crabtree. 2000. Age, growth, maturation, and protandric sex reversal in the common snook, *Centropomus undecimalis*, from South Florida waters. Fishery Bulletin 98: 612–624.

Taylor, R. G., J. A. Whittington, D. E. Haymans. 2001. Catch-and-release mortality rates of common snook in Florida. North American Journal of Fisheries Management. 21:70–75

Then, A. Y., J. M. Hoenig, N. G. Hall, and D. A. Hewitt. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. ICES Journal of Marine Science 72:82-92.

Thue, E. B., E. S. Rutherford and D. G. Buker. 1982. Age, growth and mortality of the common snook, *Centropomus undecimalis* (Bloch), in the Everglades National Park, Florida. U.S. National Park Service South Florida Research Center Report T-683.

Tolley, S. G., E. T. Dohner, and E. B. Peebles. 1987. Occurrence of larval snook, *Centropomus undecimalis* (Bloch), in Naples Bay, Florida. Florida Scientist 50:34–38.

Tringali, M. D. and T. M. Bert. 1996. The genetic stock structure of common snook (*Centropomus undecimalis*). Canadian Journal of Fisheries and Aquatic Science 53:974–984.

Tringali, M. D., S. Seyoum, E. M. Wallace, M. Higham, R. G. Taylor, A. A. Trotter, and J. A. Whittington. 2008. Limits to the use of contemporary genetic analyses in delineating biological populations for restocking and stock enhancement. Reviews in Fisheries Science 16:111–116.

Trotter, A. A., D. A. Blewett, R. G. Taylor and P. W. Stevens. 2012. Migrations of common snook from riverine habitat and evidence for skipped spawning. Transactions of the American Fisheries Society 141:1016-1025 .

Tucker, J. W.,Jr., and S. W. Campbell. 1988. Spawning season of common snook along the east central Florida coast. Florida Scientist 51(1):1–6.

Volpe, A. V. 1959. Aspects of the biology of the common snook, *Centropomus undecimalis* (Bloch) of southwest Florida. Florida State Board of Conservation Technical Series Number 31.

8.0. LITERATURE CITED continued

Winner, B.L., D.A. Blewett, R.H. McMichael Jr., and C.B. Guenther. 2010. Relative abundance and distribution of common snook along shoreline habitats of Florida estuaries. Transactions of the American Fisheries Society 139:62-79.

Young, J.M., B.G. Yeiser, and J.A. Whittington. 2014. Spatiotemporal dynamics of spawning aggregations of common snook on the east coast of Florida. Marine Ecology Progress Series 505:227-240.

Young, J.M., B.G. Yeiser, E.R. Ault, J.A. Whittington, and J. Dutka-Gianelli. 2016. Spawning site fidelity, catchment, and dispersal of Common Snook along the east coast of Florida. Transactions of the American Fisheries Society.145:400-415.

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Table 3.2.1. Estimated number of snook landed by anglers, number of fish caught and released alive, total number caught, percent released alive, number that died after being released alive (release mortality rate of 2.13%), total harvest (landings plus those that died after being released alive), and estimated number of trips directed at snook. The directed trips have been adjusted to MRIP basis.

Atlantic

Year	Landings	Released	Total catch	Percent released	Dead releases	Total harvest	Percent discards	Directed trips
1981	13,678	10,663	24,341	43.8%	227	13,905	1.6%	20,848
1982	27,172	13,579	40,751	33.3%	289	27,461	1.1%	18,835
1983	4,973	2,194	7,167	30.6%	47	5,020	0.9%	21,025
1984	23,440	13,478	36,918	36.5%	287	23,727	1.2%	14,297
1985	4,128	48,652	52,780	92.2%	1,036	5,164	20.1%	46,444
1986	8,656	48,223	56,879	84.8%	1,027	9,683	10.6%	50,922
1987	19,996	48,421	68,417	70.8%	1,031	21,027	4.9%	64,334
1988	22,477	56,758	79,235	71.6%	1,209	23,686	5.1%	77,661
1989	10,122	211,787	221,909	95.4%	4,511	14,633	30.8%	137,435
1990	7,194	164,541	171,735	95.8%	3,505	10,699	32.8%	92,019
1991	19,591	195,619	215,210	90.9%	4,167	23,758	17.5%	262,424
1992	22,793	353,138	375,931	93.9%	7,522	30,315	24.8%	439,929
1993	18,451	176,081	194,532	90.5%	3,751	22,202	16.9%	316,065
1994	38,382	472,699	511,081	92.5%	10,068	48,450	20.8%	478,520
1995	33,912	649,502	683,414	95.0%	13,834	47,746	29.0%	683,034
1996	42,953	368,989	411,942	89.6%	7,859	50,812	15.5%	542,066
1997	51,648	434,511	486,159	89.4%	9,255	60,903	15.2%	556,473
1998	22,090	312,134	334,224	93.4%	6,648	28,738	23.1%	540,766
1999	24,203	378,960	403,163	94.0%	8,072	32,275	25.0%	578,014
2000	23,515	416,058	439,573	94.7%	8,862	32,377	27.4%	808,998
2001	20,421	444,048	464,469	95.6%	9,458	29,879	31.7%	775,732
2002	20,014	288,678	308,692	93.5%	6,149	26,163	23.5%	646,611
2003	25,705	560,936	586,641	95.6%	11,948	37,653	31.7%	918,961
2004	22,573	555,613	578,186	96.1%	11,835	34,408	34.4%	947,859
2005	13,331	475,251	488,582	97.3%	10,123	23,454	43.2%	1,243,018
2006	13,969	521,762	535,731	97.4%	11,114	25,083	44.3%	1,037,430
2007	8,695	550,760	559,455	98.4%	11,731	20,426	57.4%	1,627,551
2008	14,802	418,521	433,323	96.6%	8,914	23,716	37.6%	987,758
2009	9,843	275,306	285,149	96.5%	5,864	15,707	37.3%	613,871
2010	585	275,373	275,958	99.8%	5,865	6,450	90.9%	699,362
2011	8,021	182,763	190,784	95.8%	3,893	11,914	32.7%	740,097
2012	4,266	231,434	235,700	98.2%	4,930	9,196	53.6%	716,121
2013	8,050	279,391	287,441	97.2%	5,951	14,001	42.5%	556,759
2014	8,922	421,584	430,506	97.9%	8,980	17,902	50.2%	561,559

Table 3.2.1 continued. Estimated number of snook landed by anglers, number of fish caught and released alive, total number caught, percent released alive, number that died after being released alive (release mortality rate of 2.13%), total harvest (landings plus those that died after being released alive), and estimated number of trips directed at snook.

Gulf

Year	Landings	Released	Total catch	Percent released	Dead releases	Total harvest	Percent discards	Directed trips
1981	23,755	13,275	37,030	35.8%	283	24,038	1.2%	90,667
1982	21,934	17,057	38,991	43.7%	363	22,297	1.6%	145,119
1983	38,396	59,498	97,894	60.8%	1,267	39,663	3.2%	167,794
1984	1,111	11,033	12,144	90.9%	235	1,346	17.5%	300,657
1985	15,747	44,652	60,399	73.9%	951	16,698	5.7%	83,331
1986	4,503	165,831	170,334	97.4%	3,532	8,035	44.0%	450,451
1987	20,501	42,995	63,496	67.7%	916	21,417	4.3%	308,752
1988	68,091	191,044	259,135	73.7%	4,069	72,160	5.6%	375,246
1989	15,295	154,077	169,372	91.0%	3,282	18,577	17.7%	402,524
1990	8,256	86,867	95,123	91.3%	1,850	10,106	18.3%	294,561
1991	40,648	540,925	581,573	93.0%	11,522	52,170	22.1%	885,851
1992	83,122	633,750	716,872	88.4%	13,499	96,621	14.0%	1,367,628
1993	61,780	707,619	769,399	92.0%	15,072	76,852	19.6%	1,098,422
1994	68,668	844,282	912,950	92.5%	17,983	86,651	20.8%	1,118,666
1995	49,420	581,869	631,289	92.2%	12,394	61,814	20.1%	957,649
1996	114,489	1,364,242	1,478,731	92.3%	29,058	143,547	20.2%	984,282
1997	124,220	1,145,310	1,269,530	90.2%	24,395	148,615	16.4%	1,239,687
1998	69,367	633,067	702,434	90.1%	13,484	82,851	16.3%	1,134,341
1999	70,627	837,209	907,836	92.2%	17,833	88,460	20.2%	1,039,115
2000	37,209	1,305,261	1,342,470	97.2%	27,802	65,011	42.8%	1,282,082
2001	37,803	1,322,816	1,360,619	97.2%	28,176	65,979	42.7%	1,371,221
2002	47,317	1,321,760	1,369,077	96.5%	28,153	75,470	37.3%	1,570,590
2003	42,530	1,413,264	1,455,794	97.1%	30,103	72,633	41.4%	1,980,465
2004	70,557	2,197,457	2,268,014	96.9%	46,806	117,363	39.9%	2,354,441
2005	61,949	2,280,821	2,342,770	97.4%	48,581	110,530	44.0%	2,614,587
2006	24,874	1,390,595	1,415,469	98.2%	29,620	54,494	54.4%	2,238,543
2007	35,437	1,591,148	1,626,585	97.8%	33,891	69,328	48.9%	2,725,145
2008	25,429	1,595,274	1,620,703	98.4%	33,979	59,408	57.2%	2,392,375
2009	13,936	1,924,431	1,938,367	99.3%	40,990	54,926	74.6%	2,028,889
2010	0	600,351	600,351	100.0%	12,787	12,787	100.0%	1,470,584
2011	599	746,797	747,396	99.9%	15,907	16,506	96.4%	2,044,465
2012	369	1,040,123	1,040,492	100.0%	22,155	22,524	98.4%	2,402,197
2013	32,652	1,547,280	1,579,932	97.9%	32,957	65,609	50.2%	1,473,106
2014	13,851	1,577,880	1,591,731	99.1%	33,609	47,460	70.8%	1,312,446

Table 3.2.2. Seasonal distribution of numbers of fish landed and number released alive by coast expressed as a percentage of the total annual harvest based on the sum of two-month wave averages over the periods 1986–1998, 1999–2005, 2008-2012, and 2013-2014.

1986-1998

	Atlantic		Gulf	
Wave	Landings	Releases	Landings	Releases
Jan-Feb	4%	6%	3%	6%
Mar-Apr	20%	11%	27%	16%
May-Jun	14%	21%	24%	28%
Jul-Aug	2%	26%	6%	17%
Sep-Oct	49%	24%	29%	20%
Nov-Dec	11%	13%	11%	12%
Annual	100%	100%	100%	100%

1999-2005

	Atlantic		Gulf	
Wave	Landings	Releases	Landings	Releases
Jan-Feb	10%	8%	3%	5%
Mar-Apr	21%	13%	36%	17%
May-Jun	16%	14%	14%	25%
Jul-Aug	0%	23%	1%	16%
Sep-Oct	38%	25%	29%	23%
Nov-Dec	16%	17%	17%	15%
Annual	100%	100%	100%	100%

2008-2012

	Atlantic		Gulf	
Wave	Landings	Releases	Landings	Releases
Jan-Feb	5%	7%	1%	7%
Mar-Apr	21%	15%	44%	19%
May-Jun	7%	16%	3%	24%
Jul-Aug	1%	25%	6%	17%
Sep-Oct	50%	26%	30%	19%
Nov-Dec	16%	11%	16%	14%
Annual	100%	100%	100%	100%

2013-2014

	Atlantic		Gulf	
Wave	Landings	Releases	Landings	Releases
Jan-Feb	0%	10%	0%	8%
Mar-Apr	5%	8%	38%	17%
May-Jun	3%	12%	0%	14%
Jul-Aug	0%	38%	0%	18%
Sep-Oct	65%	23%	42%	25%
Nov-Dec	27%	9%	20%	18%
Annual	100%	100%	100%	100%

Table 3.3.1. The five most commonly sought species by coast as specified in MRFSS/MRIP angler interviews made during 1987, 2000, 2004, 2009, and 2014. The total number of intercepts and the number of intercepts that identified a species preference are included and the percentages are based on the interviews that specified a preference.

Atlantic

		1987		2000		2004		2009		2014
Total number of intercepts		4,659		17,058		16,218		14,665		10,970
Intercepts specifying preferences		2,235		8,648		7,455		6,795		5,388
Rank	Description	Percent of Intercepts	Description	Percent of Intercepts	Description	Intercepts	Description	Percent of Intercepts	Description	Percent of Intercepts
1	Dolphin	27%	Red drum	25%	Red drum	27%	Red drum	21%	Red drum	25%
2	Sailfish	17%	Dolphin	19%	Dolphin	18%	Dolphin	17%	Dolphin	20%
3	Spotted seatrout	15%	Spotted seatrout	16%	Spotted seatrout	16%	Spotted seatrout	12%	Spotted seatrout	11%
4	King mackerel	13%	King mackerel	10%	King mackerel	10%	King mackerel	10%	**Common snook**	7%
5	Bluefish	7%	**Common snook**	9%	**Common snook**	8%	**Common snook**	8%	King Mackerel	7%
	Common snook (8)	4%							**)**	

Gulf

		1987		2000		2004		2009		2014
Total number of intercepts		7,961		27,147		30,880		24,981		22,561
Intercepts specifying preferences		4,381		12,450		15,709		11,903		12,365
Rank	Description	Percent of Intercepts	Description	Rank	Description	Intercepts	Description	Percent of Intercepts	Description	Percent of Intercepts
1	King mackerel	18%	Spotted seatrout	20%	Red drum	22%	Red drum	28%	Red drum	29%
2	Spotted seatrout	17%	Red drum	16%	Spotted seatrout	21%	Spotted seatrout	26%	Spotted seatrout	21%
3	Spanish mackerel	10%	Dolphin	11%	Groupers	14%	**Common snook**	11%	**Common snook**	10%
4	Seatrouts	10%	Groupers	11%	**Common snook**	12%	Spanish mackerel	8%	Red grouper	8%
5	Groupers	6%	**Common snook**	9%	Spanish mackerel	7%	King mackerel	7%	Gray Snapper	7%
	Common snook (31)	1%								

Table 3.4.1. Numbers of snook landed (kept) by total length in inches, year, and coast (MRFSS/MRIP Type a+b1).

Atlantic

	Total Length (in)																	
Year	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	3,774	809	539	539	0	270	0	0	270	0	270	539	539	270	809	809	539	1,348
1988	1,791	163	163	109	54	163	54	0	54	0	0	109	271	814	868	1,357	1,519	2,008
1989	1,452	201	201	67	156	223	380	156	134	89	112	112	313	223	179	357	447	469
1990	604	0	0	50	25	75	151	75	126	176	50	75	478	302	327	352	251	402
1991	486	0	54	0	216	216	216	54	0	216	54	271	379	595	162	216	812	758
1992	0	0	0	0	0	0	0	0	0	0	3,258	0	0	6,517	0	2,172	0	2,172
1993	0	0	0	0	0	0	0	0	0	0	640	1,279	640	0	1,279	1,919	2,558	0
1994	0	0	0	0	0	0	0	729	729	0	0	1,458	729	5,104	1,458	2,188	3,646	2,917
1995	0	0	0	0	0	0	0	0	0	0	736	2,207	2,207	736	2,942	1,471	1,471	2,207
1996	0	0	0	0	0	0	0	0	0	0	2,971	0	8,912	1,485	0	5,941	2,971	743
1997	0	0	0	0	0	0	0	0	69	0	0	549	2,128	2,952	2,197	1,922	2,952	2,471
1998	0	0	36	0	0	0	0	0	0	36	36	324	792	756	612	936	612	1,440
1999	0	0	83	0	0	0	0	0	0	0	0	83	249	1,164	1,828	831	1,247	1,995
2000	0	0	0	0	0	0	0	0	0	0	0	185	185	432	1,421	2,038	865	1,853
2001	0	0	0	0	104	52	104	0	52	0	155	104	207	311	2,021	2,176	2,384	1,451
2002	19	0	0	0	0	0	0	0	0	39	0	0	58	676	3,305	2,648	2,106	1,836
2003	0	0	0	0	0	0	0	0	0	0	0	0	23	250	3,552	2,254	2,254	2,004
2004	0	0	19	0	19	38	38	0	0	0	0	0	0	285	3,309	2,453	2,092	2,206
2005	93	0	13	0	0	0	0	0	13	0	0	27	0	160	2,017	1,550	1,630	1,376
2006	0	0	0	0	0	0	0	0	0	0	0	12	0	208	1,295	1,748	1,833	1,381
2007	0	0	0	0	14	14	14	0	14	28	28	0	0	42	166	623	969	1,329
2008	0	106	53	0	0	0	0	0	0	0	0	0	53	53	0	1,012	2,449	1,970
2009	0	0	0	0	0	0	0	12	0	12	0	0	0	24	35	354	1,709	1,792
2010	0	0	0	0	0	0	0	1	0	2	0	1	0	0	0	17	109	124
2011	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	175	1,300	1,461
2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	125	695	712
2013	38	0	0	0	0	0	13	0	0	13	13	0	0	0	13	151	1,472	1,321
2014	0	0	0	0	0	0	0	16	0	0	0	0	0	16	0	239	1,928	1,625

Table 3.4.1 continued. Numbers of snook landed (kept) by total length in inches, year, and coast (MRFSS/MRIP Type a+b1).

Atlantic

	Total Length (in)																	
Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total
1986	1,755	0	0	2,632	0	0	0	877	1,755	1,755	0	0	0	0	0	0	0	8,774
1987	809	270	1,618	1,618	270	1,348	539	809	539	539	270	270	0	0	0	0	0	20,223
1988	1,682	2,605	2,062	1,899	1,248	1,194	543	868	217	163	271	109	109	163	0	0	0	22,630
1989	514	581	982	715	290	335	246	380	201	156	156	112	156	89	22	45	0	10,251
1990	327	352	528	478	503	276	276	276	151	201	101	101	75	50	0	0	0	7,214
1991	1,407	1,624	2,002	2,057	1,570	1,461	1,299	974	487	866	541	433	162	0	108	0	0	19,696
1992	2,172	4,344	0	0	1,086	0	1,086	0	0	0	0	0	0	0	0	0	0	22,807
1993	2,558	3,837	1,279	1,279	0	0	640	640	0	0	0	0	0	0	0	0	0	18,548
1994	1,458	2,917	7,292	1,458	2,188	0	1,458	2,917	0	0	0	0	0	0	0	0	0	38,646
1995	3,678	6,620	1,471	2,942	1,471	0	736	0	736	0	0	0	736	0	0	0	0	32,367
1996	3,713	4,456	2,971	743	3,713	3,713	743	0	0	0	0	0	0	0	0	0	0	43,075
1997	4,394	4,394	4,600	4,256	3,501	3,433	3,089	2,403	1,236	2,128	824	1,167	755	481	0	0	0	51,901
1998	1,656	2,231	1,871	2,267	1,728	1,620	1,476	1,044	1,044	864	324	288	324	0	36	0	0	22,353
1999	2,493	2,576	3,491	2,660	1,745	1,164	665	499	499	416	416	83	83	83	0	0	0	24,353
2000	2,285	2,409	3,768	5,992	1,421	618	124	0	0	0	0	0	0	0	0	0	0	23,596
2001	3,006	2,073	2,332	2,280	1,140	363	0	52	0	52	0	52	52	0	0	0	0	20,523
2002	1,990	1,797	1,990	2,068	1,121	406	58	39	0	19	0	0	0	0	0	0	0	20,175
2003	2,231	2,914	3,871	4,098	1,776	182	0	0	0	0	0	0	0	0	0	0	0	25,409
2004	2,244	2,301	2,320	2,910	2,168	114	19	0	19	19	0	0	0	0	0	0	0	22,573
2005	1,149	1,256	1,456	1,483	935	53	67	13	40	0	0	0	0	0	0	0	0	13,331
2006	1,552	1,454	1,686	1,576	1,063	122	24	0	0	12	0	0	0	0	0	0	0	13,966
2007	1,274	1,315	1,246	886	651	42	14	0	0	0	14	14	0	0	0	0	0	8,697
2008	2,822	3,035	3,035	160	53	0	0	0	0	0	0	0	0	0	0	0	0	14,801
2009	2,087	2,405	1,179	177	24	12	24	0	0	0	0	0	0	0	0	0	0	9,846
2010	115	140	64	9	2	0	0	0	0	0	0	0	0	0	0	0	0	584
2011	1,899	1,841	1,183	117	15	0	0	15	0	0	0	0	0	0	0	0	0	8,021
2012	864	1,078	712	80	0	0	0	0	0	0	0	0	0	0	0	0	0	4,266
2013	1,472	1,799	1,522	138	38	25	13	13	0	0	0	0	0	0	0	0	0	8,054
2014	1,577	1,864	1,577	48	16	16	0	0	0	0	0	0	0	0	0	0	0	8,922

Table 3.4.1 continued. Numbers of snook landed (kept) by total length in inches, year, and coast (MRFSS/MRIP Type a+b1).

Gulf

	Total Length (in)																	
Year	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1986	0	0	0	0	11	0	0	22	0	22	32	172	333	398	624	484	301	280
1987	39	0	0	0	0	0	0	0	118	118	157	786	943	1,690	2,200	3,890	2,043	2,043
1988	266	133	398	265	398	531	0	0	265	398	664	664	1,991	2,920	4,380	9,424	5,575	10,088
1989	0	0	21	63	42	84	105	0	84	294	42	378	588	945	1,345	1,639	1,219	1,870
1990	0	0	26	39	52	0	39	39	39	13	13	235	497	1,007	876	889	980	954
1991	0	0	0	196	0	0	0	0	0	0	196	2,160	6,677	5,204	6,088	4,026	3,142	3,437
1992	0	0	126	505	379	126	126	632	126	379	379	4,169	8,464	11,370	11,243	10,612	9,222	6,316
1993	0	309	154	77	231	309	0	154	231	0	154	2,237	5,555	9,104	8,101	7,406	5,478	5,092
1994	1,144	286	1,087	973	1,030	343	286	801	1,774	744	1,145	3,033	5,208	8,757	6,181	7,498	5,037	4,579
1995	0	0	0	71	214	71	0	0	71	143	571	1,998	5,637	6,136	3,710	4,709	4,995	3,853
1996	100	0	0	0	0	100	201	100	201	201	904	2,512	12,660	16,779	12,559	13,865	10,148	7,837
1997	0	0	186	0	93	278	1,207	1,392	1,392	93	464	4,269	13,829	16,056	13,457	12,436	9,931	8,167
1998	0	0	62	0	0	123	0	0	123	62	62	2,222	14,630	13,827	11,235	8,580	6,852	6,296
1999	0	0	0	0	0	0	0	0	165	248	83	496	496	5,041	10,578	12,065	9,503	8,099
2000	168	56	0	167	56	167	222	56	111	222	222	0	56	1,890	5,002	7,058	4,557	4,669
2001	46	0	0	0	0	0	0	0	46	0	0	137	273	1,866	6,191	6,282	5,007	4,051
2002	0	0	25	0	0	25	0	0	0	49	49	25	295	2,705	8,091	8,115	6,960	5,705
2003	0	0	0	0	0	0	0	0	0	0	0	42	231	2,561	8,395	8,311	7,199	4,785
2004	0	0	0	0	0	0	0	30	0	30	0	89	325	4,140	13,662	13,603	11,148	9,404
2005	0	0	0	0	0	0	0	0	39	0	39	116	232	3,407	10,725	10,222	8,673	7,860
2006	0	0	0	0	0	0	0	20	0	20	0	20	120	800	2,839	9,118	3,479	2,359
2007	0	0	0	0	0	0	0	0	0	36	0	72	0	215	1,538	12,444	6,401	4,971
2008	0	0	50	0	0	0	50	0	0	0	0	50	0	50	200	8,993	4,296	3,747
2009	0	0	0	0	0	0	0	0	0	0	30	120	0	0	30	3,094	2,823	2,283
2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0	61	30	0	112	81
2012	26	0	0	0	0	0	0	0	0	0	0	0	4	4	9	4	30	56
2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,041	5,306	5,034
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	92	1,743	2,523	2,339

Table 3.4.1 continued. Numbers of snook landed (kept) by total length in inches, year, and coast (MRFSS/MRIP Type a+b1).

Gulf

	Total Length (in)																	
Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total
1986	387	269	75	118	54	65	118	43	43	32	65	65	0	0	0	0	0	4013
1987	1297	1179	393	629	314	432	472	432	314	314	236	472	0	0	0	0	0	20511
1988	6106	4115	2920	3982	1991	2655	1195	1991	1460	929	531	1858	0	0	0	0	0	68093
1989	1050	1029	819	588	714	567	420	252	189	294	462	168	0	21	0	0	0	15292
1990	484	327	471	418	222	183	78	105	118	92	52	13	0	0	0	0	0	8261
1991	1866	1767	1080	982	1276	491	491	786	295	295	196	0	0	0	0	0	0	40651
1992	4421	2653	3032	1516	2527	1516	758	632	1011	126	253	126	126	0	126	0	126	83123
1993	3317	2855	2392	2006	1312	2392	926	694	617	386	77	77	154	0	0	0	0	61797
1994	3262	3033	2804	1488	2518	1660	1030	1087	744	630	172	114	114	57	57	0	57	68733
1995	3068	2925	3354	1498	1998	1498	499	999	428	428	285	71	214	0	0	0	0	49444
1996	5426	8038	7535	3215	4019	2914	2009	1507	1306	201	301	0	100	0	0	0	0	114738
1997	6961	8446	6497	5754	4176	3248	2320	650	1578	1021	93	186	186	0	0	0	0	124366
1998	3395	3086	2901	2284	2222	1235	926	926	309	185	247	123	0	0	0	0	0	81913
1999	5371	5454	4297	3636	1322	83	83	0	0	0	0	0	0	0	0	0	0	67020
2000	3446	3112	2223	2835	333	500	0	56	56	0	0	0	0	0	0	0	0	37240
2001	3414	4097	3323	1912	728	273	0	46	0	91	46	0	0	0	0	0	0	37829
2002	4500	3812	2902	2533	1328	98	74	25	25	0	0	0	0	0	0	0	0	47341
2003	4366	2749	1952	1343	483	63	42	0	21	0	0	0	0	0	0	0	0	42543
2004	6269	4643	3401	2277	1124	296	89	0	0	0	30	0	0	0	0	0	0	70560
2005	7627	5575	3717	3214	503	0	0	0	0	0	0	0	0	0	0	0	0	61949
2006	2099	1500	1380	740	320	40	0	20	0	0	0	0	0	0	0	0	0	24874
2007	3647	2253	2003	1287	501	72	0	0	0	0	0	0	0	0	0	0	0	35440
2008	2848	2248	1749	999	100	50	0	0	0	0	0	0	0	0	0	0	0	25430
2009	1652	2012	1352	390	90	60	0	0	0	0	0	0	0	0	0	0	0	13936
2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	152	41	51	71	0	0	0	0	0	0	0	0	0	0	0	0	0	599
2012	64	73	73	26	0	0	0	0	0	0	0	0	0	0	0	0	0	369
2013	6122	8435	4082	1088	544	0	0	0	0	0	0	0	0	0	0	0	0	32652
2014	2477	1789	2064	780	46	0	0	0	0	0	0	0	0	0	0	0	0	13853

Table 3.4.2. Numbers of snook released alive by total length in inches, year, and coast (MRFSS/MRIP Type b2).

Atlantic

	Total Length (in)																	
Year	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1986	711	464	757	1,220	1,926	2,944	4,285	5,813	7,177	7,897	7,661	6,575	48	48	48	48	48	48
1987	715	466	761	1,226	1,935	2,958	4,305	5,841	7,212	7,935	7,698	6,607	48	48	48	48	48	48
1988	838	547	892	1,437	2,269	3,468	5,047	6,848	8,454	9,303	9,024	7,745	57	57	57	57	57	57
1989	3,125	2,039	3,327	5,361	8,462	12,934	18,826	25,542	31,535	34,699	33,661	28,889	211	211	211	211	211	211
1990	2,428	1,584	2,585	4,166	6,576	10,050	14,629	19,847	24,504	26,963	26,156	22,448	164	164	164	164	164	164
1991	2,887	1,883	3,074	4,952	7,817	11,948	17,391	23,595	29,131	32,054	31,095	26,687	195	195	195	195	195	195
1992	5,207	3,397	5,544	8,933	14,101	21,552	31,370	42,560	52,546	57,819	56,088	48,137	352	352	352	352	352	352
1993	2,597	1,694	2,765	4,455	7,033	10,749	15,646	21,227	26,207	28,837	27,974	24,008	176	176	176	176	176	176
1994	6,959	4,540	7,409	11,938	18,844	28,802	41,923	56,877	70,223	77,269	74,956	64,331	470	470	470	470	470	470
1995	9,526	6,215	10,142	16,341	25,795	39,426	57,387	77,857	96,126	105,771	102,604	88,060	644	644	644	644	644	644
1996	5,441	3,550	5,793	9,334	14,734	22,520	32,779	44,472	54,907	60,417	58,608	50,300	368	368	368	368	368	368
1997	6,414	4,185	6,829	11,003	17,369	26,547	38,641	52,424	64,725	71,220	69,088	59,294	433	433	433	433	433	433
1998	4,555	2,971	4,849	7,813	12,333	18,850	27,437	37,224	45,959	50,571	49,057	42,103	308	308	308	308	308	308
1999	4,213	2,748	4,485	7,226	11,407	17,434	25,377	34,429	42,508	46,773	45,373	38,941	30,060	21,360	278	278	278	278
2000	4,619	3,013	4,918	7,923	12,507	19,116	27,825	37,750	46,608	51,285	49,749	42,697	32,959	23,421	305	305	305	305
2001	4,912	3,204	5,229	8,426	13,300	20,329	29,590	40,144	49,564	54,538	52,905	45,405	35,050	24,906	325	325	325	325
2002	5,528	1,962	4,280	3,923	7,312	11,770	18,368	21,578	23,540	31,030	38,520	39,946	31,208	31,565	0	0	0	0
2003	5,658	8,040	12,209	11,316	21,738	25,312	34,245	36,032	42,286	55,388	61,940	67,002	61,344	58,962	0	596	596	0
2004	9,953	6,733	12,880	8,489	16,979	25,468	36,885	39,812	40,983	38,934	56,498	51,814	67,622	59,133	585	878	293	878
2005	7,138	4,884	4,884	6,387	19,160	17,282	34,564	21,414	36,066	30,807	45,083	39,823	62,741	72,509	376	751	1,503	0
2006	3,255	6,045	4,650	3,255	6,975	4,650	13,486	20,926	23,716	24,181	46,968	51,153	72,544	108,352	26,042	0	0	0
2007	16,353	3,504	5,256	5,256	15,769	16,353	15,769	20,442	25,114	26,282	32,707	30,955	52,565	64,246	64,246	19,858	1,168	0
2008	7,966	5,515	4,902	7,353	8,579	7,966	24,511	22,672	34,928	29,413	41,056	47,183	30,026	13,481	20,221	17,770	0	0
2009	6,692	2,868	6,691	1,434	3,824	5,736	6,691	10,515	14,339	15,773	26,766	25,332	30,590	20,552	30,112	23,420	0	0
2010	12,209	2,713	2,713	4,522	4,974	5,878	8,591	7,235	17,635	22,156	17,183	20,800	25,322	18,539	18,539	18,991	4,974	5,878
2011	5,896	769	1,538	513	2,307	3,589	4,870	5,127	11,791	15,380	18,712	24,608	18,968	13,585	11,791	11,022	256	513
2012	24,797	1,929	4,133	6,888	3,306	3,306	5,235	4,133	5,510	4,408	8,817	10,470	18,735	19,286	23,143	14,602	4,684	5,510
2013	5,584	2,311	3,273	5,584	5,584	3,658	6,932	2,503	5,199	2,696	8,087	9,242	14,634	20,218	25,224	25,994	6,932	4,236
2014	21,064	9,912	13,320	12,390	13,939	12,390	15,178	13,320	14,559	12,081	12,700	21,993	23,542	27,569	27,878	21,064	620	1,859

Table 3.4.2 continued. Numbers of snook released alive by total length in inches, year, and coast (MRFSS/MRIP Type b2).

Atlantic

	Total Length (in)																	
Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total
1986	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48,535
1987	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48,769
1988	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57,173
1989	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	213,258
1990	164	164	164	164	164	164	164	164	164	164	164	164	164	164	164	164	164	165,710
1991	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	195	197,002
1992	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	355,347
1993	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	177,229
1994	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	470	474,887
1995	644	644	644	644	644	644	644	644	644	644	644	644	644	644	644	644	644	650,055
1996	368	368	368	368	368	368	368	368	368	368	368	368	368	368	368	368	368	371,313
1997	433	433	433	433	433	433	433	433	433	433	433	433	433	433	433	433	433	437,710
1998	308	308	308	308	308	308	308	308	308	308	308	308	308	308	308	308	308	310,800
1999	278	278	278	278	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	3,406	378,840
2000	305	305	305	305	3,734	3,734	3,734	3,734	3,734	3,734	3,734	3,734	3,734	3,734	3,734	3,734	3,734	415,381
2001	325	325	325	325	3,971	3,971	3,971	3,971	3,971	3,971	3,971	3,971	3,971	3,971	3,971	3,971	3,971	441,729
2002	0	0	0	0	0	3,032	3,388	3,032	1,427	1,783	1,427	1,427	892	1,248	178	535	357	289,256
2003	298	596	0	0	298	13,996	12,209	9,827	5,956	6,254	3,573	4,169	893	893	893	298	298	563,115
2004	585	878	585	1,171	878	21,955	11,124	11,417	8,489	7,318	5,269	2,927	3,513	2,342	1,171	878	293	555,610
2005	0	376	0	376	0	13,149	12,398	11,271	9,392	6,387	5,260	5,260	3,381	1,127	1,127	376	0	475,252
2006	0	0	0	465	0	16,276	18,136	13,951	17,206	8,371	9,766	3,720	6,510	3,255	3,255	1,860	2,790	521,759
2007	0	0	584	18,106	15,769	24,530	20,442	12,849	9,929	10,513	7,593	6,425	4,672	584	584	584	1,752	550,759
2008	613	0	613	20,221	20,834	18,383	9,192	6,740	7,353	3,677	1,226	1,838	2,451	1,226	613	0	0	418,522
2009	0	0	0	11,471	11,471	3,346	6,213	956	1,434	1,912	1,912	3,824	956	0	0	0	478	275,308
2010	6,330	2,261	904	10,400	12,209	4,974	4,522	2,713	3,617	2,261	3,165	0	2,261	452	452	0	0	275,373
2011	256	256	0	10,766	6,921	5,383	3,589	2,051	769	256	1,282	0	0	0	0	0	0	182,764
2012	3,306	3,306	2,755	9,643	11,021	6,337	8,817	2,480	6,061	3,857	2,204	1,102	827	276	276	0	276	231,436
2013	2,888	4,044	3,466	16,944	19,833	16,559	13,479	11,168	8,665	7,509	6,354	5,199	3,658	385	385	578	386	279,391
2014	310	929	620	13,010	20,444	24,471	17,966	17,037	11,461	14,868	8,364	5,885	7,744	1,549	929	310	310	421,585

Table 3.4.2 continued. Numbers of snook released alive by total length in inches, year, and coast (MRFSS/MRIP Type b2).

Gulf

	Total Length (in)																	
Year	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1986	520	372	630	1,058	1,742	2,780	4,225	5,966	7,604	8,520	8,272	6,987	103	103	103	103	103	103
1987	145	104	176	295	486	775	1,178	1,664	2,120	2,376	2,307	1,948	29	29	29	29	29	29
1988	1,828	1,306	2,216	3,719	6,122	9,773	14,852	20,971	26,728	29,949	29,079	24,561	363	363	363	363	363	363
1989	1,557	1,112	1,888	3,167	5,215	8,323	12,650	17,861	22,764	25,507	24,766	20,919	309	309	309	309	309	309
1990	793	566	961	1,613	2,655	4,238	6,441	9,094	11,591	12,988	12,610	10,651	158	158	158	158	158	158
1991	5,508	3,935	6,678	11,205	18,448	29,447	44,753	63,190	80,537	90,241	87,620	74,008	1,095	1,095	1,095	1,095	1,095	1,095
1992	6,473	4,624	7,847	13,167	21,679	34,604	52,592	74,258	94,643	106,047	102,967	86,970	1,286	1,286	1,286	1,286	1,286	1,286
1993	7,235	5,169	8,771	14,718	24,232	38,679	58,785	83,002	105,787	118,534	115,091	97,211	1,438	1,438	1,438	1,438	1,438	1,438
1994	8,635	6,168	10,468	17,565	28,919	46,161	70,156	99,058	126,250	141,462	137,354	116,015	1,716	1,716	1,716	1,716	1,716	1,716
1995	5,932	4,237	7,191	12,066	19,867	31,711	48,195	68,050	86,730	97,180	94,358	79,699	1,179	1,179	1,179	1,179	1,179	1,179
1996	14,028	10,021	17,006	28,535	46,982	74,992	113,974	160,927	205,103	229,817	223,142	188,476	2,788	2,788	2,788	2,788	2,788	2,788
1997	11,740	8,387	14,233	23,881	39,320	62,761	95,386	134,681	171,652	192,336	186,749	157,737	2,333	2,333	2,333	2,333	2,333	2,333
1998	6,086	4,348	7,378	12,380	20,384	32,536	49,449	69,820	88,987	99,709	96,813	81,773	1,210	1,210	1,210	1,210	1,210	1,210
1999	6,541	4,673	7,930	13,305	21,906	34,967	53,143	75,036	95,634	107,157	104,045	87,881	65,904	45,146	1,379	1,379	1,379	1,379
2000	11,423	8,160	13,848	23,236	38,257	61,066	92,808	131,042	167,014	187,138	181,703	153,474	115,094	78,843	2,409	2,409	2,409	2,409
2001	11,499	8,215	13,941	23,392	38,513	61,475	93,430	131,919	168,133	188,392	182,920	154,502	115,865	79,371	2,425	2,425	2,425	2,425
2002	6,974	0	10,777	9,509	43,110	41,842	101,434	88,121	110,310	145,812	200,333	168,001	200,333	177,510	0	634	0	0
2003	63,694	19,715	21,990	18,199	21,990	18,957	65,970	66,728	90,234	165,303	253,263	188,051	222,932	155,446	8,341	4,550	3,033	758
2004	59,753	33,889	52,618	42,808	70,454	32,998	118,613	106,127	185,500	236,334	409,348	278,249	313,031	183,716	892	3,567	892	2,675
2005	73,121	28,124	44,998	47,810	89,995	118,119	230,613	179,991	295,297	202,490	247,487	213,739	261,549	137,805	14,062	11,249	11,249	5,625
2006	35,155	5,859	23,437	31,249	64,452	58,592	142,575	85,936	195,308	117,185	115,232	132,810	150,387	83,983	46,874	1,953	3,906	1,953
2007	24,641	17,601	35,202	49,283	77,445	70,405	151,370	70,405	147,850	77,445	183,052	130,249	158,411	133,769	116,168	24,642	0	0
2008	27,317	21,853	49,169	10,927	43,706	65,559	142,045	49,169	191,214	163,898	158,435	76,486	152,971	87,412	120,192	60,096	5,463	10,927
2009	12,717	12,717	25,433	21,194	29,672	38,150	80,538	72,060	105,971	144,120	97,493	161,076	284,002	339,107	258,569	122,926	0	12,717
2010	38,185	2,121	21,214	14,850	27,578	21,214	95,462	23,335	48,792	40,306	21,214	25,457	31,821	21,214	21,214	25,457	10,607	12,728
2011	33,249	23,018	10,230	20,460	23,018	33,248	66,496	30,690	79,283	61,381	56,266	48,593	74,168	28,133	23,018	23,018	10,230	20,460
2012	50,239	14,885	26,050	22,328	53,960	44,656	81,870	52,099	89,313	52,099	53,960	63,263	81,870	87,452	80,009	35,353	11,164	13,025
2013	98,763	32,921	108,445	73,588	120,064	122,001	114,255	94,890	118,128	108,445	102,636	75,524	61,969	56,159	42,603	54,223	15,492	5,810
2014	89,562	44,781	52,684	31,610	60,586	47,415	105,368	79,026	134,344	105,368	131,710	100,099	158,051	102,733	102,733	47,415	15,805	2,634

Table 3.4.2 continued. Numbers of snook released alive by total length in inches, year, and coast (MRFSS/MRIP Type b2).

Gulf

	Total Length (in)																	
Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total
1986	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103	103	51,053
1987	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	14,236
1988	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	363	179,459
1989	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	309	152,846
1990	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	77,825
1991	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	1,095	540,747
1992	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	635,461
1993	1,438	1,438	1,438	1,438	1,438	1,438	1,438	1,438	1,438	1,438	1,438	1,438	1,438	1,438	1,438	1,438	1,438	710,286
1994	1,716	1,716	1,716	1,716	1,716	1,716	1,716	1,716	1,716	1,716	1,716	1,716	1,716	1,716	1,716	1,716	1,716	847,679
1995	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	582,330
1996	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	2,788	1,377,123
1997	2,333	2,333	2,333	2,333	2,333	2,333	2,333	2,333	2,333	2,333	2,333	2,333	2,333	2,333	2,333	2,333	2,333	1,152,524
1998	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	1,210	597,482
1999	1,379	1,379	1,379	1,379	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	750,517
2000	2,409	2,409	2,409	2,409	2,178	2,178	2,178	2,178	2,178	2,178	2,178	2,178	2,178	2,178	2,178	2,178	2,178	1,310,694
2001	2,425	2,425	2,425	2,425	2,193	2,193	2,193	2,193	2,193	2,193	2,193	2,193	2,193	2,193	2,193	2,193	2,193	1,319,475
2002	0	634	0	0	0	5,706	6,340	3,170	1,902	634	1,268	0	0	1,268	0	0	0	1,325,622
2003	1,517	758	1,517	758	2,275	1,517	4,550	3,033	3,791	3,033	758	0	758	0	0	758	0	1,414,177
2004	4,459	3,567	3,567	4,459	0	6,243	11,594	4,459	11,594	3,567	6,243	3,567	1,784	892	0	0	0	2,197,459
2005	8,437	2,812	0	0	0	22,499	16,874	2,812	11,249	2,812	0	0	0	0	0	0	0	2,280,818
2006	0	0	0	0	0	9,765	23,437	17,578	23,437	9,765	7,812	1,953	0	0	0	0	0	1,390,593
2007	3,520	0	0	0	3,520	7,040	24,642	7,040	10,561	10,561	31,682	3,520	10,561	3,520	3,520	0	3,520	1,591,145
2008	0	5,463	0	5,463	54,633	10,927	27,316	10,927	21,853	10,927	5,463	0	5,463	0	0	0	0	1,595,274
2009	4,239	4,239	0	12,717	42,388	8,478	0	8,478	8,478	4,239	4,239	4,239	0	4,239	0	0	0	1,924,435
2010	8,486	4,243	8,486	4,243	6,364	2,121	10,607	14,850	2,121	4,243	21,214	2,121	8,486	0	0	0	0	600,354
2011	10,230	2,558	17,903	2,558	10,230	10,230	10,230	2,558	2,558	2,558	5,115	0	5,115	0	0	0	0	746,802
2012	18,607	11,164	9,303	11,164	37,214	11,164	14,885	0	5,582	1,861	5,582	0	0	0	0	0	0	1,040,121
2013	36,794	9,683	13,556	9,683	21,302	7,746	27,111	5,810	5,810	1,937	0	0	0	1,937	0	0	0	1,547,285
2014	7,903	10,537	7,903	10,537	36,879	31,610	18,439	5,268	10,537	2,634	10,537	5,268	7,903	0	0	0	0	1,577,879

Table 3.4.3. Total recreational catch (numbers of snook kept or released alive) by total length in inches, year, and coast (MRFSS/MRIP Type a+b1+b2).

Atlantic

	Total Length (in)																	
Year	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1986	711	464	757	1,220	1,926	2,944	4,285	5,813	7,177	7,897	7,661	6,575	48	48	48	48	48	48
1987	4,489	1,275	1,300	1,765	1,935	3,228	4,305	5,841	7,482	7,935	7,968	7,146	587	318	857	857	587	1,396
1988	2,629	710	1,055	1,546	2,323	3,631	5,101	6,848	8,508	9,303	9,024	7,854	328	871	925	1,414	1,576	2,065
1989	4,577	2,240	3,528	5,428	8,618	13,157	19,206	25,698	31,669	34,788	33,773	29,001	524	434	390	568	658	680
1990	3,032	1,584	2,585	4,216	6,601	10,125	14,780	19,922	24,630	27,139	26,206	22,523	642	466	491	516	415	566
1991	3,373	1,883	3,128	4,952	8,033	12,164	17,607	23,649	29,131	32,270	31,149	26,958	574	790	357	411	1,007	953
1992	5,207	3,397	5,544	8,933	14,101	21,552	31,370	42,560	52,546	57,819	59,346	48,137	352	6,869	352	2,524	352	2,524
1993	2,597	1,694	2,765	4,455	7,033	10,749	15,646	21,227	26,207	28,837	28,614	25,287	816	176	1,455	2,095	2,734	176
1994	6,959	4,540	7,409	11,938	18,844	28,802	41,923	57,606	70,952	77,269	74,956	65,789	1,199	5,574	1,928	2,658	4,116	3,387
1995	9,526	6,215	10,142	16,341	25,795	39,426	57,387	77,857	96,126	105,771	103,340	90,267	2,851	1,380	3,586	2,115	2,115	2,851
1996	5,441	3,550	5,793	9,334	14,734	22,520	32,779	44,472	54,907	60,417	61,579	50,300	9,280	1,853	368	6,309	3,339	1,111
1997	6,414	4,185	6,829	11,003	17,369	26,547	38,641	52,424	64,794	71,220	69,088	59,843	2,561	3,385	2,630	2,355	3,385	2,904
1998	4,555	2,971	4,885	7,813	12,333	18,850	27,437	37,224	45,959	50,607	49,093	42,427	1,100	1,064	920	1,244	920	1,748
1999	4,213	2,748	4,568	7,226	11,407	17,434	25,377	34,429	42,508	46,773	45,373	39,024	30,309	22,524	2,106	1,109	1,525	2,273
2000	4,619	3,013	4,918	7,923	12,507	19,116	27,825	37,750	46,608	51,285	49,749	42,882	33,144	23,853	1,726	2,343	1,170	2,158
2001	4,912	3,204	5,229	8,426	13,404	20,381	29,694	40,144	49,616	54,538	53,060	45,509	35,257	25,217	2,346	2,501	2,709	1,776
2002	5,547	1,962	4,280	3,923	7,312	11,770	18,368	21,578	23,540	31,069	38,520	39,946	31,266	32,241	3,305	2,648	2,106	1,836
2003	5,658	8,040	12,209	11,316	21,738	25,312	34,245	36,032	42,286	55,388	61,940	67,002	61,367	59,212	3,552	2,850	2,850	2,004
2004	9,953	6,733	12,899	8,489	16,998	25,506	36,923	39,812	40,983	38,934	56,498	51,814	67,622	59,418	3,894	3,331	2,385	3,084
2005	7,231	4,884	4,897	6,387	19,160	17,282	34,564	21,414	36,079	30,807	45,083	39,850	62,741	72,669	2,393	2,301	3,133	1,376
2006	3,255	6,045	4,650	3,255	6,975	4,650	13,486	20,926	23,716	24,181	46,968	51,165	72,544	108,560	27,337	1,748	1,833	1,381
2007	16,353	3,504	5,256	5,256	15,783	16,367	15,783	20,442	25,128	26,310	32,735	30,955	52,565	64,288	64,412	20,481	2,137	1,329
2008	7,966	5,621	4,955	7,353	8,579	7,966	24,511	22,672	34,928	29,413	41,056	47,183	30,079	13,534	20,221	18,782	2,449	1,970
2009	6,692	2,868	6,691	1,434	3,824	5,736	6,691	10,527	14,339	15,785	26,766	25,332	30,590	20,576	30,147	23,774	1,709	1,792
2010	12,209	2,713	2,713	4,522	4,974	5,878	8,591	7,236	17,635	22,158	17,183	20,801	25,322	18,539	18,539	19,008	5,083	6,002
2011	5,896	769	1,538	528	2,307	3,589	4,870	5,127	11,791	15,380	18,712	24,608	18,968	13,585	11,791	11,197	1,556	1,974
2012	24,797	1,929	4,133	6,888	3,306	3,306	5,235	4,133	5,510	4,408	8,817	10,470	18,735	19,286	23,143	14,727	5,379	6,222
2013	5,622	2,311	3,273	5,584	5,584	3,658	6,945	2,503	5,199	2,709	8,100	9,242	14,634	20,218	25,237	26,145	8,404	5,557
2014	21,064	9,912	13,320	12,390	13,939	12,390	15,178	13,336	14,559	12,081	12,700	21,993	23,542	27,585	27,878	21,303	2,548	3,484

Table 3.4.3 continued. Total recreational catch (numbers of snook kept or released alive) by total length in inches, year, and coast (MRFSS/MRIP Type a+b1+b2)

Atlantic

	Total Length (in)																	
Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total
1986	1,803	48	48	2,680	48	48	48	925	1,803	1,803	48	48	48	48	48	48	48	57,309
1987	857	318	1,666	1,666	318	1,396	587	857	587	587	318	318	48	48	48	48	48	68,992
1988	1,739	2,662	2,119	1,956	1,305	1,251	600	925	274	220	328	166	166	220	57	57	57	79,803
1989	725	792	1,193	926	501	546	457	591	412	367	367	323	367	300	233	256	211	223,509
1990	491	516	692	642	667	440	440	440	315	365	265	265	239	214	164	164	164	172,924
1991	1,602	1,819	2,197	2,252	1,765	1,656	1,494	1,169	682	1,061	736	628	357	195	303	195	195	216,698
1992	2,524	4,696	352	352	1,438	352	1,438	352	352	352	352	352	352	352	352	352	352	378,154
1993	2,734	4,013	1,455	1,455	176	176	816	816	176	176	176	176	176	176	176	176	176	195,777
1994	1,928	3,387	7,762	1,928	2,658	470	1,928	3,387	470	470	470	470	470	470	470	470	470	513,533
1995	4,322	7,264	2,115	3,586	2,115	644	1,380	644	1,380	644	644	644	1,380	644	644	644	644	682,422
1996	4,081	4,824	3,339	1,111	4,081	4,081	1,111	368	368	368	368	368	368	368	368	368	368	414,388
1997	4,827	4,827	5,033	4,689	3,934	3,866	3,522	2,836	1,669	2,561	1,257	1,600	1,188	914	433	433	433	489,611
1998	1,964	2,539	2,179	2,575	2,036	1,928	1,784	1,352	1,352	1,172	632	596	632	308	344	308	308	333,153
1999	2,771	2,854	3,769	2,938	5,151	4,570	4,071	3,905	3,905	3,822	3,822	3,489	3,489	3,489	3,406	3,406	3,406	403,193
2000	2,590	2,714	4,073	6,297	5,155	4,352	3,858	3,734	3,734	3,734	3,734	3,734	3,734	3,734	3,734	3,734	3,734	438,977
2001	3,331	2,398	2,657	2,605	5,111	4,334	3,971	4,023	3,971	4,023	3,971	4,023	4,023	3,971	3,971	3,971	3,971	462,252
2002	1,990	1,797	1,990	2,068	1,121	3,438	3,446	3,071	1,427	1,802	1,427	1,427	892	1,248	178	535	357	309,431
2003	2,529	3,510	3,871	4,098	2,074	14,178	12,209	9,827	5,956	6,254	3,573	4,169	893	893	893	298	298	588,524
2004	2,829	3,179	2,905	4,081	3,046	22,069	11,143	11,417	8,508	7,337	5,269	2,927	3,513	2,342	1,171	878	293	578,183
2005	1,149	1,632	1,456	1,859	935	13,202	12,465	11,284	9,432	6,387	5,260	5,260	3,381	1,127	1,127	376	0	488,583
2006	1,552	1,454	1,686	2,041	1,063	16,398	18,160	13,951	17,206	8,383	9,766	3,720	6,510	3,255	3,255	1,860	2,790	535,725
2007	1,274	1,315	1,830	18,992	16,420	24,572	20,456	12,849	9,929	10,513	7,607	6,439	4,672	584	584	584	1,752	559,456
2008	3,435	3,035	3,648	20,381	20,887	18,383	9,192	6,740	7,353	3,677	1,226	1,838	2,451	1,226	613	0	0	433,323
2009	2,087	2,405	1,179	11,648	11,495	3,358	6,237	956	1,434	1,912	1,912	3,824	956	0	0	0	478	285,154
2010	6,445	2,401	968	10,409	12,211	4,974	4,522	2,713	3,617	2,261	3,165	0	2,261	452	452	0	0	275,957
2011	2,155	2,097	1,183	10,883	6,936	5,383	3,589	2,066	769	256	1,282	0	0	0	0	0	0	190,785
2012	4,170	4,384	3,467	9,723	11,021	6,337	8,817	2,480	6,061	3,857	2,204	1,102	827	276	276	0	276	235,702
2013	4,360	5,843	4,988	17,082	19,871	16,584	13,492	11,181	8,665	7,509	6,354	5,199	3,658	385	385	578	386	287,445
2014	1,887	2,793	2,197	13,058	20,460	24,487	17,966	17,037	11,461	14,868	8,364	5,885	7,744	1,549	929	310	310	430,507

Table 3.4.3 continued. Total recreational catch (numbers of snook kept or released alive) by total length in inches, year, and coast (MRFSS/MRIP Type a+b1+b2).

Gulf

	Total Length (in)																	
Year	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1986	520	372	630	1058	1753	2780	4225	5988	7604	8542	8304	7159	436	501	727	587	404	383
1987	184	104	176	295	486	775	1178	1664	2238	2494	2464	2734	972	1719	2229	3919	2072	2072
1988	2094	1439	2614	3984	6520	10304	14852	20971	26993	30347	29743	25225	2354	3283	4743	9787	5938	10451
1989	1557	1112	1909	3230	5257	8407	12755	17861	22848	25801	24808	21297	897	1254	1654	1948	1528	2179
1990	793	566	987	1652	2707	4238	6480	9133	11630	13001	12623	10886	655	1165	1034	1047	1138	1112
1991	5508	3935	6678	11401	18448	29447	44753	63190	80537	90241	87816	76168	7772	6299	7183	5121	4237	4532
1992	6473	4624	7973	13672	22058	34730	52718	74890	94769	106426	103346	91139	9750	12656	12529	11898	10508	7602
1993	7235	5478	8925	14795	24463	38988	58785	83156	106018	118534	115245	99448	6993	10542	9539	8844	6916	6530
1994	9779	6454	11555	18538	29949	46504	70442	99859	128024	142206	138499	119048	6924	10473	7897	9214	6753	6295
1995	5932	4237	7191	12137	20081	31782	48195	68050	86801	97323	94929	81697	6816	7315	4889	5888	6174	5032
1996	14128	10021	17006	28535	46982	75092	114175	161027	205304	230018	224046	190988	15448	19567	15347	16653	12936	10625
1997	11740	8387	14419	23881	39413	63039	96593	136073	173044	192429	187213	162006	16162	18389	15790	14769	12264	10500
1998	6086	4348	7440	12380	20384	32659	49449	69820	89110	99771	96875	83995	15840	15037	12445	9790	8062	7506
1999	6541	4673	7930	13305	21906	34967	53143	75036	95799	107405	104128	88377	66400	50187	11957	13444	10882	9478
2000	11591	8216	13848	23403	38313	61233	93030	131098	167125	187360	181925	153474	115150	80733	7411	9467	6966	7078
2001	11545	8215	13941	23392	38513	61475	93430	131919	168179	188392	182920	154639	116138	81237	8616	8707	7432	6476
2002	6974	0	10802	9509	43110	41867	101434	88121	110310	145861	200382	168026	200628	180215	8091	8749	6960	5705
2003	63694	19715	21990	18199	21990	18957	65970	66728	90234	165303	253263	188093	223163	158007	16736	12861	10232	5543
2004	59753	33889	52618	42808	70454	32998	118613	106157	185500	236364	409348	278338	313356	187856	14554	17170	12040	12079
2005	73121	28124	44998	47810	89995	118119	230613	179991	295336	202490	247526	213855	261781	141212	24787	21471	19922	13485
2006	35155	5859	23437	31249	64452	58592	142575	85956	195308	117205	115232	132830	150507	84783	49713	11071	7385	4312
2007	24641	17601	35202	49283	77445	70405	151370	70405	147850	77481	183052	130321	158411	133984	117706	37086	6401	4971
2008	27317	21853	49219	10927	43706	65559	142095	49169	191214	163898	158435	76536	152971	87462	120392	69089	9759	14674
2009	12717	12717	25433	21194	29672	38150	80538	72060	105971	144120	97523	161196	284002	339107	258599	126020	2823	15000
2010	38185	2121	21214	14850	27578	21214	95462	23335	48792	40306	21214	25457	31821	21214	21214	25457	10607	12728
2011	33249	23018	10230	20460	23018	33248	66496	30690	79283	61381	56266	48593	74168	28194	23048	23018	10342	20541
2012	50265	14885	26050	22328	53960	44656	81870	52099	89313	52099	53960	63263	81874	87456	80018	35357	11194	13081
2013	98763	32921	108445	73588	120064	122001	114255	94890	118128	108445	102636	75524	61969	56159	42603	56264	20798	10844
2014	89562	44781	52684	31610	60586	47415	105368	79026	134344	105368	131710	100099	158051	102733	102825	49158	18328	4973

Table 3.4.3 continued. Total recreational catch (numbers of snook kept or released alive) by total length in inches, year, and coast (MRFSS/MRIP Type a+b1+b2)

Gulf

	Total Length (in)																	
Year	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	Total
1986	490	372	178	221	157	168	221	146	146	135	168	168	103	103	103	103	103	55,066
1987	1,326	1,208	422	658	343	461	501	461	343	343	265	501	29	29	29	29	29	34,747
1988	6,469	4,478	3,283	4,345	2,354	3,018	1,558	2,354	1,823	1,292	894	2,221	363	363	363	363	363	247,552
1989	1,359	1,338	1,128	897	1,023	876	729	561	498	603	771	477	309	330	309	309	309	168,138
1990	642	485	629	576	380	341	236	263	276	250	210	171	158	158	158	158	158	86,086
1991	2,961	2,862	2,175	2,077	2,371	1,586	1,586	1,881	1,390	1,390	1,291	1,095	1,095	1,095	1,095	1,095	1,095	581,398
1992	5,707	3,939	4,318	2,802	3,813	2,802	2,044	1,918	2,297	1,412	1,539	1,412	1,412	1,286	1,412	1,286	1,412	718,584
1993	4,755	4,293	3,830	3,444	2,750	3,830	2,364	2,132	2,055	1,824	1,515	1,515	1,592	1,438	1,438	1,438	1,438	772,083
1994	4,978	4,749	4,520	3,204	4,234	3,376	2,746	2,803	2,460	2,346	1,888	1,830	1,830	1,773	1,773	1,716	1,773	916,412
1995	4,247	4,104	4,533	2,677	3,177	2,677	1,678	2,178	1,607	1,607	1,464	1,250	1,393	1,179	1,179	1,179	1,179	631,774
1996	8,214	10,826	10,323	6,003	6,807	5,702	4,797	4,295	4,094	2,989	3,089	2,788	2,888	2,788	2,788	2,788	2,788	1,491,861
1997	9,294	10,779	8,830	8,087	6,509	5,581	4,653	2,983	3,911	3,354	2,426	2,519	2,519	2,333	2,333	2,333	2,333	1,276,890
1998	4,605	4,296	4,111	3,494	3,432	2,445	2,136	2,136	1,519	1,395	1,457	1,333	1,210	1,210	1,210	1,210	1,210	679,395
1999	6,750	6,833	5,676	5,015	2,569	1,330	1,330	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	1,247	817,537
2000	5,855	5,521	4,632	5,244	2,511	2,678	2,178	2,234	2,234	2,178	2,178	2,178	2,178	2,178	2,178	2,178	2,178	1,347,934
2001	5,839	6,522	5,748	4,337	2,921	2,466	2,193	2,239	2,193	2,284	2,239	2,193	2,193	2,193	2,193	2,193	2,193	1,357,304
2002	4,500	4,446	2,902	2,533	1,328	5,804	6,414	3,195	1,927	634	1,268	0	0	1,268	0	0	0	1,372,963
2003	5,883	3,507	3,469	2,101	2,758	1,580	4,592	3,033	3,812	3,033	758	0	758	0	0	758	0	1,456,720
2004	10,728	8,210	6,968	6,736	1,124	6,539	11,683	4,459	11,594	3,567	6,273	3,567	1,784	892	0	0	0	2,268,019
2005	16,064	8,387	3,717	3,214	503	22,499	16,874	2,812	11,249	2,812	0	0	0	0	0	0	0	2,342,767
2006	2,099	1,500	1,380	740	320	9,805	23,437	17,598	23,437	9,765	7,812	1,953	0	0	0	0	0	1,415,467
2007	7,167	2,253	2,003	1,287	4,021	7,112	24,642	7,040	10,561	10,561	31,682	3,520	10,561	3,520	3,520	0	3,520	1,626,585
2008	2,848	7,711	1,749	6,462	54,733	10,977	27,316	10,927	21,853	10,927	5,463	0	5,463	0	0	0	0	1,620,704
2009	5,891	6,251	1,352	13,107	42,478	8,538	0	8,478	8,478	4,239	4,239	4,239	0	4,239	0	0	0	1,938,371
2010	8,486	4,243	8,486	4,243	6,364	2,121	10,607	14,850	2,121	4,243	21,214	2,121	8,486	0	0	0	0	600,354
2011	10,382	2,599	17,954	2,629	10,230	10,230	10,230	2,558	2,558	2,558	5,115	0	5,115	0	0	0	0	747,401
2012	18,671	11,237	9,376	11,190	37,214	11,164	14,885	0	5,582	1,861	5,582	0	0	0	0	0	0	1,040,490
2013	42,916	18,118	17,638	10,771	21,846	7,746	27,111	5,810	5,810	1,937	0	0	0	1,937	0	0	0	1,579,937
2014	10,380	12,326	9,967	11,317	36,925	31,610	18,439	5,268	10,537	2,634	10,537	5,268	7,903	0	0	0	0	1,591,732

Table 3.5.1. The number of snook ages by coast, year, and source.

	Atlantic		Gulf	
	Fishery Dependent	Fishery independent	Fishery Dependent	Fishery independent
Year	Num fish	Num fish	Num fish	Num fish
1986	6	0	0	19
1987	122	19	0	42
1988	812	305	6	614
1989	884	417	214	405
1990	568	195	0	23
1991	704	434	0	0
1992	0	1	0	2
1993	0	3	0	5
1994	0	5	0	540
1995	0	258	0	125
1996	0	112	50	127
1997	679	891	537	1,707
1998	569	434	389	467
1999	219	344	154	503
2000	296	291	127	646
2001	324	451	138	839
2002	553	304	1,040	403
2003	333	292	1,070	382
2004	333	311	1,308	479
2005	396	287	1,033	574
2006	446	249	754	526
2007	290	295	580	513
2008	128	291	267	557
2009	667	282	199	580
2010	406	209	0	236
2011	359	170	0	308
2012	291	219	0	502
2013	383	184	142	481
2014	316	255	178	847
Total	10,084	7,508	8,186	12,452

Table 3.5.2. Numbers of snook harvested by coast, age, and year. All fish aged 12 and older on each coast have been aggregated into a plus group.

Atlantic

	Number of fish by age												
Year	1	2	3	4	5	6	7	8	9	10	11	12+	Total
1986	0	0	0	937	1,407	952	958	1,771	869	637	452	788	8,771
1987	4,044	2,157	2,187	2,438	4,167	1,482	415	1,140	646	668	154	723	20,221
1988	1,899	326	1,151	4,734	3,996	5,335	2,415	1,089	380	597	217	488	22,627
1989	1,206	581	1,101	1,639	1,480	929	1,288	708	246	357	246	469	10,250
1990	503	101	201	1,186	1,739	603	377	1,254	534	126	256	333	7,213
1991	487	108	635	1,061	3,468	5,059	2,246	1,660	1,865	1,312	555	1,245	19,701
1992	0	476	1,310	6,141	6,004	4,030	2,016	1,455	888	233	126	129	22,808
1993	0	91	713	4,269	4,929	3,874	1,947	1,397	693	299	127	204	18,543
1994	0	83	2,141	7,518	8,809	7,345	5,418	3,653	1,854	788	466	571	38,646
1995	0	112	1,370	6,383	8,307	6,748	4,235	2,313	1,400	384	271	839	32,362
1996	0	428	2,310	10,848	9,765	8,040	5,445	3,469	1,404	549	412	406	43,076
1997	0	82	889	4,991	6,871	10,477	11,220	6,338	2,417	1,595	2,472	4,548	51,900
1998	0	5	262	1,069	3,566	3,695	4,704	4,031	2,013	743	752	1,509	22,349
1999	14	42	243	1,983	4,898	5,157	4,575	3,499	2,163	809	457	511	24,351
2000	0	0	441	1,645	3,812	5,661	4,300	3,236	2,159	1,891	259	191	23,595
2001	0	19	989	3,700	4,250	4,886	2,775	1,921	1,006	438	364	173	20,521
2002	0	0	479	3,300	6,803	2,915	2,733	1,696	1,056	484	394	312	20,172
2003	0	0	121	3,162	9,856	5,341	3,039	1,944	967	473	292	214	25,409
2004	0	0	1,047	2,653	6,844	6,571	2,377	1,481	1,063	206	275	57	22,574
2005	3	89	372	2,344	2,845	3,171	2,181	1,131	560	270	148	214	13,328
2006	0	0	214	1,500	3,100	2,493	2,622	1,849	931	477	427	354	13,967
2007	0	0	8	977	2,144	3,152	952	869	308	164	26	95	8,695
2008	53	0	205	1,147	4,187	4,507	1,441	1,106	945	857	355	0	14,803
2009	0	0	271	2,347	3,742	2,077	800	368	151	42	30	15	9,843
2010	0	0	11	155	167	146	68	18	5	9	3	3	585
2011	0	10	354	2,121	1,990	1,424	1,313	502	126	151	30	0	8,021
2012	0	0	49	686	1,068	694	697	682	167	164	47	12	4,266
2013	6	31	620	1,823	1,047	1,216	732	1,243	649	250	244	189	8,050
2014	0	0	2,618	1,419	1,777	561	995	444	371	484	107	146	8,922

Table 3.5.2 continued. Numbers of snook harvested by coast, age, and year. All fish aged 12 and older on the Atlantic coast and aged 10 and older on the gulf coast have been aggregated into a plus group.

Gulf

	Number of fish by age												
Year	1	2	3	4	5	6	7	8	9	10	11	12+	Total
1986	3	6	156	392	938	1,096	756	275	162	107	29	90	4,010
1987	39	13	647	2,011	4,830	5,591	3,713	1,320	1,006	651	181	510	20,512
1988	264	1,323	2,332	4,569	17,414	18,308	11,113	4,276	3,199	2,607	687	2,001	68,093
1989	11	124	2,380	1,208	3,195	2,956	3,189	876	606	366	112	273	15,296
1990	48	65	283	800	1,956	2,254	1,621	597	308	214	58	57	8,261
1991	63	105	1,341	4,326	9,714	11,386	7,927	2,923	1,606	863	194	202	40,650
1992	444	496	3,008	9,309	19,705	23,239	15,506	5,768	3,007	1,539	451	652	83,124
1993	53	900	2,095	6,229	14,477	16,997	12,107	4,447	2,315	1,353	454	371	61,798
1994	1,219	1,613	4,975	8,031	14,434	16,903	12,007	4,492	2,588	1,545	396	535	68,738
1995	92	166	1,463	4,913	11,680	13,219	10,060	3,765	2,034	1,253	324	479	49,448
1996	99	11	814	21,155	38,990	30,857	10,657	6,722	2,279	1,917	661	576	114,738
1997	0	400	3,509	14,690	30,542	36,828	21,646	8,590	3,601	2,222	950	1,386	124,364
1998	45	141	55	8,675	16,568	23,711	17,278	7,782	5,353	1,945	85	275	81,913
1999	2	12	8,317	8,192	17,493	14,680	11,830	4,167	2,014	297	10	8	67,022
2000	159	388	617	4,435	5,805	11,504	8,375	3,782	656	619	311	586	37,237
2001	0	2	465	5,183	11,697	4,966	7,960	2,551	2,587	1,264	464	689	37,828
2002	25	5	835	13,392	16,881	9,146	3,088	1,972	1,095	413	249	239	47,340
2003	0	0	452	8,465	19,588	8,904	3,470	764	641	80	137	42	42,543
2004	0	55	1,077	7,209	27,537	22,435	8,268	2,654	459	469	224	171	70,558
2005	0	0	1,470	7,719	10,288	25,609	12,150	3,025	1,310	204	63	111	61,949
2006	0	1	273	10,330	5,201	3,922	3,492	1,071	388	79	88	28	24,873
2007	0	1	9	3,108	24,738	3,568	1,554	1,305	899	117	45	93	35,437
2008	0	50	120	3,040	4,037	15,654	1,217	855	452	5	0	0	25,430
2009	0	0	5	1,258	2,292	4,417	5,836	60	4	0	0	66	13,938
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	11	112	127	219	90	16	16	2	3	2	598
2012	24	1	2	55	71	128	58	11	12	3	2	2	369
2013	0	0	0	11,162	8,996	5,837	2,627	2,636	605	407	383	0	32,653
2014	0	0	0	2,444	4,781	3,607	1,072	599	890	218	99	141	13,851

Table 4.2.2.2. Parameter estimates and their precisions (standard errors) from ASAP by coast.

Coast	Parameter number	Parameter	Estimate	Standard error
Atlantic	1	Fleet select alpha	3.112	0.10524
Atlantic	2	Fleet select beta	0.66383	0.050679
Atlantic	3	log_Fmult_1986	-1.2253	0.26134
Atlantic	4	log_Fmult_devs_1987	0.10035	0.32097
Atlantic	5	log_Fmult_devs_1988	0.15572	0.25827
Atlantic	6	log_Fmult_devs_1989	0.60519	0.24968
Atlantic	7	log_Fmult_devs_1990	-0.29604	0.30198
Atlantic	8	log_Fmult_devs_1991	0.56406	0.27426
Atlantic	9	log_Fmult_devs_1992	0.4307	0.17902
Atlantic	10	log_Fmult_devs_1993	-0.67425	0.13891
Atlantic	11	log_Fmult_devs_1994	0.81337	0.13205
Atlantic	12	log_Fmult_devs_1995	0.19515	0.11278
Atlantic	13	log_Fmult_devs_1996	-0.30206	0.11155
Atlantic	14	log_Fmult_devs_1997	0.019425	0.19857
Atlantic	15	log_Fmult_devs_1998	-0.01241	0.18594
Atlantic	16	log_Fmult_devs_1999	0.30311	0.12
Atlantic	17	log_Fmult_devs_2000	0.35978	0.11106
Atlantic	18	log_Fmult_devs_2001	0.11229	0.12724
Atlantic	19	log_Fmult_devs_2002	-0.671	0.1237
Atlantic	20	log_Fmult_devs_2003	0.63419	0.11004
Atlantic	21	log_Fmult_devs_2004	0.2236	0.16135
Atlantic	22	log_Fmult_devs_2005	-0.18775	0.20408
Atlantic	23	log_Fmult_devs_2006	0.45499	0.25101
Atlantic	24	log_Fmult_devs_2007	-0.10215	0.23493
Atlantic	25	log_Fmult_devs_2008	-0.03771	0.1923
Atlantic	26	log_Fmult_devs_2009	-0.27425	0.20798
Atlantic	27	log_Fmult_devs_2010	-0.4272	0.27103
Atlantic	28	log_Fmult_devs_2011	-0.0143	0.27495
Atlantic	29	log_Fmult_devs_2012	0.1794	0.2553
Atlantic	30	log_Fmult_devs_2013	-0.05896	0.23701
Atlantic	31	log_Fmult_devs_2014	0.51361	0.19917
Atlantic	32	log_recruit_devs 1986	0.32157	0.14528
Atlantic	33	log_recruit_devs 1987	0.30149	0.1452
Atlantic	34	log_recruit_devs 1988	0.091765	0.17177
Atlantic	35	log_recruit_devs 1989	0.21122	0.17943
Atlantic	36	log_recruit_devs 1990	0.6647	0.14749
Atlantic	37	log_recruit_devs 1991	0.71268	0.12582

Table 4.2.2.2 continued. Parameter estimates and their precisions (standard errors) from ASAP by coast.

Coast	Parameter number	Parameter	Estimate	Standard error
Atlantic	38	log_recruit_devs 1992	0.49345	0.12818
Atlantic	39	log_recruit_devs 1993	0.21825	0.13266
Atlantic	40	log_recruit_devs 1994	0.029279	0.12279
Atlantic	41	log_recruit_devs 1995	0.042746	0.11729
Atlantic	42	log_recruit_devs 1996	-0.21106	0.1172
Atlantic	43	log_recruit_devs 1997	-0.27718	0.10901
Atlantic	44	log_recruit_devs 1998	-0.05924	0.096348
Atlantic	45	log_recruit_devs 1999	0.19727	0.089931
Atlantic	46	log_recruit_devs 2000	0.012314	0.10061
Atlantic	47	log_recruit_devs 2001	-0.11254	0.11352
Atlantic	48	log_recruit_devs 2002	0.085871	0.11061
Atlantic	49	log_recruit_devs 2003	0.000774	0.11654
Atlantic	50	log_recruit_devs 2004	-0.11831	0.10762
Atlantic	51	log_recruit_devs 2005	-0.16333	0.10483
Atlantic	52	log_recruit_devs 2006	-0.30264	0.10894
Atlantic	53	log_recruit_devs 2007	-0.48309	0.12062
Atlantic	54	log_recruit_devs 2008	-0.21563	0.11953
Atlantic	55	log_recruit_devs 2009	-0.59451	0.15264
Atlantic	56	log_recruit_devs 2010	-0.42576	0.16872
Atlantic	57	log_recruit_devs 2011	-0.47075	0.19572
Atlantic	58	log_recruit_devs 2012	0.28259	0.17191
Atlantic	59	log_recruit_devs 2013	-0.33345	0.24798
Atlantic	60	log_recruit_devs 2014	0.10153	0.29634
Atlantic	61	log_N_year_1986_devs_age_2	0.10578	0.1859
Atlantic	62	log_N_year_1986_devs_age_3	0.34255	0.21468
Atlantic	63	log_N_year_1986_devs_age_4	0.23022	0.21622
Atlantic	64	log_N_year_1986_devs_age_5	0.50218	0.27112
Atlantic	65	log_N_year_1986_devs_age_6	0.19504	0.41457
Atlantic	66	log_N_year_1986_devs_age_7	0.28366	0.46713
Atlantic	67	log_N_year_1986_devs_age_8	0.74073	0.49112
Atlantic	68	log_N_year_1986_devs_age_9	-0.55866	0.8124
Atlantic	69	log_N_year_1986_devs_age_10	-1.2975	1.2813
Atlantic	70	log_N_year_1986_devs_age_11	0.55173	2.2933
Atlantic	71	log_N_year_1986_devs_age_12+	-0.44749	0.97264
Atlantic	72	log_q_year_1986 FIM index	-5.2088	0.086337
Atlantic	73	log_q_year_1986 MRFSS index	-4.3993	0.092574
Atlantic	74	log_q_year_1986 FIM age-1 index	-4.4521	0.091017

Table 4.2.2.2 continued. Parameter estimates and their precisions (standard errors) from ASAP by coast

Coast	Parameter number	Parameter	Estimate	Standard error
Atlantic	75	FIM index select alpha	2.107	0.10518
Atlantic	76	FIM index select beta	0.37761	0.047317
Atlantic	77	MRFSS/MRIP index select alpha	4.6295	0.14164
Atlantic	78	MRFSS/MRIP index select beta	0.6346	0.051885
Atlantic	79	log_SSB unexploited	7.5033	0.23861
Atlantic	80	Steepness	0.66838	0.084432
Gulf	1	Fleet1_select_alpha	4.5166	0.13856
Gulf	2	Fleet1_select_beta	1.0867	0.059546
Gulf	3	log_Fleet1_Fmult_year_1986	-1.1415	0.35985
Gulf	5	log_Fleet1_Fmult_devs_1987	-0.43587	0.46208
Gulf	6	log_Fleet1_Fmult_devs_1988	1.8316	0.34225
Gulf	7	log_Fleet1_Fmult_devs_1989	-0.57663	0.27728
Gulf	8	log_Fleet1_Fmult_devs_1990	-0.83005	0.33807
Gulf	9	log_Fleet1_Fmult_devs_1991	1.5092	0.34309
Gulf	10	log_Fleet1_Fmult_devs_1992	0.18114	0.2437
Gulf	11	log_Fleet1_Fmult_devs_1993	0.00068	0.1392
Gulf	12	log_Fleet1_Fmult_devs_1994	0.24867	0.13432
Gulf	13	log_Fleet1_Fmult_devs_1995	-0.41161	0.13968
Gulf	14	log_Fleet1_Fmult_devs_1996	0.66227	0.16563
Gulf	15	log_Fleet1_Fmult_devs_1997	0.18268	0.14134
Gulf	16	log_Fleet1_Fmult_devs_1998	-0.38616	0.11214
Gulf	17	log_Fleet1_Fmult_devs_1999	-0.19637	0.11875
Gulf	18	log_Fleet1_Fmult_devs_2000	0.59231	0.12383
Gulf	19	log_Fleet1_Fmult_devs_2001	-0.19845	0.11605
Gulf	20	log_Fleet1_Fmult_devs_2002	-0.0895	0.10412
Gulf	21	log_Fleet1_Fmult_devs_2003	-0.08903	0.10131
Gulf	22	log_Fleet1_Fmult_devs_2004	0.41105	0.13174
Gulf	23	log_Fleet1_Fmult_devs_2005	-0.05468	0.14022
Gulf	24	log_Fleet1_Fmult_devs_2006	-0.54127	0.1472
Gulf	25	log_Fleet1_Fmult_devs_2007	0.034415	0.16068
Gulf	26	log_Fleet1_Fmult_devs_2008	0.41753	0.16093
Gulf	27	log_Fleet1_Fmult_devs_2009	0.26689	0.13327
Gulf	28	log_Fleet1_Fmult_devs_2010	-0.79941	0.24731
Gulf	29	log_Fleet1_Fmult_devs_2011	-0.25406	0.24936
Gulf	30	log_Fleet1_Fmult_devs_2012	0.34433	0.14247
Gulf	30	log_Fleet1_Fmult_devs_2013	0.39731	0.10794
Gulf	31	log_Fleet1_Fmult_devs_2014	-0.10533	0.10684

Table 4.2.2.2 continued. Parameter estimates and their precisions (standard errors) from ASAP by coast.

Coast	Parameter number	Parameter	Estimate	Standard error
Gulf	32	log_recruit_devs 1986	-0.2885	0.19965
Gulf	33	log_recruit_devs 1987	-0.03527	0.20345
Gulf	34	log_recruit_devs 1988	0.24329	0.2012
Gulf	35	log_recruit_devs 1989	0.39687	0.16502
Gulf	36	log_recruit_devs 1990	0.23022	0.14566
Gulf	37	log_recruit_devs 1991	0.013117	0.11138
Gulf	38	log_recruit_devs 1992	-0.0207	0.094901
Gulf	39	log_recruit_devs 1993	0.031454	0.082878
Gulf	40	log_recruit_devs 1994	-0.10764	0.08042
Gulf	41	log_recruit_devs 1995	0.013123	0.074726
Gulf	42	log_recruit_devs 1996	-0.34502	0.091751
Gulf	43	log_recruit_devs 1997	-0.05704	0.079004
Gulf	44	log_recruit_devs 1998	0.005812	0.079341
Gulf	45	log_recruit_devs 1999	0.43856	0.069241
Gulf	46	log_recruit_devs 2000	0.54265	0.065095
Gulf	47	log_recruit_devs 2001	-0.32525	0.10143
Gulf	48	log_recruit_devs 2002	-0.19236	0.10757
Gulf	49	log_recruit_devs 2003	0.84573	0.068501
Gulf	50	log_recruit_devs 2004	0.061566	0.11078
Gulf	51	log_recruit_devs 2005	-0.59819	0.12473
Gulf	52	log_recruit_devs 2006	-0.74569	0.12023
Gulf	53	log_recruit_devs 2007	-1.0023	0.13093
Gulf	54	log_recruit_devs 2008	-1.0813	0.13673
Gulf	55	log_recruit_devs 2009	-0.65578	0.12041
Gulf	56	log_recruit_devs 2010	-0.27401	0.11483
Gulf	57	log_recruit_devs 2011	-0.02626	0.13892
Gulf	58	log_recruit_devs 2012	0.7891	0.14901
Gulf	59	log_recruit_devs 2013	0.97695	0.19471
Gulf	60	log_recruit_devs 2014	1.1669	0.21879
Gulf	61	log_N_year_1986_devs_age_2	0.17545	0.16444
Gulf	62	log_N_year_1986_devs_age_3	0.049455	0.17707
Gulf	63	log_N_year_1986_devs_age_4	-0.20888	0.21629
Gulf	64	log_N_year_1986_devs_age_5	0.27774	0.27104
Gulf	65	log_N_year_1986_devs_age_6	0.63848	0.32097
Gulf	66	log_N_year_1986_devs_age_7	0.91736	0.42982
Gulf	67	log_N_year_1986_devs_age_8	-0.37006	0.5799
Gulf	68	log_N_year_1986_devs_age_9	-1.1677	1.0652

Table 4.2.2.2 continued. Parameter estimates and their precisions (standard errors) from ASAP by coast.

Coast	Parameter number	Parameter	Estimate	Standard error
Gulf	69	log_N_year_1986_devs_age_10	-1.1206	1.8699
Gulf	70	log_N_year_1986_devs_age_11	-2.0684	6.4588
Gulf	71	log_N_year_1986_devs_age_12	-0.85279	4.4411
Gulf	72	log_catchability_1986_FIM	-6.3643	0.077075
Gulf	73	log_catchability_1986_MRFSS	-6.3616	0.070635
Gulf	74	log_catchability_1986_ENP	-5.2052	0.072523
Gulf	75	log_catchability_1986_FIM_Age_1	-6.0531	0.079976
Gulf	76	FIM_index_select_alpha	2.6212	0.13084
Gulf	77	FIM_index_sel_beta	0.5958	0.06405
Gulf	78	MRFSS/MRIP_index_select_alpha	2.5139	0.11707
Gulf	79	MRFSS/MRIP_index_sel_beta	0.51803	0.054255
Gulf	80	ENP_index_sel_alpha	4.4067	0.074884
Gulf	81	ENP_index_sel_beta	0.41529	0.027334
Gulf	82	log_SSB unexploited	7.8347	0.12891
Gulf	83	Steepness	0.72773	0.079202

Table 4.2.2.4.1. Objective function component totals for ASAP base runs by coast. Legend: RSS - residual sum of squares, nobs -- the number of observations, MSE -- the mean square error, lambda (λ) -- the weight assigned to component, and the objective function is the log-likelihood that was minimized.

Atlantic

Component	RSS	nobs	MSE	Lambda	Objective Function
Catch_Fleet_Total	29.06	29	1.00	1	176.30
Discard_Fleet_Total	2.62	29	0.09	1	-9.94
FIM adult index	4.63	18	0.26	1	9.38
MRFSS/MRIP index	0.86	24	0.04	1	-19.18
FIM Age-1 index	1.54	18	0.09	1	-13.56
Catch age composition		348		1	869.19
Discard age composition		348		1	1304.00
Survey age composition		504		1	1585.90
Selectivity fleet				2	22.48
Selectivity FIM index				2	-1.78
Selectivity MRFSS/MRIP index				2	14.70
Catchability for indices				3	12.03
Fmult year 1 Fleet				0	0.00
Recruitment deviations				1	-10.59
SRR_steepness				-2.00	-2.03
SR_unexploited SSB				0	0.00
Fmult penalty				1000	0.00
F penalty				0	0.00
Objective function total					3936.92

Table 4.2.2.4.1 continued. Objective function component totals for ASAP base runs by coast. Legend: RSS - residual sum of squares, nobs -- the number of observations, MSE -- the mean square error, lambda (λ) -- the weight assigned to component, and the objective function is the log-likelihood that was minimized.

Gulf

Component	RSS	nobs	MSE	Lambda	Objective Function
Catch_Fleet_Total	2.76	28	0.10	1	-11.29
Discard_Fleet_Total	0.48	29	0.02	1	-42.87
FIM adult index	1.56	19	0.08	1	-1.95
MRFSS/MRIP index	0.89	24	0.04	1	33.94
ENP index	2.05	29	0.07	1	159.67
FIM Age-1 index	10.25	19	0.54	1	18.97
Catch age composition		336		1	468.50
Discard age composition		348		1	1065.97
Index age composition		852		1	2562.46
Selectivity fleet				2	11.23
Selectivity FIM index				2	8.88
Selectivity MRFSS/MRIP index				2	0.92
Selectivity ENP index				2	2.35
Catchability indices				4	2.51
Fmult year 1 Fleet1				0	0.00
Recruitment deviations				1	-3.19
RR_steepness				1	-2.02
SR_unexploited SSB				0	0.00
Fmult penalty				1000	0.02
F penalty				0	0.00
Objective function total					4274.09

Table 4.2.2.4.3. Estimated fishing mortality per year from ASAP and transitional spawning potential ratios (tSPR). The average natural mortality rates used in the analyses were 0.20 per year on the Atlantic coast and 0.25 per year on the Gulf coast.

Atlantic

	Instantaneous fishing mortality per year												
	Ages(yr)												
Year	1	2	3	4	5	6	7	8	9	10	11	12+	tSPR
1986	0.00	0.00	0.00	0.01	0.05	0.06	0.14	0.06	0.11	0.10	0.04	0.06	0.30
1987	0.00	0.00	0.02	0.09	0.24	0.27	0.30	0.26	0.30	0.30	0.25	0.27	0.31
1988	0.00	0.00	0.01	0.03	0.19	0.18	0.27	0.19	0.30	0.28	0.19	0.24	0.30
1989	0.00	0.00	0.02	0.03	0.15	0.11	0.43	0.15	0.32	0.32	0.11	0.15	0.30
1990	0.00	0.00	0.01	0.02	0.10	0.13	0.27	0.13	0.21	0.18	0.08	0.05	0.32
1991	0.00	0.00	0.01	0.03	0.14	0.19	0.39	0.17	0.30	0.23	0.09	0.06	0.33
1992	0.00	0.01	0.03	0.06	0.36	0.44	0.82	0.40	0.67	0.50	0.23	0.21	0.30
1993	0.00	0.00	0.01	0.03	0.12	0.16	0.33	0.15	0.25	0.20	0.10	0.06	0.28
1994	0.01	0.01	0.03	0.06	0.22	0.24	0.74	0.27	0.61	0.48	0.20	0.17	0.28
1995	0.00	0.01	0.03	0.08	0.19	0.44	0.99	0.44	0.80	0.64	0.27	0.24	0.25
1996	0.00	0.00	0.02	0.06	0.29	0.35	0.83	0.30	0.39	0.36	0.18	0.11	0.23
1997	0.00	0.01	0.02	0.08	0.27	0.28	0.53	0.39	0.59	0.45	0.26	0.23	0.22
1998	0.00	0.01	0.01	0.09	0.21	0.48	0.56	0.29	0.70	0.63	0.09	0.12	0.21
1999	0.00	0.01	0.08	0.14	0.20	0.36	0.20	0.96	0.56	0.42	0.05	0.06	0.21
2000	0.00	0.01	0.03	0.08	0.13	0.25	0.19	0.49	0.13	0.61	1.03	0.34	0.22
2001	0.00	0.01	0.03	0.11	0.14	0.18	0.21	0.41	0.35	0.18	1.75	1.21	0.21
2002	0.00	0.01	0.02	0.09	0.09	0.14	0.07	0.48	0.07	0.58	0.21	0.29	0.23
2003	0.00	0.01	0.04	0.10	0.25	0.15	0.13	0.32	0.17	0.16	0.10	0.22	0.25
2004	0.00	0.01	0.05	0.14	0.34	0.21	0.20	0.15	0.15	0.39	0.27	0.31	0.26
2005	0.00	0.01	0.03	0.11	0.21	0.21	0.20	0.19	0.28	0.11	0.17	0.22	0.27
2006	0.00	0.02	0.05	0.19	0.19	0.39	0.19	0.22	0.17	0.14	1.39	0.27	0.26
2007	0.00	0.02	0.04	0.11	0.37	0.62	0.61	0.24	0.12	0.12	0.11	0.11	0.25
2008	0.00	0.01	0.04	0.10	0.21	0.39	0.17	0.29	0.14	0.09	0.09	0.09	0.25
2009	0.00	0.01	0.03	0.06	0.10	0.12	0.17	0.08	0.07	0.07	0.07	0.10	0.27
2010	0.00	0.01	0.02	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.30
2011	0.00	0.01	0.02	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.34
2012	0.00	0.01	0.02	0.04	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.38
2013	0.00	0.01	0.02	0.09	0.17	0.32	0.22	0.21	0.12	0.13	0.12	0.05	0.40
2014	0.00	0.01	0.04	0.09	0.14	0.21	0.16	0.12	0.25	0.14	0.16	0.13	0.39

Table 4.2.2.4.3 continued. Estimated fishing mortality per year from ASAP and transitional spawning potential ratios (tSPR). The average natural mortality rates used in the analyses were 0.20 per year on the Atlantic coast and 0.25 per year on the Gulf coast.

Gulf

	Instantaneous fishing mortality per year												
	Ages(yr)												
Year	1	2	3	4	5	6	7	8	9	10	11	12+	tSPR
1986	0.00	0.00	0.00	0.01	0.04	0.06	0.14	0.06	0.12	0.10	0.05	0.07	0.40
1987	0.00	0.00	0.01	0.03	0.10	0.14	0.18	0.16	0.19	0.19	0.16	0.17	0.44
1988	0.01	0.01	0.02	0.05	0.41	0.50	0.84	0.61	1.01	0.93	0.66	0.81	0.40
1989	0.00	0.00	0.01	0.01	0.10	0.09	0.40	0.15	0.33	0.33	0.11	0.15	0.37
1990	0.00	0.00	0.00	0.01	0.04	0.07	0.15	0.07	0.12	0.11	0.05	0.03	0.41
1991	0.00	0.00	0.01	0.03	0.15	0.24	0.56	0.26	0.47	0.35	0.13	0.09	0.43
1992	0.00	0.00	0.01	0.04	0.29	0.44	0.92	0.47	0.81	0.60	0.29	0.25	0.40
1993	0.00	0.00	0.01	0.03	0.19	0.31	0.73	0.35	0.60	0.48	0.25	0.14	0.37
1994	0.01	0.01	0.02	0.04	0.20	0.27	0.92	0.35	0.82	0.65	0.27	0.23	0.36
1995	0.00	0.00	0.01	0.03	0.09	0.27	0.67	0.32	0.59	0.48	0.20	0.18	0.36
1996	0.00	0.01	0.01	0.06	0.36	0.55	1.48	0.57	0.74	0.70	0.35	0.22	0.34
1997	0.00	0.01	0.02	0.09	0.41	0.53	1.11	0.86	1.35	1.03	0.60	0.53	0.30
1998	0.00	0.00	0.01	0.07	0.22	0.62	0.81	0.45	1.10	0.99	0.14	0.19	0.29
1999	0.00	0.00	0.03	0.07	0.13	0.28	0.17	0.89	0.53	0.40	0.05	0.06	0.31
2000	0.00	0.01	0.02	0.04	0.10	0.24	0.21	0.57	0.16	0.74	1.25	0.41	0.34
2001	0.00	0.01	0.01	0.05	0.08	0.13	0.17	0.35	0.31	0.16	1.56	1.07	0.37
2002	0.00	0.00	0.01	0.07	0.09	0.18	0.10	0.73	0.11	0.92	0.34	0.46	0.39
2003	0.00	0.00	0.01	0.04	0.12	0.10	0.09	0.24	0.13	0.12	0.07	0.17	0.42
2004	0.00	0.01	0.02	0.06	0.20	0.16	0.17	0.13	0.13	0.36	0.25	0.29	0.44
2005	0.00	0.01	0.02	0.05	0.14	0.18	0.20	0.20	0.30	0.12	0.18	0.23	0.45
2006	0.00	0.00	0.01	0.04	0.05	0.12	0.07	0.08	0.06	0.06	0.55	0.11	0.47
2007	0.00	0.00	0.01	0.02	0.11	0.23	0.25	0.11	0.05	0.05	0.05	0.05	0.49
2008	0.00	0.01	0.01	0.03	0.10	0.22	0.11	0.20	0.10	0.07	0.07	0.07	0.51
2009	0.00	0.01	0.02	0.04	0.08	0.12	0.19	0.10	0.08	0.08	0.09	0.12	0.52
2010	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.55
2011	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.59
2012	0.00	0.00	0.01	0.02	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.63
2013	0.00	0.01	0.01	0.05	0.14	0.32	0.24	0.25	0.15	0.16	0.14	0.06	0.63
2014	0.00	0.01	0.01	0.03	0.06	0.11	0.09	0.08	0.16	0.09	0.11	0.09	0.61

Table 4.2.2.4.4. Estimated population size from ASAP at the beginning of each year by coast and age.

Atlantic

	Number of fish												
	Age (yr												
Year	1	2	3	4	5	6	7	8	9	10	11	12+	Total
1986	199,592	70,030	47,890	41,543	28,090	10,938	11,952	12,585	6,864	6,284	3,473	10,867	450,106
1987	197,100	121,998	50,093	36,524	32,636	21,651	8,459	8,675	9,968	5,169	4,840	11,548	508,658
1988	159,336	120,310	87,232	37,590	26,450	20,757	13,689	5,198	5,624	6,214	3,259	10,723	496,381
1989	176,762	97,195	85,774	66,063	28,972	17,842	14,285	8,679	3,619	3,506	3,995	9,520	516,213
1990	280,671	107,997	69,381	64,232	51,192	20,321	13,226	7,776	6,299	2,222	2,154	10,085	635,557
1991	304,549	171,472	77,151	52,705	49,927	37,457	14,670	8,446	5,755	4,325	1,566	9,854	737,877
1992	252,875	186,040	122,377	58,349	40,494	35,133	25,638	8,275	5,970	3,582	2,925	9,160	750,818
1993	190,394	154,283	132,347	91,291	43,574	22,904	18,661	9,375	4,656	2,569	1,847	8,346	680,248
1994	159,369	116,329	110,082	100,307	70,555	31,277	16,090	11,155	6,772	3,049	1,782	8,147	634,914
1995	164,436	96,752	82,346	81,719	74,897	45,760	20,264	6,419	7,153	3,107	1,604	7,149	591,607
1996	124,511	100,340	68,762	61,288	59,981	50,315	24,221	6,292	3,466	2,717	1,383	5,831	509,108
1997	112,668	76,023	71,500	51,829	45,678	36,615	29,355	8,792	3,906	1,988	1,604	5,445	445,404
1998	135,508	68,799	54,126	53,616	37,864	28,245	22,741	14,387	4,999	1,822	1,075	4,742	427,924
1999	168,141	82,738	48,997	40,849	39,071	24,808	14,339	10,823	9,018	2,087	821	4,439	446,131
2000	133,859	102,630	58,852	34,590	28,153	25,931	14,237	9,792	3,478	4,333	1,161	4,238	421,255
2001	115,087	81,626	72,702	43,653	25,482	20,112	16,698	9,817	5,029	2,577	1,996	2,943	397,720
2002	137,157	70,176	57,831	53,783	30,985	17,969	13,918	11,296	5,459	2,982	1,822	1,047	404,425
2003	127,841	83,737	49,977	43,478	39,166	23,027	12,855	10,840	5,887	4,280	1,412	1,924	404,423
2004	116,994	77,961	59,350	36,849	31,125	24,796	16,275	9,389	6,607	4,185	3,101	2,407	389,040
2005	112,769	71,300	55,109	43,139	25,356	18,078	16,595	11,098	6,784	4,817	2,393	3,524	370,961
2006	98,421	68,763	50,517	40,762	30,854	16,734	12,041	11,260	7,685	4,317	3,652	4,130	349,136
2007	80,707	59,922	48,422	36,747	26,760	20,709	9,362	8,278	7,593	5,494	3,167	3,465	310,625
2008	102,007	49,157	42,265	35,486	26,226	14,961	9,149	4,216	5,450	5,694	4,143	5,075	303,829
2009	68,978	62,139	34,683	31,011	25,635	17,219	8,356	6,428	2,645	3,989	4,396	7,171	272,648
2010	82,993	42,056	44,007	25,718	23,219	18,910	12,572	5,887	4,971	2,080	3,151	9,021	274,583
2011	82,158	50,650	29,898	32,998	19,708	18,063	14,904	10,004	4,721	4,007	1,683	9,932	278,726
2012	180,758	50,141	36,012	22,425	25,265	15,286	14,162	11,826	8,007	3,800	3,241	9,481	380,403
2013	100,535	110,276	35,600	26,902	17,067	19,466	11,890	11,158	9,395	6,389	3,046	10,280	362,004
2014	156,953	61,343	78,334	26,632	19,504	11,651	11,624	7,974	7,594	6,998	4,732	10,666	404,005

Table 4.2.2.4.4 continued. Estimated population size from ASAP at the beginning of each year by coast and age

Gulf

	Number of fish												
	Age (yr)												
Year	1	2	3	4	5	6	7	8	9	10	11	12+	Total
1986	238,401	119,178	78,802	40,575	31,684	20,830	15,016	8,979	2,800	1,304	253	426	558,247
1987	319,569	149,856	82,021	57,116	30,301	23,478	15,396	10,380	6,753	1,997	954	524	698,345
1988	458,583	200,734	103,147	59,229	41,701	21,068	16,017	10,226	7,083	4,501	1,343	1,026	924,659
1989	550,221	286,214	137,077	73,699	42,323	21,329	10,032	5,454	4,431	2,072	1,437	945	1,135,234
1990	492,409	345,720	196,742	98,543	54,672	29,477	15,249	5,307	3,767	2,577	1,204	1,715	1,247,381
1991	434,683	309,472	237,891	142,564	73,552	40,333	21,586	10,419	3,939	2,681	1,868	2,297	1,281,285
1992	445,924	272,957	212,491	171,299	104,400	48,882	24,897	9,785	6,418	1,981	1,528	3,050	1,303,611
1993	478,941	279,693	187,120	152,177	124,041	60,282	24,735	7,868	4,879	2,294	877	2,886	1,325,793
1994	421,056	300,680	191,678	134,439	110,696	78,700	34,531	9,472	4,440	2,156	1,152	2,619	1,291,620
1995	478,256	262,323	205,219	136,653	96,925	69,763	47,149	10,929	5,310	1,574	914	2,436	1,317,450
1996	336,265	300,294	180,078	147,659	99,764	68,003	41,768	19,104	6,364	2,380	792	2,280	1,204,751
1997	439,676	210,899	205,681	129,032	104,406	53,474	30,787	7,531	8,652	2,436	956	1,964	1,195,493
1998	450,941	275,698	144,151	146,275	88,267	53,508	24,684	8,017	2,537	1,816	707	1,374	1,197,976
1999	684,518	282,962	188,933	103,641	102,831	54,467	22,490	8,716	4,104	681	544	1,437	1,455,324
2000	782,396	429,742	194,157	132,622	72,869	69,735	32,140	14,973	2,864	1,940	369	1,538	1,735,345
2001	343,619	490,445	293,753	138,649	95,302	50,659	42,797	20,664	6,741	1,975	754	929	1,486,287
2002	404,619	215,566	335,940	210,494	99,221	67,553	34,929	28,645	11,608	3,987	1,365	391	1,414,318
2003	1,167,360	253,852	147,722	240,882	147,863	69,623	44,017	25,109	11,032	8,340	1,288	996	2,118,084
2004	550,564	732,606	174,035	105,921	174,047	100,398	49,456	31,795	15,821	7,805	5,995	1,664	1,950,108
2005	290,448	345,187	501,080	123,746	74,577	109,376	67,108	33,065	22,218	11,149	4,396	4,833	1,587,182
2006	252,400	182,130	236,197	358,100	88,062	49,715	71,198	43,588	21,704	13,321	8,039	6,129	1,330,583
2007	196,526	158,450	124,958	170,022	259,435	64,502	34,373	52,662	32,072	16,401	10,208	8,329	1,127,938
2008	182,407	123,367	108,698	89,965	124,777	178,925	40,198	21,159	37,887	24,526	12,620	14,450	958,978
2009	277,473	114,408	84,452	77,901	65,411	87,011	111,910	28,528	13,862	27,640	18,621	20,772	927,989
2010	401,803	173,902	78,187	60,293	56,508	46,614	60,361	73,610	20,711	10,265	20,582	29,020	1,031,855
2011	512,482	252,273	119,348	56,344	44,635	42,436	35,351	46,178	56,707	16,069	8,009	39,125	1,228,955
2012	1,165,240	321,867	173,267	86,153	41,830	33,644	32,302	27,199	35,807	44,308	12,635	37,583	2,011,836
2013	1,428,340	731,479	220,823	124,773	63,680	31,314	25,359	24,600	20,860	27,644	34,410	39,497	2,772,778
2014	1,757,480	895,969	500,924	158,373	88,757	42,641	17,767	15,758	15,336	14,451	19,013	54,871	3,581,340

Table 4.2.2.4.8. Sensitivity runs and management benchmarks including natural mortality (M), geometric mean of fishing mortality rates from 2012-2014 (F_{gm}) on age-7 fish, target fishing mortality rate ($F_{40\%}$), fishing mortality ratio ($F_{gm}/F_{40\%SPR}$), spawning biomass in 2014 (SSB_{2014}), spawning biomass corresponding to $F_{40\%SPR}$, spawning biomass ratio ($SSB_{2014}/SSB_{40\%SPR}$), transitional spawning potential ratio (tSPR), and steepness from ASAP.

Run	Coast	Description	M (per year)	F_{gm} (per year)	$F_{40\%SPR}$ (per year)	F ratio	SSB_{2014} (mt)	$SSB_{40\%SPR}$ (mt)	SSB ratio	tSPR	Steepness
1	Atlantic	Base	0.20	0.12	0.13	0.98	345	571	0.60	0.39	0.67
2		Low natural mortality	0.15	0.14	0.10	1.43	316	1,238	0.26	0.29	0.66
3		High natural mortality	0.34	0.06	0.27	0.24	619	358	1.73	0.74	0.69
4		High weight on FIM age-1 index	0.20	0.13	0.13	1.03	322	498	0.65	0.35	0.66
5	Gulf	Base	0.25	0.10	0.24	0.40	1,404	854	1.64	0.61	0.73
6		Low natural mortality	0.20	0.11	0.17	0.64	1,192	1,044	1.14	0.51	0.76
7		High natural mortality	0.41	0.07	1.27	0.06	2,661	745	3.57	0.84	0.69
8		High weight on FIM age-1 index	0.25	0.05	0.23	0.24	1,861	987	1.88	0.70	0.71
9		Environmental effects	0.25	0.15	0.24	0.60	1,305	1,451	0.90	0.63	0.73
10		Environmental effects (half)	0.25	0.15	0.24	0.63	1,156	1,340	0.86	0.60	0.73

Table 4.2.2.4.9.1. Retrospective comparison of the results from 1997–2015 stock assessments including average fishing mortality rates on ages 6–10, transitional spawning potential ratios, and numbers of age-6 and older fish by coast.

Atlantic

Average fishing mortality rate on ages 6-10

	Assessment									
Year	1997	1998	1999	2000	2001	2002	2006	2011	2013	2015
1987	0.26	0.24	0.21	0.25	0.26	0.18	0.26	0.29	0.40	0.29
1988	0.29	0.28	0.25	0.30	0.27	0.21	0.29	0.19	0.13	0.24
1989	0.16	0.15	0.14	0.13	0.15	0.14	0.15	0.13	0.17	0.26
1990	0.10	0.10	0.09	0.11	0.10	0.10	0.12	0.11	0.14	0.18
1991	0.21	0.21	0.20	0.24	0.19	0.19	0.22	0.18	0.19	0.26
1992	0.26	0.25	0.24	0.29	0.25	0.26	0.37	0.17	0.16	0.57
1993	0.17	0.12	0.11	0.16	0.14	0.14	0.16	0.19	0.18	0.22
1994	0.36	0.24	0.22	0.29	0.25	0.29	0.21	0.54	0.50	0.47
1995	0.38	0.22	0.19	0.24	0.21	0.25	0.31	0.53	0.34	0.66
1996	0.53	0.27	0.22	0.31	0.23	0.29	0.35	0.49	0.24	0.44
1997		0.59	0.37	0.49	0.30	0.34	0.49	0.55	0.84	0.45
1998			0.26	0.31	0.16	0.22	0.30	0.36	0.41	0.53
1999				0.16	0.20	0.17	0.25	0.43	0.46	0.50
2000					0.21	0.26	0.33	0.46	0.50	0.33
2001						0.17	0.27	0.32	0.33	0.27
2002							0.24	0.23	0.24	0.27
2003							0.31	0.34	0.37	0.19
2004							0.26	0.21	0.27	0.22
2005								0.21	0.25	0.20
2006								0.30	0.37	0.22
2007								0.12	0.15	0.34
2008								0.19	0.22	0.22
2009								0.09	0.12	0.10
2010								0.03	0.04	0.05
2011									0.10	0.05
2012									0.10	0.06
2013										0.20
2014										0.18

Table 4.2.2.4.9.1 continued. Retrospective comparison of the results from 1997–2015 stock assessments including average fishing mortality rates on ages 6–10, transitional spawning potential ratios, and numbers of age-6 and older fish by coast.

Atlantic

Transitional spawning potential ratios

	Assessment									
Year	1997	1998	1999	2000	2001	2002	2006	2011	2013	2015
1987	0.38	0.35	0.31	0.30	0.31	0.37	0.28	0.30	0.44	0.31
1988	0.37	0.35	0.31	0.30	0.30	0.36	0.27	0.30	0.43	0.30
1989	0.36	0.33	0.32	0.31	0.31	0.36	0.28	0.32	0.43	0.30
1990	0.40	0.37	0.34	0.34	0.34	0.38	0.30	0.35	0.44	0.32
1991	0.45	0.41	0.36	0.35	0.36	0.39	0.32	0.37	0.45	0.33
1992	0.43	0.39	0.35	0.34	0.36	0.37	0.31	0.38	0.44	0.30
1993	0.40	0.37	0.36	0.34	0.36	0.36	0.30	0.38	0.42	0.28
1994	0.43	0.41	0.36	0.34	0.37	0.35	0.31	0.36	0.38	0.28
1995	0.36	0.37	0.36	0.33	0.36	0.33	0.31	0.33	0.32	0.25
1996	0.32	0.36	0.35	0.31	0.35	0.31	0.29	0.30	0.28	0.23
1997		0.33	0.32	0.28	0.33	0.28	0.25	0.25	0.23	0.22
1998			0.29	0.25	0.33	0.27	0.23	0.22	0.21	0.21
1999				0.26	0.34	0.28	0.24	0.22	0.21	0.21
2000					0.34	0.29	0.24	0.21	0.21	0.22
2001						0.30	0.24	0.22	0.21	0.21
2002							0.25	0.23	0.23	0.23
2003							0.25	0.23	0.23	0.25
2004							0.25	0.24	0.23	0.26
2005								0.25	0.24	0.27
2006								0.26	0.25	0.26
2007								0.28	0.26	0.25
2008								0.30	0.27	0.25
2009								0.32	0.29	0.27
2010								0.36	0.33	0.30
2011									0.34	0.34
2012									0.34	0.38
2013										0.40
2014										0.39

Table 4.2.2.4.9.1 continued. Retrospective comparison of the results from 1997–2015 stock assessments including average fishing mortality rates on ages 6–10, transitional spawning potential ratios, and numbers of age-6 and older fish by coast.

Atlantic

Number of fish ages 6+

	Assessment									
Year	1997	1998	1999	2000	2001	2002	2006	2011	2013	2015
1987	68,874	119,931	77,979	76,248	78,750	100,008	65,052	92,565	72,394	70,308
1988	70,067	119,668	78,125	75,209	79,965	94,854	65,908	88,837	67,641	65,463
1989	65,018	113,942	75,367	73,163	73,203	82,731	57,518	88,509	60,261	61,446
1990	68,309	129,119	84,102	84,299	84,376	81,343	61,452	96,768	61,848	62,084
1991	75,464	149,561	101,769	104,870	99,907	87,924	76,991	104,591	80,406	82,074
1992	73,973	146,684	104,371	103,747	95,330	83,632	93,269	135,001	98,909	90,683
1993	71,188	144,513	100,522	87,955	98,041	82,828	90,480	120,027	83,399	68,359
1994	78,572	161,452	114,260	91,341	114,565	94,265	92,391	103,739	74,152	78,272
1995	73,119	152,882	121,074	96,324	122,769	105,752	110,671	96,105	61,458	91,456
1996	67,514	145,925	133,876	112,731	151,462	122,541	128,871	111,785	61,223	94,225
1997		118,368	150,375	126,145	194,974	142,938	140,712	120,240	64,053	87,705
1998			119,656	101,860	170,496	128,112	100,851	92,120	53,383	78,011
1999				98,983	146,172	136,533	89,800	81,795	53,969	66,335
2000					136,589	136,841	80,502	74,306	51,513	63,170
2001						116,890	71,388	68,563	48,943	59,171
2002							68,715	71,177	49,337	54,493
2003							73,111	75,558	54,672	60,225
2004							73,131	75,284	52,890	66,761
2005								77,397	50,045	63,288
2006								78,198	50,359	59,819
2007								81,865	53,274	58,067
2008								91,646	57,722	48,688
2009								88,390	53,263	50,204
2010								96,319	59,669	56,591
2011									67,522	63,314
2012									55,589	65,803
2013										71,624
2014										61,239

Table 4.2.2.4.9.1 continued. Retrospective comparison of the results from 1997–2015 stock assessments including average fishing mortality rates on ages 6–10, transitional spawning potential ratios, and numbers of age-6 and older fish by coast.

Gulf

Average fishing mortality rate on ages 6-10

	Assessment									
Year	1997	1998	1999	2000	2001	2002	2006	2011	2013	2015
1987	0.20	0.20	0.22	0.23	0.22	0.23	0.35	0.20	0.13	0.17
1988	0.79	1.08	1.31	1.12	0.96	1.06	1.52	1.77	2.64	0.78
1989	0.20	0.32	0.38	0.29	0.24	0.28	0.49	0.28	0.24	0.26
1990	0.08	0.09	0.10	0.10	0.08	0.10	0.16	0.08	0.15	0.10
1991	0.37	0.38	0.43	0.42	0.37	0.44	0.55	0.44	0.60	0.38
1992	0.76	0.57	0.66	0.67	0.64	0.76	0.94	1.05	1.37	0.65
1993	0.57	0.47	0.55	0.53	0.50	0.59	0.82	0.48	0.64	0.49
1994	0.51	0.50	0.61	0.52	0.47	0.60	0.68	0.30	0.62	0.60
1995	0.40	0.38	0.48	0.46	0.39	0.50	0.48	0.22	0.27	0.46
1996	0.42	0.42	0.51	0.48	0.40	0.50	0.43	0.30	0.67	0.81
1997		1.10	1.21	1.27	0.93	1.08	0.74	0.69	0.92	0.98
1998			1.01	1.00	0.56	0.62	0.57	0.68	0.61	0.79
1999				0.94	0.59	0.38	0.15	0.36	0.48	0.46
2000					0.65	0.38	0.20	0.37	0.34	0.38
2001						0.34	0.20	0.37	0.25	0.22
2002							0.19	0.19	0.24	0.41
2003							0.15	0.13	0.13	0.14
2004							0.26	0.27	0.32	0.19
2005								0.25	0.25	0.20
2006								0.13	0.09	0.08
2007								0.06	0.08	0.14
2008								0.06	0.09	0.14
2009								0.06	0.09	0.11
2010								0.02	0.01	0.04
2011									0.04	0.03
2012									0.05	0.04
2013										0.23
2014										0.11

Table 4.2.2.4.9.1 continued. Retrospective comparison of the results from 1997–2015 stock assessments including average fishing mortality rates on ages 6–10, transitional spawning potential ratios, and numbers of age-6 and older fish by coast.

Gulf

Transitional spawning potential ratios

	Assessment									
Year	1997	1998	1999	2000	2001	2002	2006	2011	2013	2015
1987	0.43	0.29	0.32	0.34	0.34	0.31	0.26	0.38	0.44	0.44
1988	0.40	0.35	0.29	0.31	0.31	0.28	0.23	0.35	0.39	0.40
1989	0.39	0.24	0.28	0.30	0.30	0.27	0.22	0.34	0.37	0.37
1990	0.45	0.30	0.33	0.35	0.35	0.32	0.27	0.38	0.41	0.41
1991	0.47	0.38	0.35	0.37	0.38	0.34	0.30	0.41	0.43	0.43
1992	0.41	0.35	0.34	0.35	0.35	0.31	0.30	0.40	0.40	0.40
1993	0.36	0.30	0.32	0.33	0.33	0.28	0.29	0.37	0.38	0.37
1994	0.36	0.31	0.32	0.33	0.32	0.27	0.28	0.36	0.37	0.36
1995	0.37	0.30	0.32	0.33	0.33	0.27	0.28	0.36	0.38	0.36
1996	0.38	0.32	0.32	0.33	0.33	0.28	0.29	0.35	0.37	0.34
1997		0.31	0.29	0.29	0.30	0.25	0.29	0.32	0.34	0.30
1998			0.26	0.26	0.28	0.23	0.28	0.30	0.32	0.29
1999				0.25	0.28	0.24	0.29	0.31	0.32	0.31
2000					0.28	0.25	0.30	0.32	0.34	0.34
2001						0.26	0.30	0.34	0.35	0.37
2002							0.31	0.35	0.35	0.39
2003							0.32	0.37	0.38	0.42
2004							0.32	0.39	0.41	0.44
2005								0.38	0.42	0.45
2006								0.39	0.43	0.47
2007								0.43	0.47	0.49
2008								0.46	0.51	0.51
2009								0.49	0.55	0.52
2010								0.51	0.54	0.55
2011									0.53	0.59
2012									0.58	0.63
2013										0.63
2014										0.61

Table 4.2.2.4.9.1 continued. Retrospective comparison of the results from 1997–2015 stock assessments including average fishing mortality rates on ages 6–10, transitional spawning potential ratios, and numbers of age-6 and older fish by coast.

Gulf

Number of fish ages 6+

	Assessment									
Year	1997	1998	1999	2000	2001	2002	2006	2011	2013	2015
1987	45,083	53,804	46,574	44,632	45,045	37,434	34,400	53,995	44,656	59,483
1988	57,741	67,463	59,435	61,825	60,769	50,433	46,777	45,363	48,300	61,265
1989	43,410	35,045	31,125	35,974	37,284	31,677	22,554	36,016	36,157	45,700
1990	58,877	51,014	46,141	51,531	52,382	44,621	30,787	55,471	42,469	59,295
1991	86,421	83,457	69,653	76,600	79,409	67,318	57,018	69,488	58,081	83,123
1992	94,633	83,938	75,039	79,447	90,049	76,563	68,919	69,599	66,451	96,540
1993	73,626	75,678	68,776	70,082	82,786	58,408	56,648	95,119	85,764	103,821
1994	73,019	79,424	68,310	65,664	76,096	58,009	61,572	114,046	109,737	133,071
1995	75,269	79,370	73,990	76,983	84,317	73,238	70,895	141,142	131,463	138,074
1996	83,469	93,767	90,838	96,389	99,831	87,062	84,505	122,019	118,008	140,691
1997		99,420	84,622	84,030	92,498	93,787	89,807	99,103	98,475	105,799
1998			54,478	46,937	56,855	57,482	86,150	71,225	78,325	92,643
1999				38,974	52,477	59,667	95,074	82,660	83,723	92,439
2000					52,734	58,269	117,335	96,445	91,853	123,559
2001						52,300	103,882	88,694	104,311	124,519
2002							84,884	125,656	91,137	148,478
2003							93,171	140,423	113,596	160,405
2004							111,034	170,088	136,182	212,935
2005								209,489	183,288	252,144
2006								185,329	173,209	213,693
2007								195,423	157,002	218,547
2008								297,450	196,462	329,764
2009								344,992	247,067	308,344
2010								280,923	227,177	261,162
2011									123,815	243,873
2012									104,686	223,478
2013										203,684
2014										179,837

Table 4.2.2.4.9.2. Comparison of model fits of the base run and the sensitivity run that included the environmental effects. Legend: RSS –sum of squared residuals, nobs – number of observations, and MSE – mean square error. A lower mean square error (MSE) indicates a closer model fit.

Run	Component	RSS	nobs	MSE
Base	Catch Fleet total	2.76	28	0.099
	Discard Fleet total	0.48	29	0.017
	FIM adult index	1.56	19	0.082
	MRFSS index	0.89	24	0.037
	ENP index	2.05	29	0.071
	FIM Age-1 index	10.25	19	0.539
w/Environmental effects	Catch Fleet total	3.02	28	0.108
	Discard Fleet total	0.44	29	0.015
	FIM adult index	1.12	333	0.003
	MRFSS index	0.46	24	0.019
	ENP index	1.83	29	0.063
	FIM Age-1 index	6.04	19	0.318

Table 5.2. Numbers of fish measured from the fishery and comparison of sizes of fish with regard to current and previous size limits (shaded) by coast. Data from 2006 and 2007 were omitted because a 27-inch minimum size limit was in effect only from July 2006 to July 2007.

		Time periods			
Coast		1986-98	1999-05	2008-14	Total
Atlantic	Number measured	1,646	5,416	3,887	10,949
		Time periods			
	Length categories	1986-98	1999-05	2008-14	
	< 24 in	2%	1%	0%	
	24-25 in	10%	2%	0%	
	26-27 in	8%	24%	3%	
	28-32 in	28%	38%	79%	
	32-34 in	17%	25%	17%	
	> 32 in	52%	35%	17%	
	> 34 in	1%	9%	0%	
	Undersized	2%	3%	4%	
	Oversized	--	9%	17%	
Gulf	Number measured	10,209	10,250	1,693	22,152
		Time periods			
	Length categories	1986-98	1999-05	2008-14	
	< 24 in	7%	1%	1%	
	24-25 in	23%	6%	1%	
	26-27 in	23%	36%	21%	
	28-33 in	33%	50%	73%	
	33-34 in	6%	6%	5%	
	> 33 in	15%	7%	5%	
	> 34 in	11%	2%	1%	
	Undersized	7%	7%	22%	
	Oversized	--	2%	5%	

Table 5.3. Bag-limit analysis of the Atlantic coast using 1986-2006 (two-fish bag limit) and 2008–2014 (one-fish bag limit) MRFSS-MRIP intercept data from the open seasons and 1986-2001 (two-fish bag limit) and 2002-2014 (one-fish bag limit) intercept data from the gulf coast.

Coast	Period	Bag limit	Number of fish kept per angler	Number of years	Number of trips	Number of anglers	Average number of anglers per trip	Number of fish caught	Number of fish retained
Atlantic	1986-06	2	0	21	7,555	11,070	1.47	5,408	49
			1	21	390	554	1.42	1,055	456
			2	18	80	115	1.44	359	214
			3	3	3	3	1.00	19	9
			4	3	3	3	1.00	13	12
			5	1	1	1	1.00	5	5
			6	1	1	2	2.00	25	12
			Totals		8,033	11,748		6,884	757
	2008-14	1	0	7	1,545	2,447	1.58	1,470	8
			1	7	62	90	1.45	186	72
			2	1	1	1	1.00	2	2
			3	1	1	2	2.00	5	5
			Totals		1,609	2,540		1,663	87
Gulf	1986-01	2	0	16	6,220	10,212	1.64	6,100	72
			1	16	394	675	1.71	1,424	487
			2	14	78	119	1.53	613	218
			3	3	3	4	1.33	18	11
			4	2	3	4	1.33	40	16
			5	1	1	1	1.00	5	5
			11	1	1	2	2.00	114	22
			20	1	1	1	1.00	20	20
			Totals		6,701	11,018		8,334	851
	2002-14	1	0	11	10,275	20,169	1.96	24,805	113
			1	10	446	863	1.93	3,122	591
			2	5	9	15	1.67	86	27
			3	1	1	1	1.00	3	3
			4	1	1	2	2.00	14	8
			5	1	1	2	2.00	20	10
			Totals		10,733	21,052		28,050	752

Table 5.4. Estimated annual catchability for fully selected fish by coast and the percent change in catchability with regulatory changes.

	Coast					
	Atlantic			Gulf		
Year	Directed trips	Fishing mortality (age-7)	Catchability	Directed trips	Fishing mortality (age-7)	Catchability
1986	20,848	0.15	7.144E-06	90,667	0.17	1.861E-06
1987	18,835	0.33	1.733E-05	145,119	0.20	1.394E-06
1988	21,025	0.30	1.419E-05	167,794	0.95	5.655E-06
1989	14,297	0.46	3.243E-05	300,657	0.49	1.635E-06
1990	46,444	0.28	6.103E-06	83,331	0.18	2.136E-06
1991	50,922	0.40	7.869E-06	450,451	0.68	1.501E-06
1992	64,334	0.80	1.241E-05	308,752	1.06	3.434E-06
1993	77,661	0.31	4.015E-06	375,246	0.84	2.247E-06
1994	137,435	0.68	4.957E-06	402,524	1.09	2.703E-06
1995	92,019	0.90	9.802E-06	294,561	0.79	2.666E-06
1996	262,424	0.75	2.841E-06	885,851	1.64	1.852E-06
1997	439,929	0.54	1.223E-06	1,367,628	1.27	9.273E-07
1998	316,065	0.53	1.661E-06	1,098,422	0.92	8.393E-07
1999	478,520	0.18	3.776E-07	1,118,666	0.20	1.775E-07
2000	683,034	0.17	2.475E-07	957,649	0.24	2.492E-07
2001	542,066	0.18	3.378E-07	984,282	0.20	2.058E-07
2002	556,473	0.06	1.090E-07	1,239,687	0.12	9.730E-08
2003	540,766	0.12	2.249E-07	1,134,341	0.11	1.006E-07
2004	578,014	0.18	3.181E-07	1,039,115	0.20	1.891E-07
2005	808,998	0.19	2.380E-07	1,282,082	0.24	1.895E-07
2006	775,732	0.19	2.423E-07	1,371,221	0.09	6.398E-08
2007	646,611	0.60	9.345E-07	1,570,590	0.33	2.105E-07
2008	918,961	0.16	1.703E-07	1,980,465	0.15	7.430E-08
2009	947,859	0.15	1.566E-07	2,354,441	0.19	8.103E-08
2010	1,243,018	0.04	3.314E-08	2,614,587	0.08	3.036E-08
2011	1,037,430	0.05	4.420E-08	2,238,543	0.04	1.953E-08
2012	1,627,551	0.06	3.437E-08	2,725,145	0.05	1.998E-08
2013	987,758	0.23	2.375E-07	2,392,375	0.30	1.245E-07
2014	613,871	0.17	2.801E-07	2,028,889	0.13	6.227E-08
Averages						
1999-05	598,267	0.16	2.651E-07	1,107,975	0.19	1.755E-07
2008-14	1,053,778	0.11	1.070E-07	2,333,492	0.15	6.293E-08
	% change from 1999-05		-60%			-64%

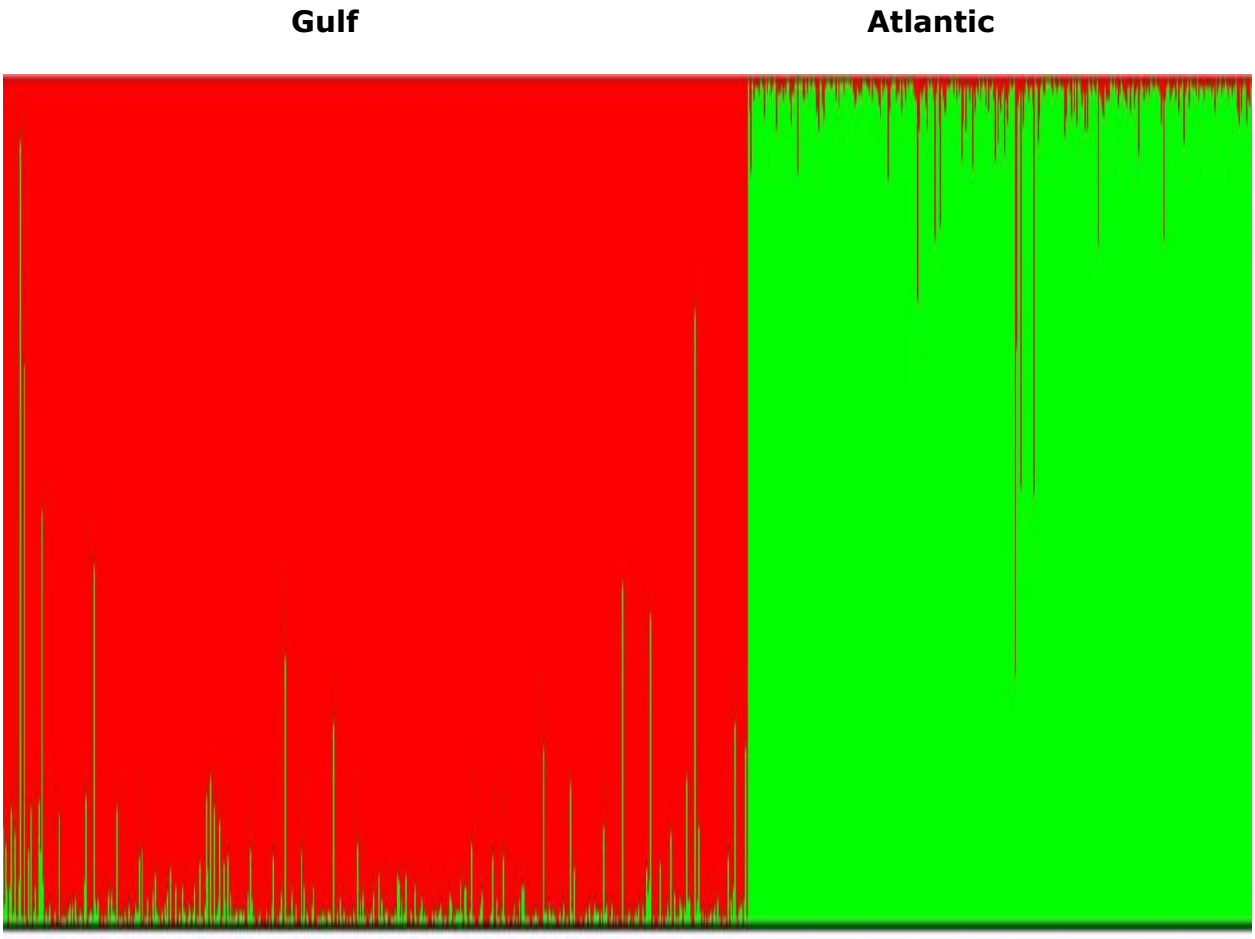


Figure 2.2. Microsatellite DNA analysis with 24 loci of Florida snook collected from both coasts (total n = 1,396 fish). The vertical lines represent the 24 loci for each fish and the red loci are associated with the gulf stock and green loci are associated with the Atlantic stock.

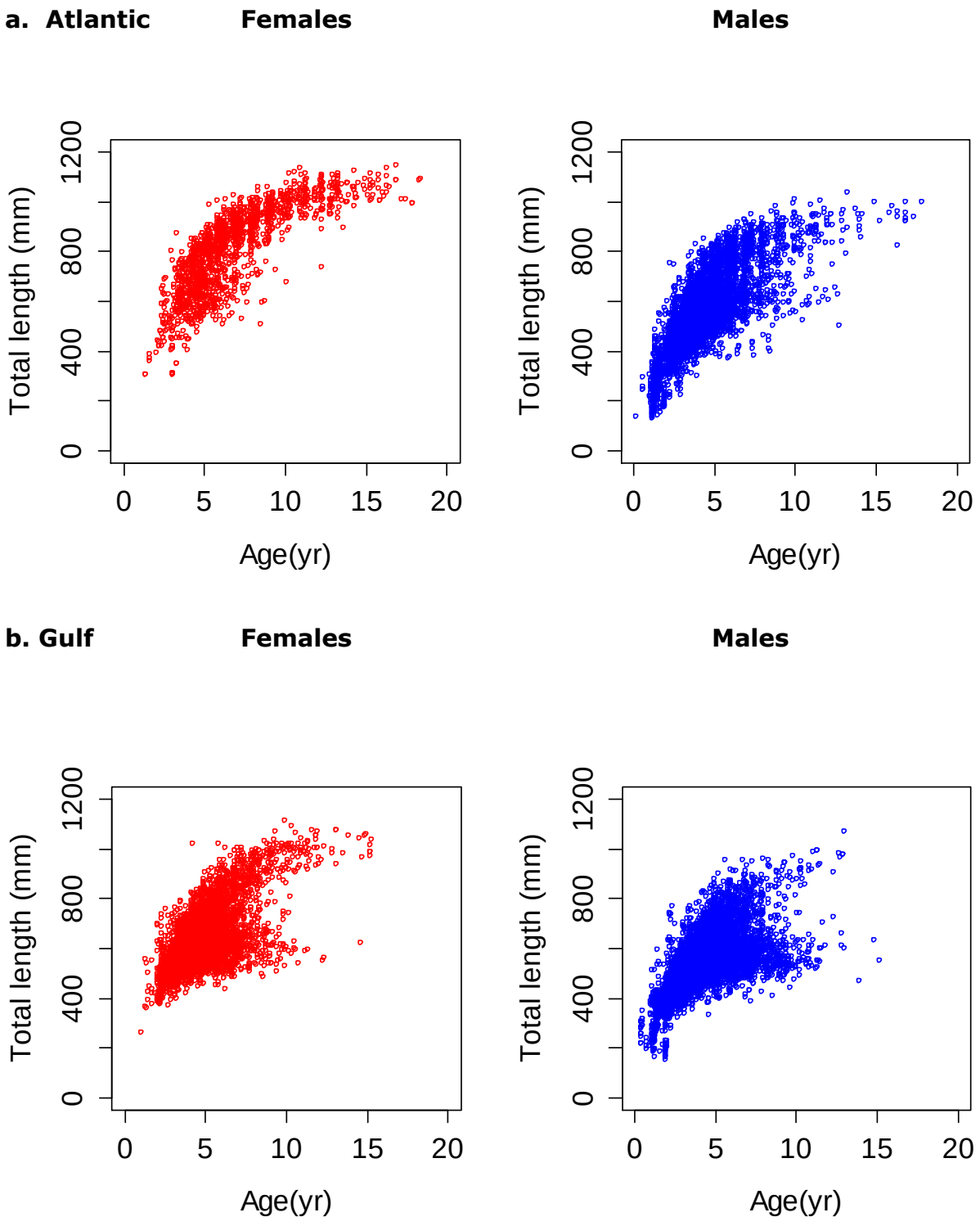


Figure 2.6. Lengths and ages of Common Snook by sex and coast collected with fishery-independent gear.

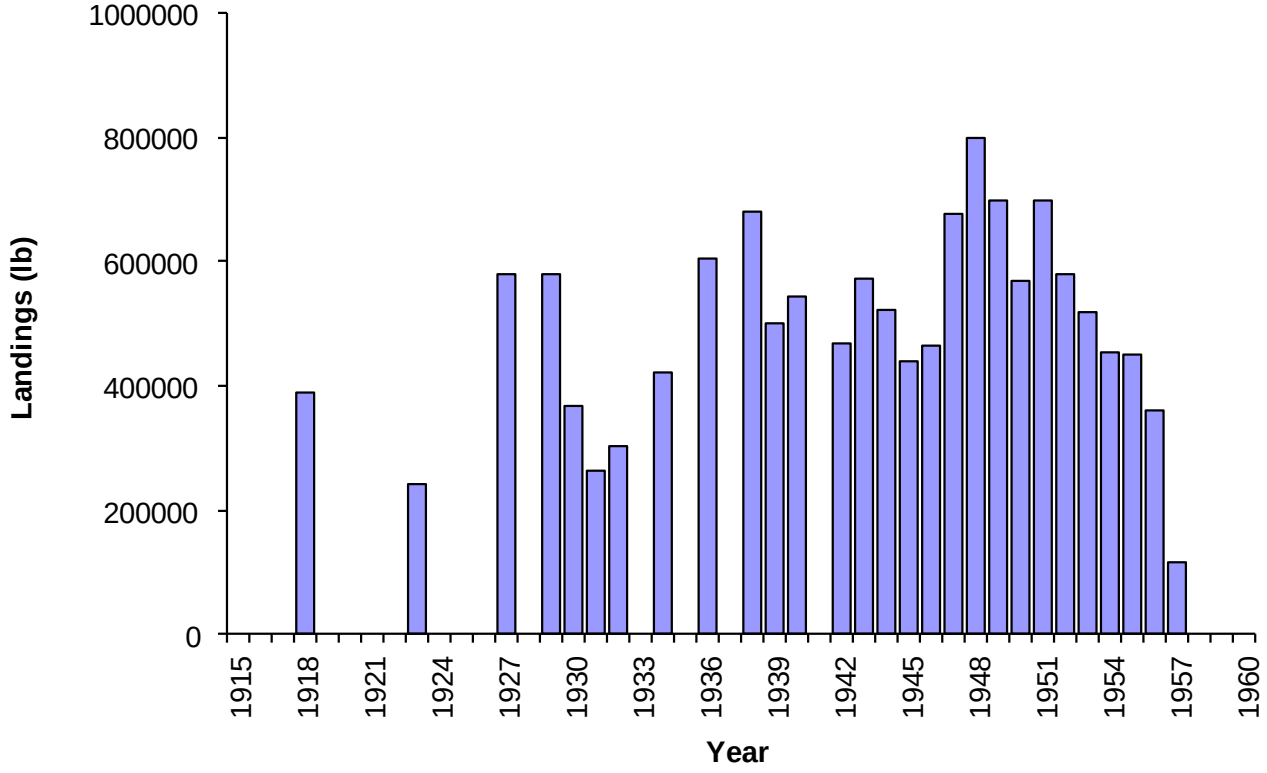


Figure 3.1. Commercial landings of snook.

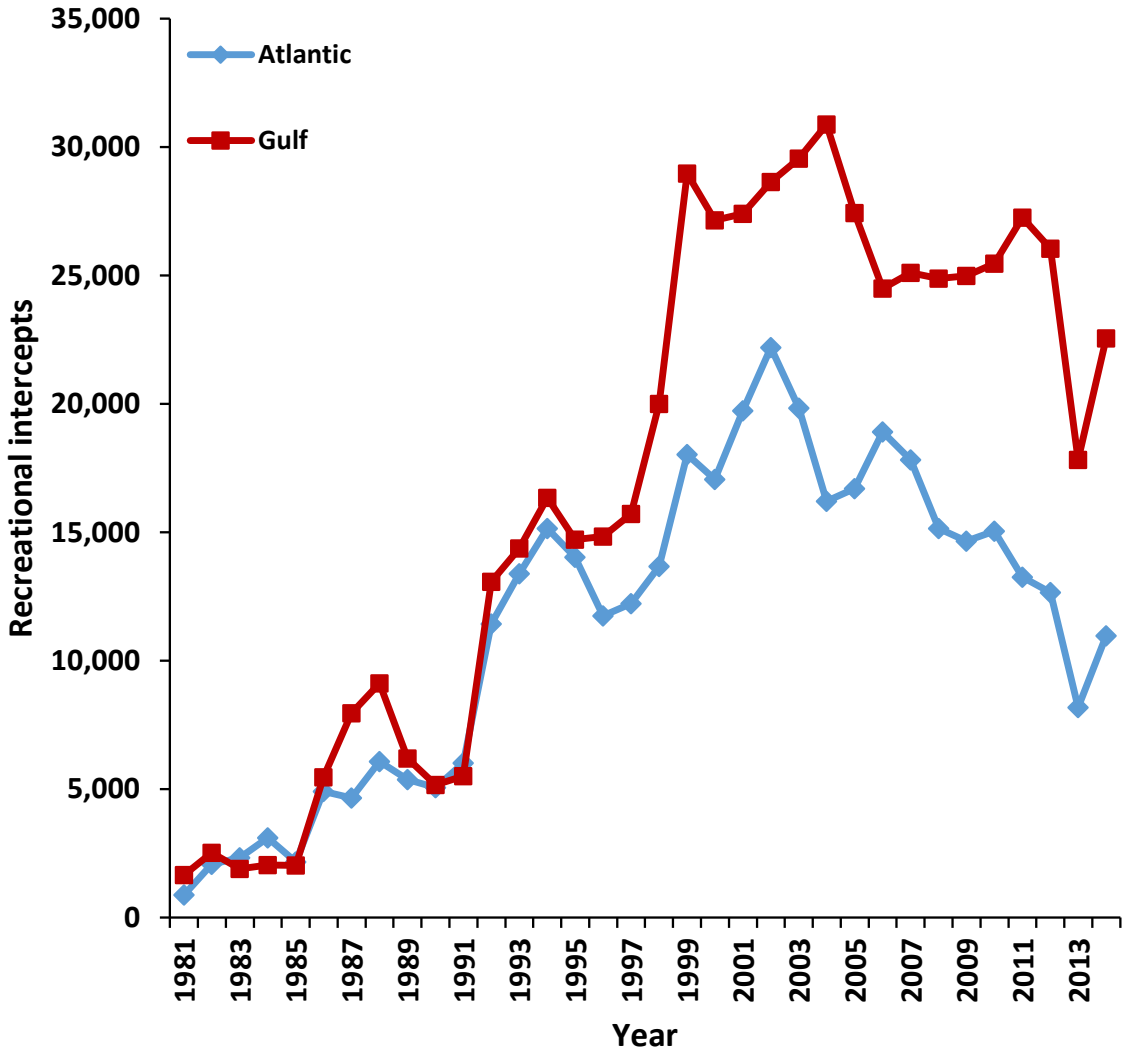
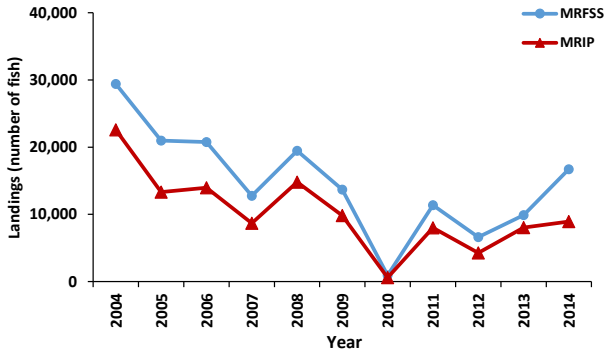
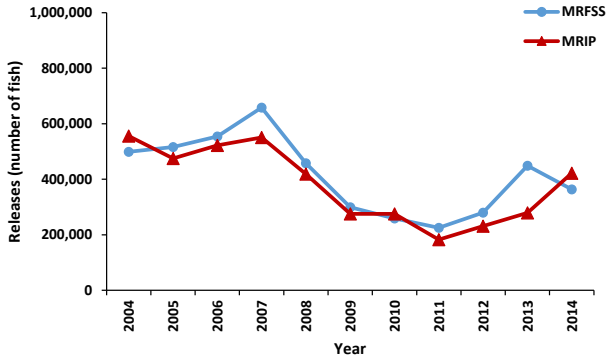


Figure 3.2.1. Number of recreational intercepts conducted by MRFSS/MRIP samplers by year and coast.

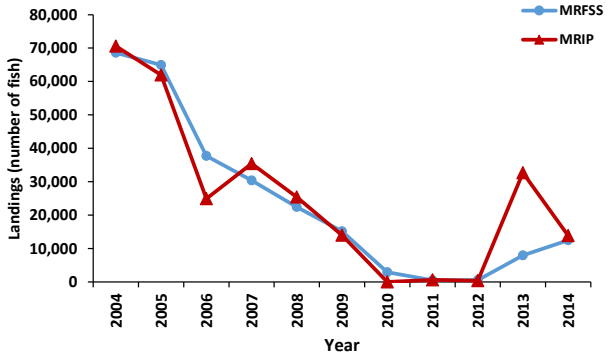
a. Atlantic landings



b. Atlantic releases



c. Gulf landings



d. Gulf releases

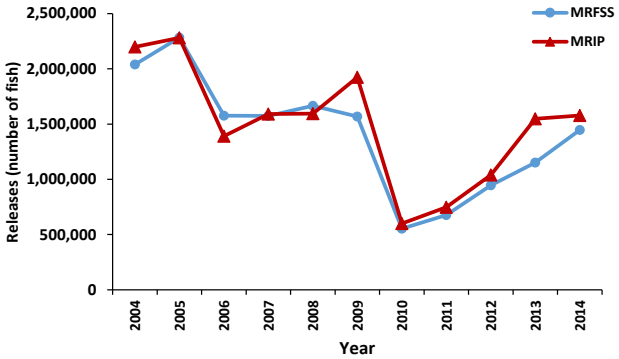
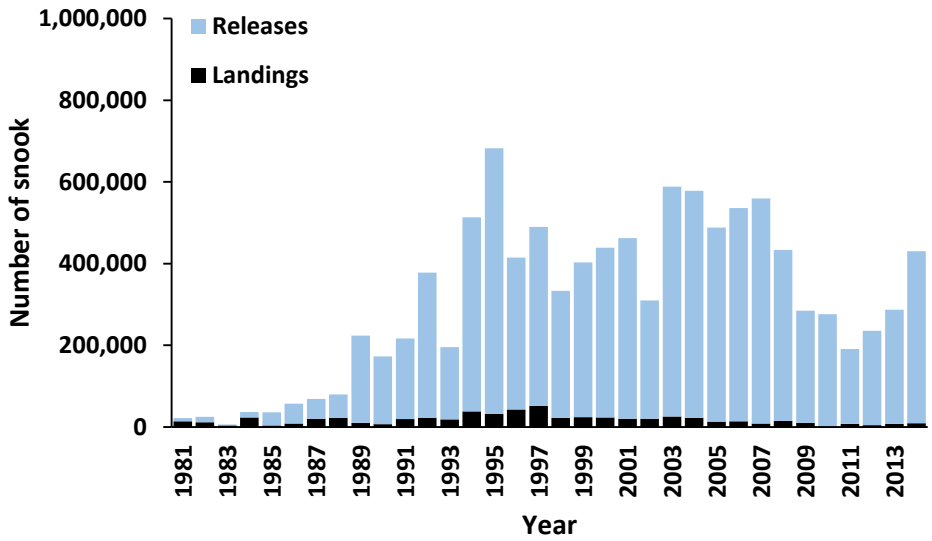


Figure 3.2.2. Comparison of estimates by MRFSS and MRIP analytical procedures for snook by coast.

a. Atlantic



b. Gulf

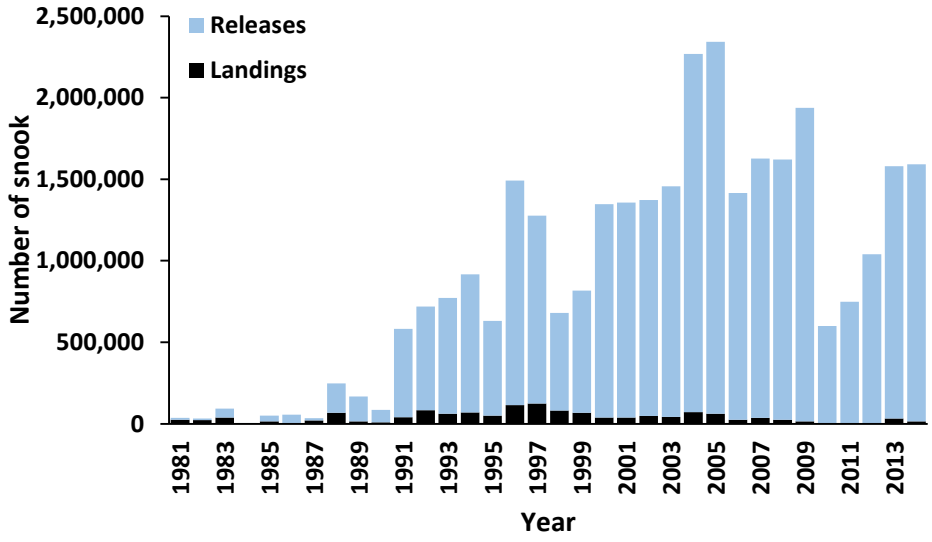
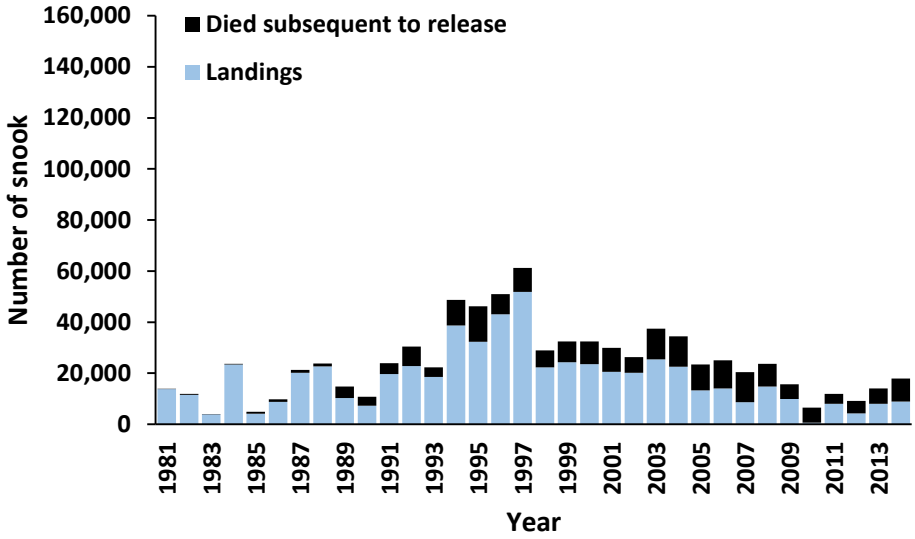


Figure 3.2.3. Annual total recreational catch of snook including fish released alive and fish kept by coast from MRFSS-MRIP.

a. Atlantic



b. Gulf

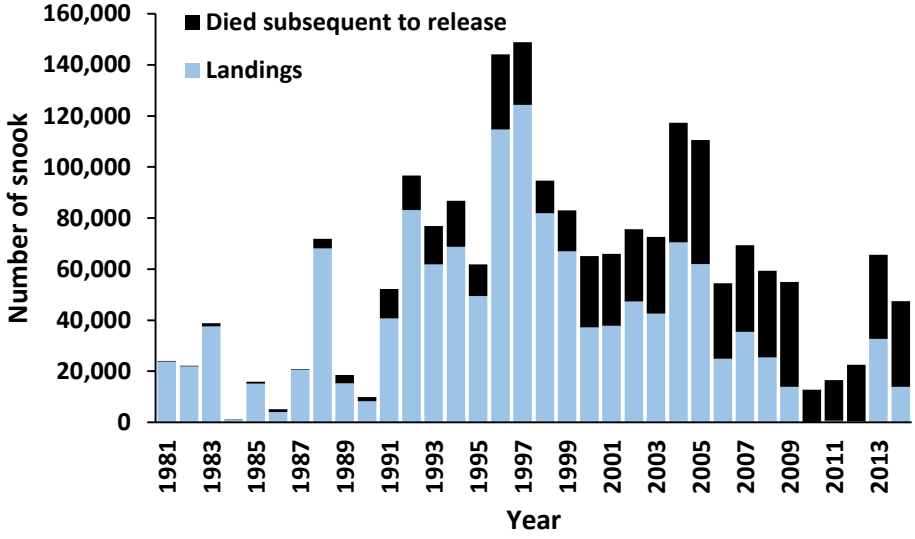
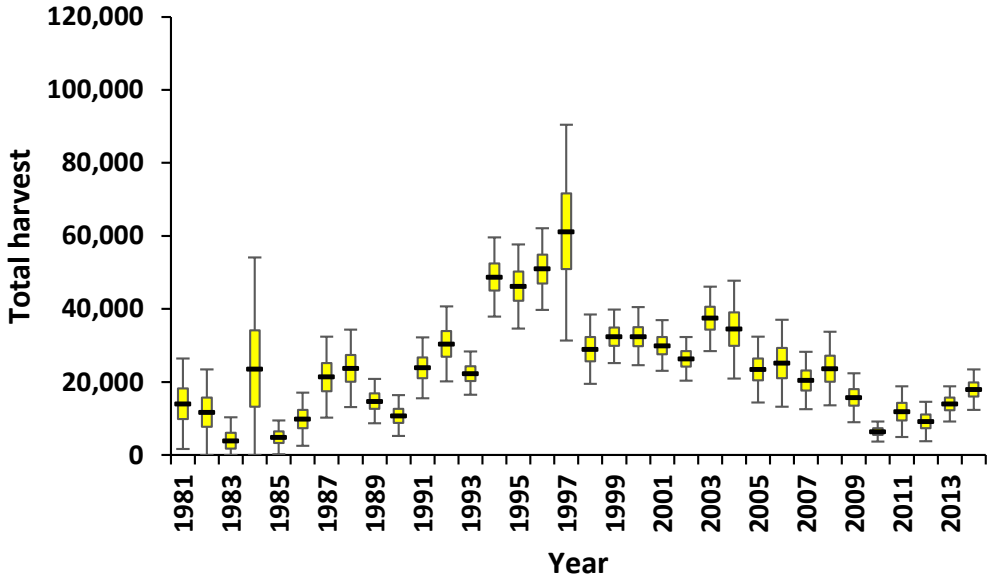


Figure 3.2.4. Total recreational harvest of snook, including those landed and kept plus those that died after being released alive by coast.

a. Atlantic



b. Gulf

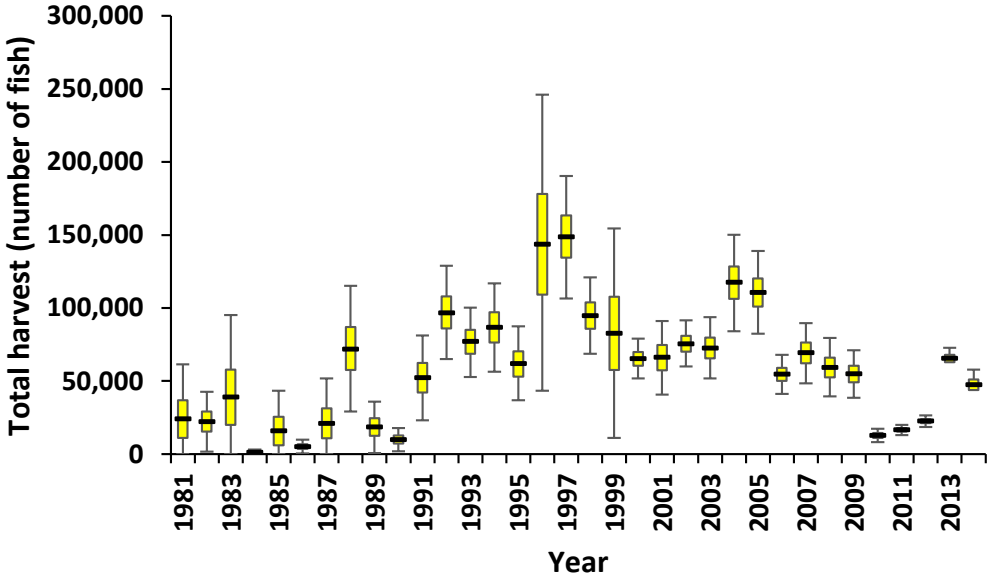
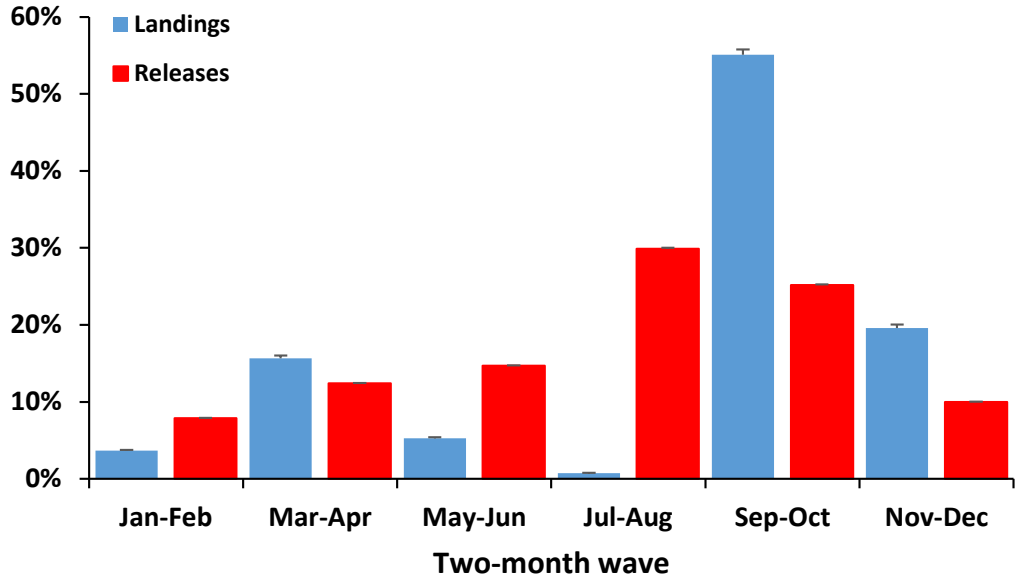


Figure 3.2.5. Distribution of total recreational harvest of common snook by coast. Harvest includes the estimated number of fish landed and kept and the number of fish that died subsequent to being released alive (2.13% of those released alive). The horizontal line is the median; the box is the inter-quartile range, and the vertical line is the 95% confidence interval.

a. Atlantic



b. Gulf

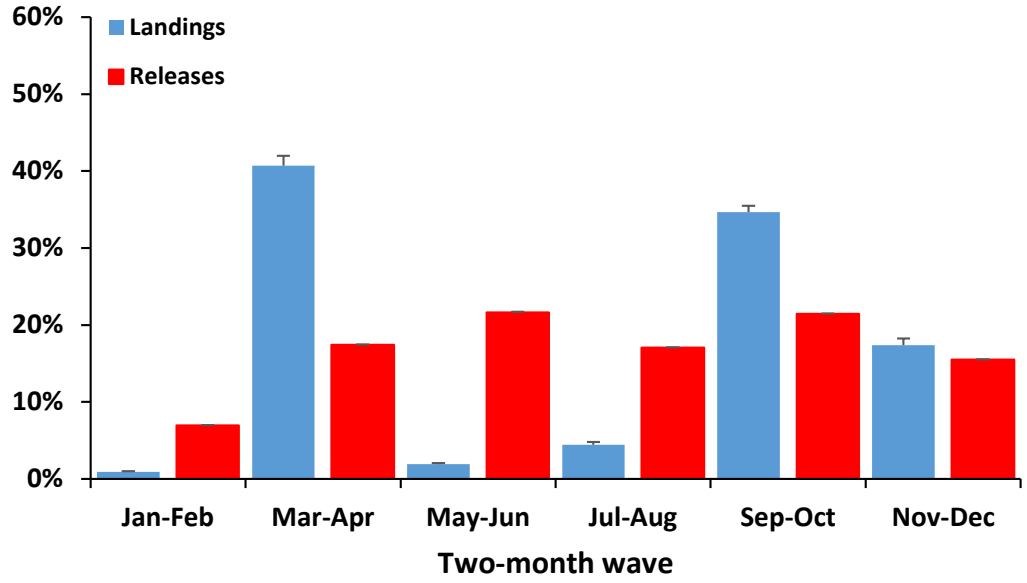
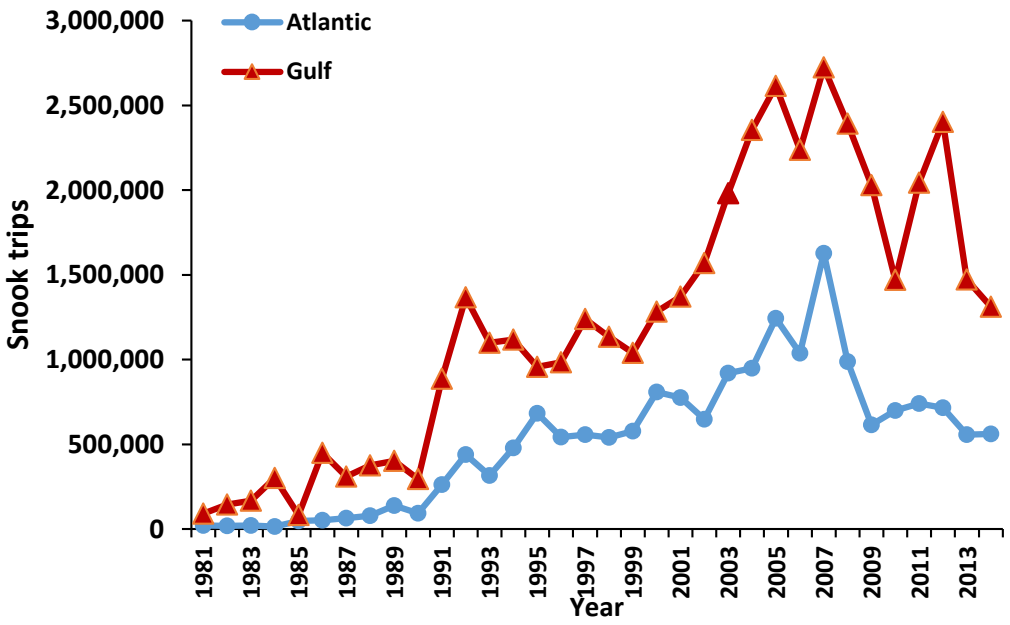


Figure 3.2.6. Percentages of snook landed and released by two-month wave and coast for 2008-14. The lines above the bars are standard deviations.

a.



b.

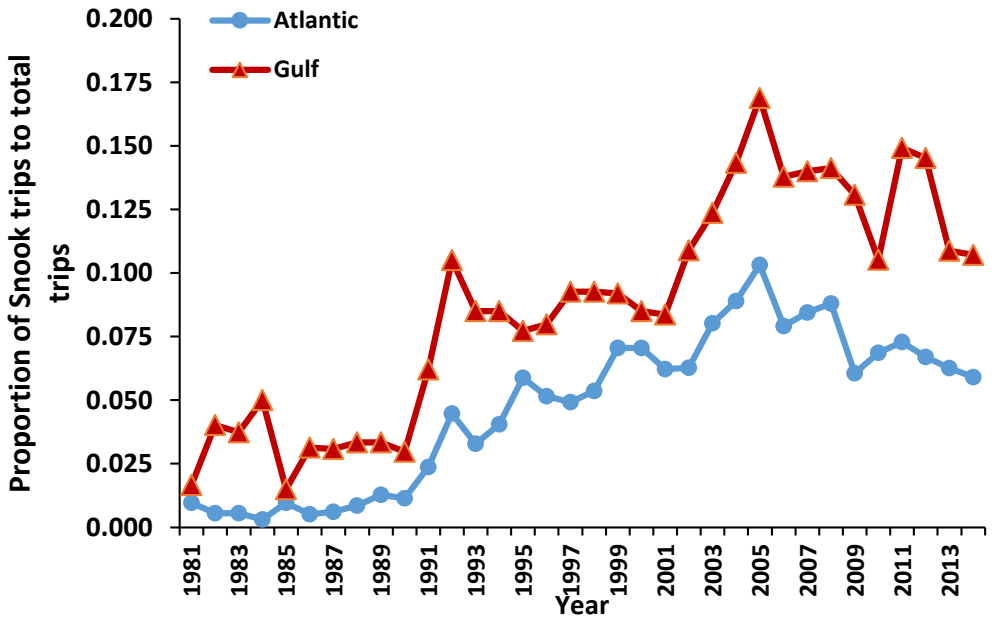


Figure 3.3.1. Estimated number of trips for snook by coast calculated by pro-rating the MRFSS/MRIP intercepts that caught or targeted Common Snook by stratum and the number of trips in the stratum (a) and the proportion of snook trips to total trips (b). These numbers were MRIP effort adjusted.

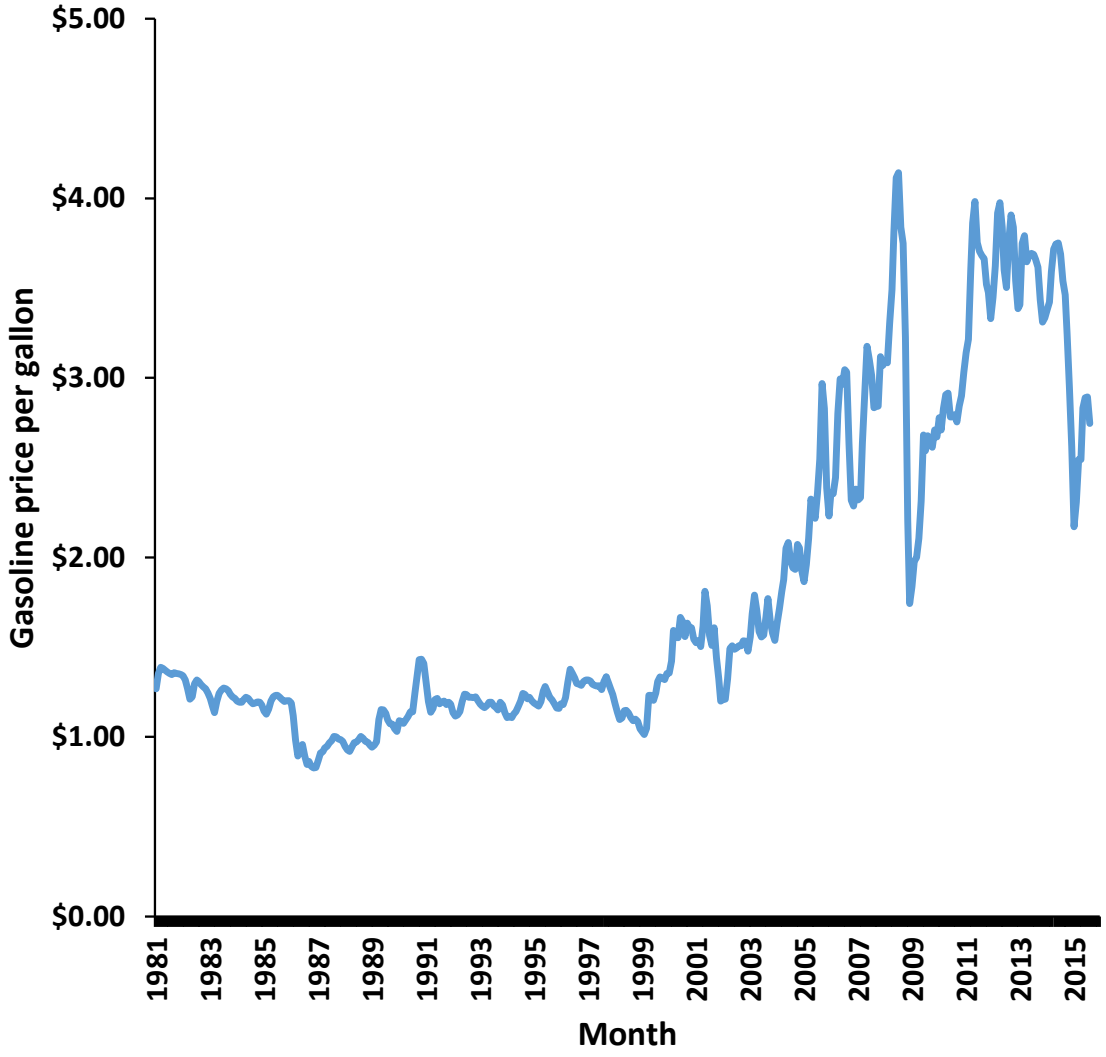
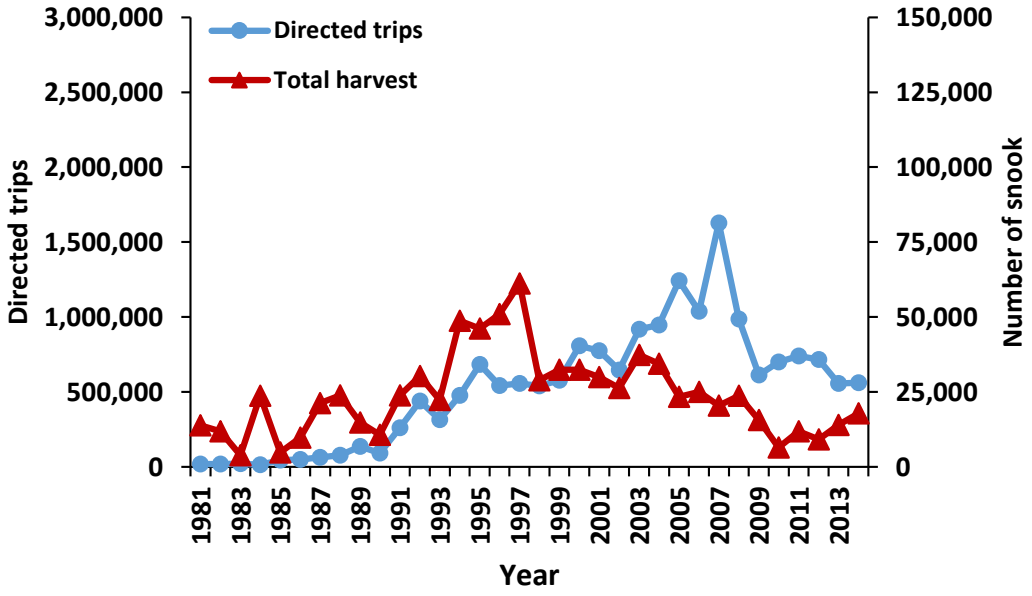


Figure 3.3.2. Average gasoline prices (all types) by month (U.S. Bureau of Labor Statistics, Consumer Price Index).

a. Atlantic



b. Gulf

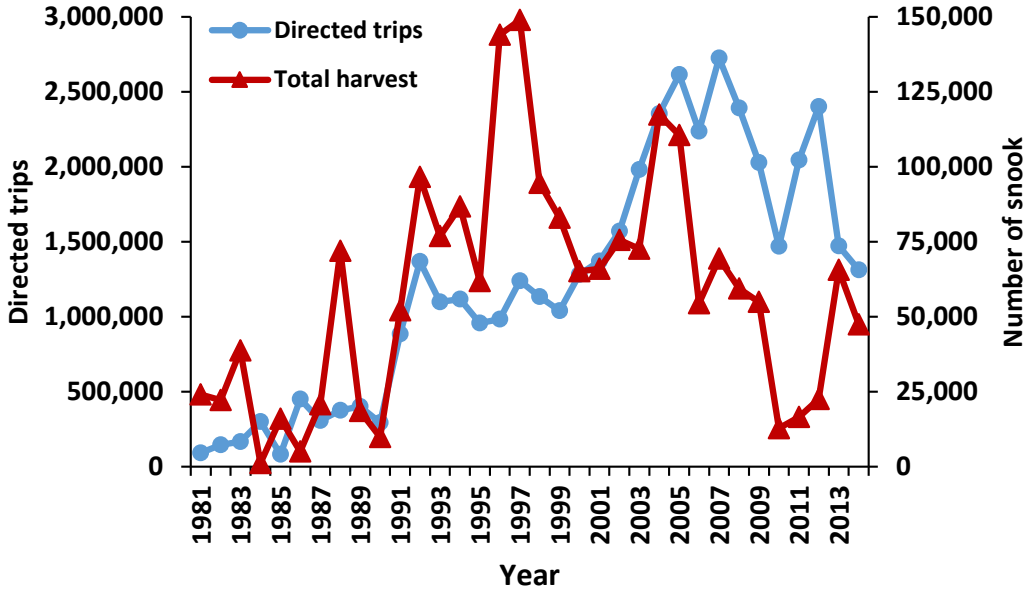
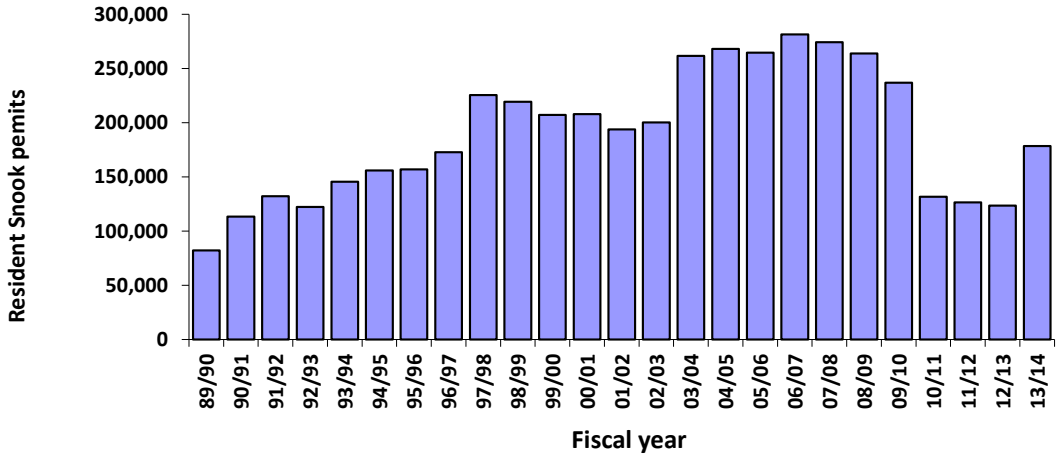
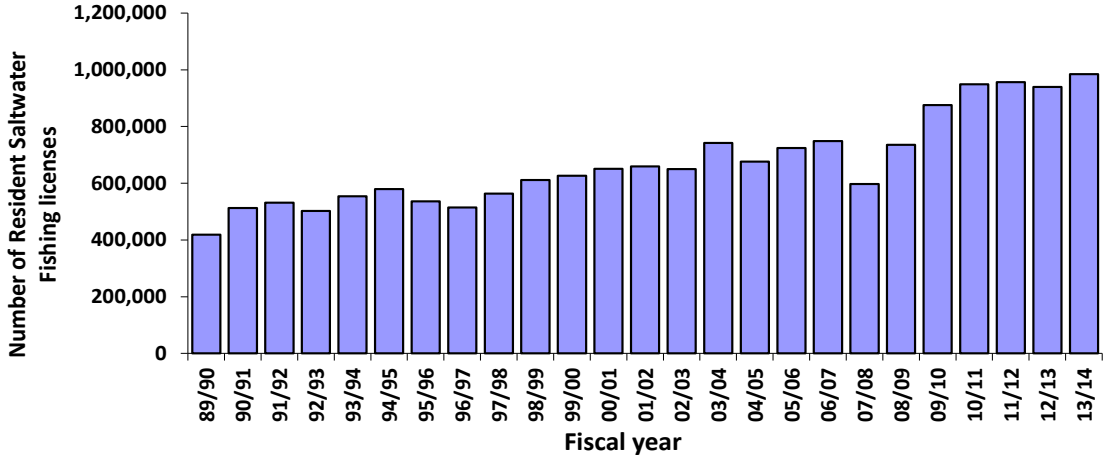


Figure 3.3.3. Total harvest of snook and the associated estimates of the number of directed snook fishing trips made during 1981–2014 by coast.

a. Statewide sales of snook permits



b. Number of resident Saltwater Fishing licenses



c. Ratio of snook stamp sales to resident license sales

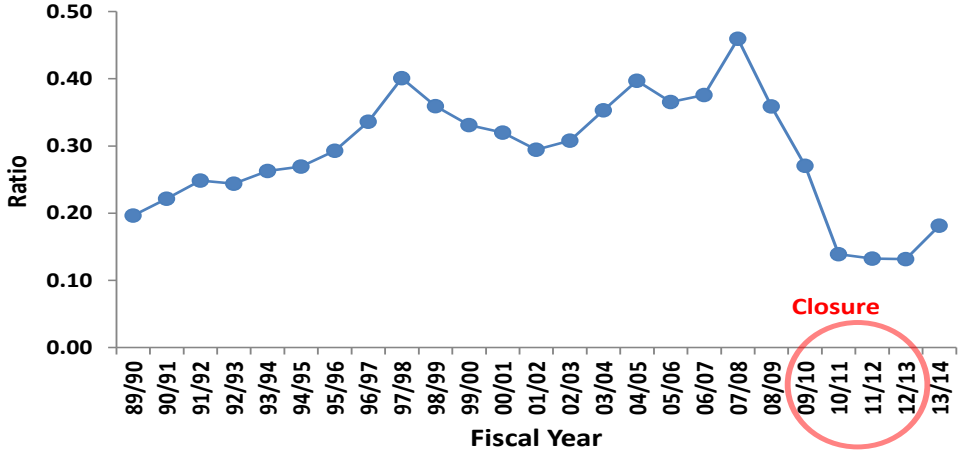
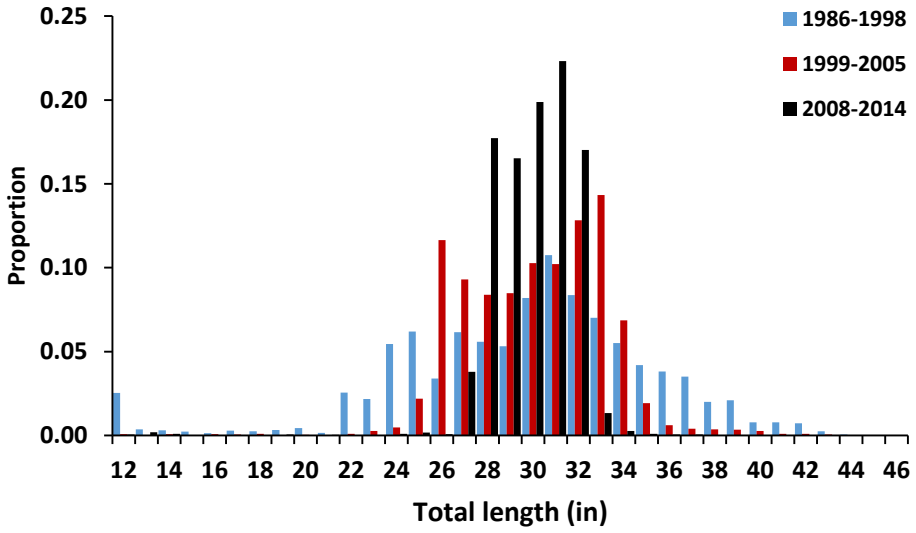


Figure 3.3.4. Statewide sales of snook permits (a), annual resident Saltwater Fishing Licenses (b), and the ratio of snook stamp sales to resident license sales (c) by fiscal year.

a. Atlantic



b. Gulf

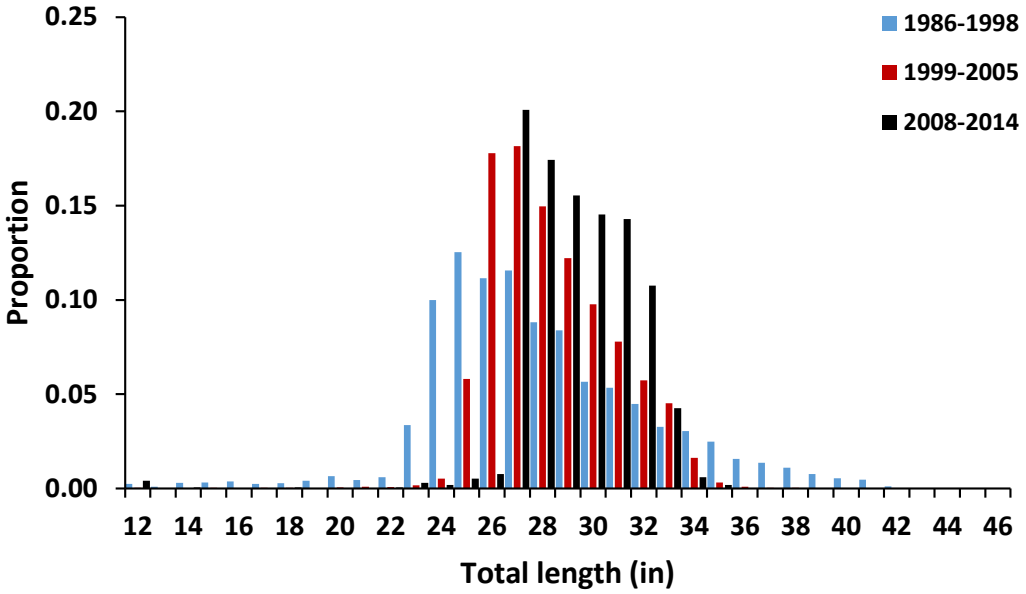
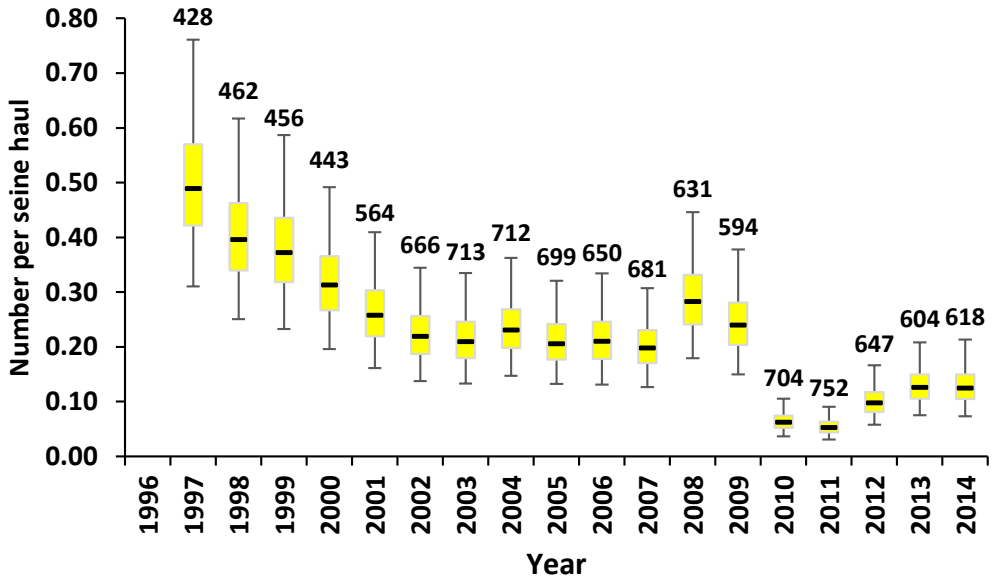


Figure 3.4.1. Total lengths of snook landed during three periods: 1986-1998, 1999-2005 and 2008–2014 by coast. Atlantic lengths were from the MRFSS/MRIP, FWRI angler interviews, and carcass drop-offs and the gulf lengths were from the MRFSS/MRIP, FWRI angler interviews, carcass drop-offs, and the Everglades National Park creel survey.

a. Atlantic



b. Gulf

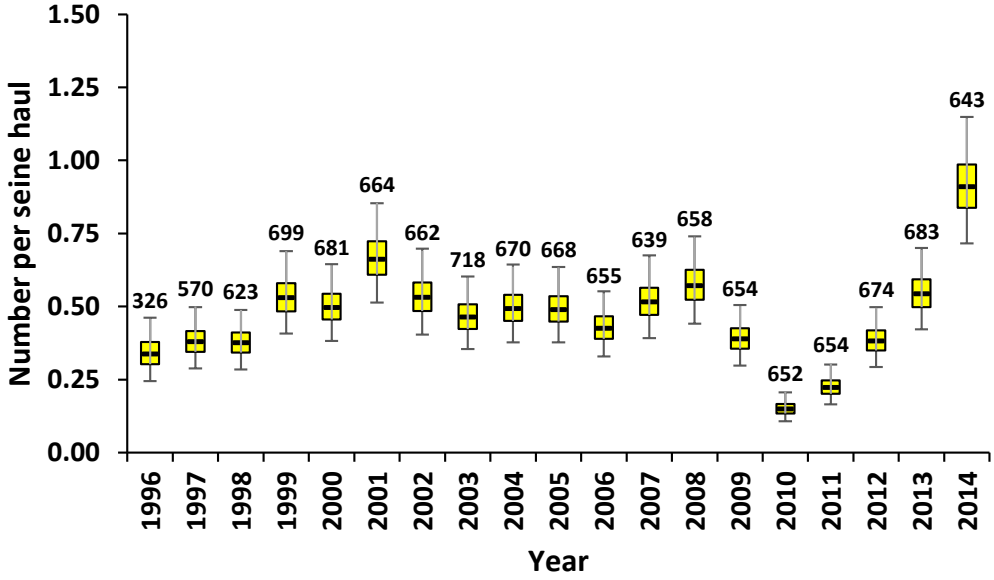
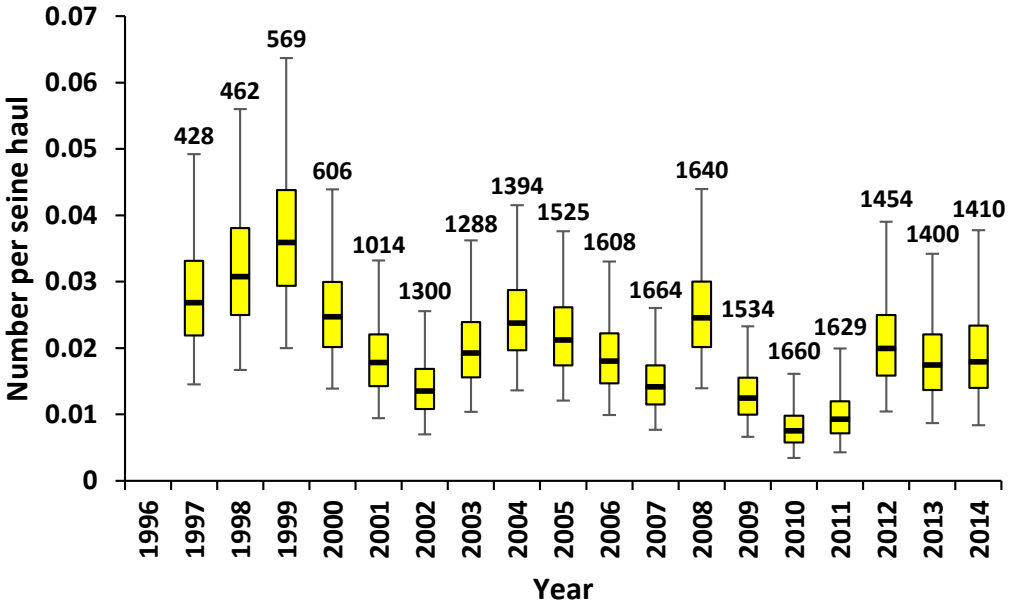


Figure 4.1.1.1. Distribution of the number of snook caught per 183-m haul seine set by year and coast. The numbers above the figures indicate the number of sets for the FIM haul seines. The horizontal lines are the medians; the boxes are the inter-quartile ranges, and the vertical lines are the 95% confidence intervals.

a Atlantic



Gulf

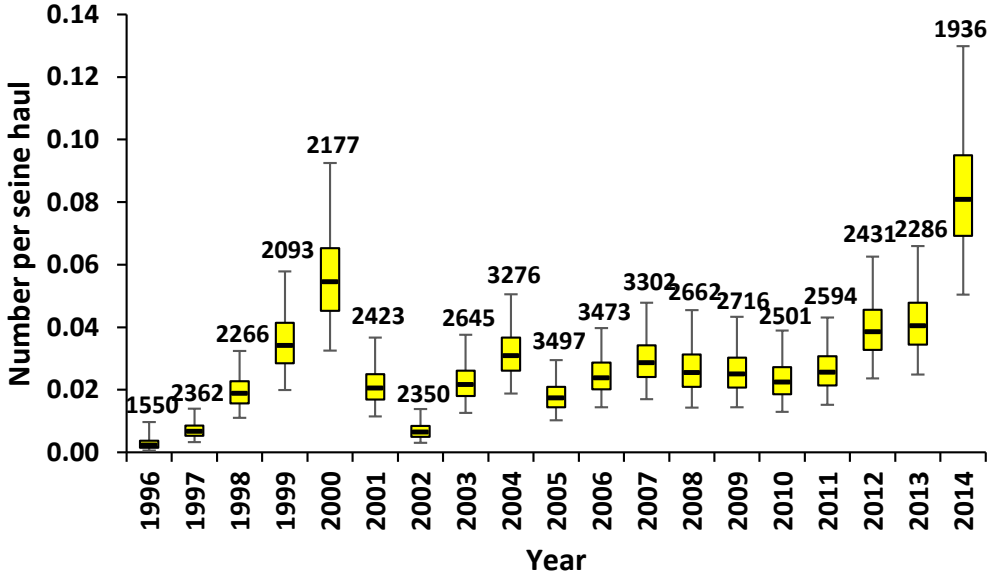
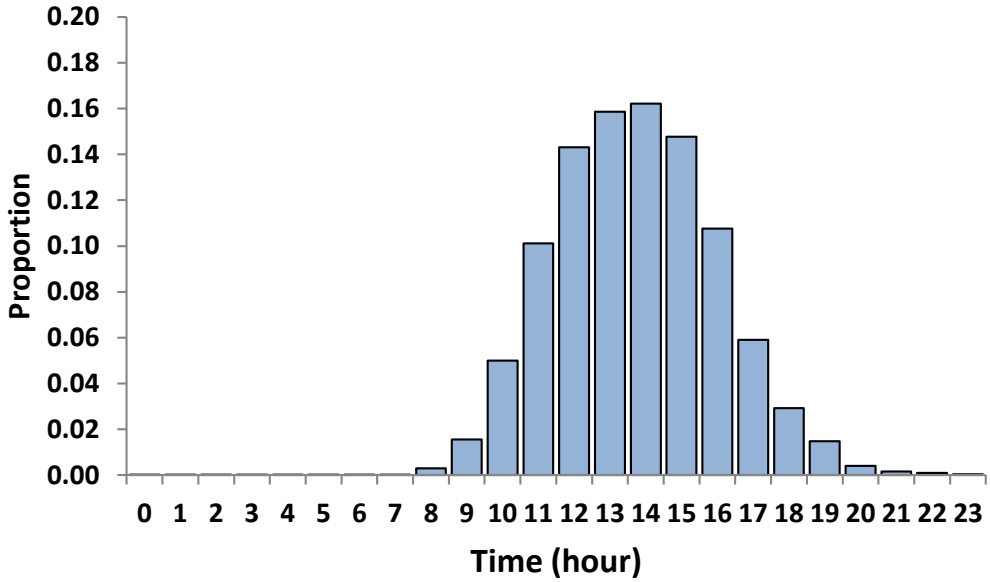


Figure 4.1.1.2. Distribution of the number of age-1 snook caught per haul seine set by coast from the FIM haul seines (21 m and 183 m). The numbers above the figures indicate the number of sets for the FIM haul seines. The horizontal lines are the medians; the boxes are the inter-quartile ranges, and the vertical lines are the 95% confidence intervals.

a.Atlantic



b.Gulf

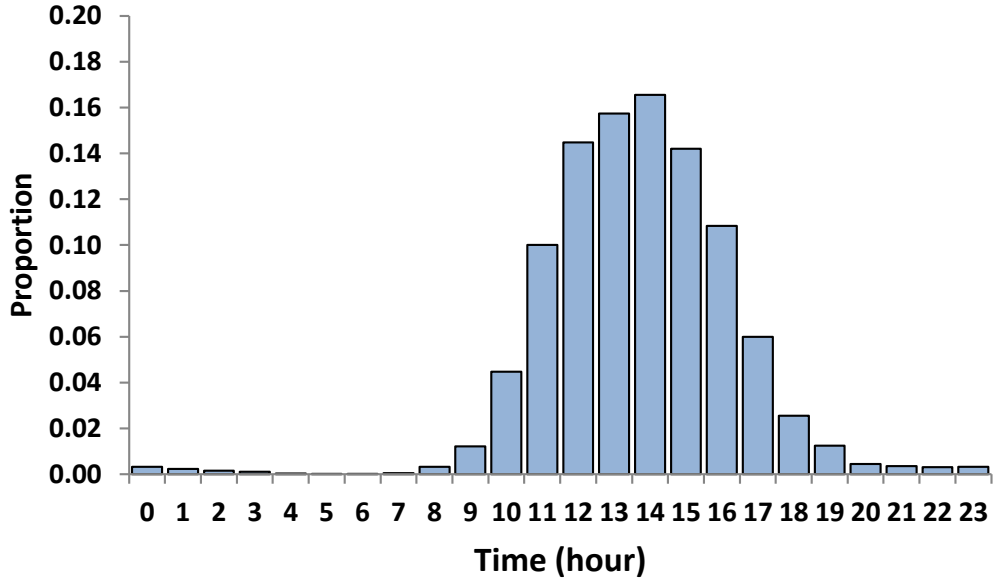
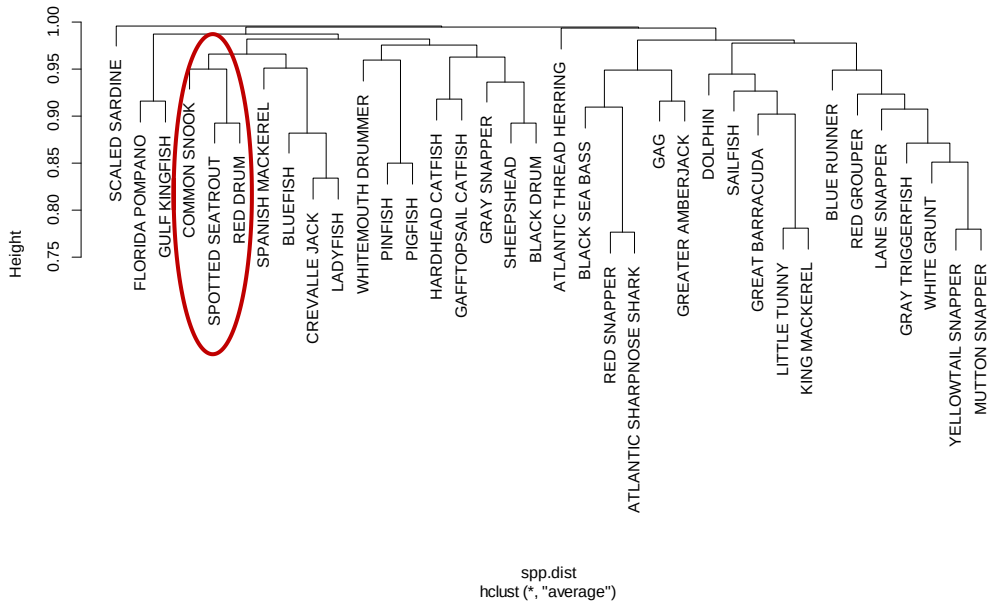


Figure 4.1.2.1. Times of day that MRFSS/MRIP intercepts were conducted by coast during the period 1999-2014.

a. Atlantic



b. Gulf

Figure 4.1.2.2. Cluster analysis of the MRFSS/MRIP (1999-2014) and Everglades National Park creel survey (1999-2014) catch data by species and coast.

c. Everglades National Park creel survey

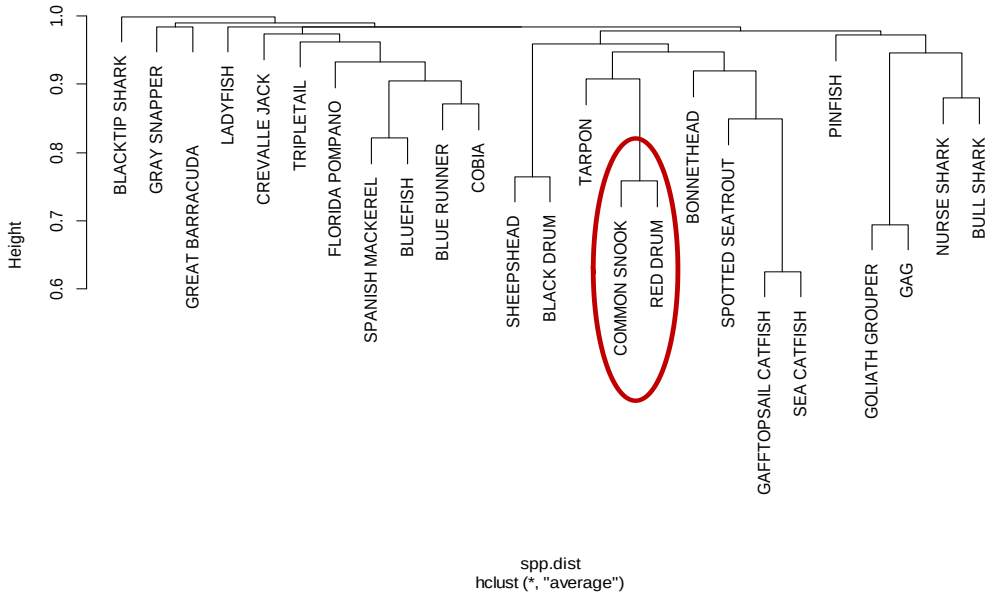
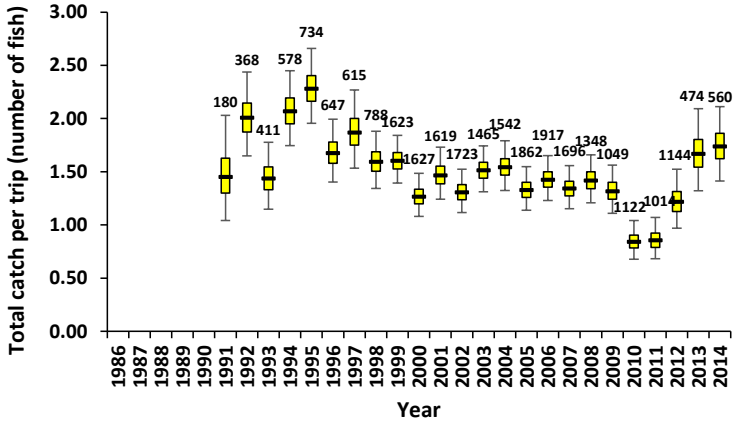
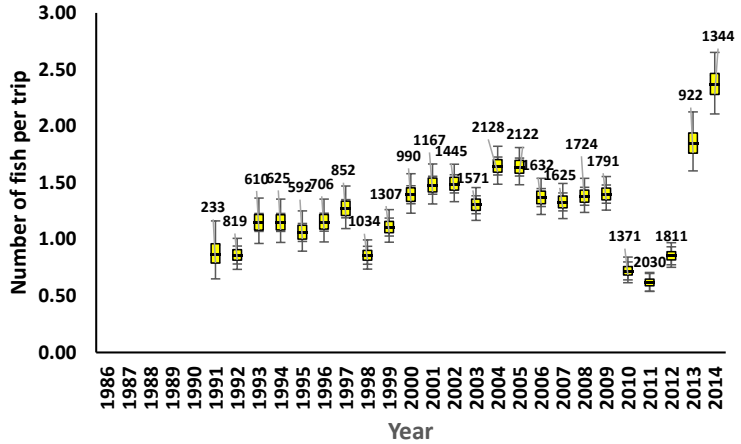


Figure 4.1.2.2 continued. Cluster analysis of the MRFSS/MRIP (1999-2014) and Everglades National Park creel survey (1999-2014) catch data by species and coast.

a. MRFSS/MRIP Atlantic



b. MRFSS/MRIP Gulf



c. Everglades National Park

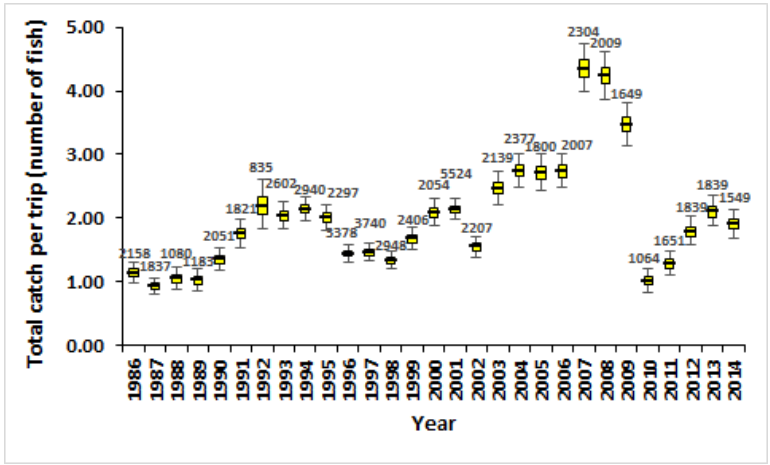
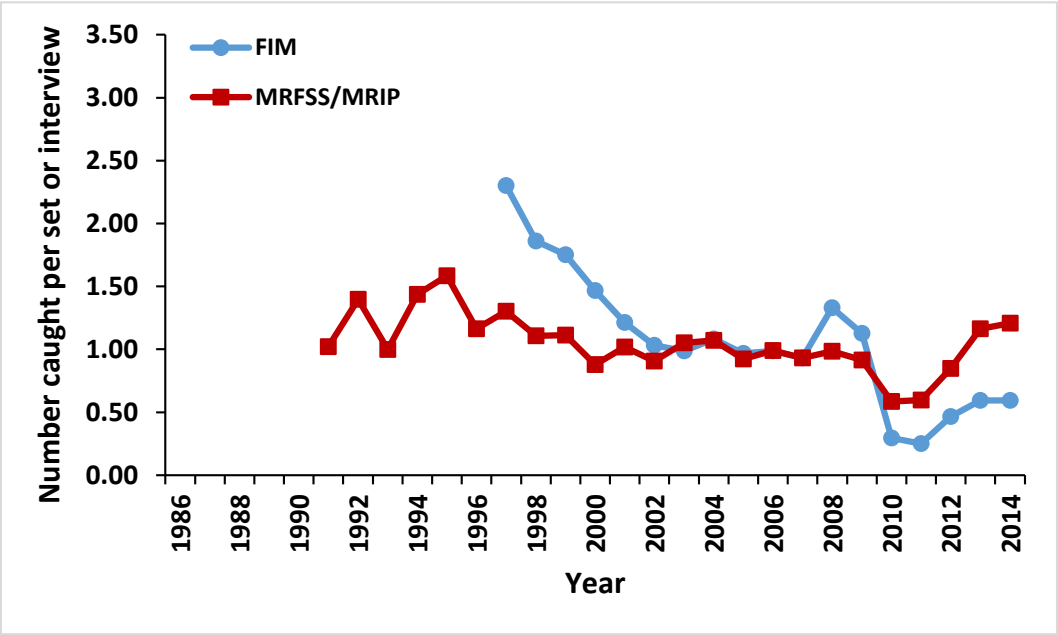


Figure 4.1.2.3. Fishery dependent tuning indices from the MRFSS/MRIP and Everglades National Park. The numbers above the figures indicate the number of intercepts, the horizontal lines are the medians; the boxes are the inter-quartile ranges, and the vertical lines are the 95% confidence intervals.

a.Atlantic



b.Gulf

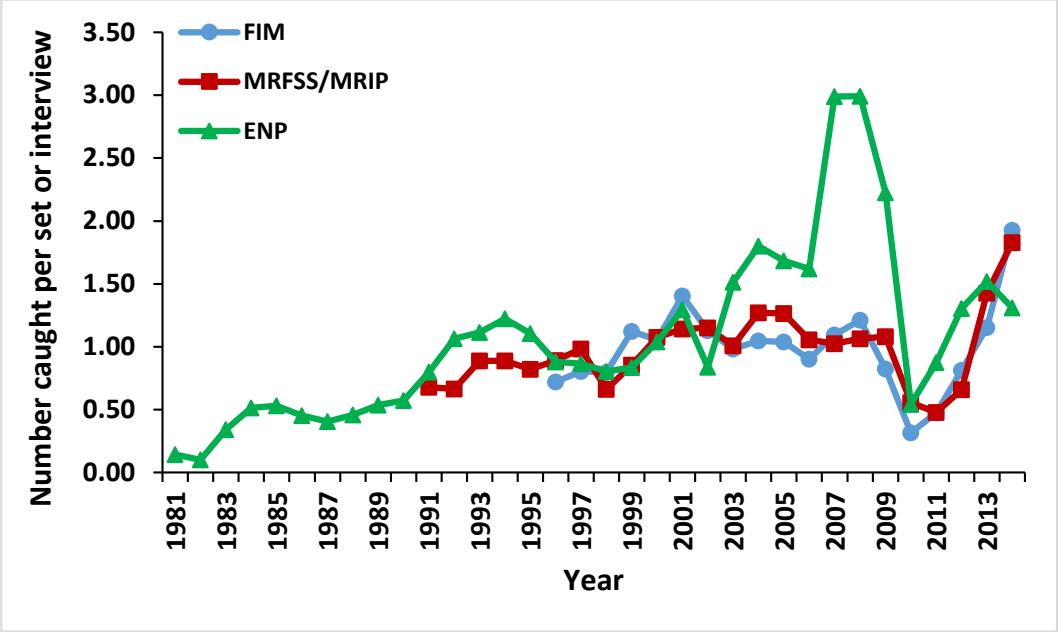
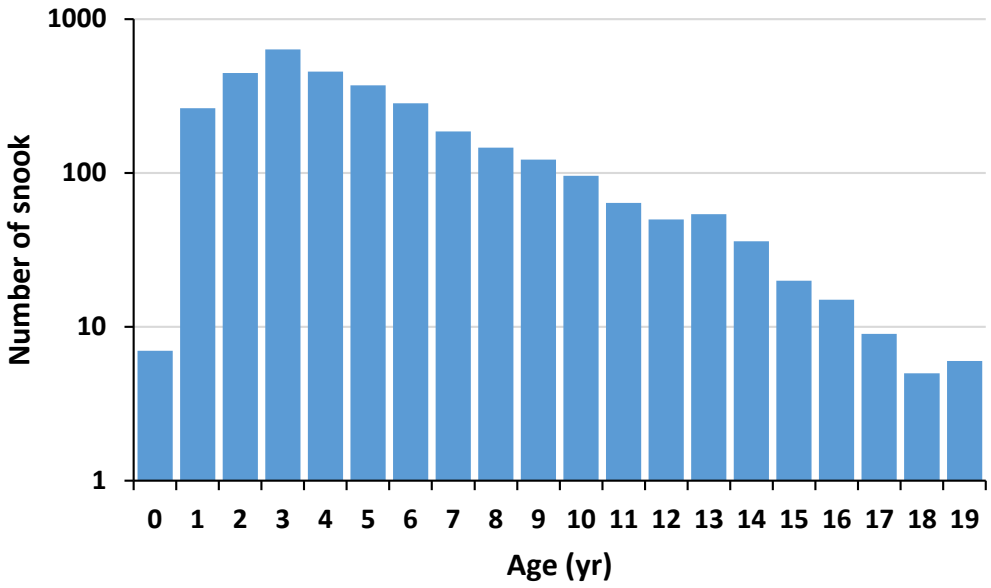


Figure 4.1.3. Comparison of fishery-independent (FIM) and fishery-dependent indices (MRFSS/MRIP and Everglades National Park creel survey (ENP) by coast and year.

a. Atlantic



b. Gulf

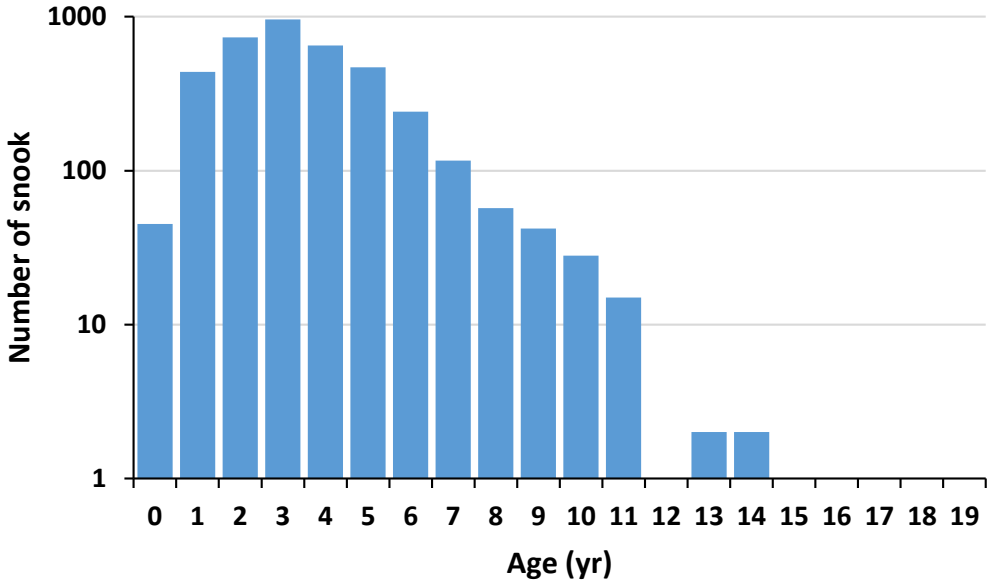


Figure 4.2.1.4. Numbers of snook at age by coast caught in FIM 21-m and 183-m haul seines during the period 2008-2014. Note that the vertical axes are on a logarithmic scale.

a. Atlantic

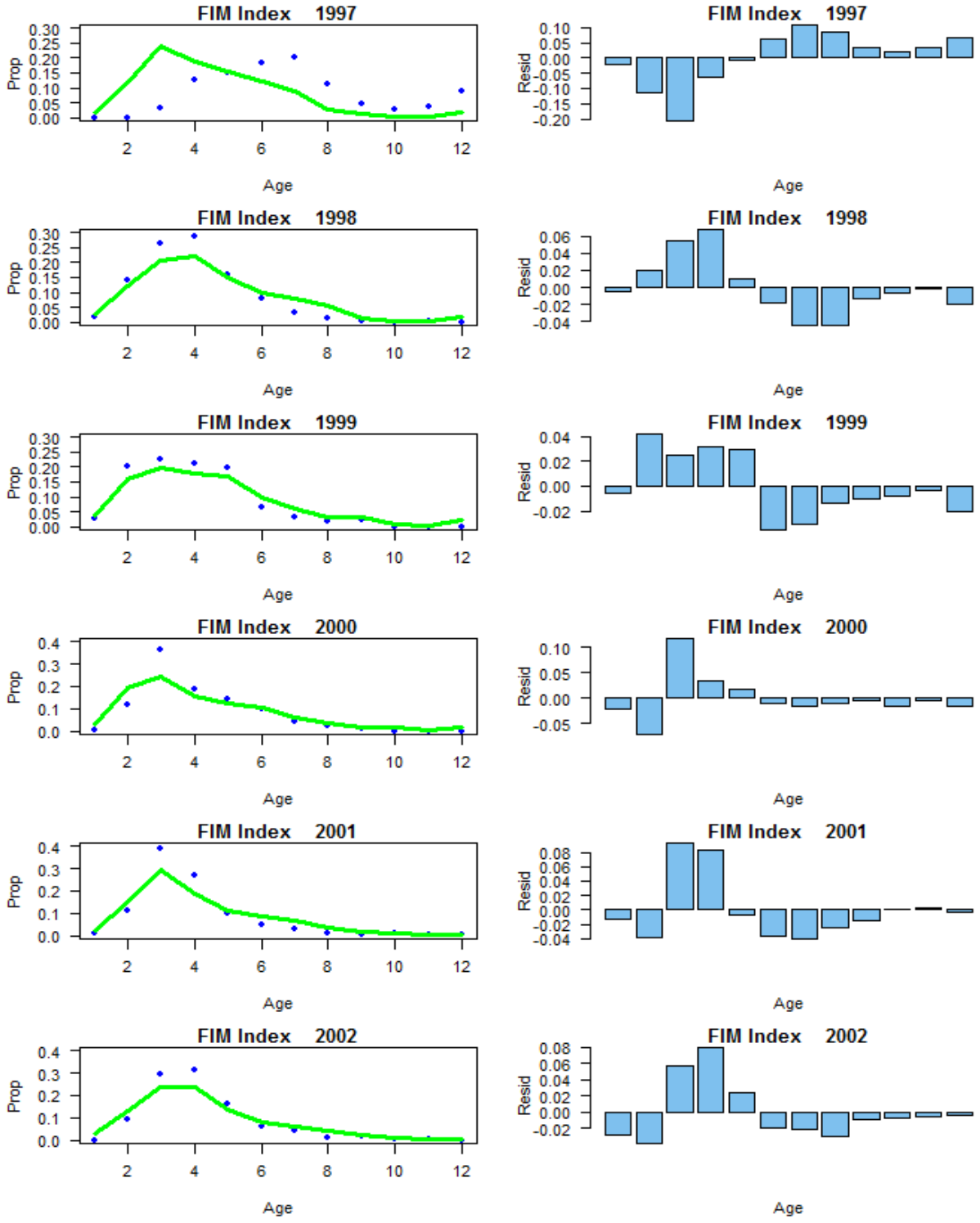


Figure 4.2.2.4.1.1. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

a. Atlantic

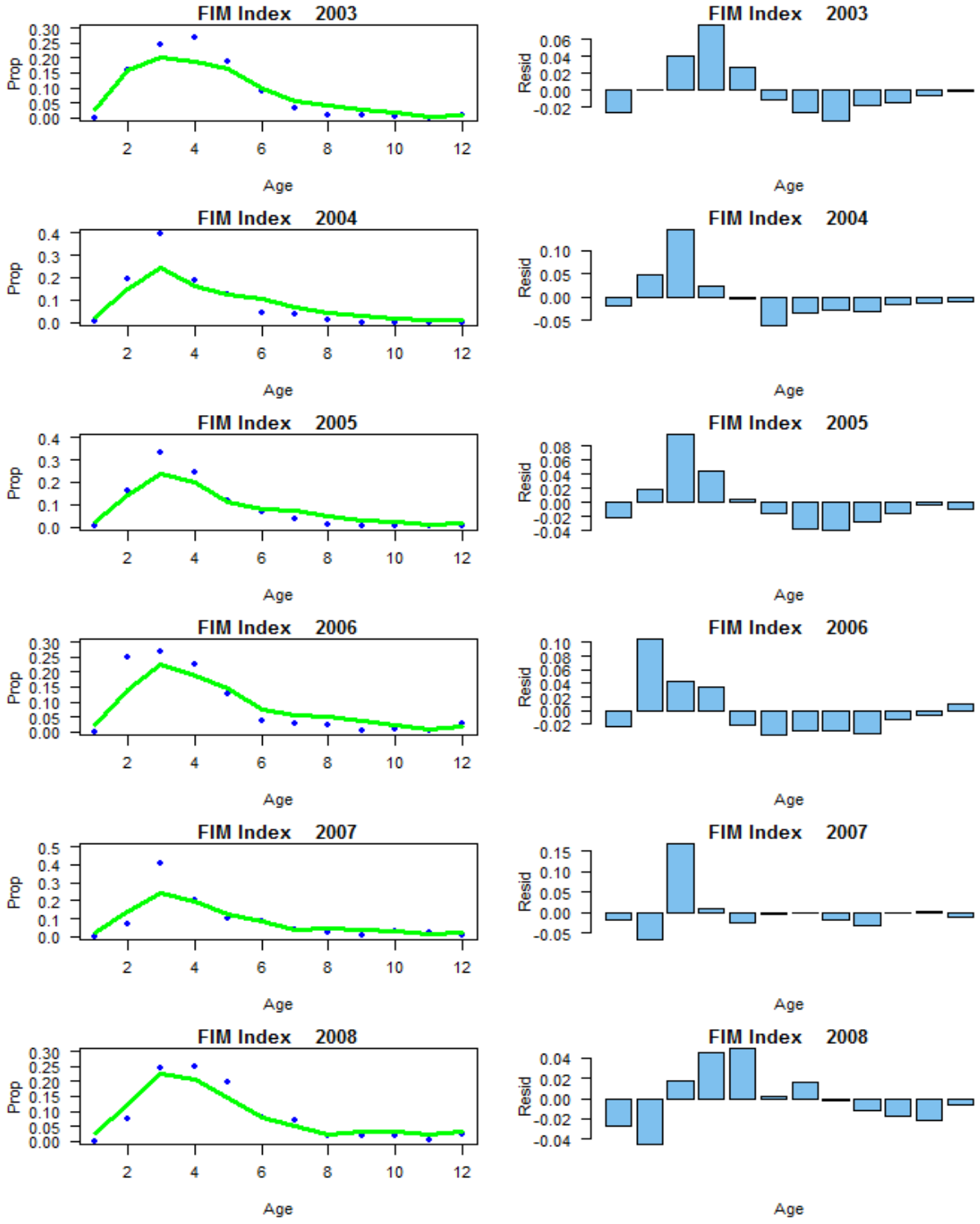


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

a. Atlantic

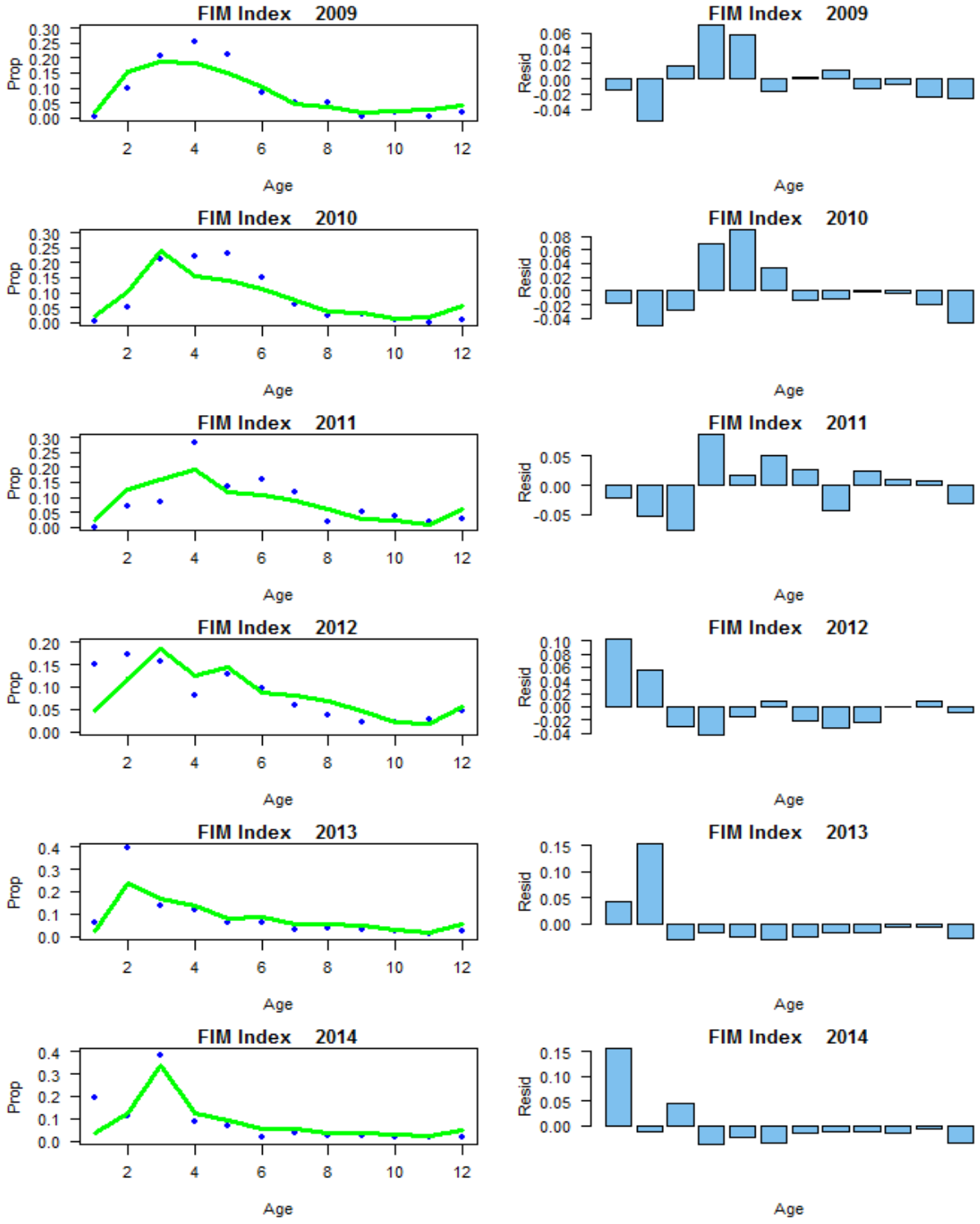


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

a. Atlantic

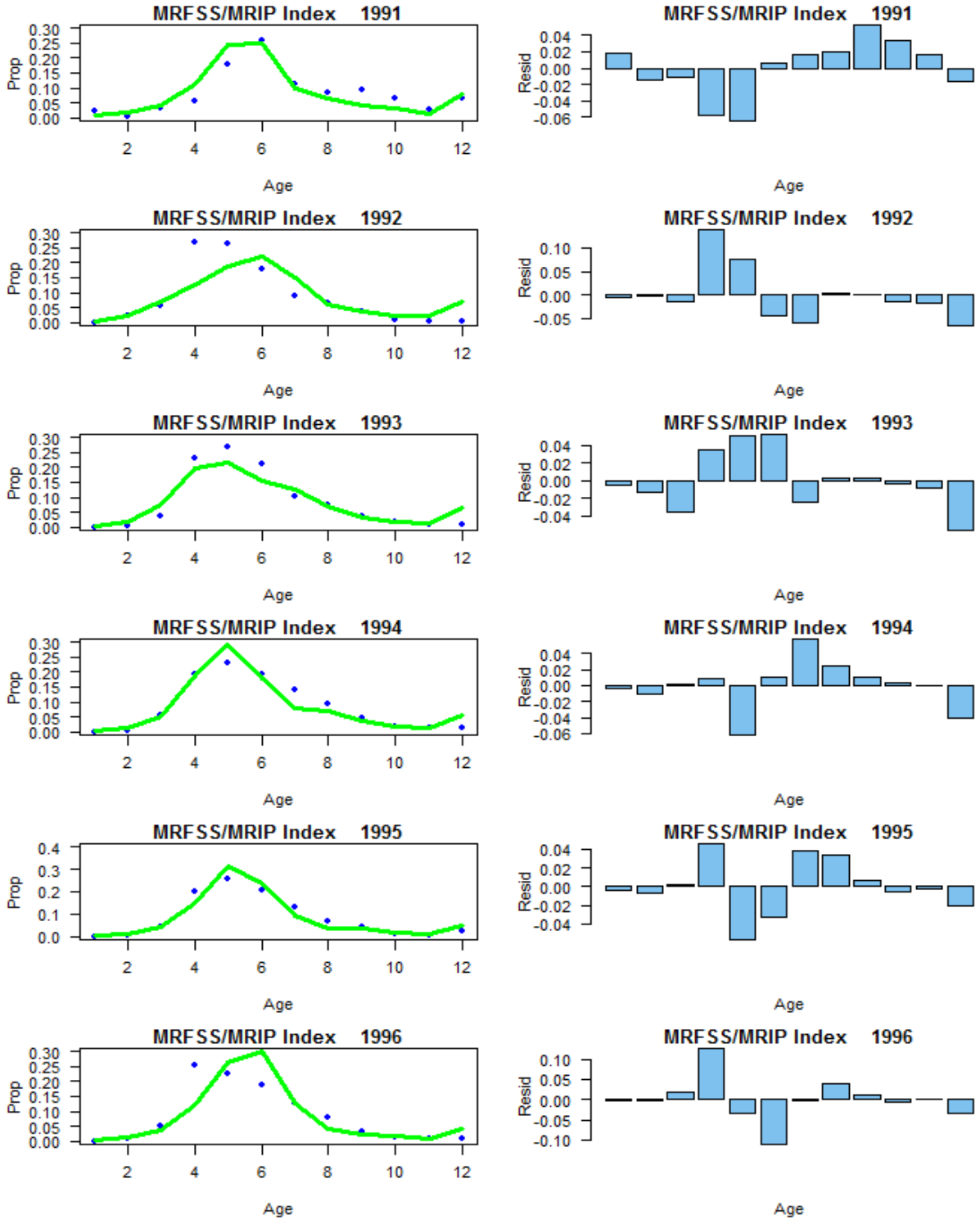


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

a. Atlantic

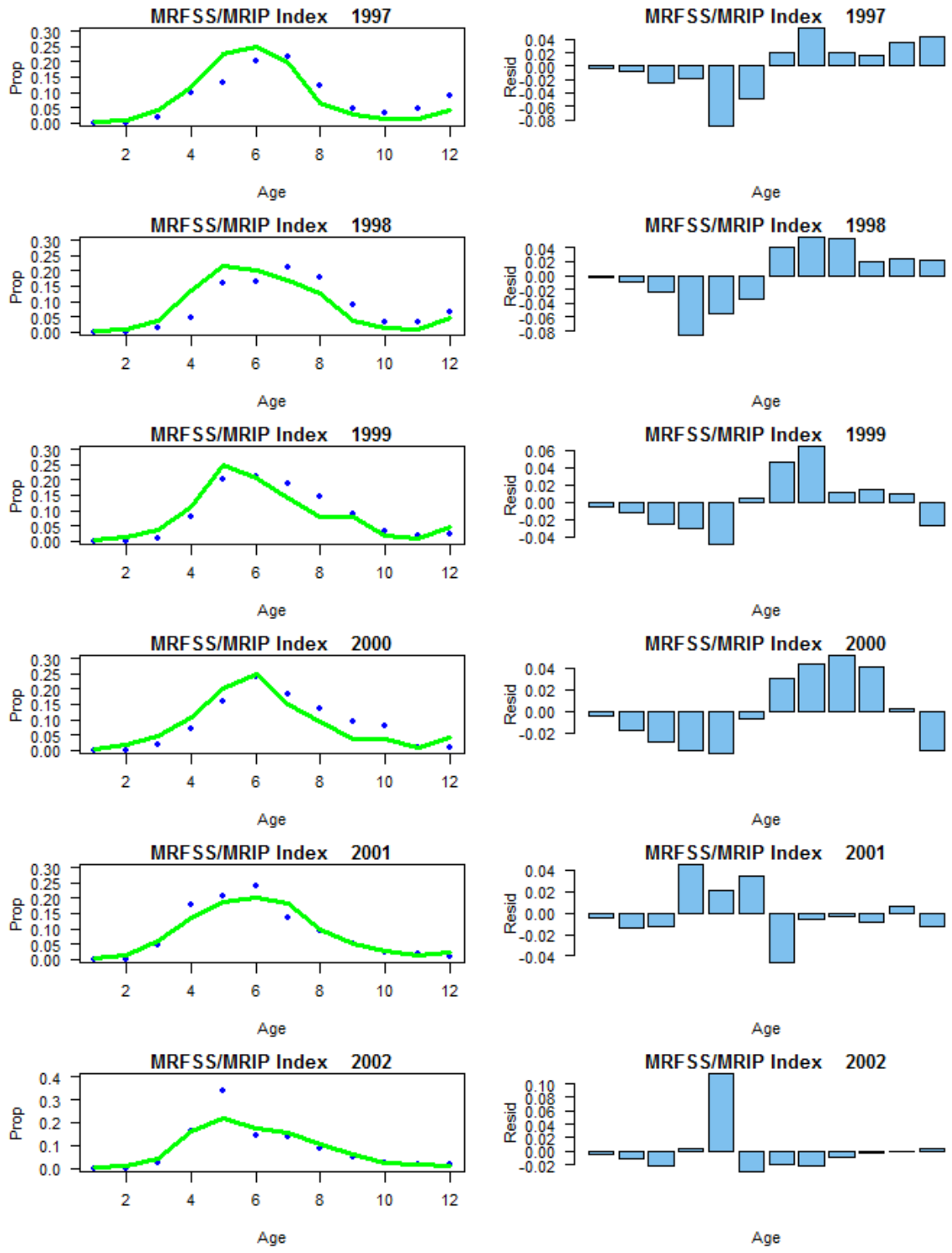


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

a. Atlantic

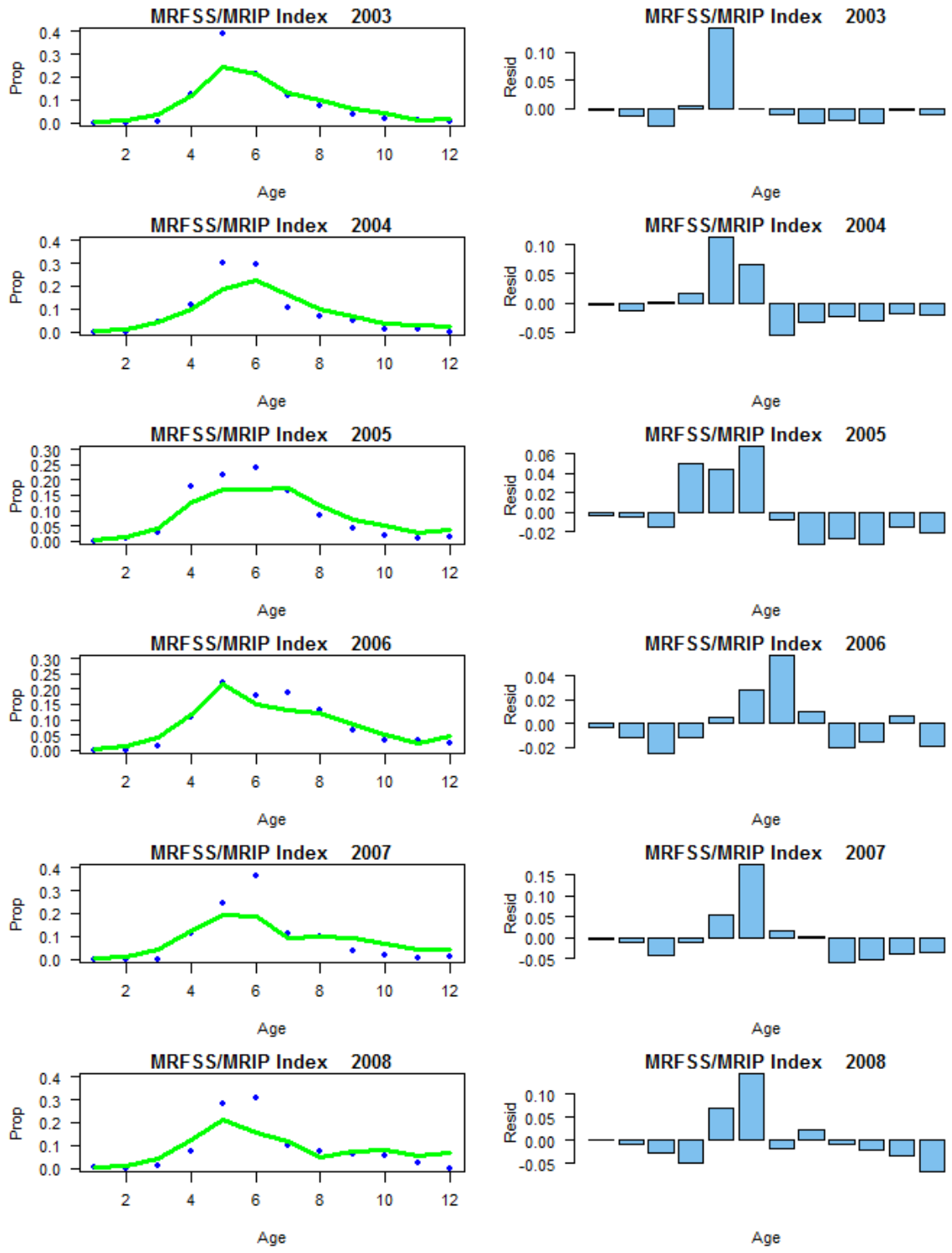


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

a. Atlantic

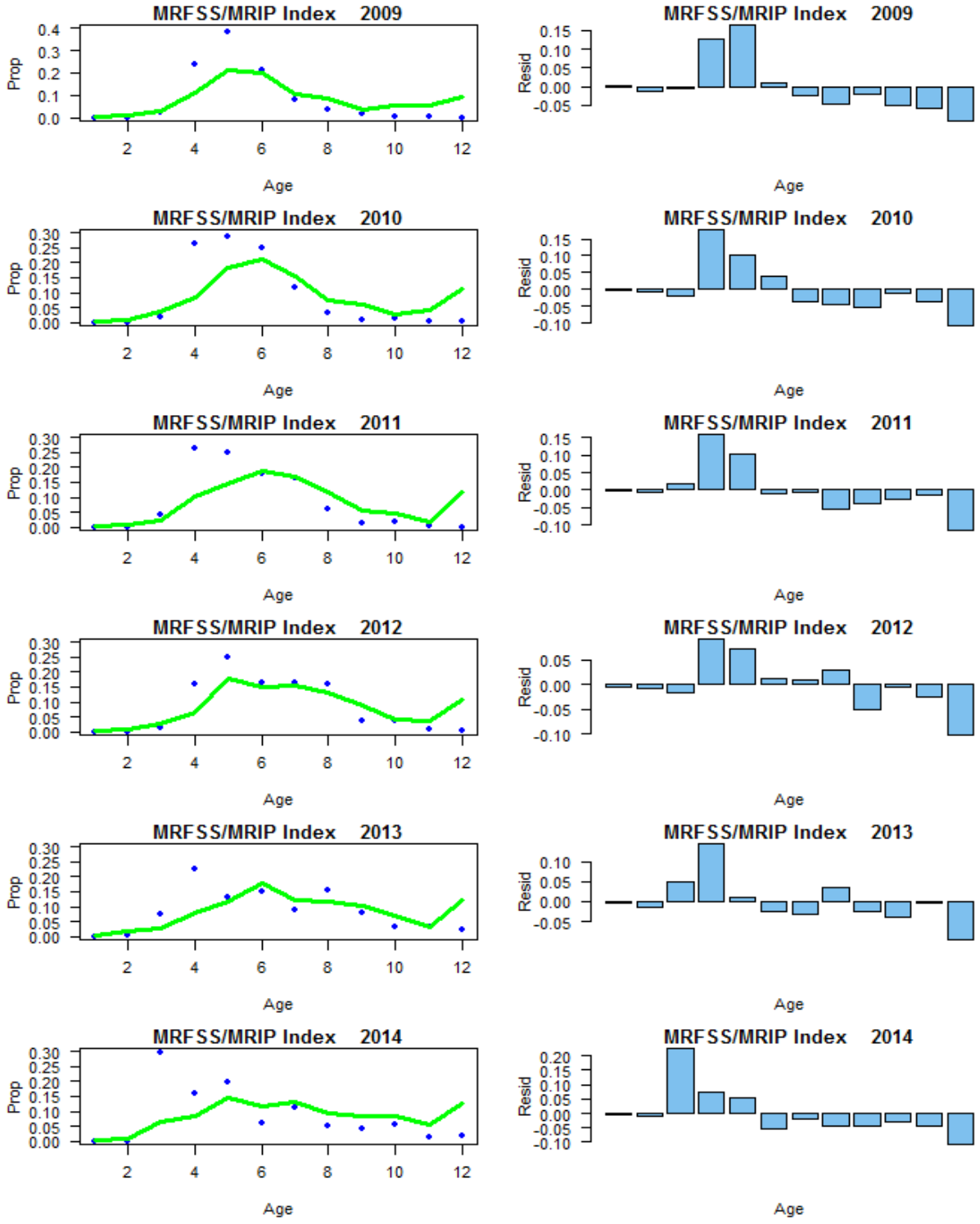


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

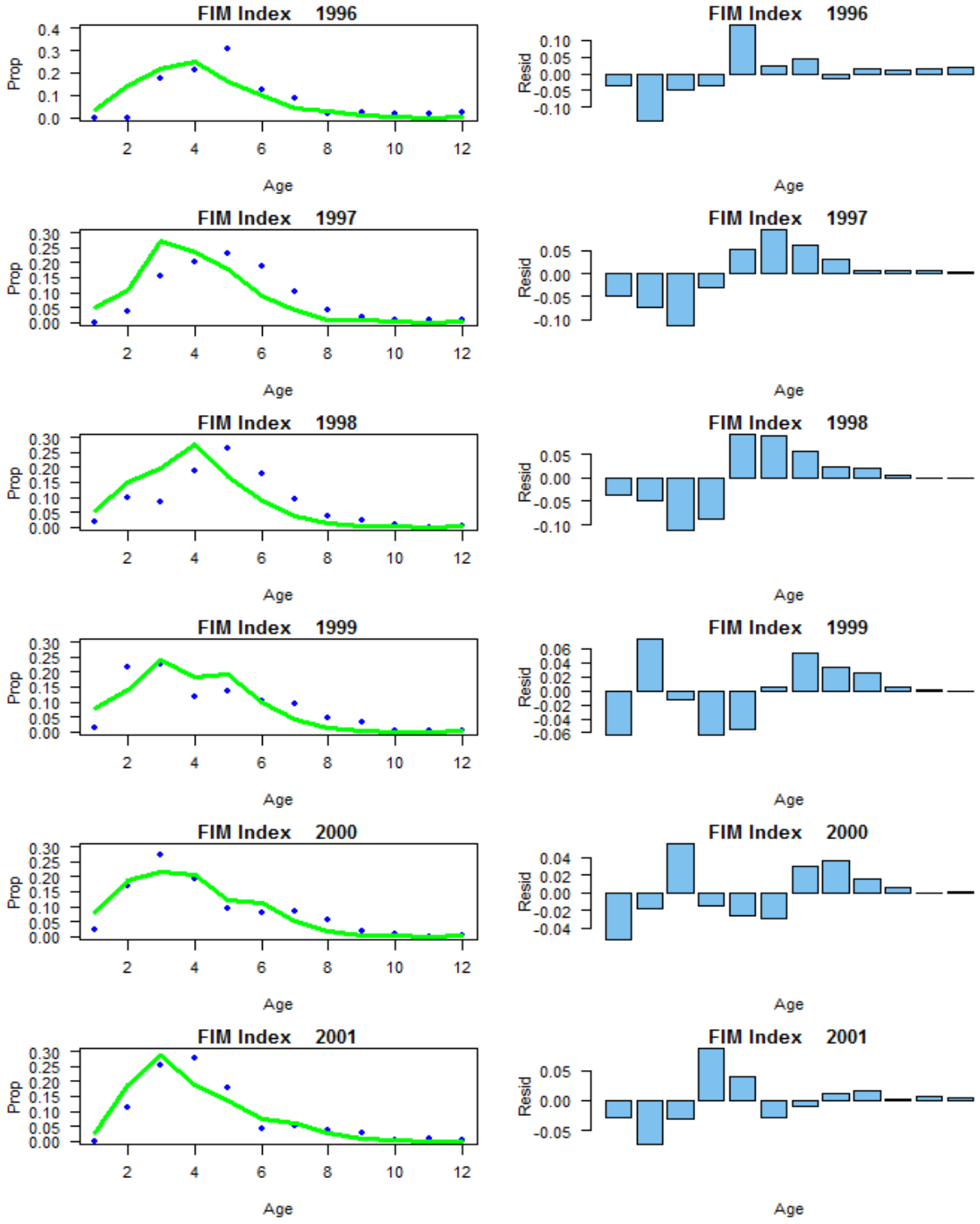


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

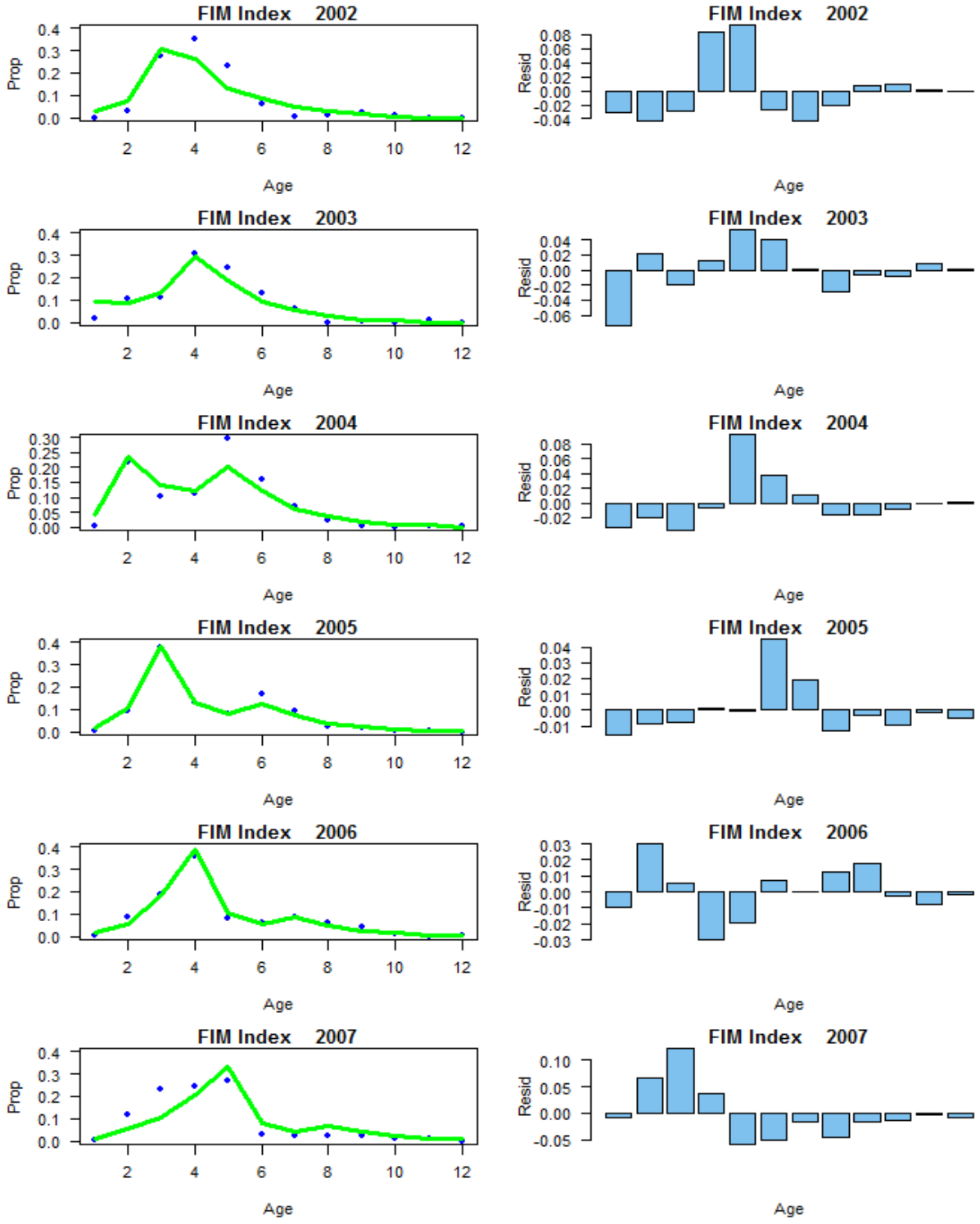


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

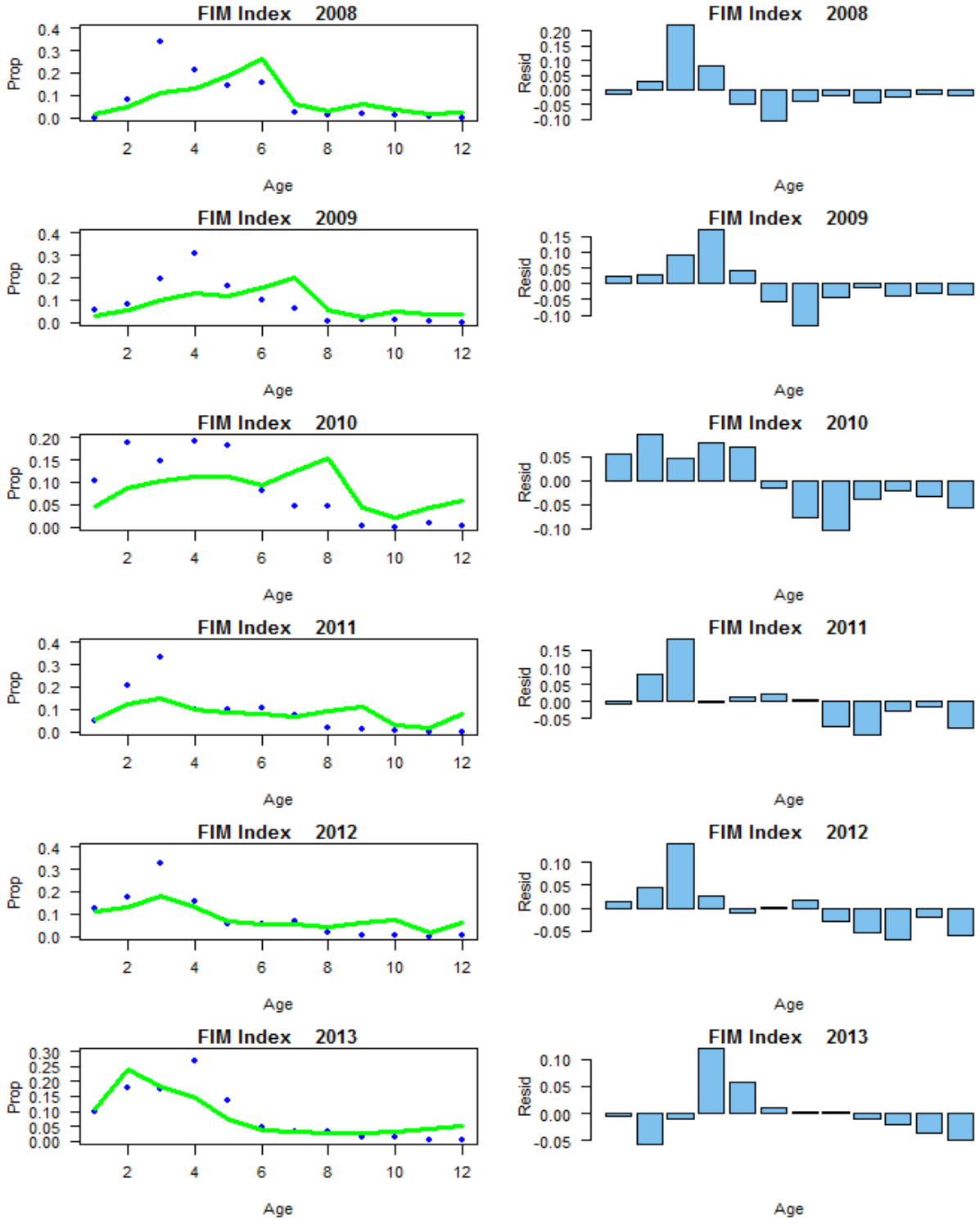


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

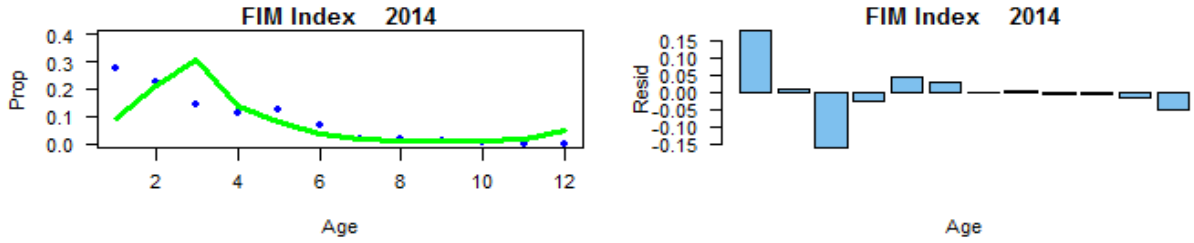


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

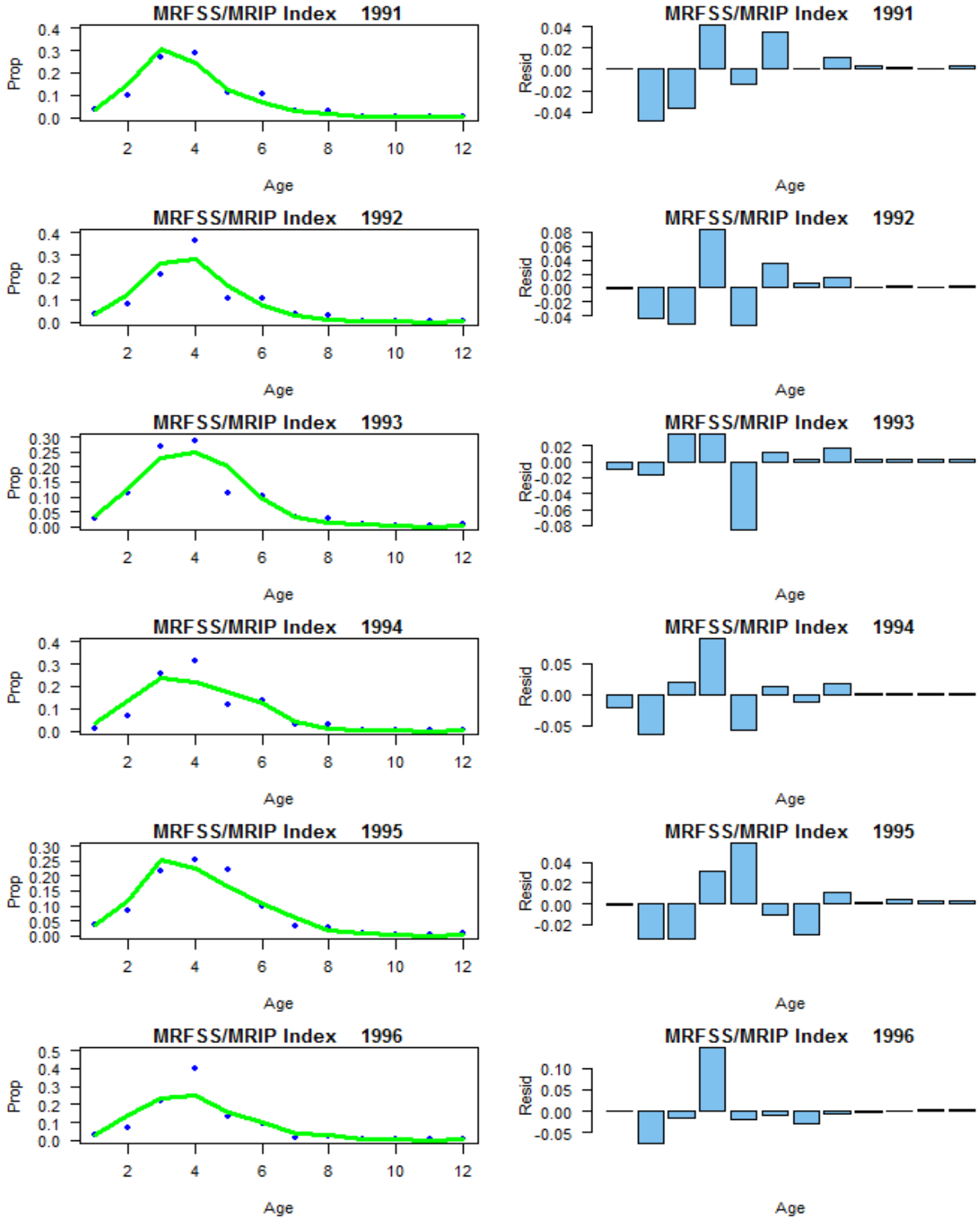


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

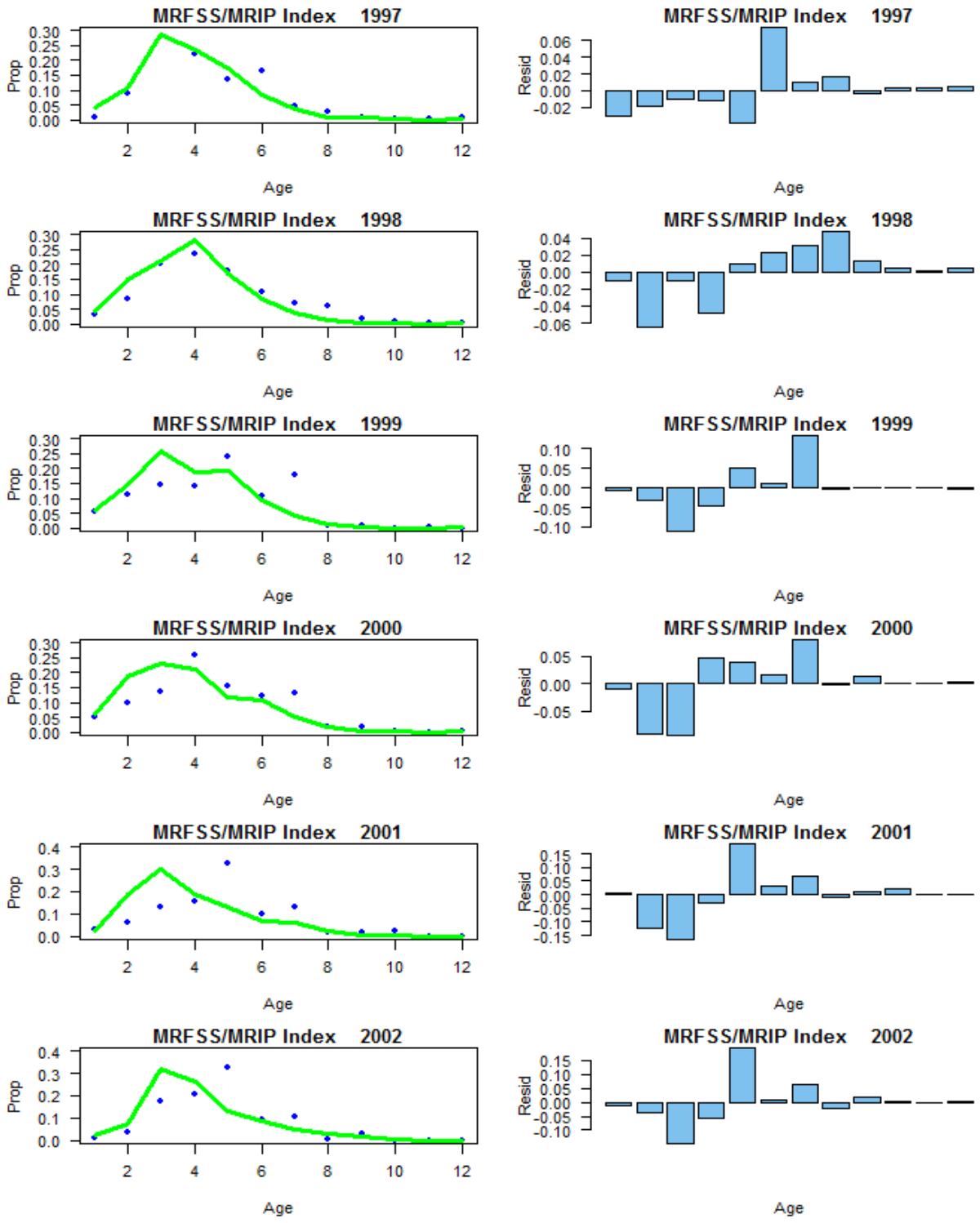


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

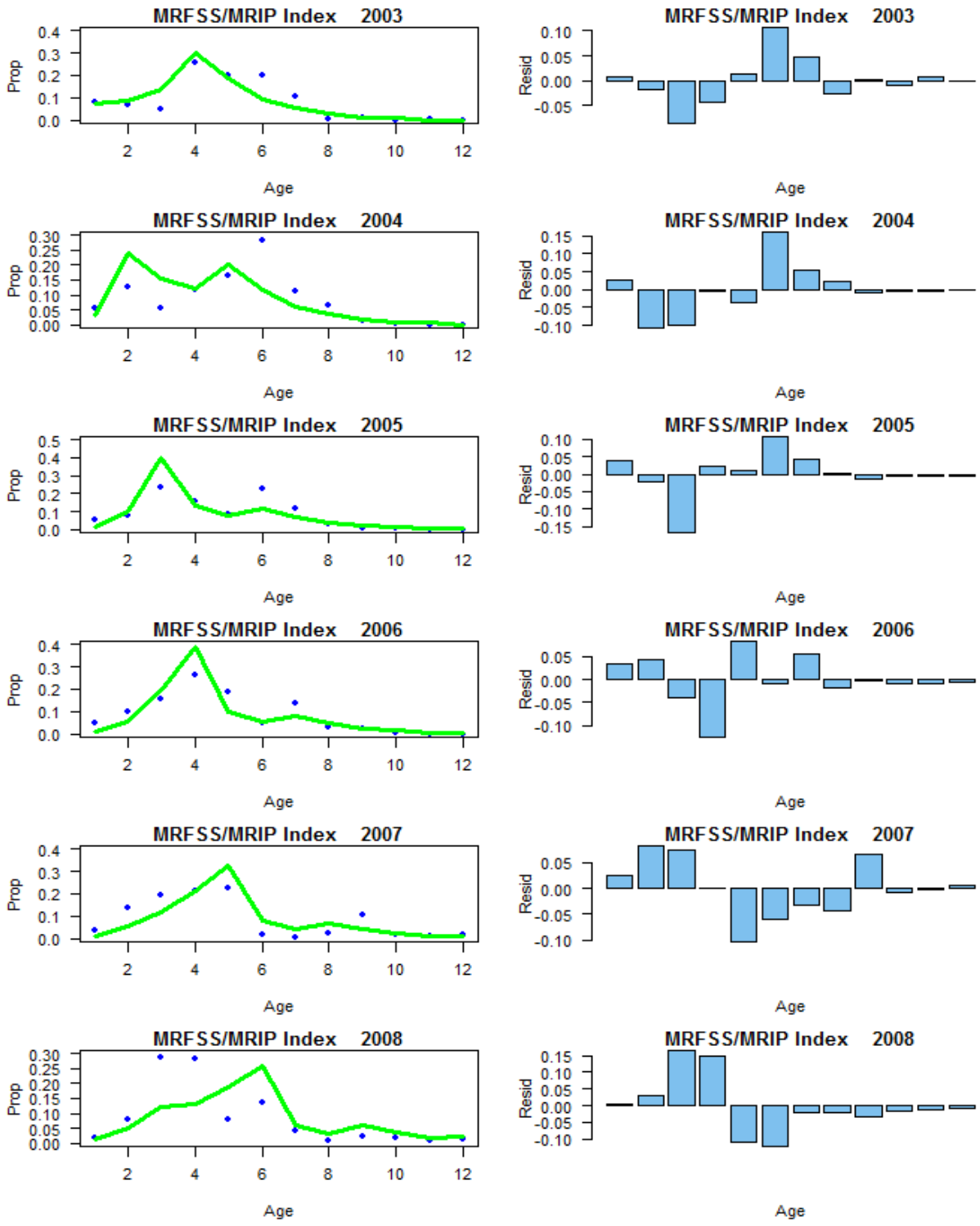


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

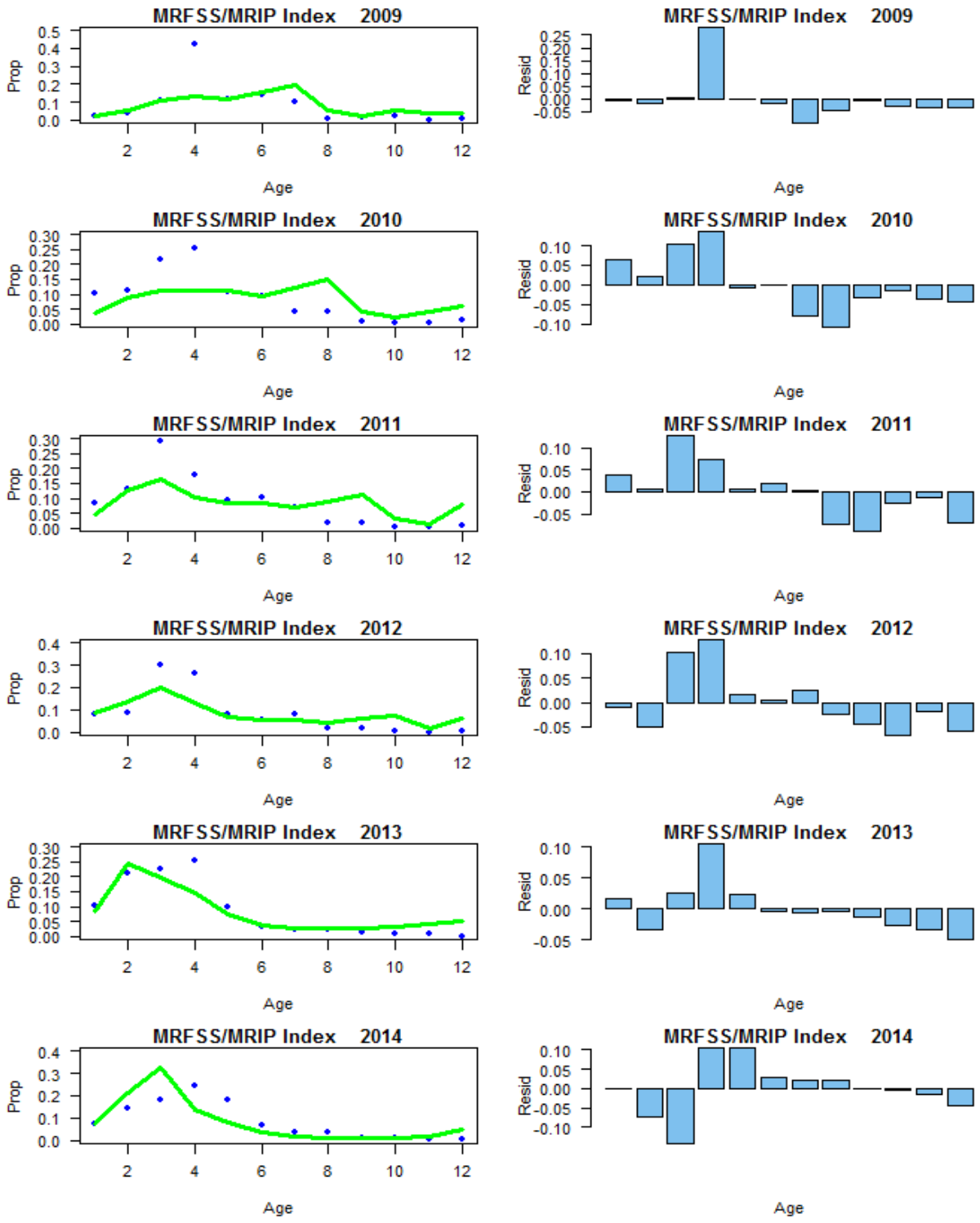


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

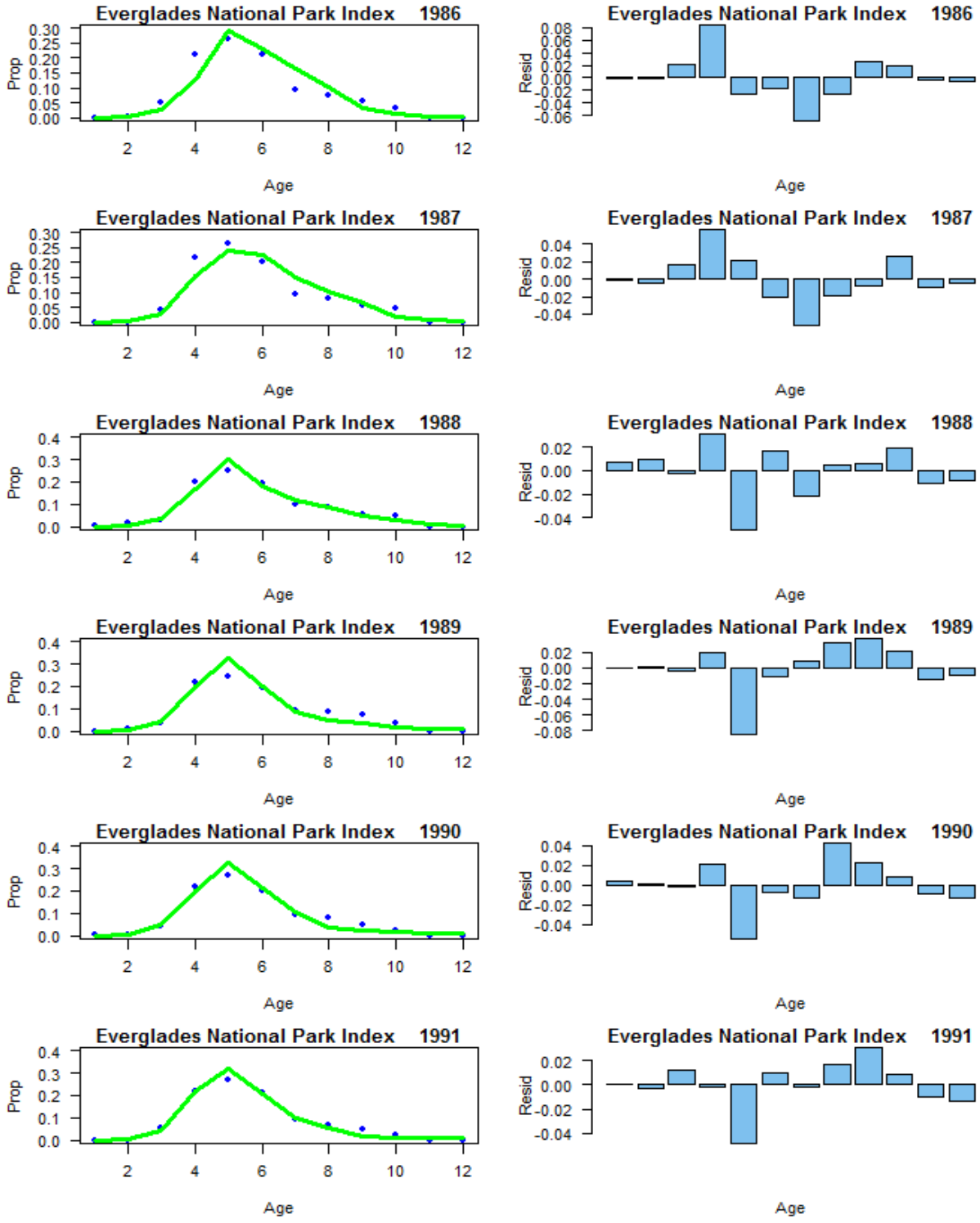


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

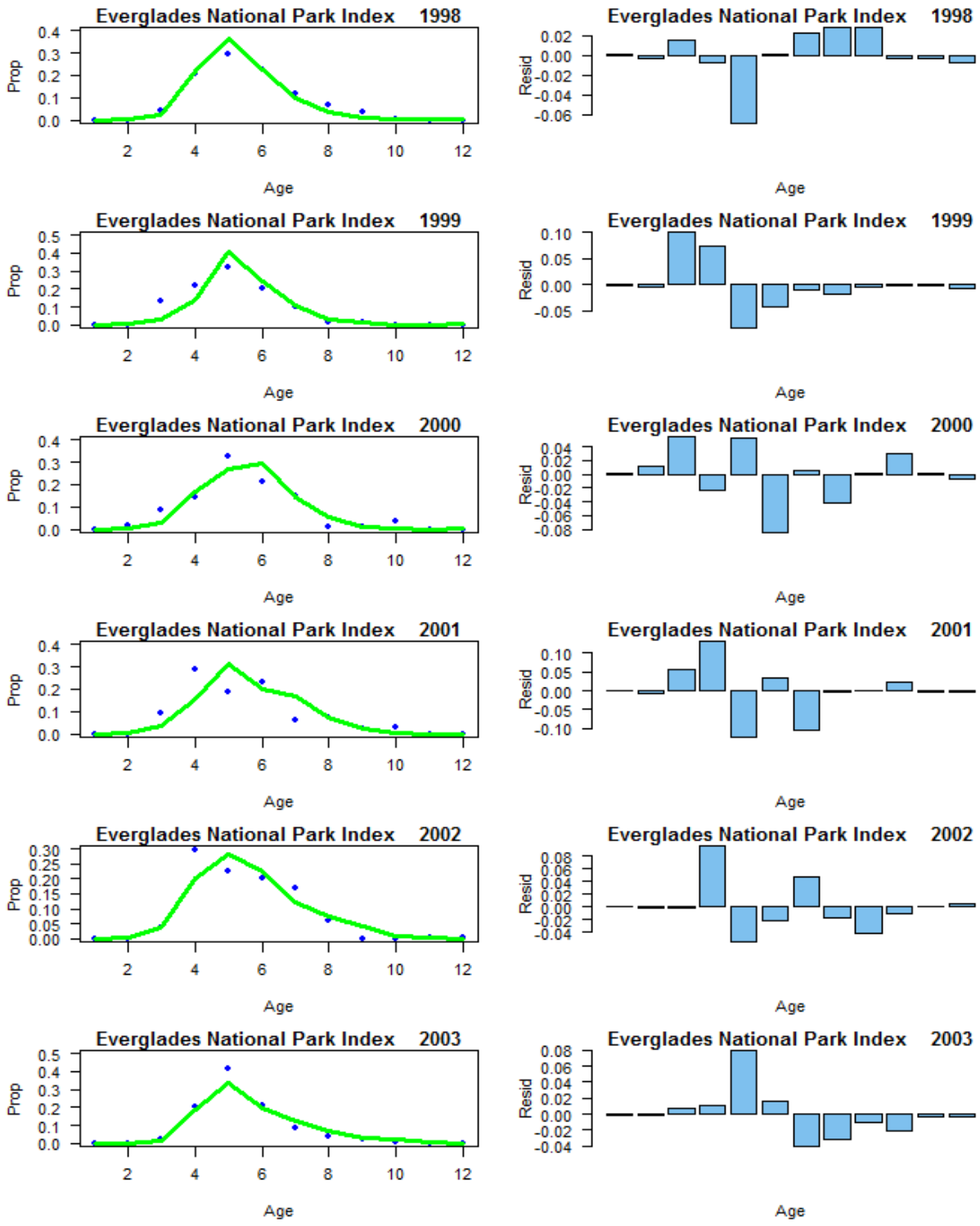


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

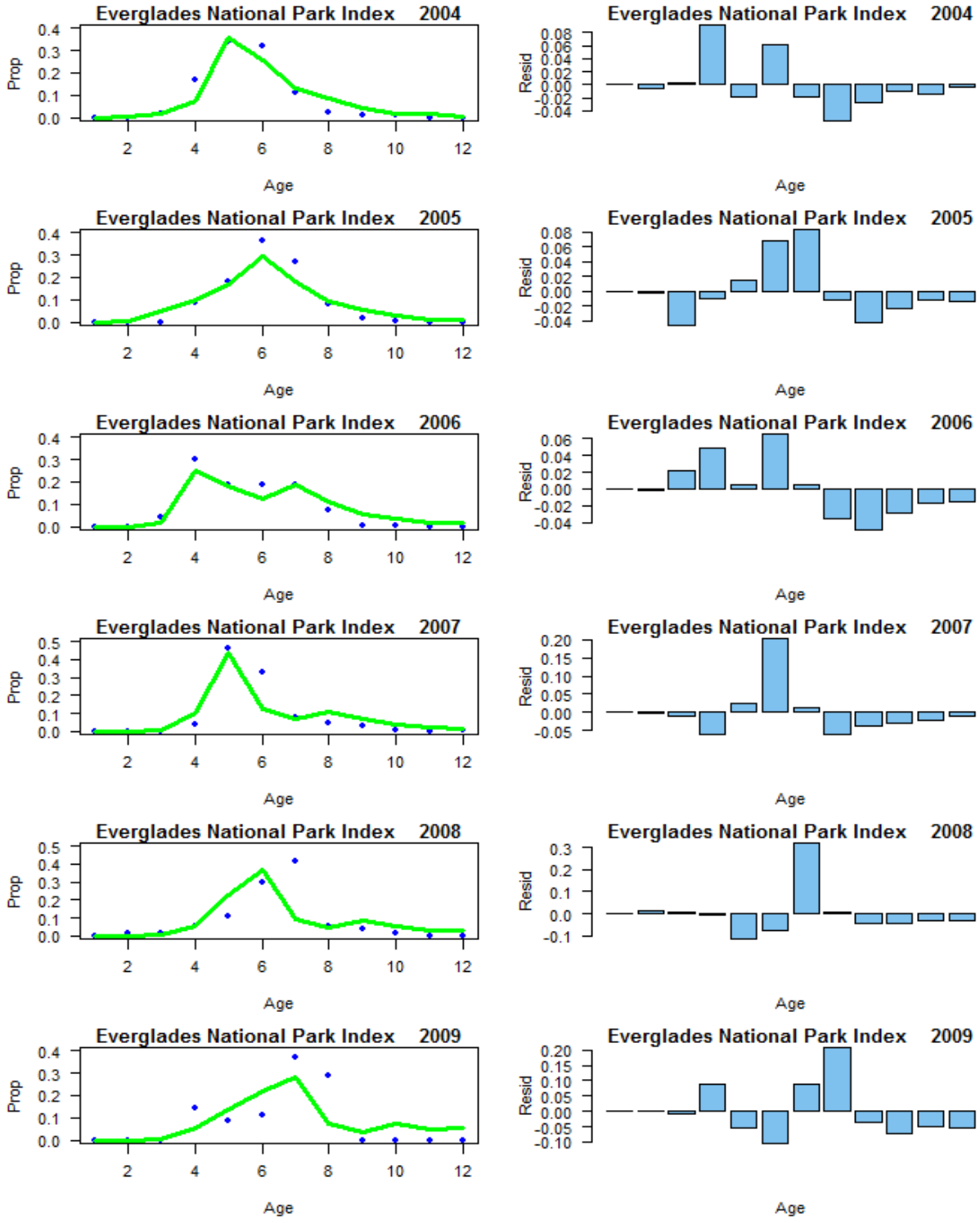


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

b. Gulf

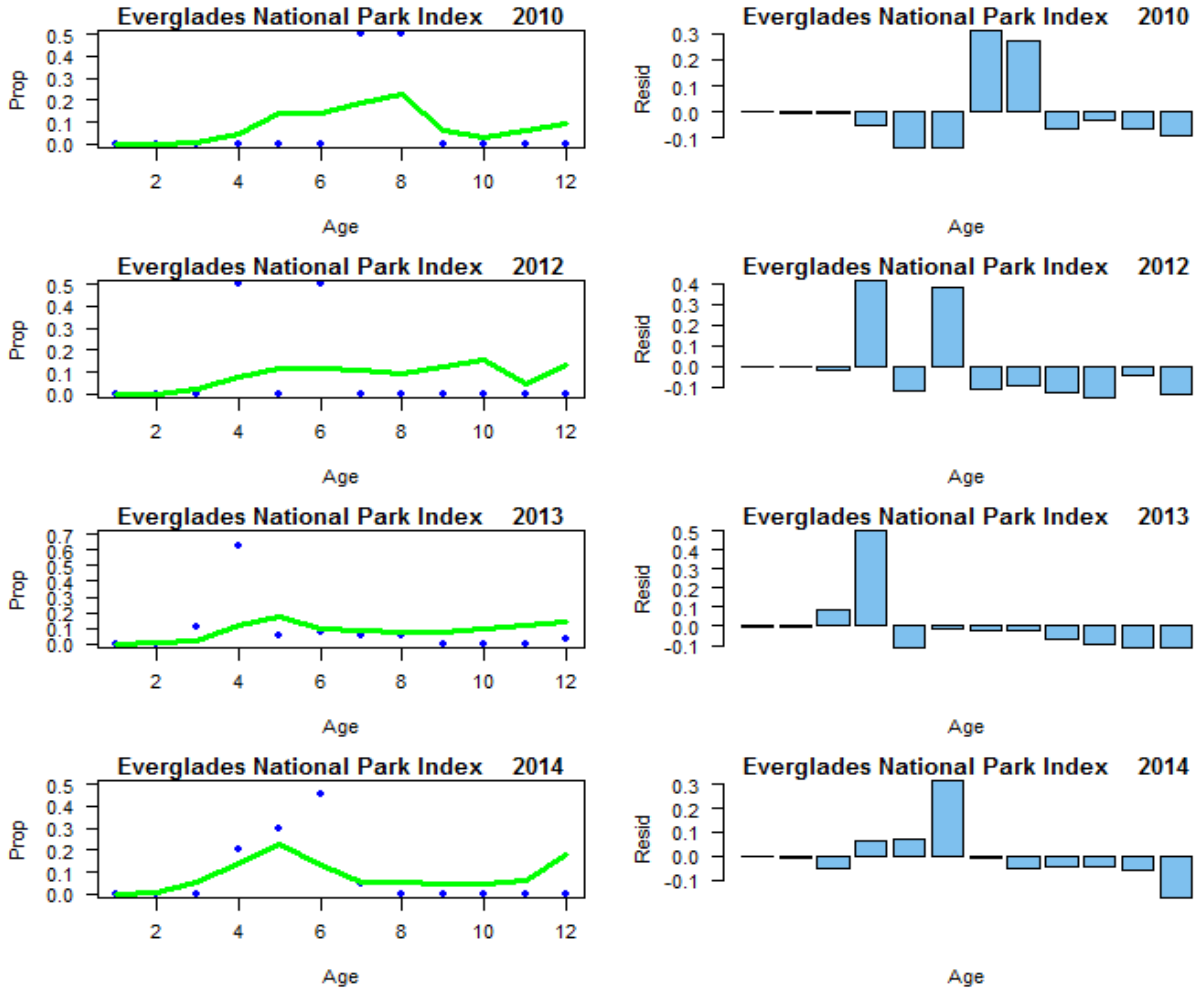


Figure 4.2.2.4.1.1 continued. Comparison of observed (ellipses) and predicted (line) proportion at age by index, year, and coast from ASAP.

a. Atlantic

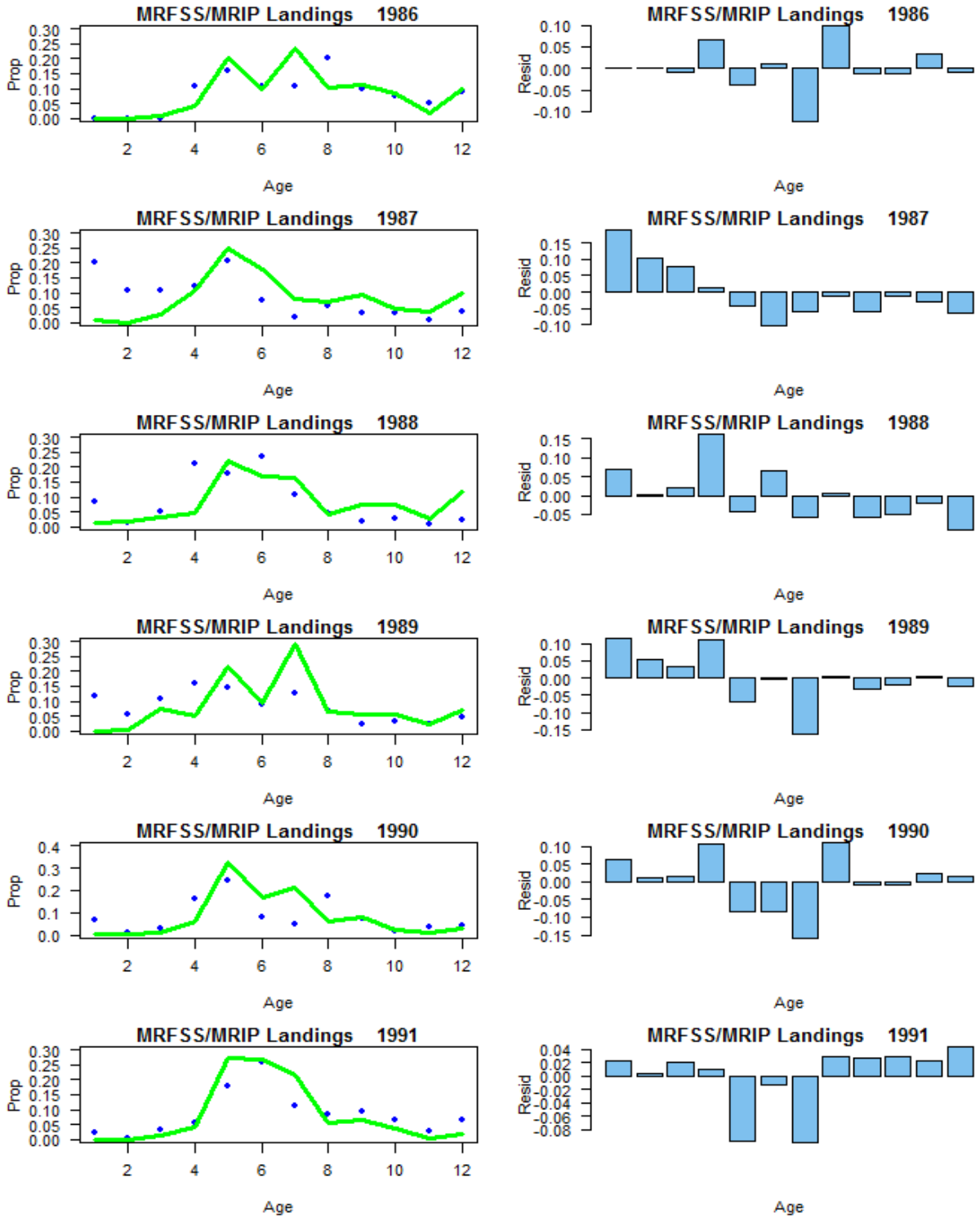


Figure 4.2.2.4.1.2. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of directed fishery from ASAP.

a. Atlantic

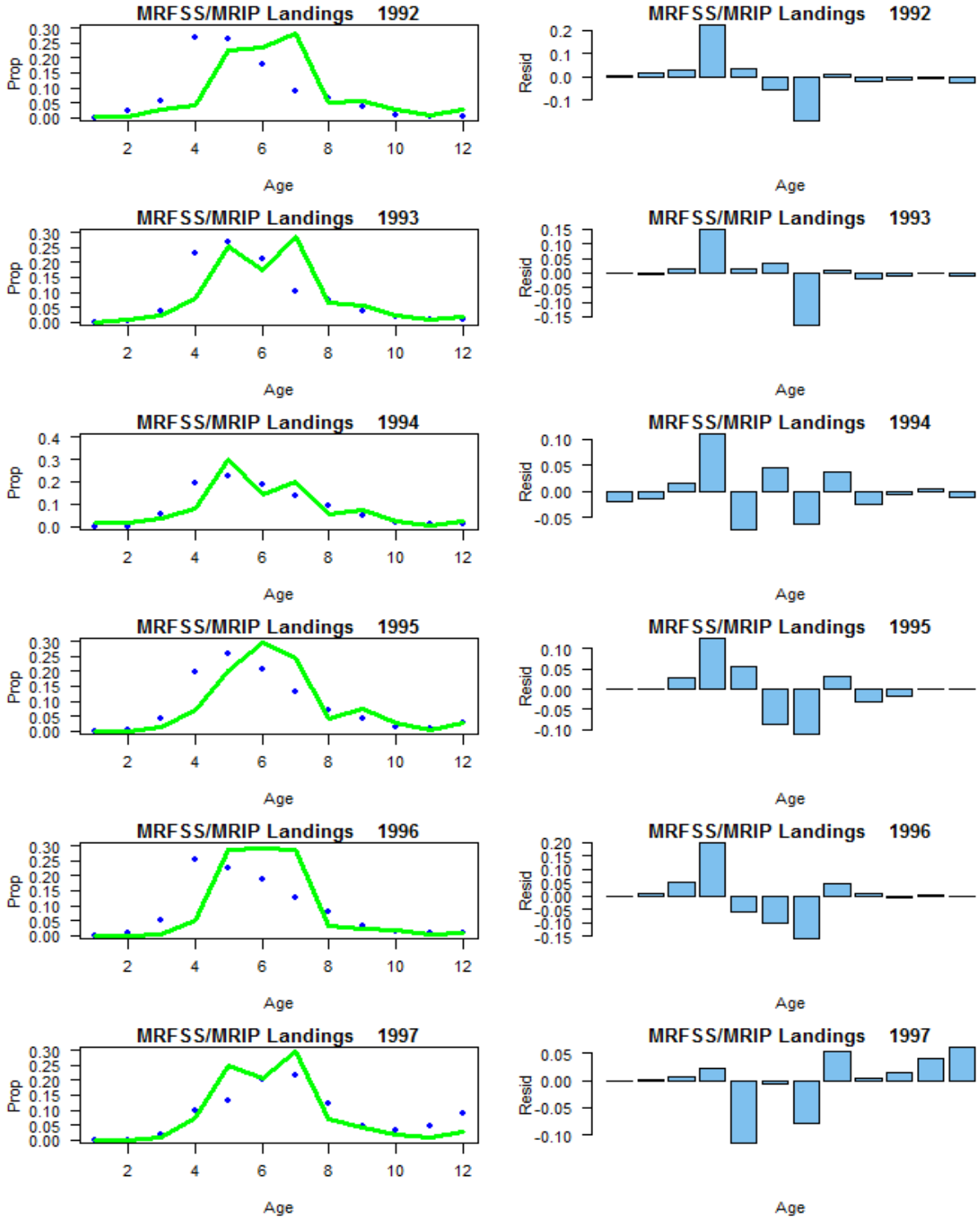


Figure 4.2.2.4.1.2 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of directed fishery from ASAP.

a. Atlantic

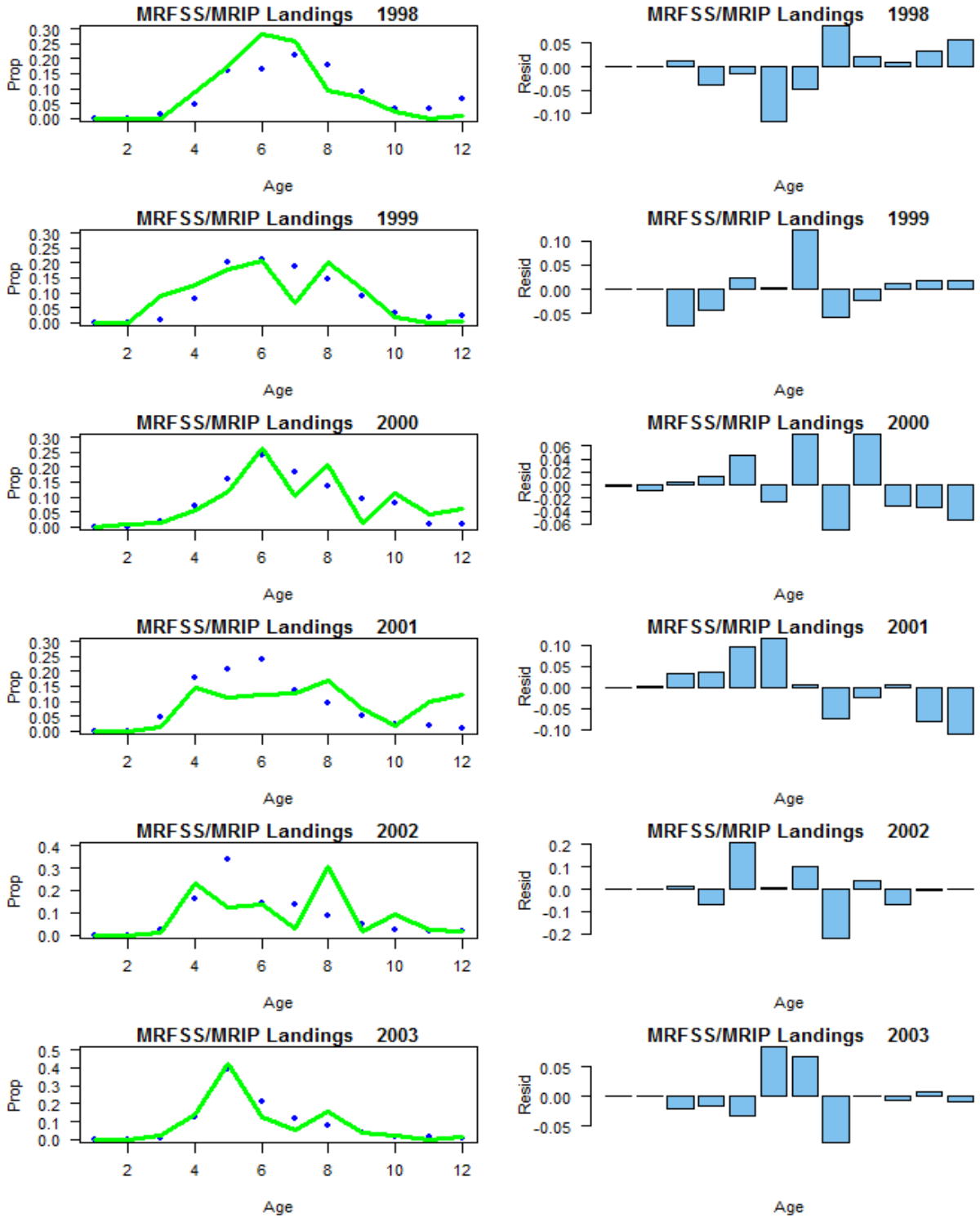


Figure 4.2.2.4.1.2 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of directed fishery from ASAP.

a. Atlantic

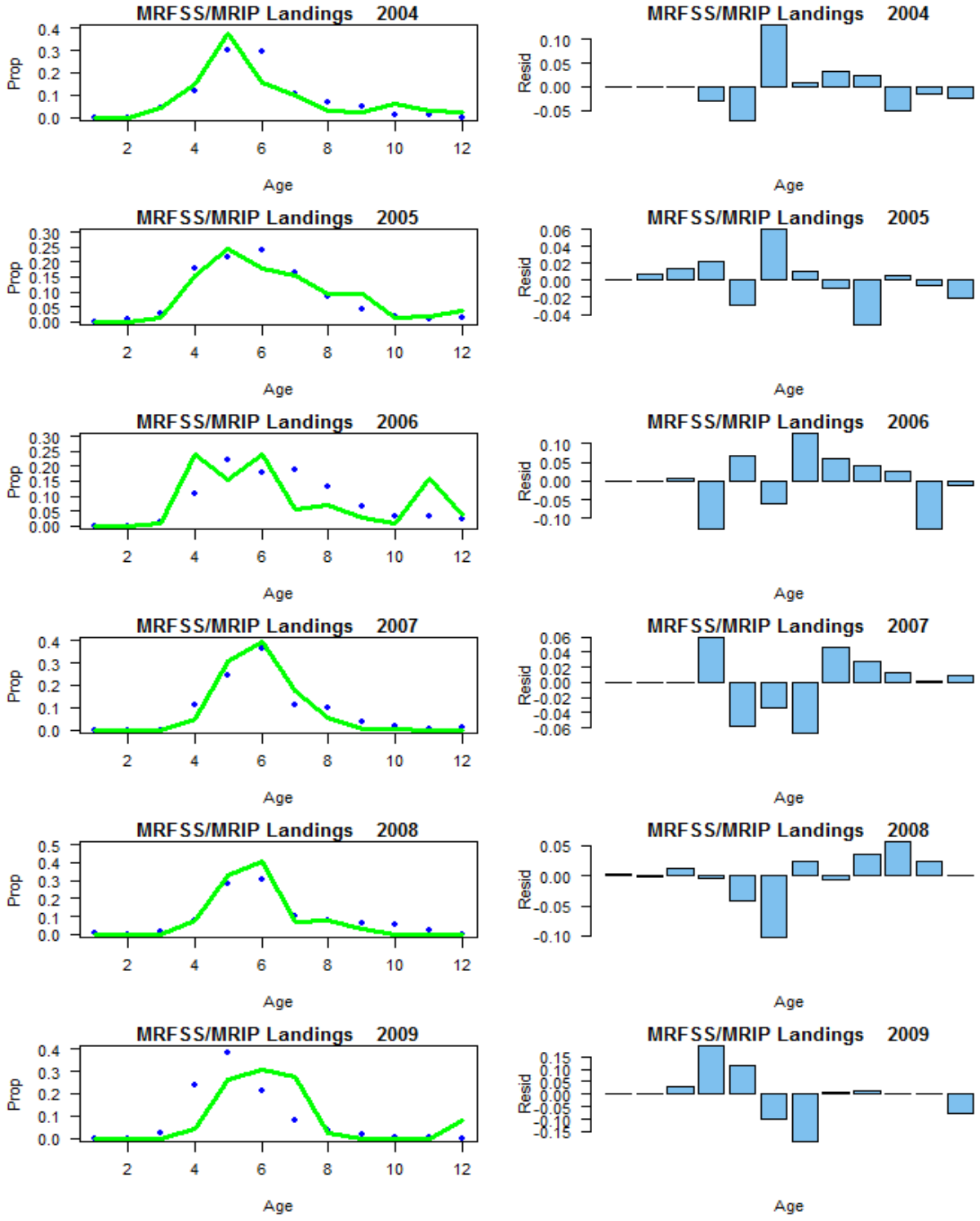


Figure 4.2.2.4.1.2 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of directed fishery from ASAP.

a. Atlantic

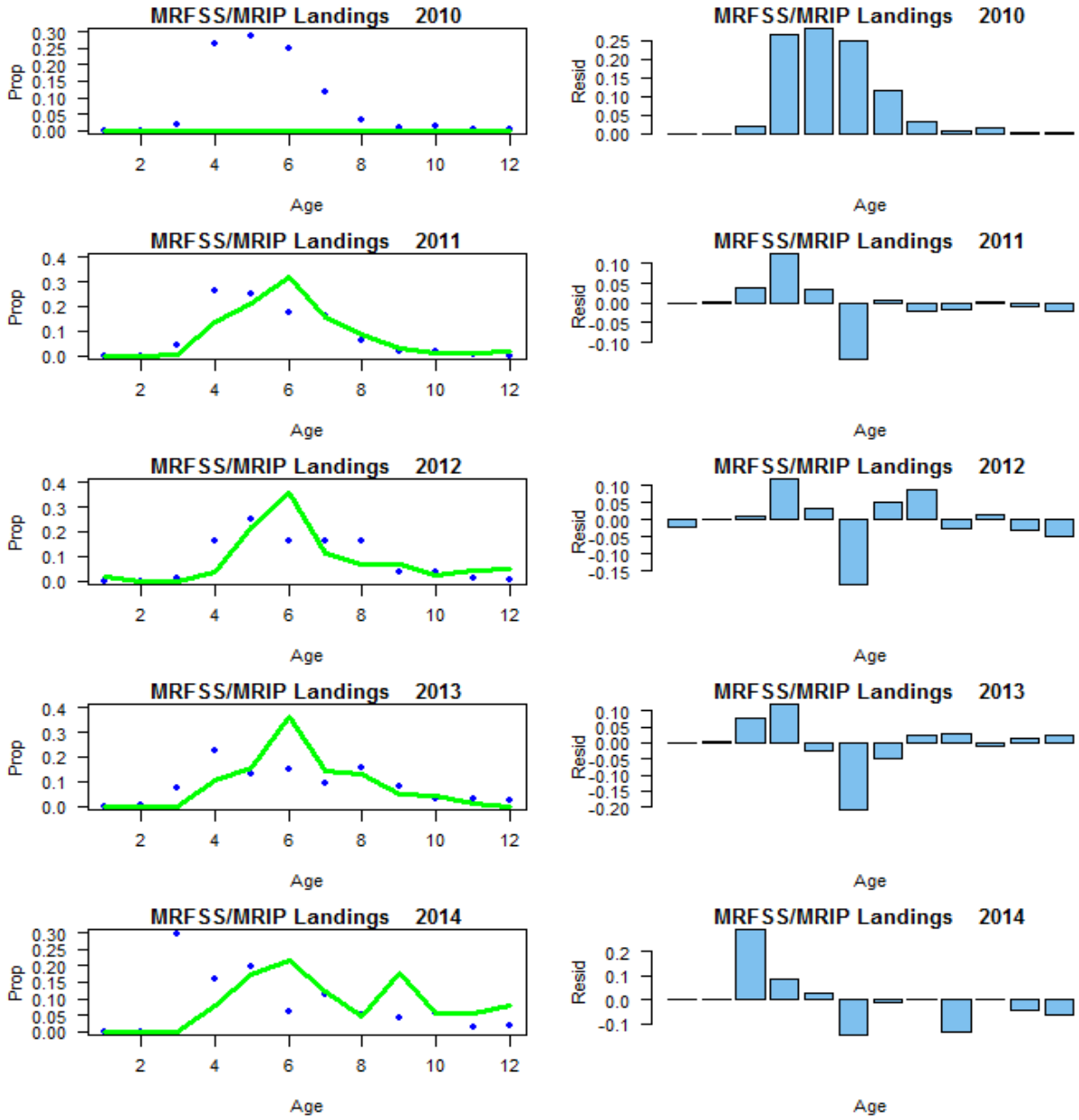


Figure 4.2.2.4.1.2 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of directed fishery from ASAP.

b. Gulf

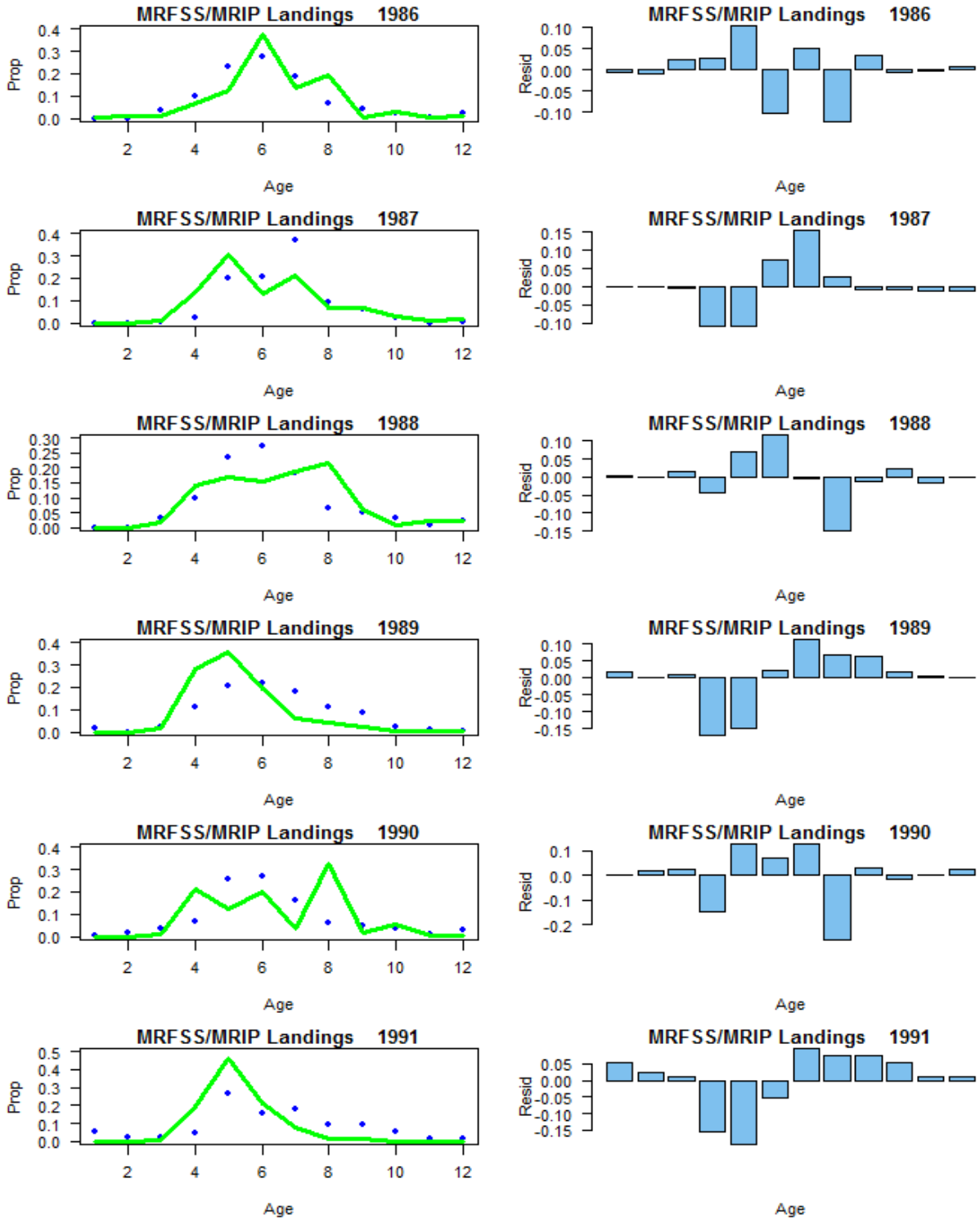


Figure 4.2.2.4.1.2 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of directed fishery from ASAP.

b. Gulf

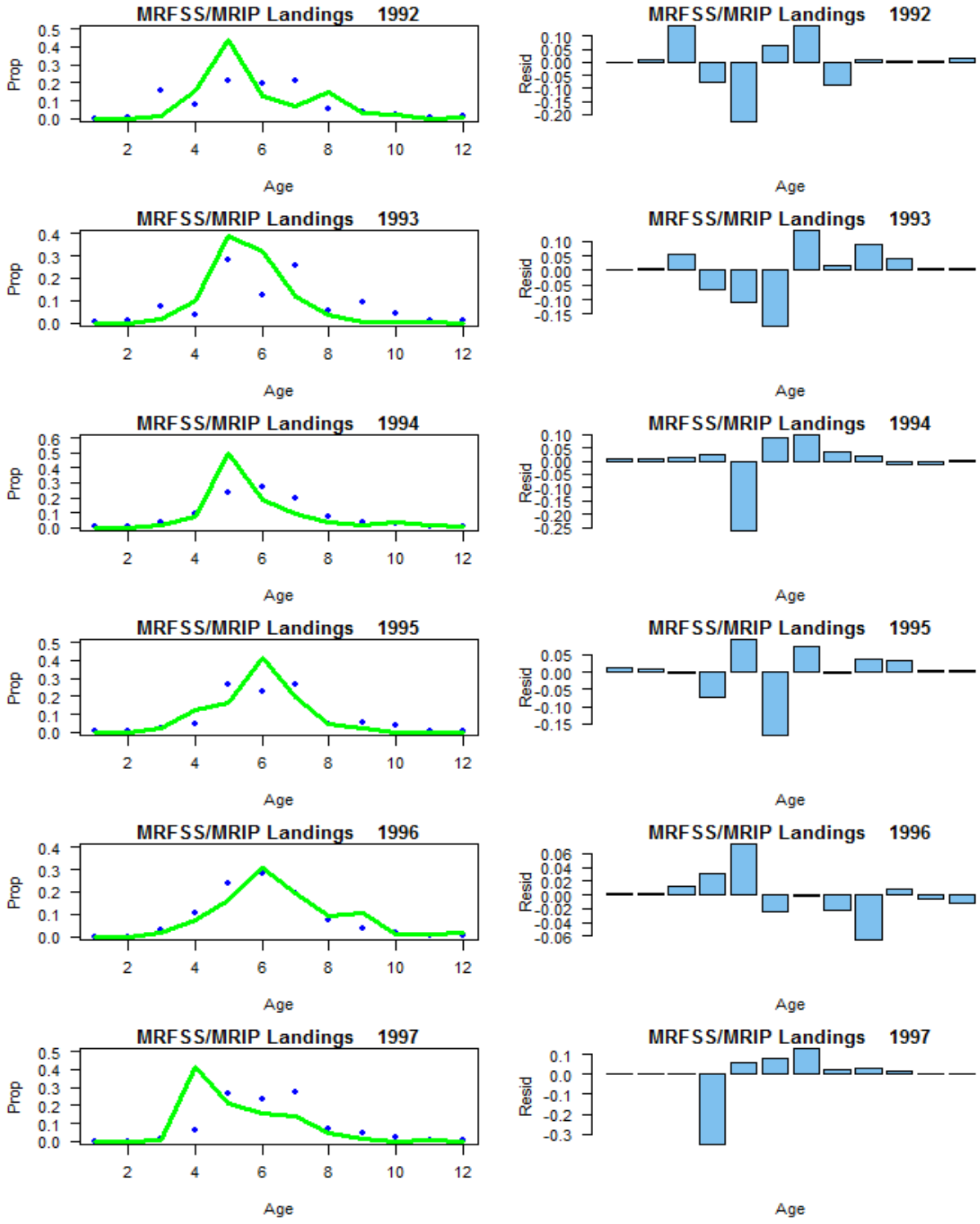


Figure 4.2.2.4.1.2 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of directed fishery from ASAP.

b. Gulf

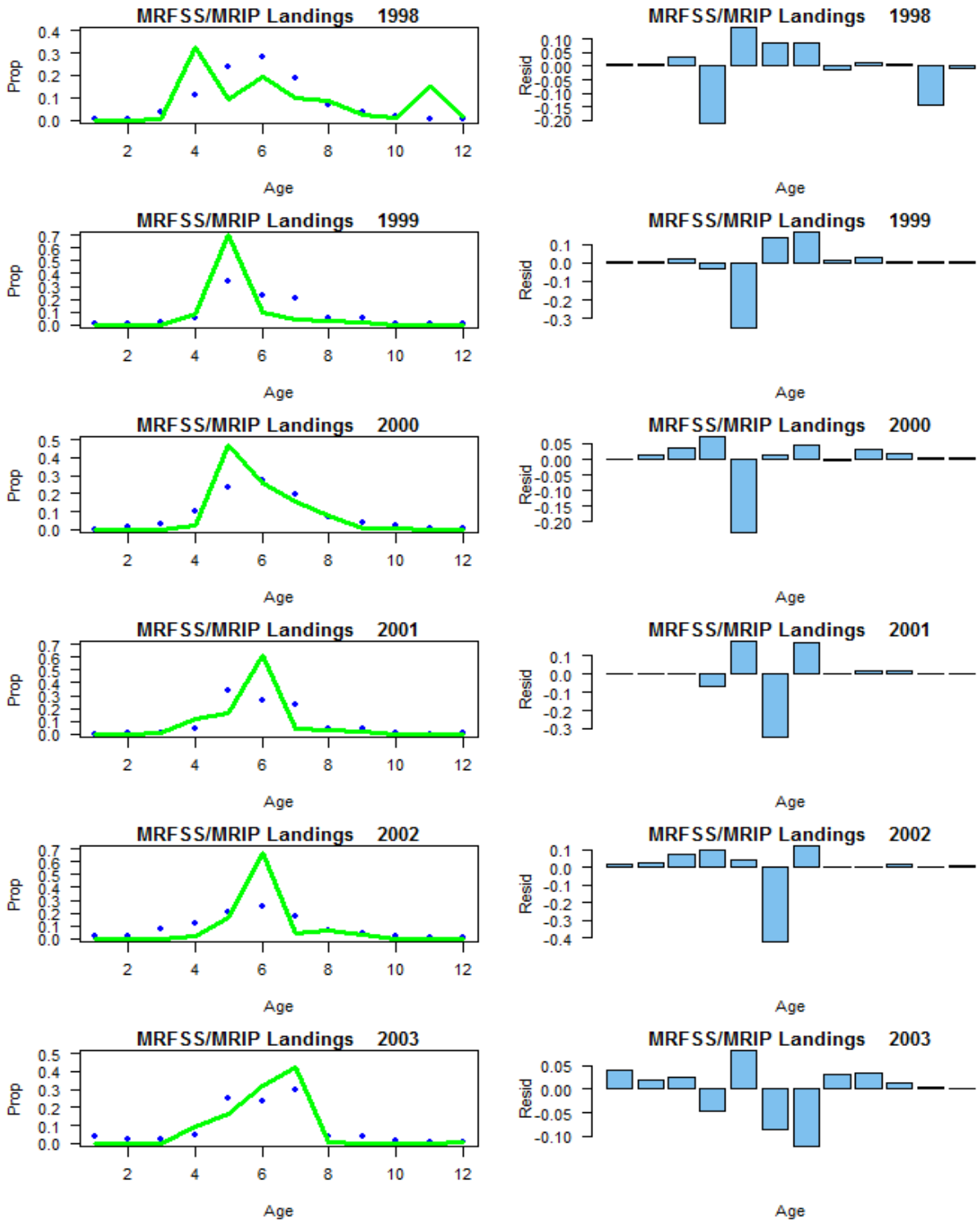


Figure 4.2.2.4.1.2 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of directed fishery from ASAP.

b. Gulf

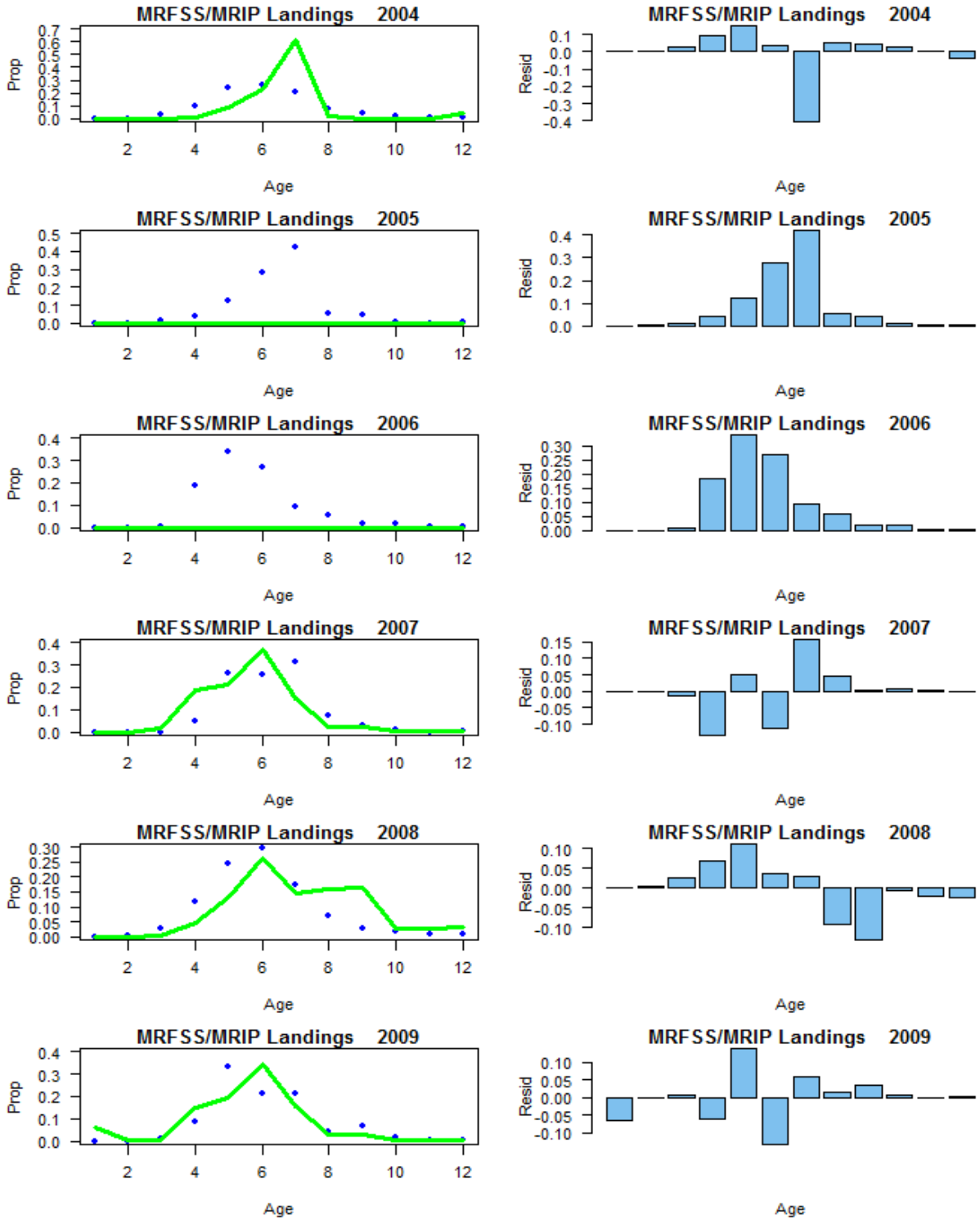


Figure 4.2.2.4.1.2 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of directed fishery from ASAP.

b. Gulf

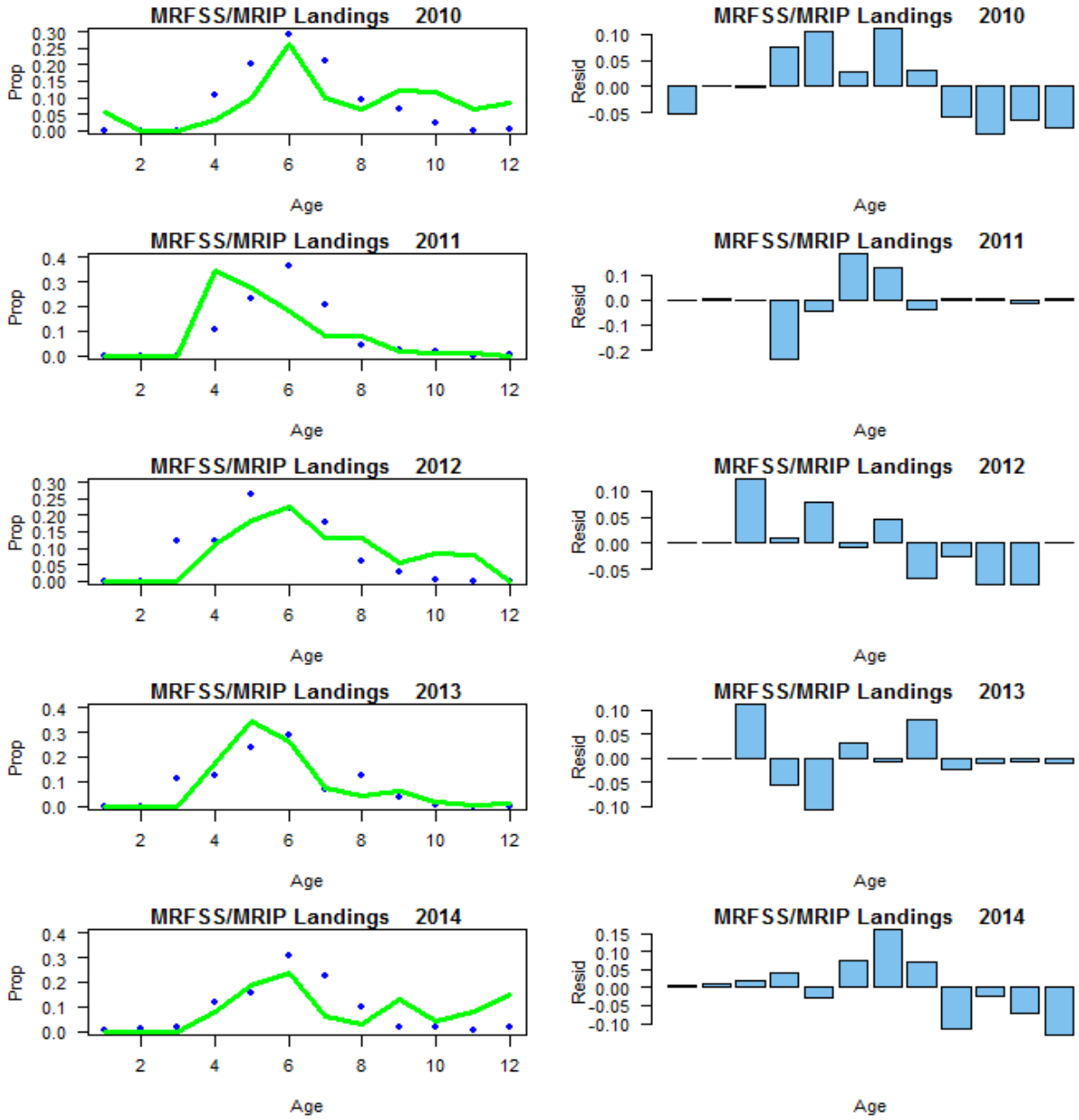


Figure 4.2.2.4.1.2 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of directed fishery from ASAP.

a. Atlantic

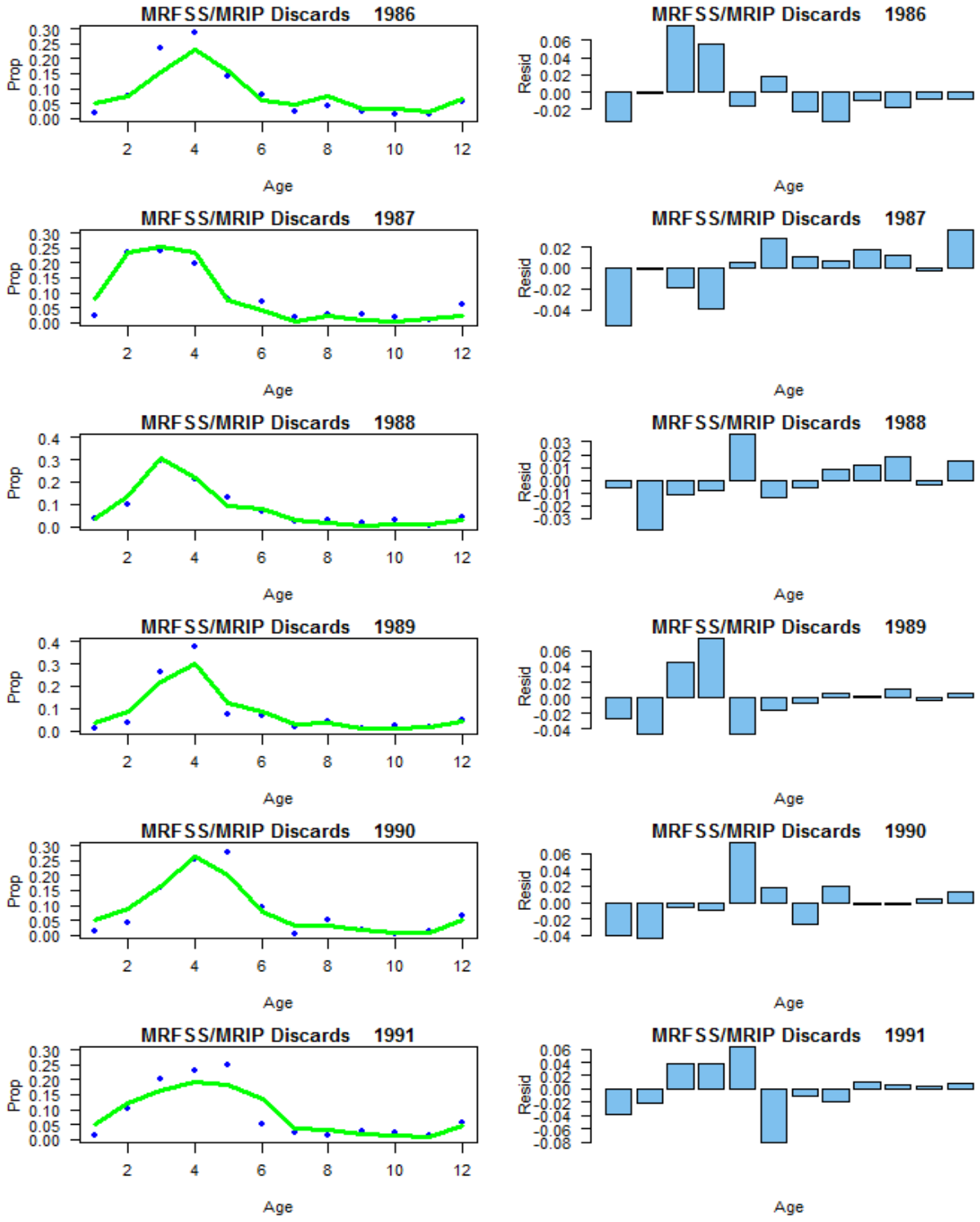


Figure 4.2.2.4.1.3. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of dead discards from ASAP.

a. Atlantic

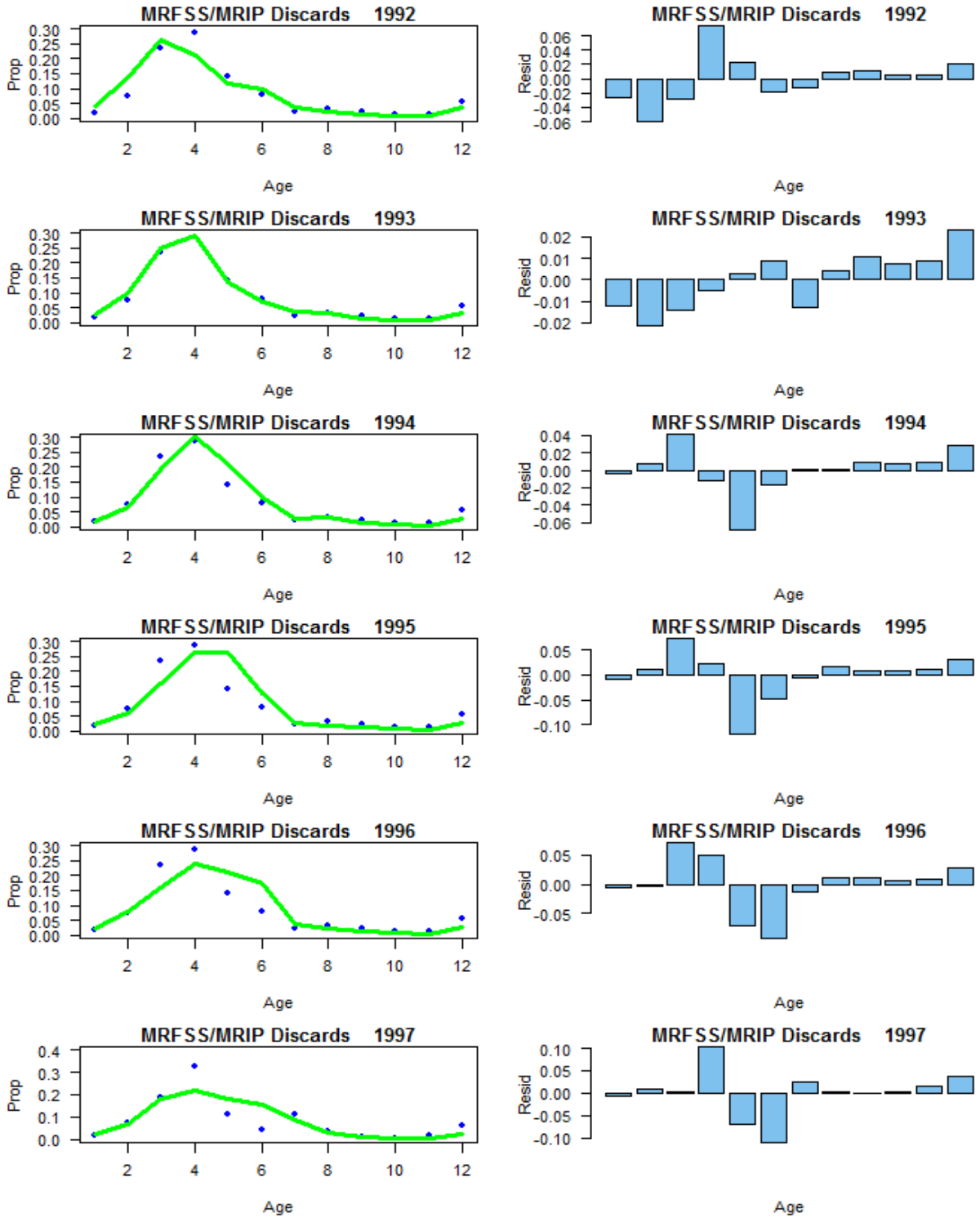


Figure 4.2.2.4.1.3 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of dead discards from ASAP.

a. Atlantic

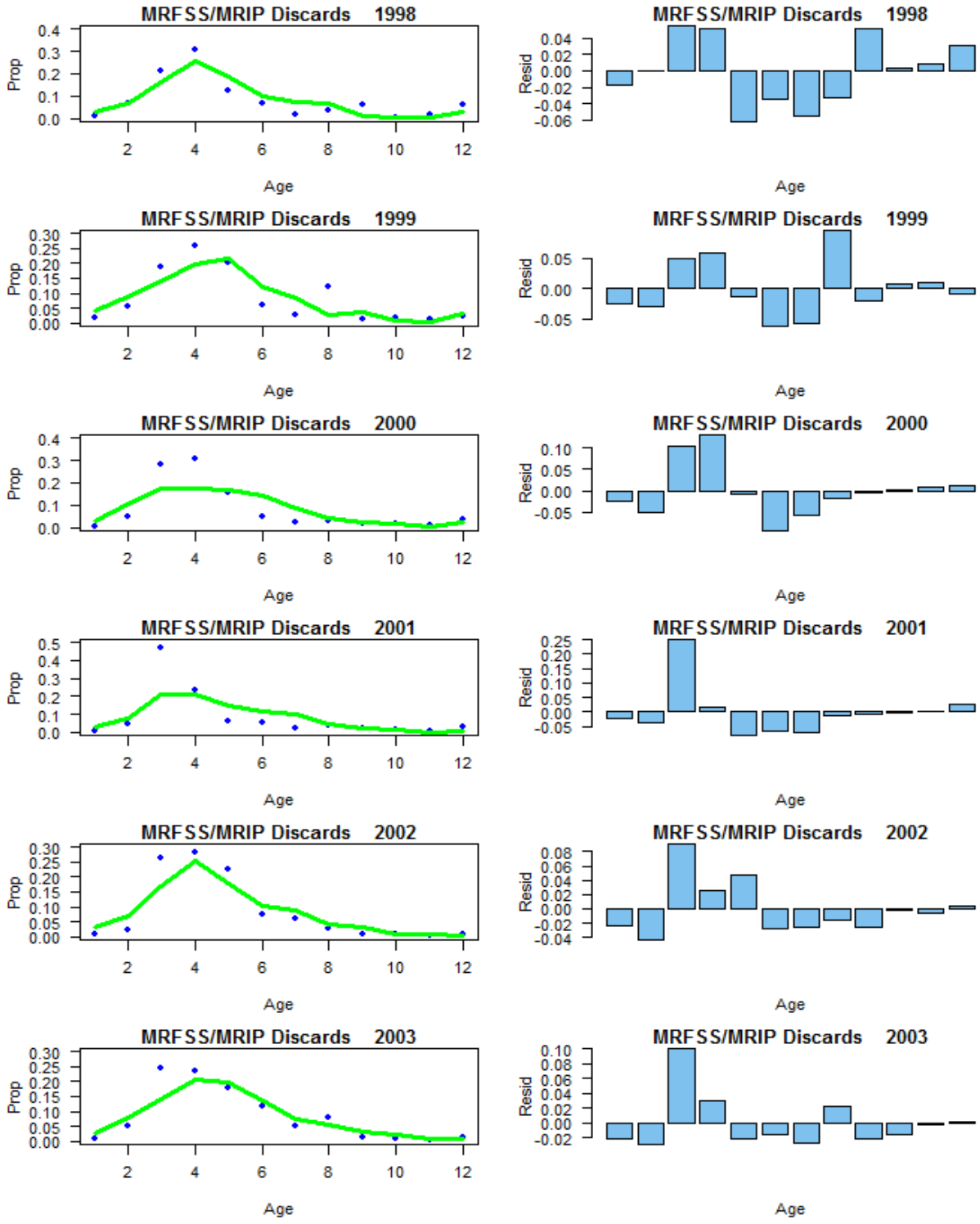


Figure 4.2.2.4.1.3 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of dead discards from ASAP.

a. Atlantic

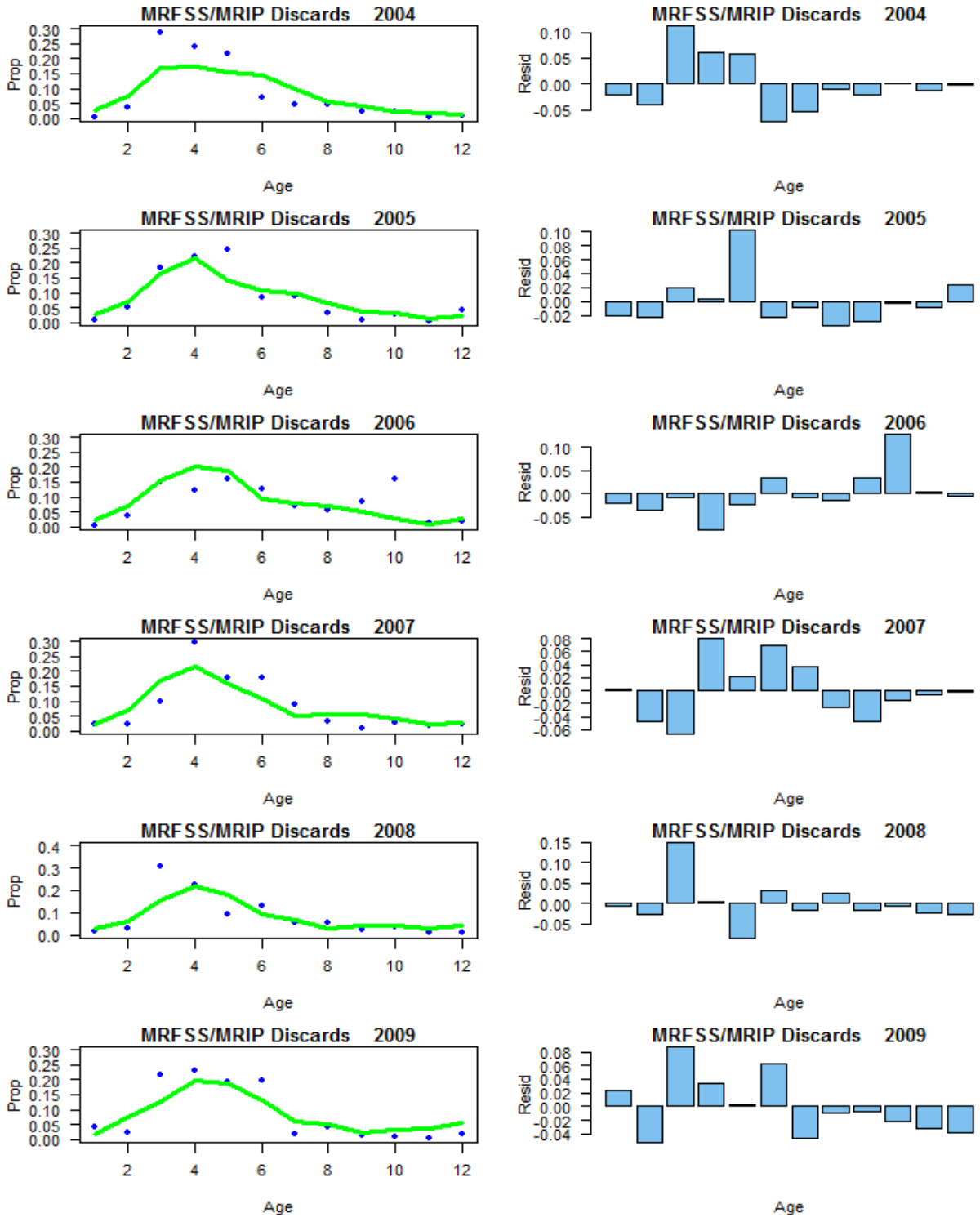


Figure 4.2.2.4.1.3 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of dead discards from ASAP.

a. Atlantic

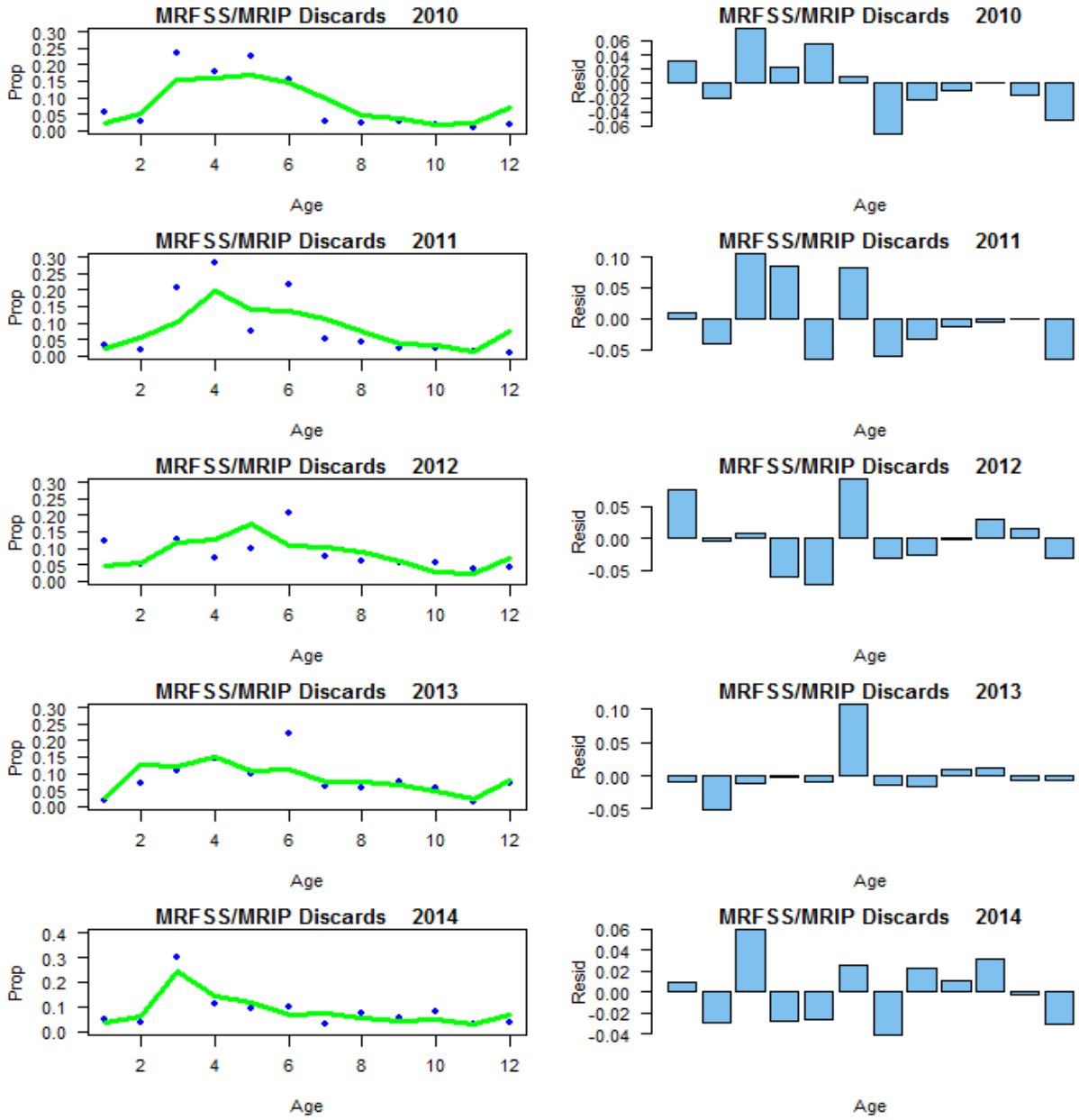


Figure 4.2.2.4.1.3 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of dead discards from ASAP.

b. Gulf

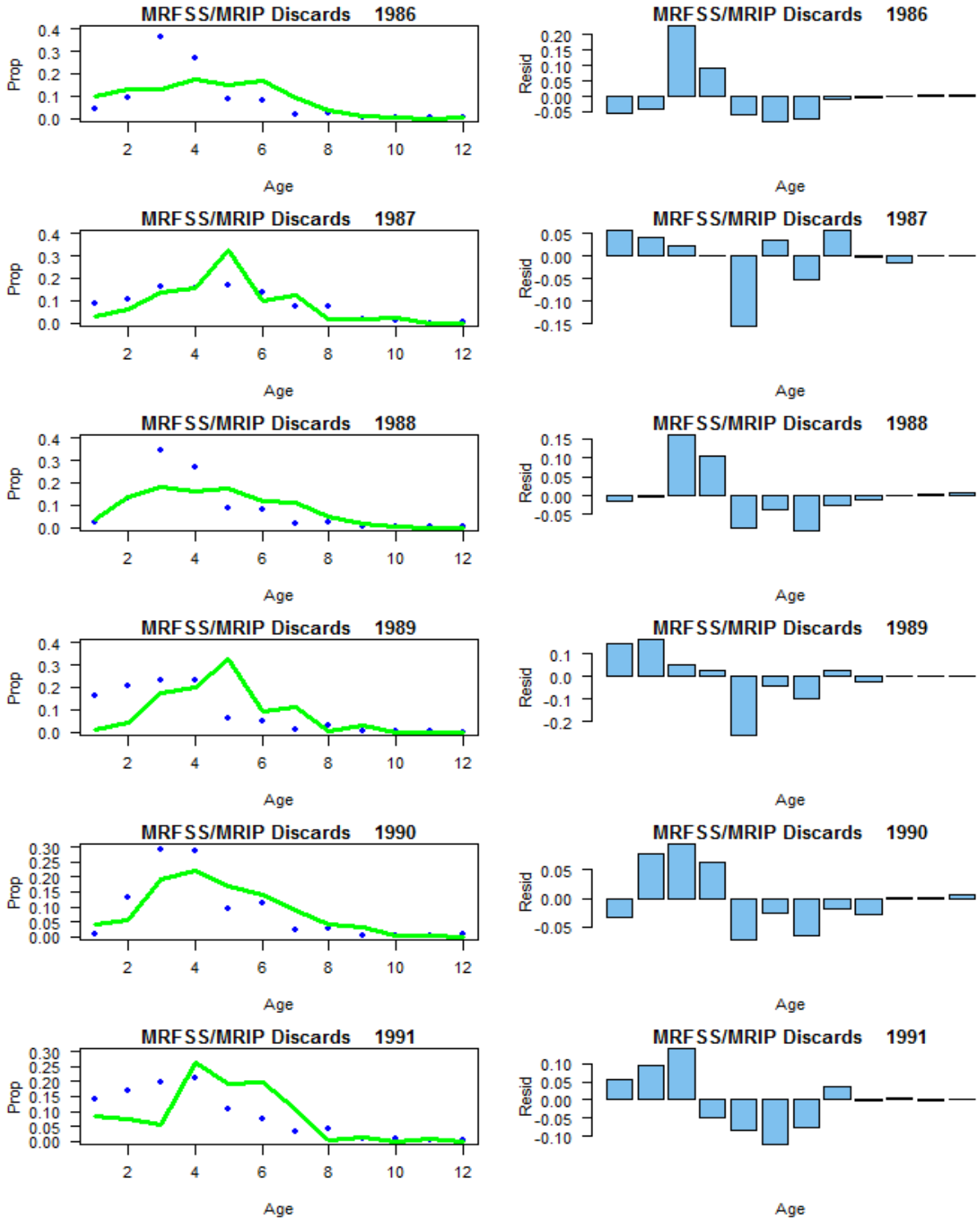


Figure 4.2.2.4.1.3 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of dead discards from ASAP.

b. Gulf

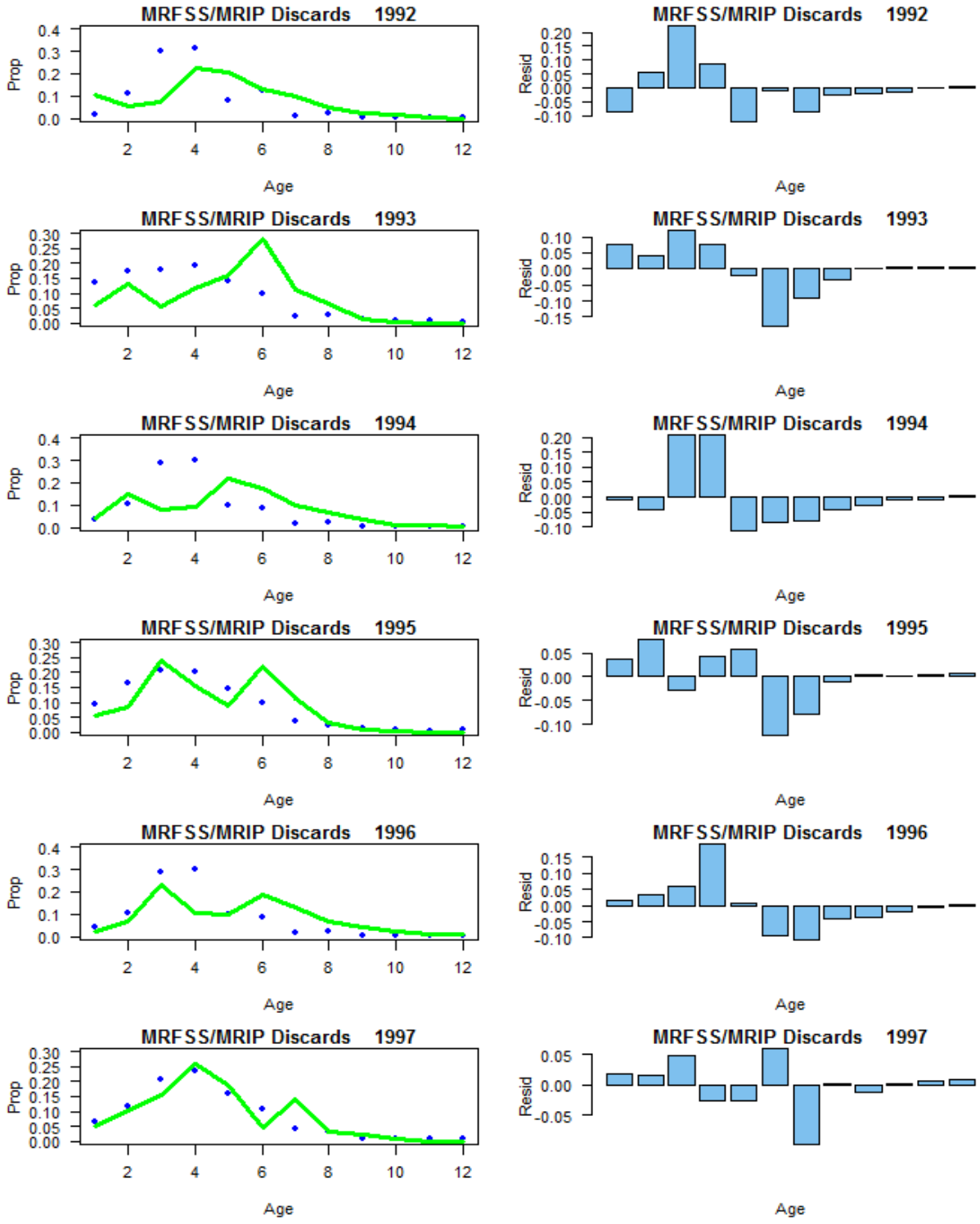


Figure 4.2.2.4.1.3. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of dead discards from ASAP.

b. Gulf

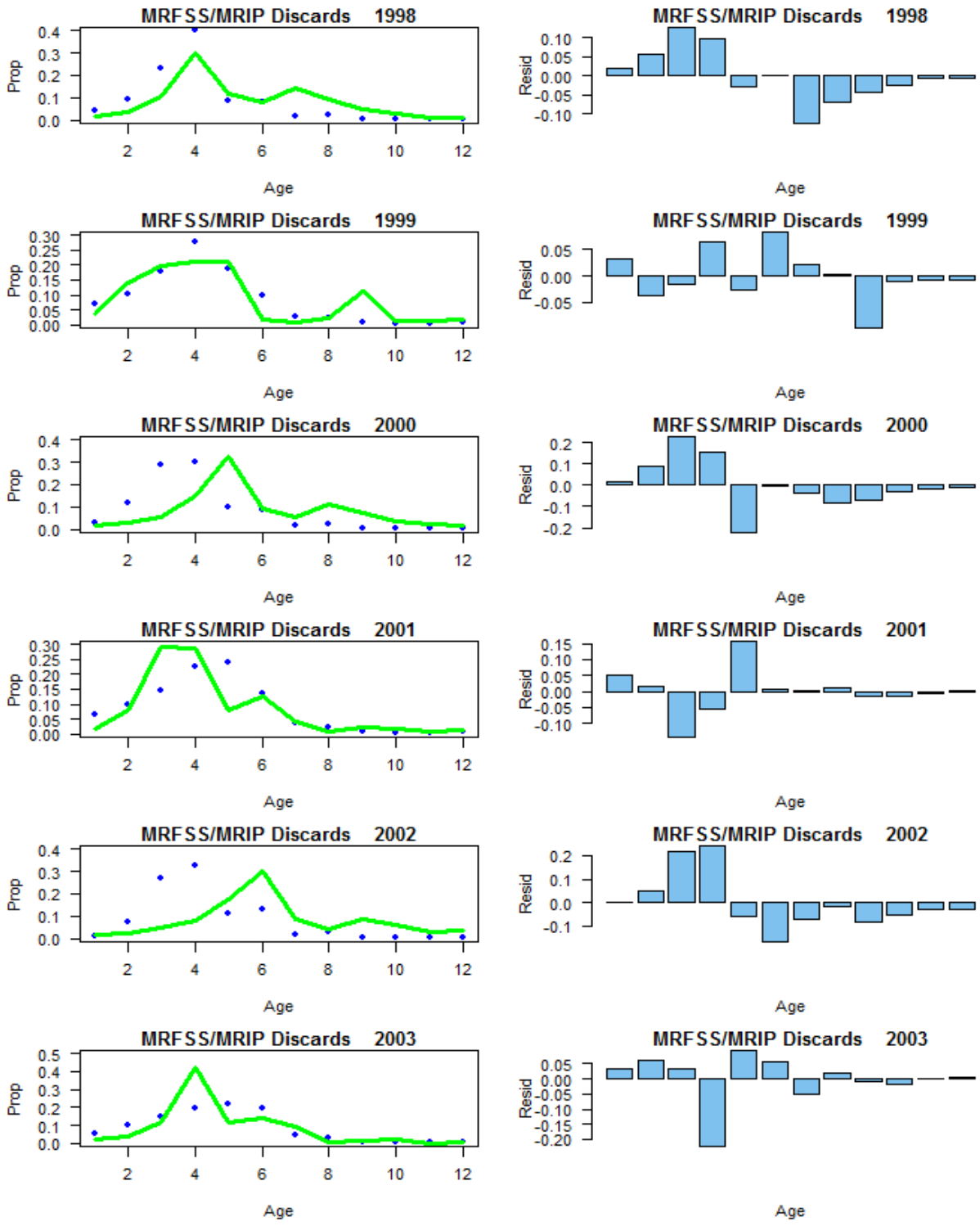


Figure 4.2.2.4.1.3 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of dead discards from ASAP.

b. Gulf

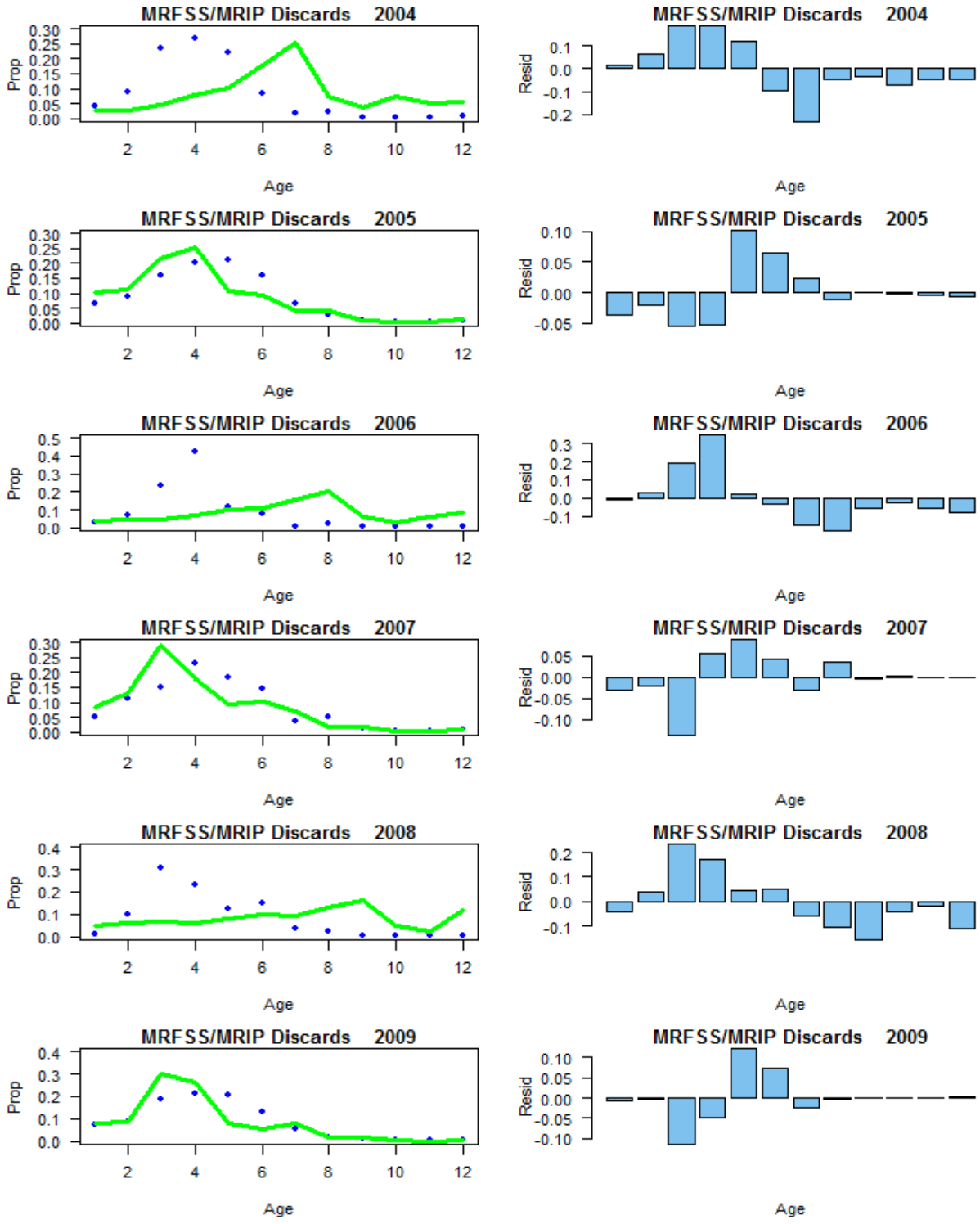


Figure 4.2.2.4.1.3 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of dead discards from ASAP.

b. Gulf

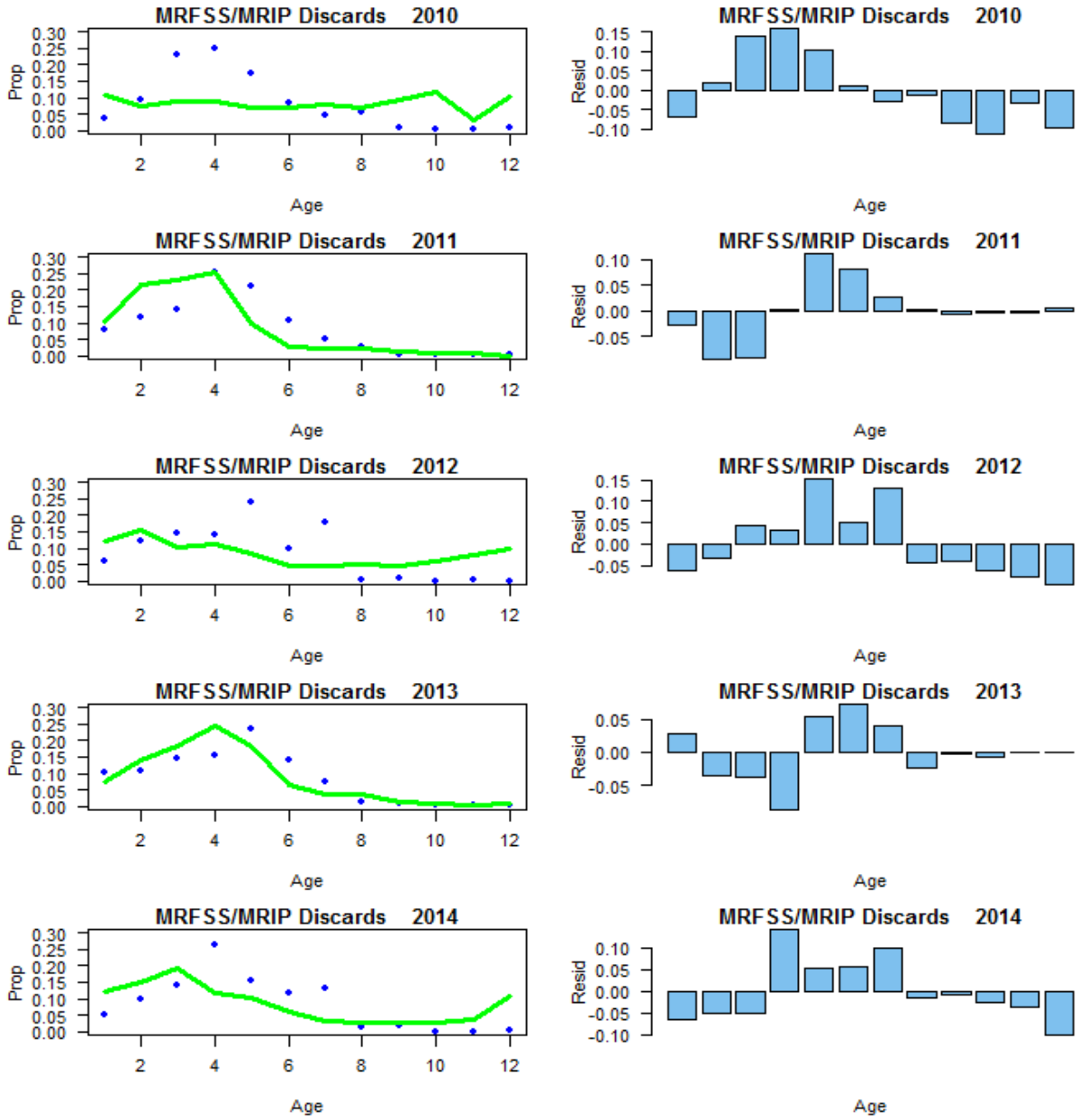
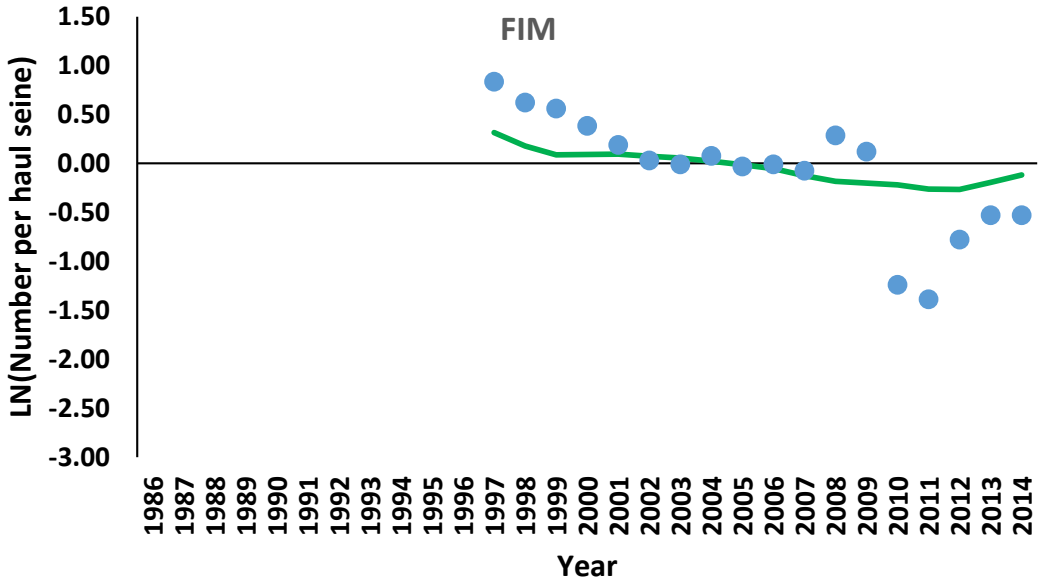


Figure 4.2.2.4.1.3 continued. Comparison of observed (ellipses) and predicted (line) proportion at age, year, and coast of dead discards from ASAP.

Atlantic

a.



b.

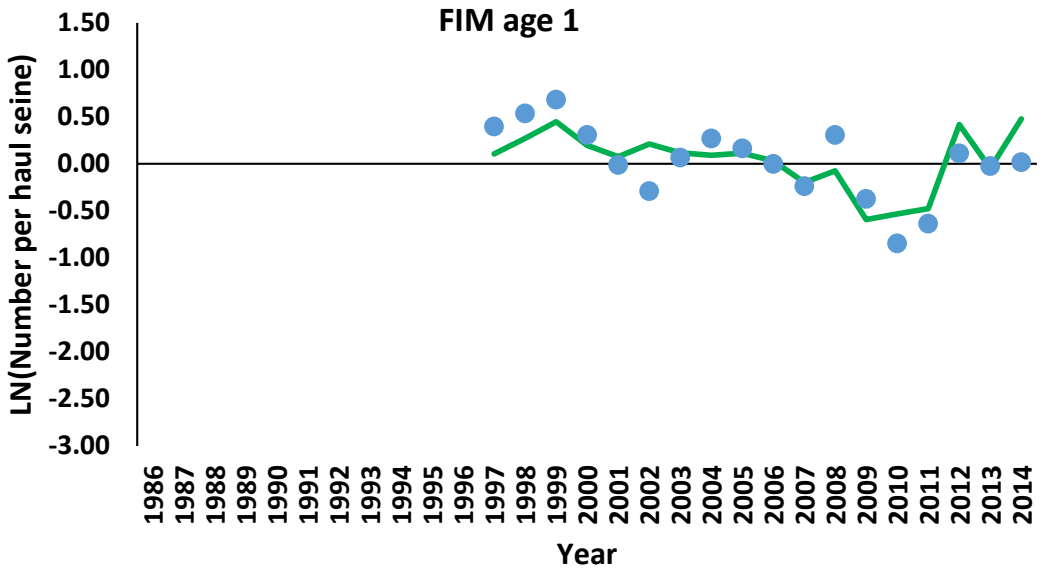


Figure 4.2.2.4.1.4. Comparison of observed (ellipses) and predicted (line) tuning index values by coast (Atlantic a-c and gulf d-g) from ASAP. All tuning indices were equally weighted in the analyses.

c.

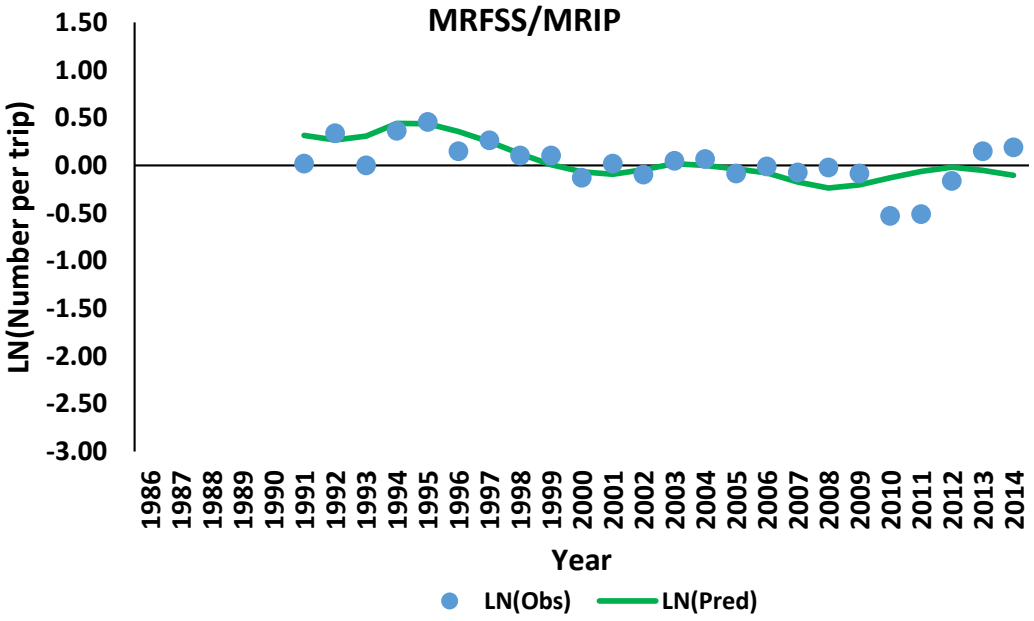
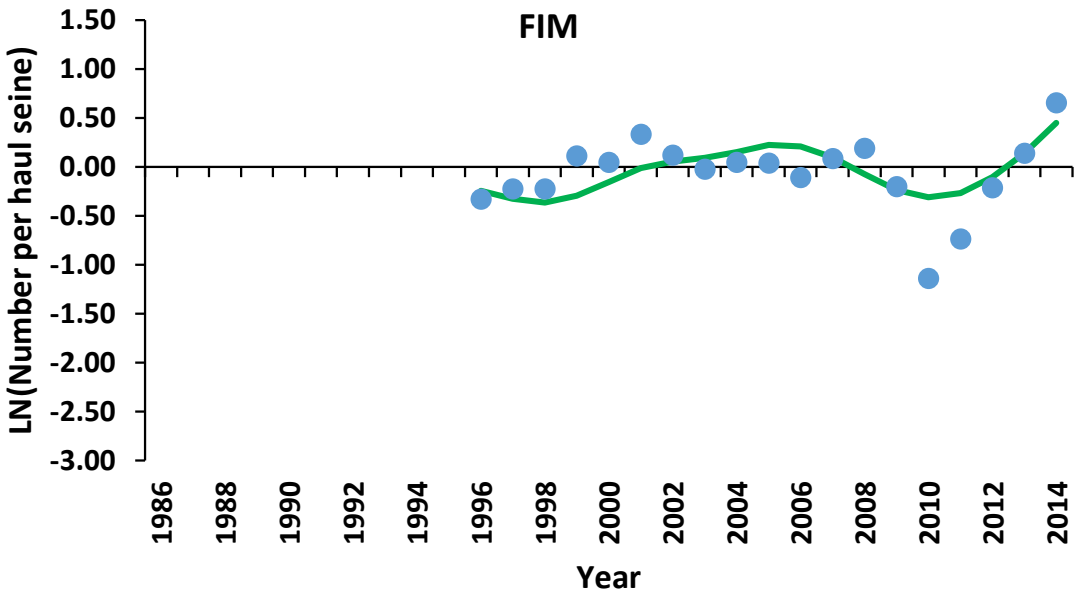


Figure 4.2.2.4.1.4 continued. Comparison of observed (ellipses) and predicted (line) tuning index values by coast (Atlantic a-c and gulf d-g) from ASAP. All tuning indices were equally weighted in the analyses.

Gulf

d.



e.

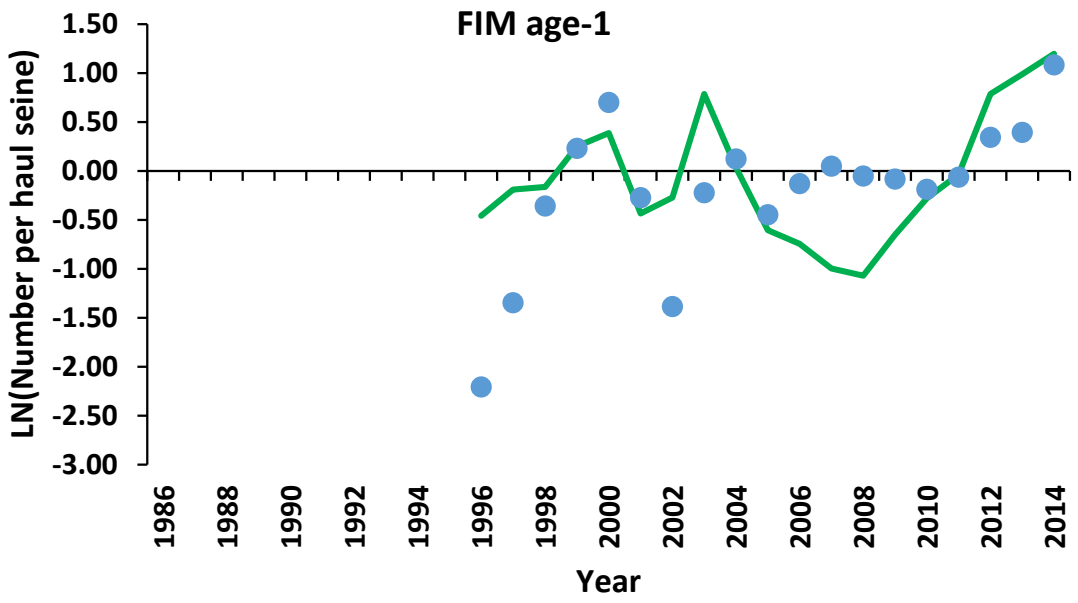
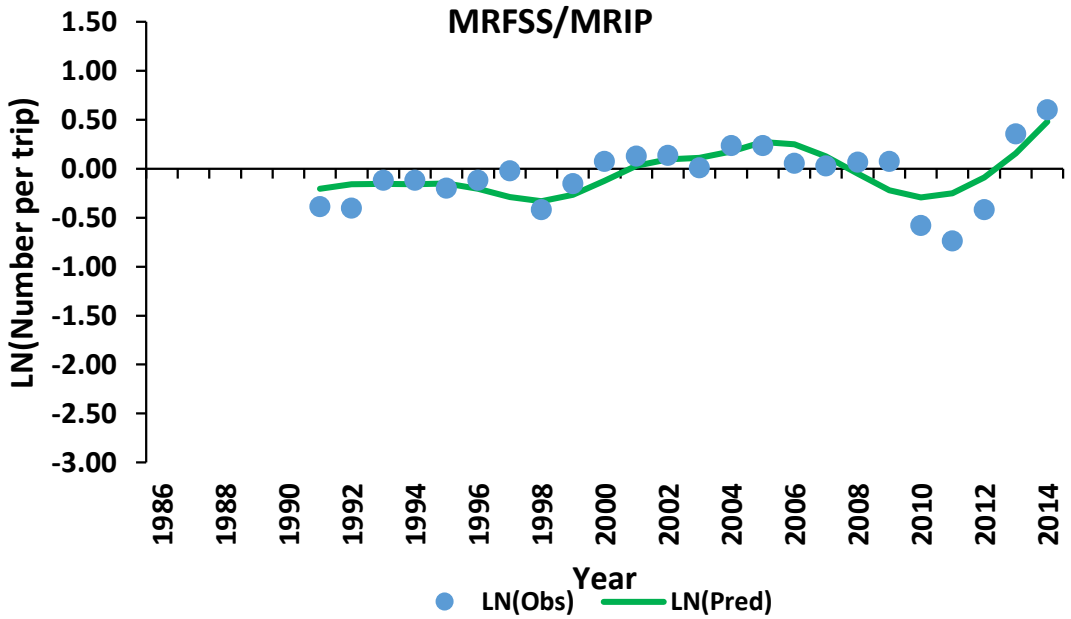


Figure 4.2.2.4.1.4 continued. Comparison of observed (ellipses) and predicted (line) tuning index values by coast (Atlantic a-c and gulf d-g) from ASAP. All tuning indices were equally weighted in the analyses.

Gulf (continued)

f.



g.

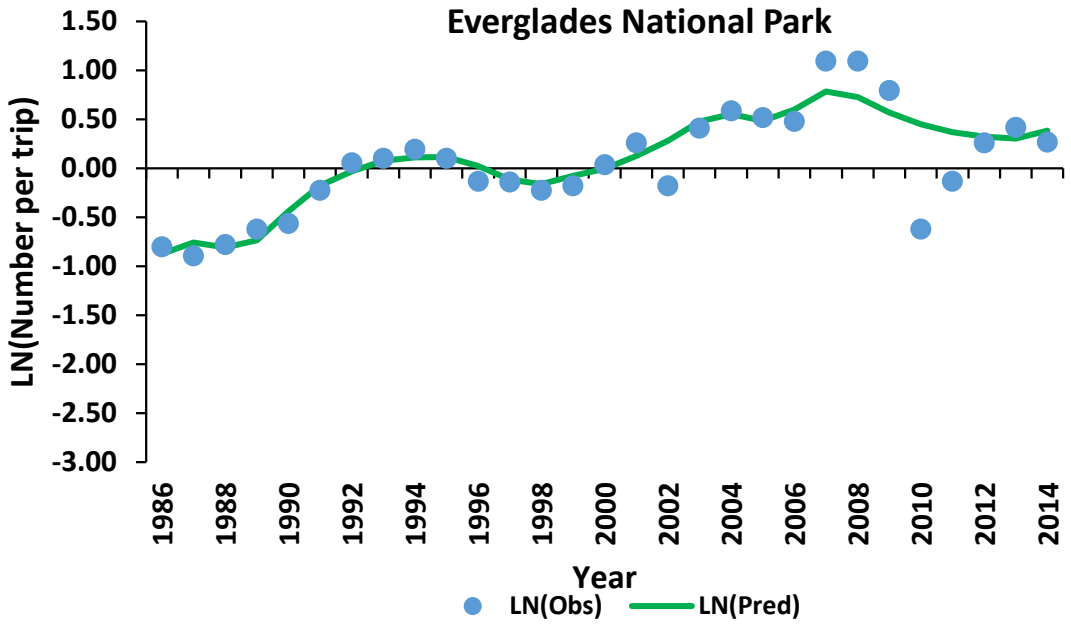


Figure 4.2.2.4.1.4 continued. Comparison of observed (ellipses) and predicted (line) tuning index values by coast (Atlantic a-c and gulf d-g) from ASAP. All tuning indices were equally weighted in the analyses.

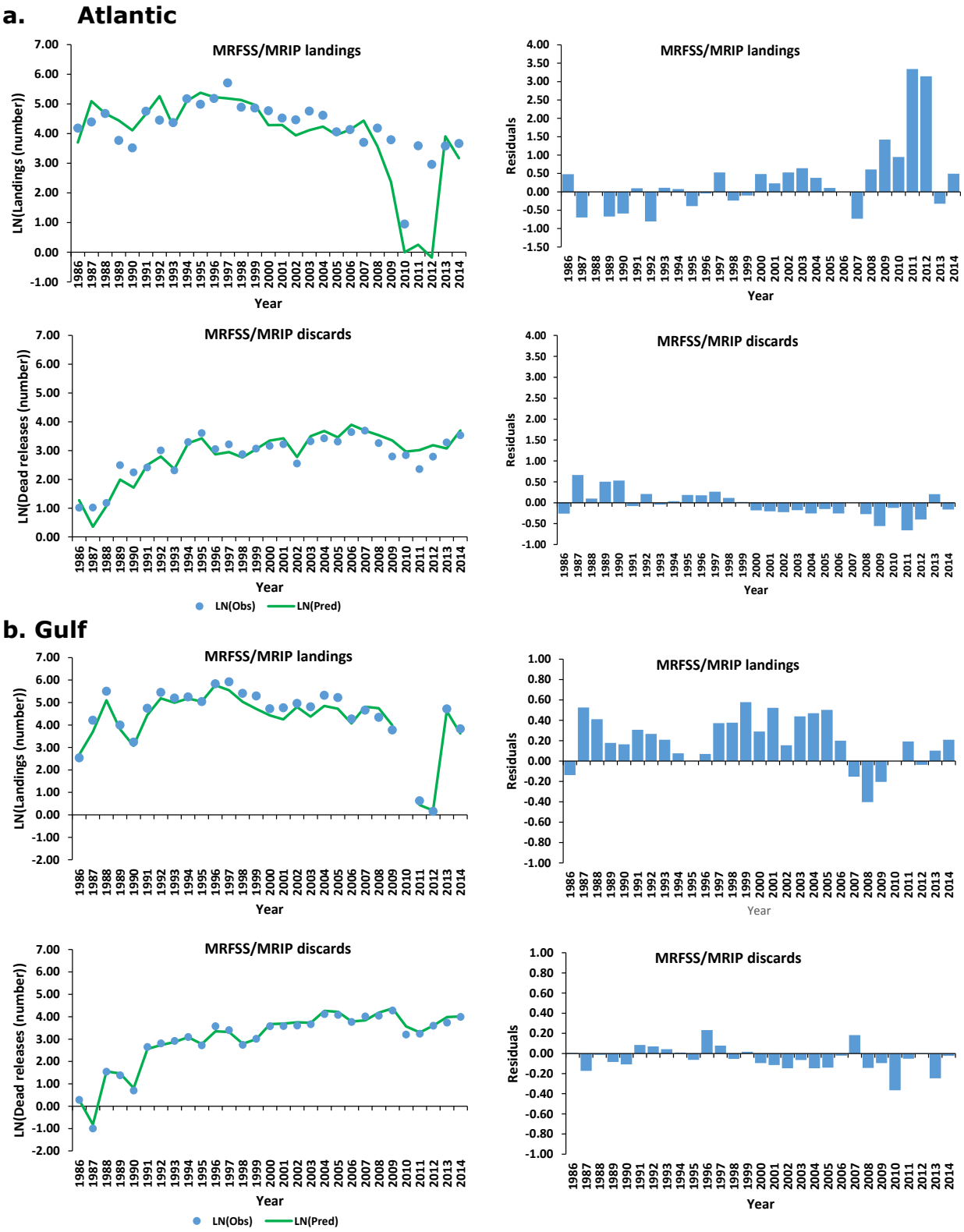
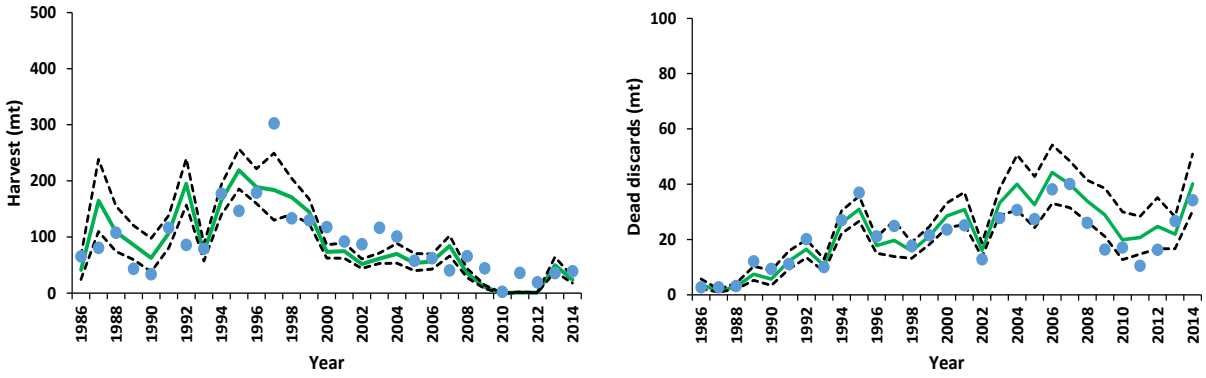


Figure 4.2.2.4.1.5. Comparison of observed (ellipses) and predicted (line) harvest and dead discards and the residuals by coast from ASAP.

a. Atlantic



b. Gulf

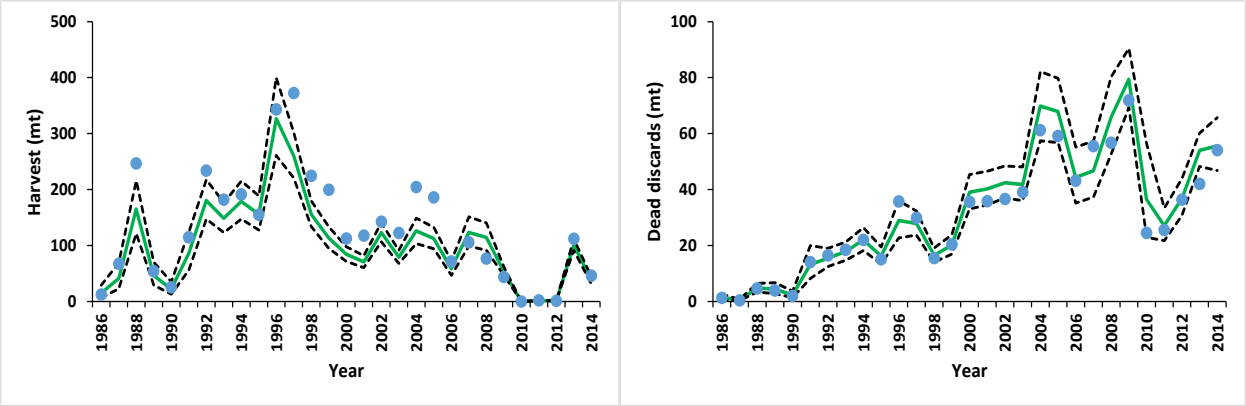
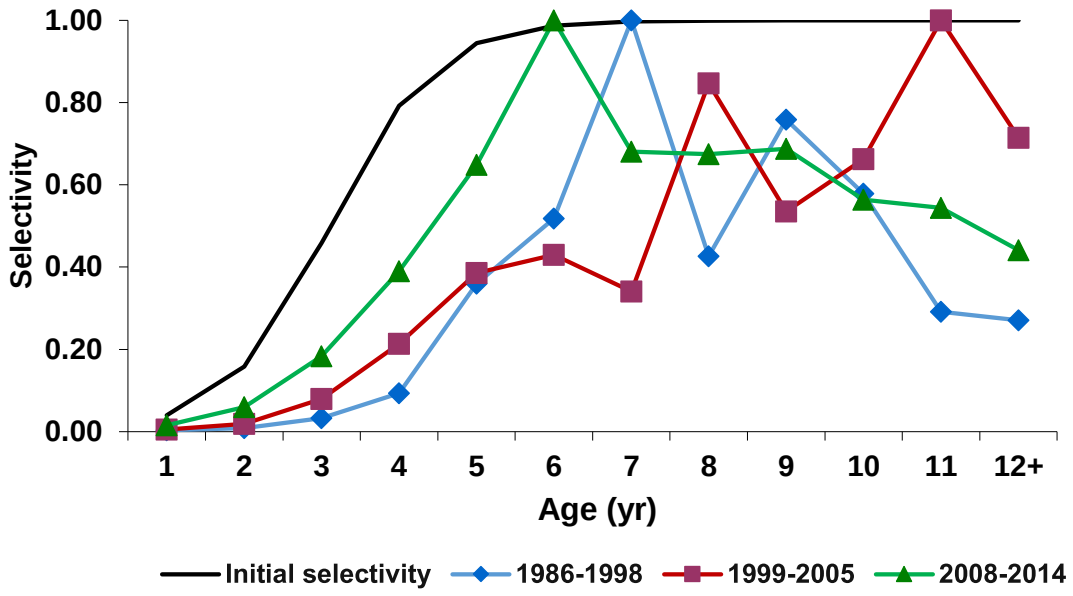


Figure 4.2.2.4.1.6. Comparison of observed (ellipses) and predicted (line) harvest and dead discards by coast from 40.4 million Markov Chain Monte Carlo simulations. The dashed lines represent the 95% credible intervals.

a. Atlantic



b. Gulf

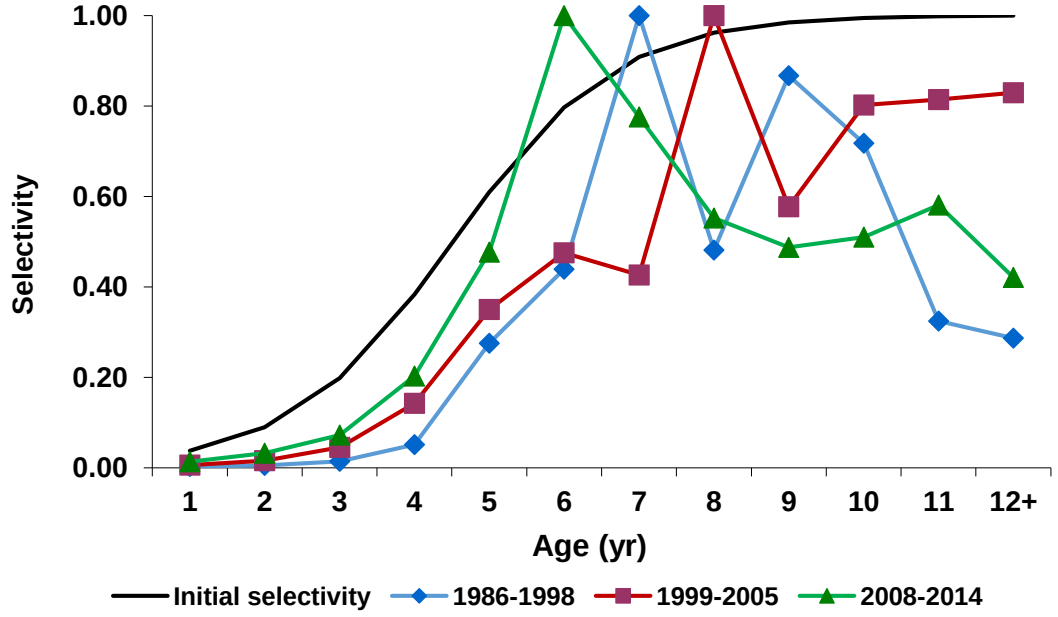
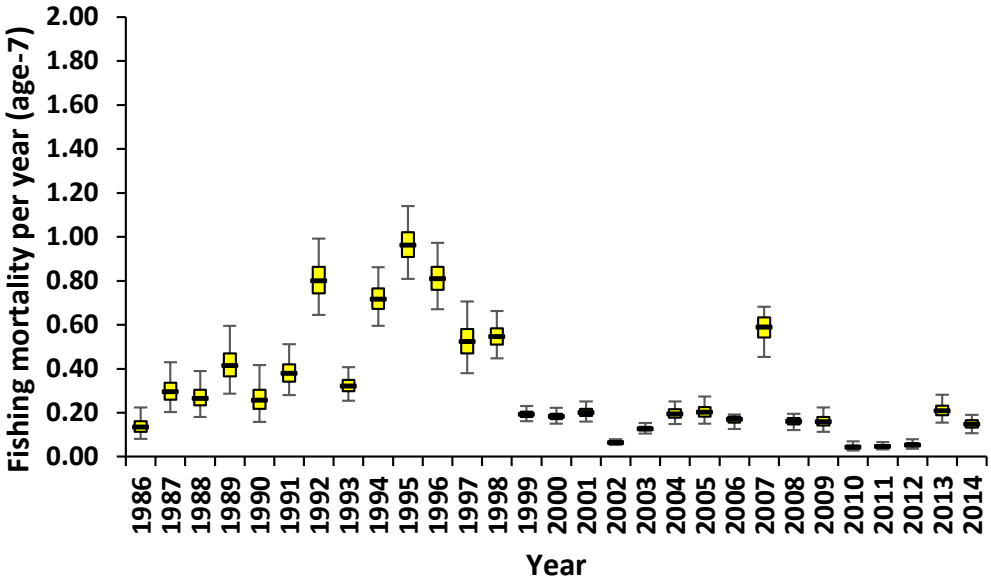


Figure 4.2.2.4.2. Normalized average age-specific selectivities from ASAP estimated fishing mortality rates by coast for before (1986-1998) and after implementing slot limits (1999-2005 and 2008-14).

a. Atlantic



b. Gulf

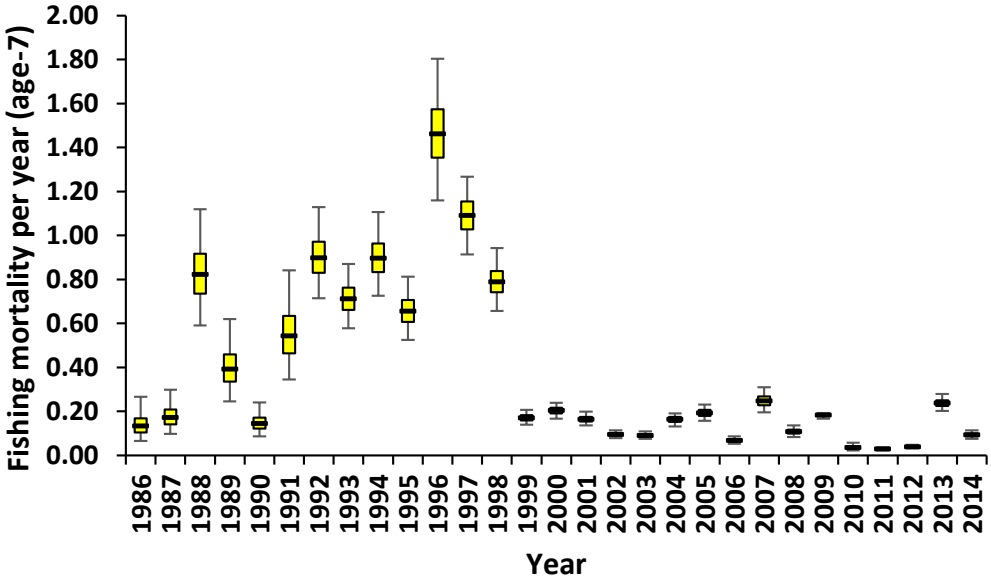
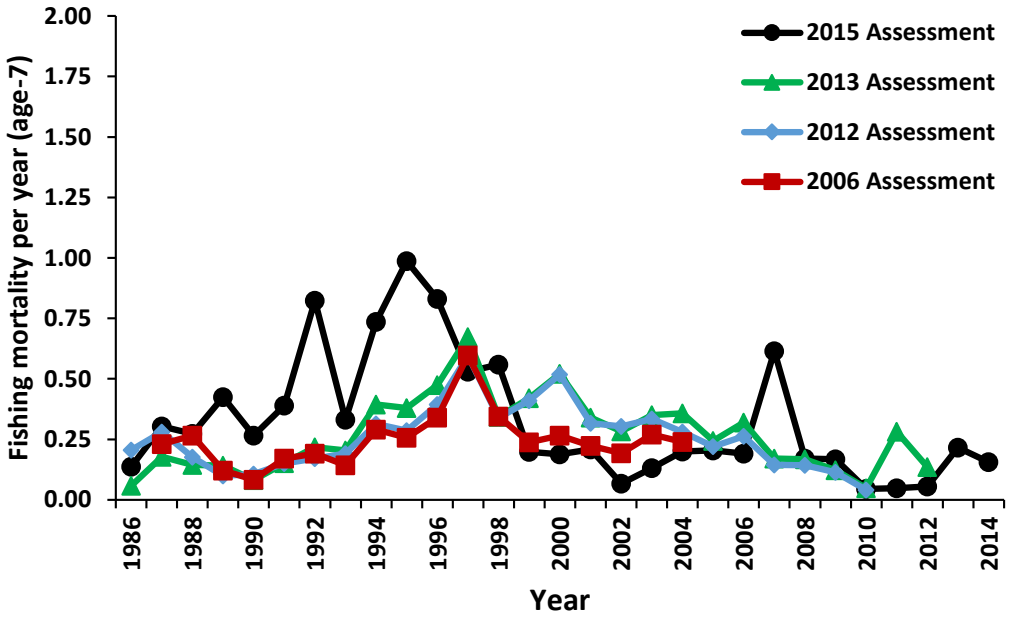


Figure 4.2.2.4.3.1. Distribution of annual fishing mortality rates per year for age-7 on both the Atlantic coast and the gulf coast estimated from 40.4 million Markov Chain Monte Carlo simulations. The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval.

a. Atlantic



b. Gulf

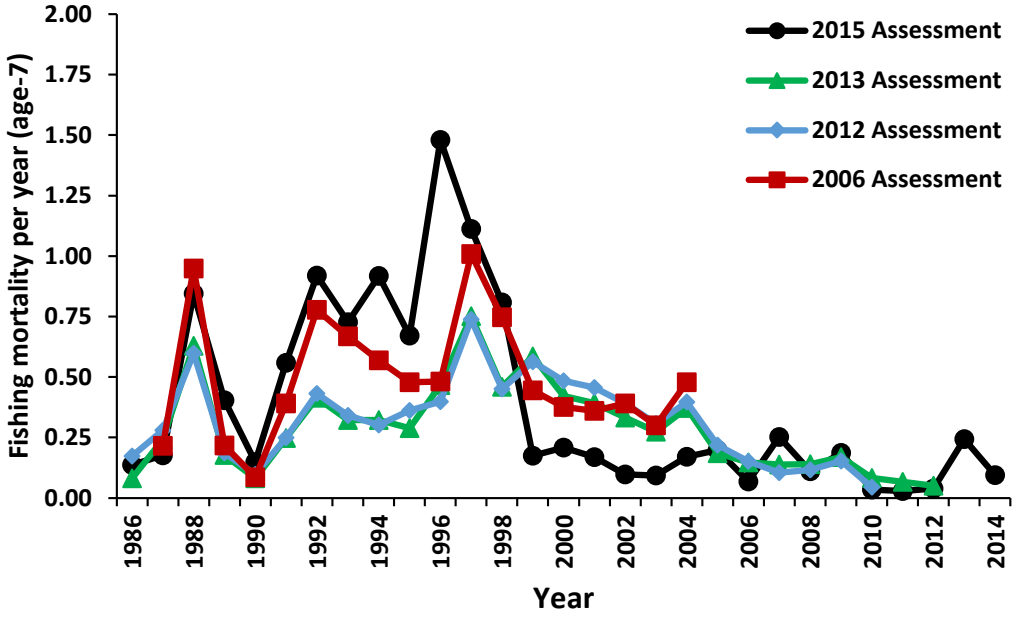
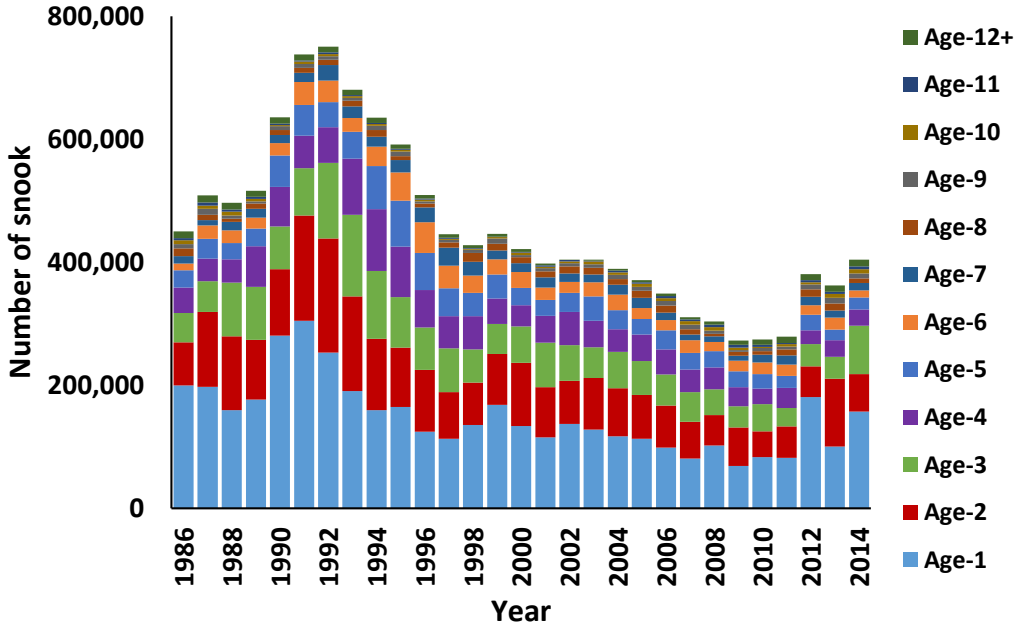


Figure 4.2.2.4.3.2. Comparison of fishing mortality rates from the 2015 assessment with the 2006, 2012, and 2013 stock assessments estimated by ASAP by year and coast: Atlantic (a) and gulf (b).

a. Atlantic



b. Gulf

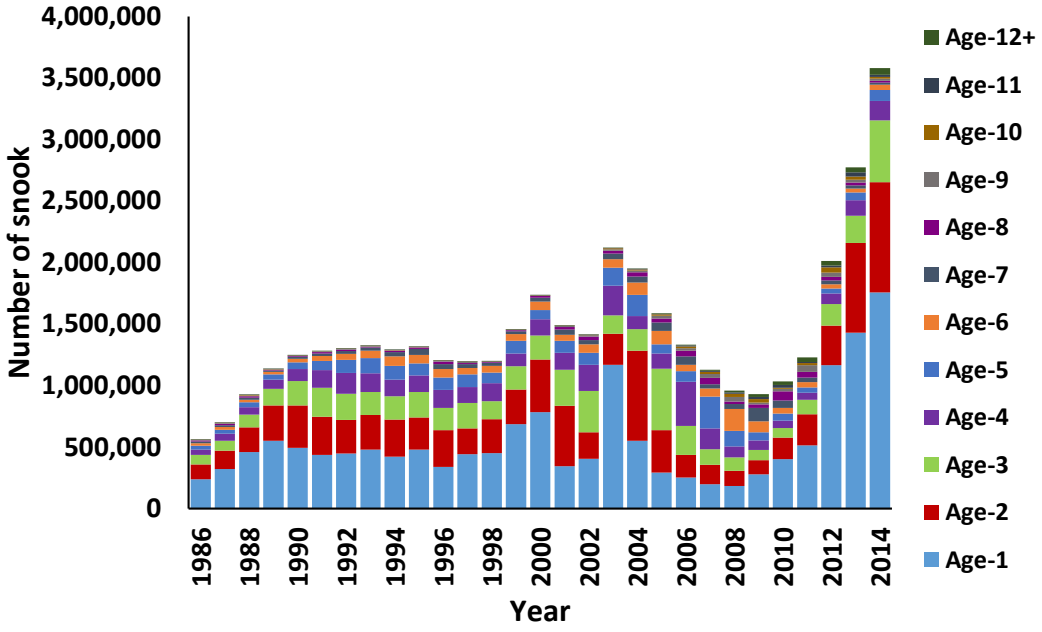
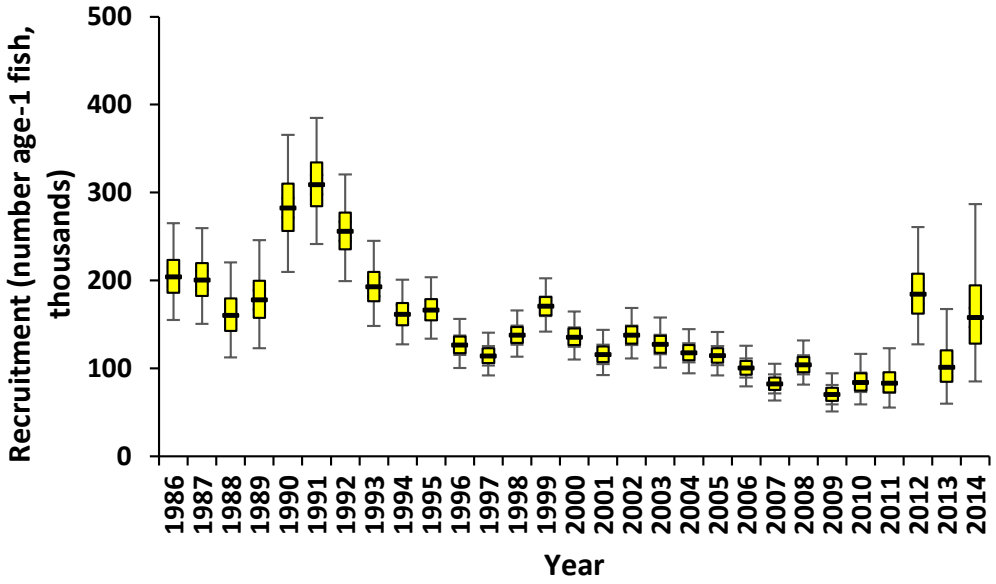


Figure 4.2.2.4.4.1. Estimated total numbers of snook by coast, year, and age from ASAP.

a. Atlantic



b. Gulf

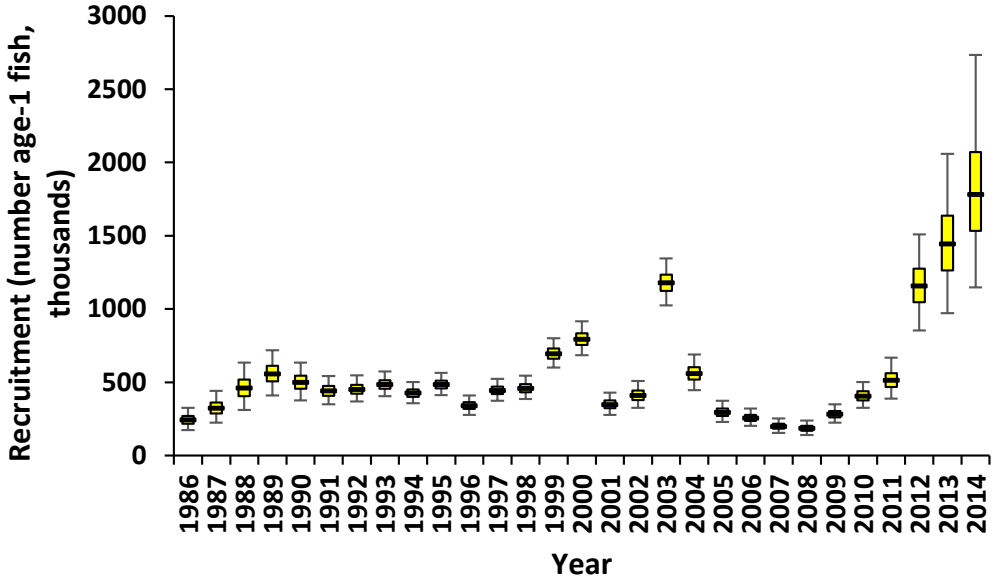
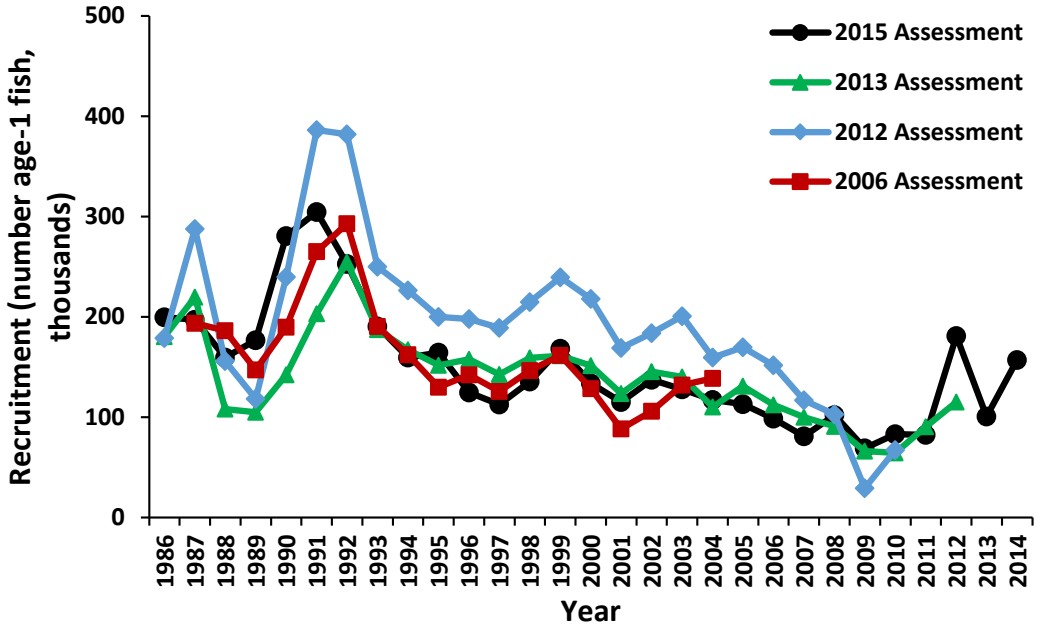


Figure 4.2.2.4.4.2. Distribution of recruitment of age-1 snook by coast and year estimated from 40.4 million Markov Chain Monte Carlo simulations. The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval. Note that the vertical scales are different between the coasts.

a. Atlantic



b. Gulf

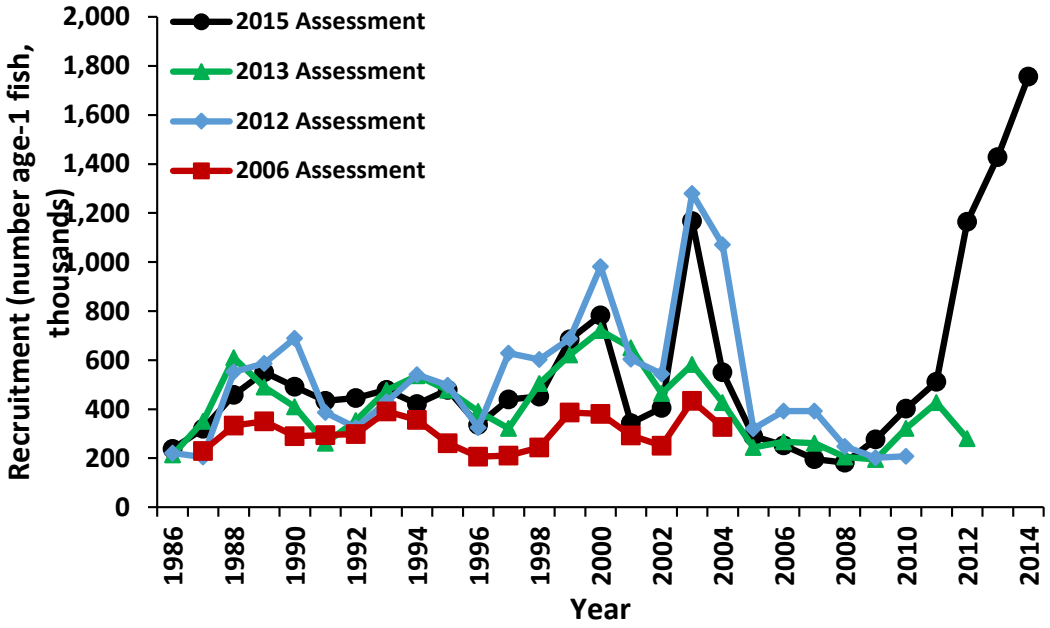
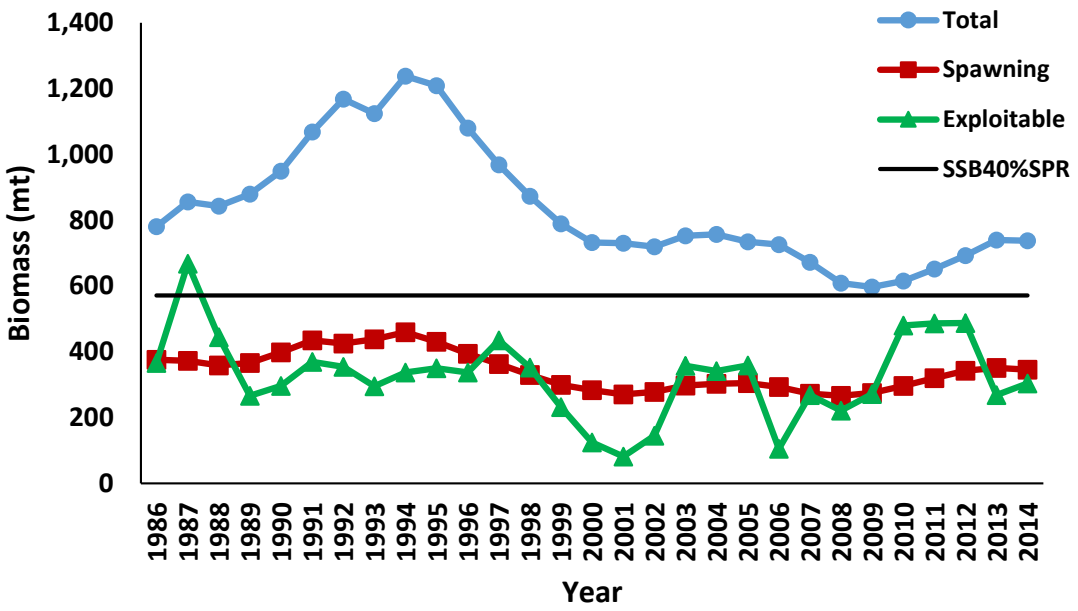


Figure 4.2.2.4.4.3. Comparison of recruitment (number of age-1 snook) from the 2015 assessment with those from the 2006, 2012, and 2013 stock assessments estimated by ASAP by year and coast: Atlantic (a) and gulf (b). Note that the vertical scales differ by coast.

a. Atlantic



b. Gulf

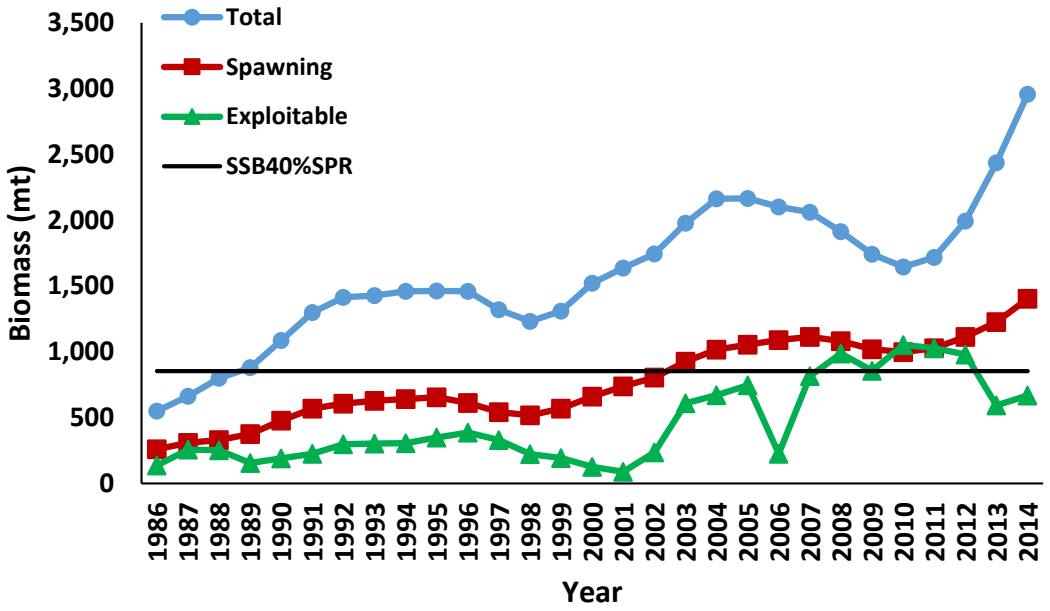
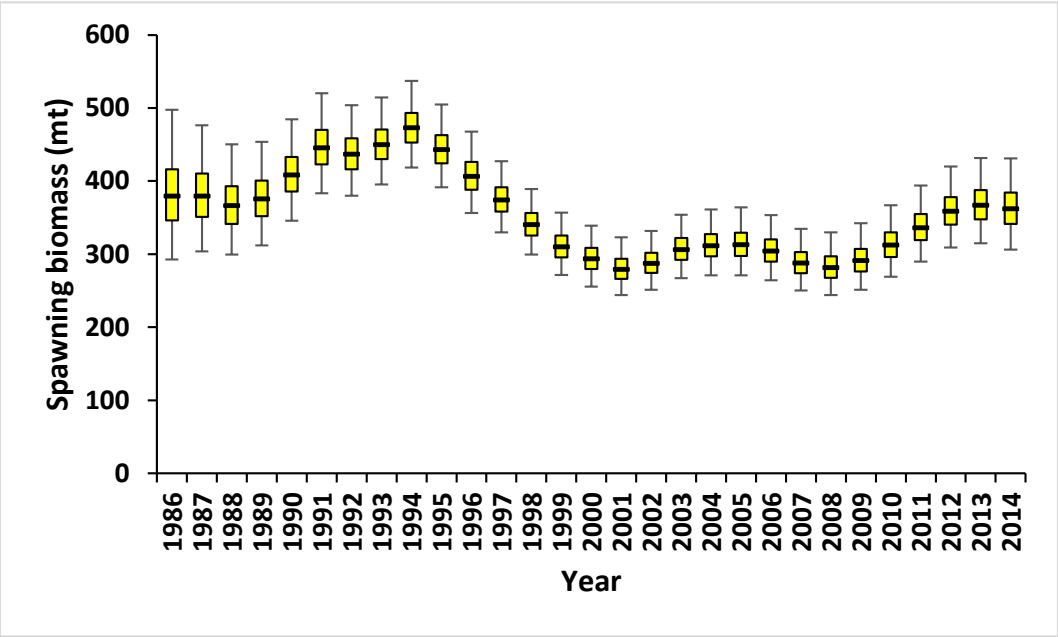


Figure 4.2.2.4.5.1. Estimated total, spawning, exploitable biomass, the spawning biomass at $F_{40\%SPR}$ ($SSB_{40\%SPR}$) by coast and year. Note that the vertical scales are different between the coasts.

a. Atlantic



b. Gulf

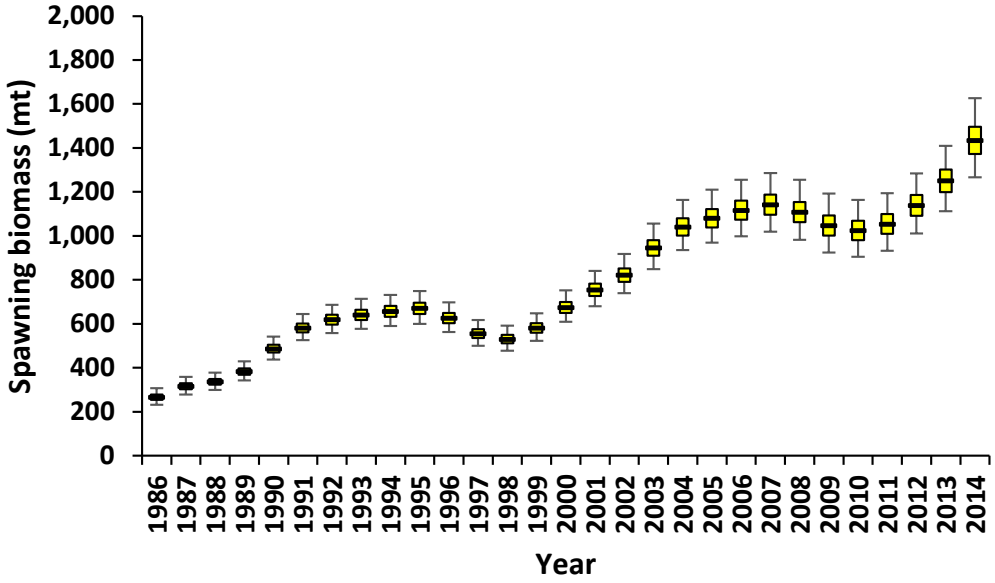
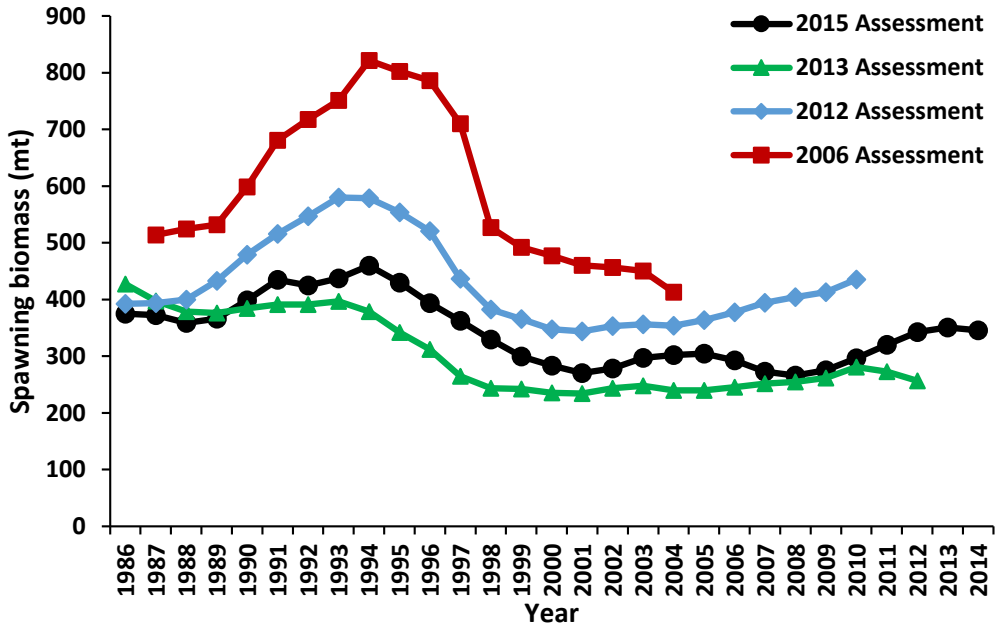


Figure 4.2.2.4.5.2. Distribution of spawning biomass by coast and year estimated from 40.4 million Markov Chain Monte Carlo simulations. . The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval. Note that the vertical scales are different between the coasts.

a. Atlantic



b. Gulf

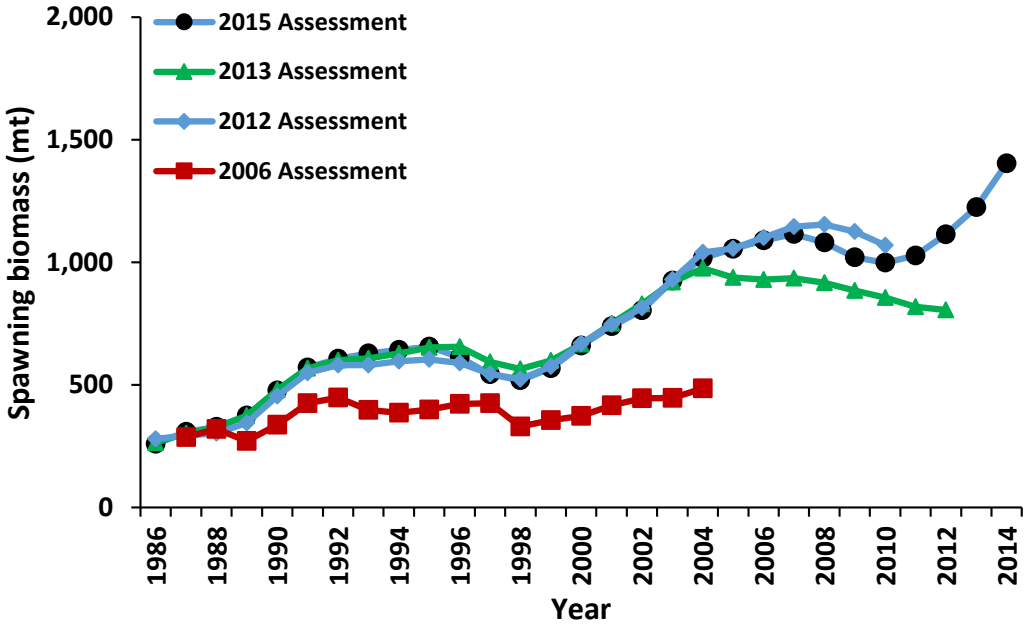
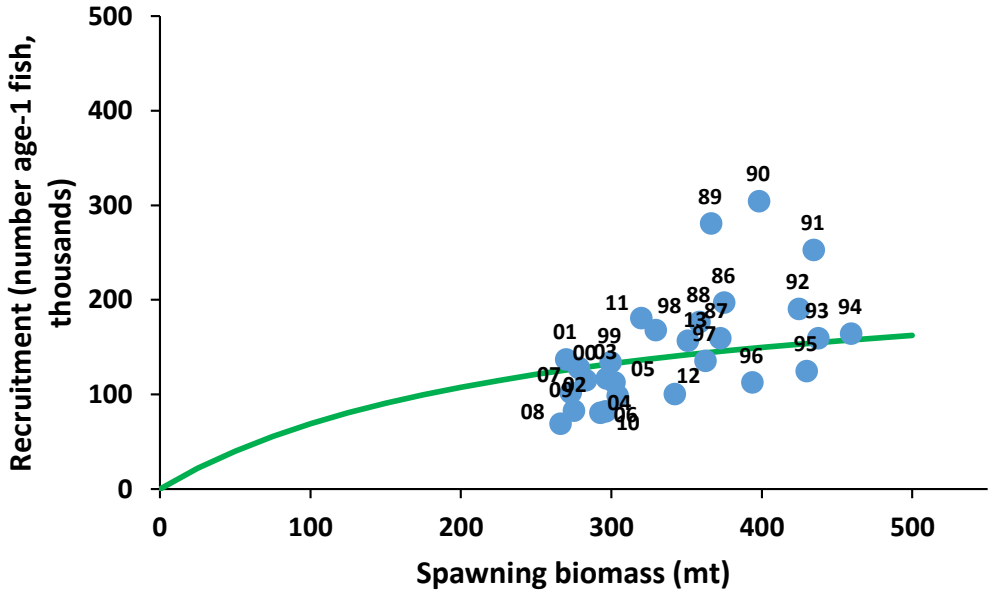


Figure 4.2.2.4.5.3. Comparison of the spawning biomass from the 2015 assessment with those from the 2006, 2012, and 2013 stock assessments.

a. Atlantic



b. Gulf

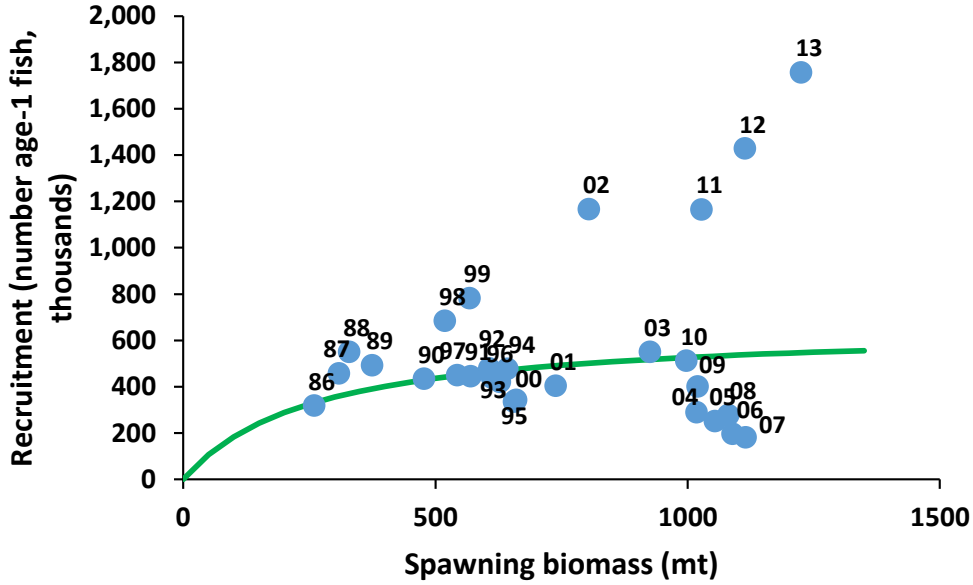
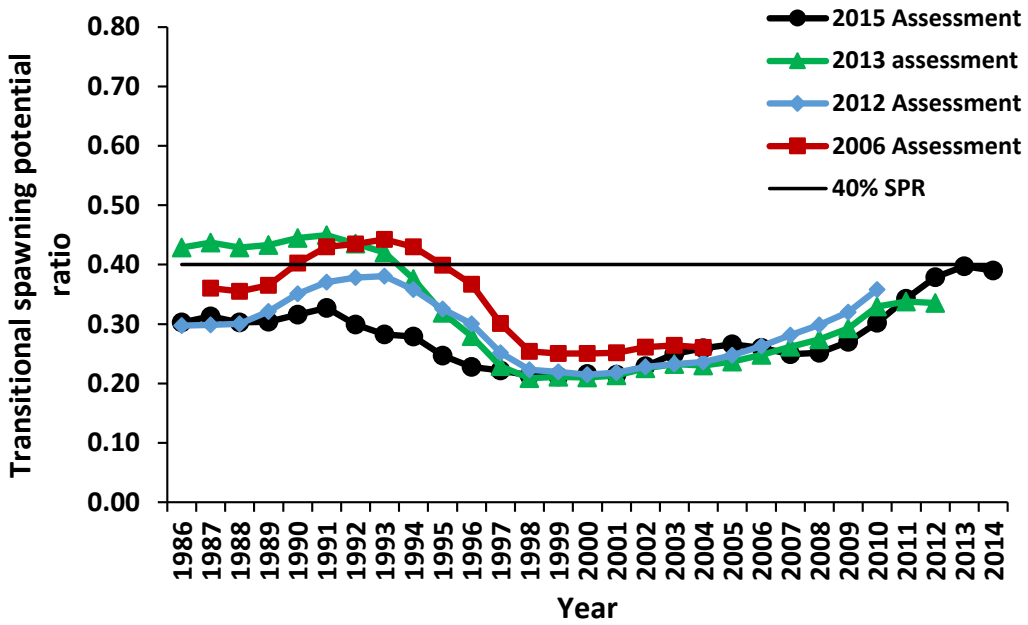


Figure 4.2.2.4.6. Beverton-Holt stock recruitment relationships estimated by ASAP with the steepness on the Atlantic coast (a) of 0.67 and 0.73 on the gulf coast (b). The points are the estimated values and the line is predicted from the equation. Note that the vertical scales differ by coast.

a. Atlantic



b. Gulf

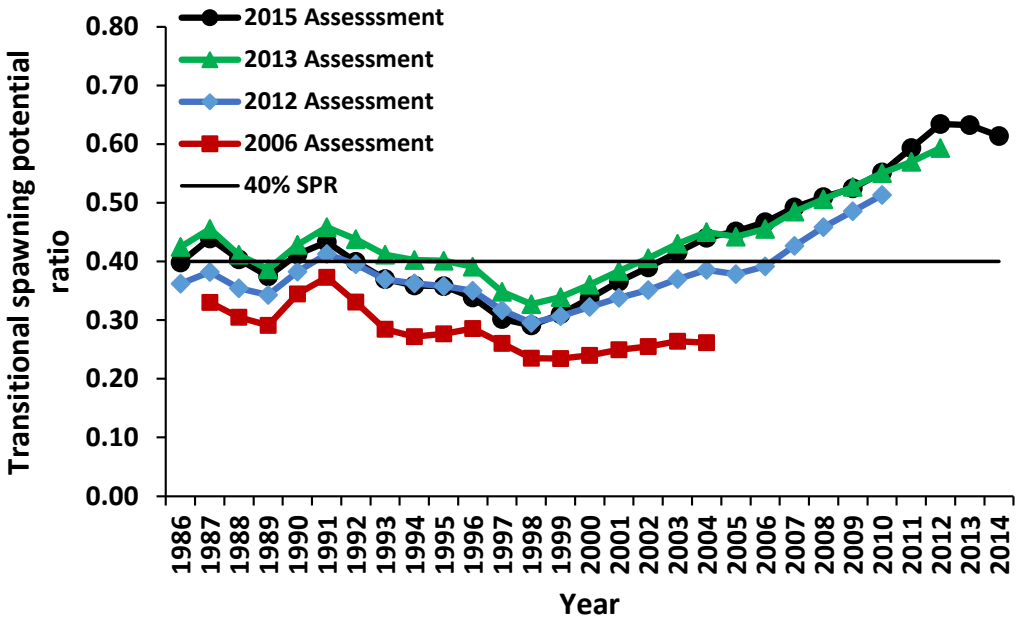
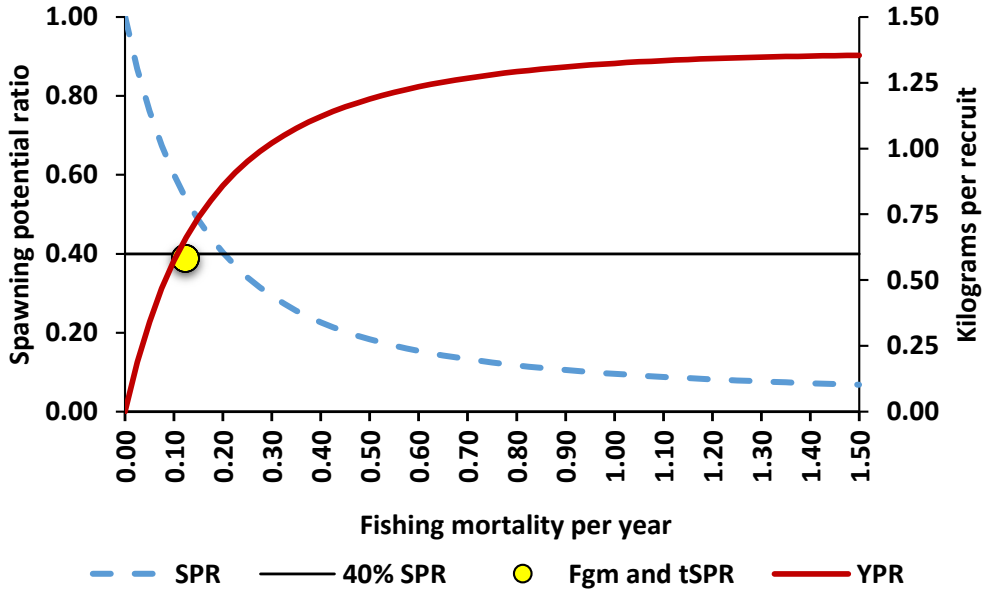


Figure 4.2.2.4.8.1. Comparison of transitional spawning potential ratios from the 2015 assessment with those from the 2006, 2012, and 2013 stock assessments, and the Commission's 40% management goal.

a. Atlantic



b. Gulf

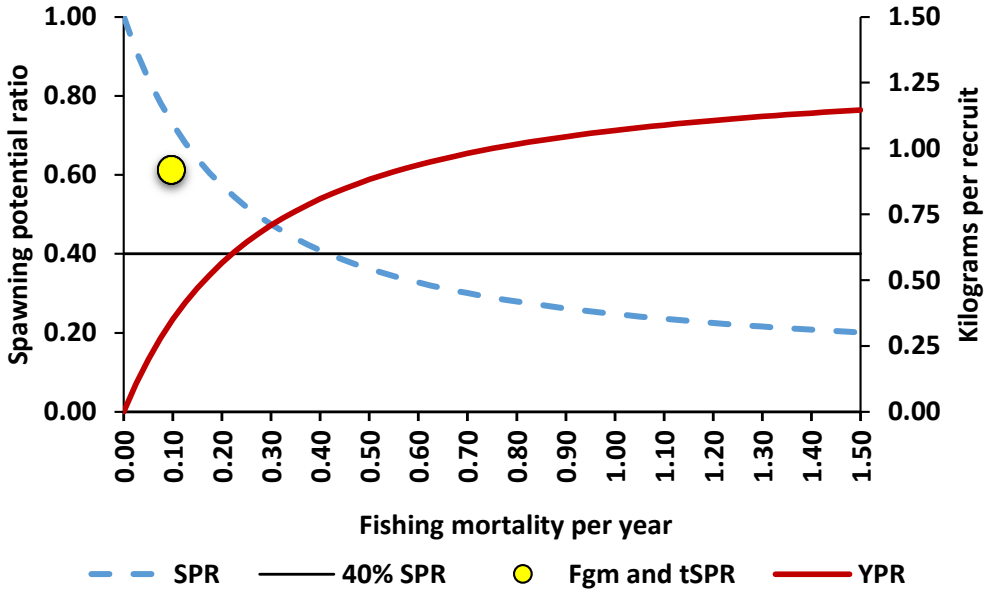
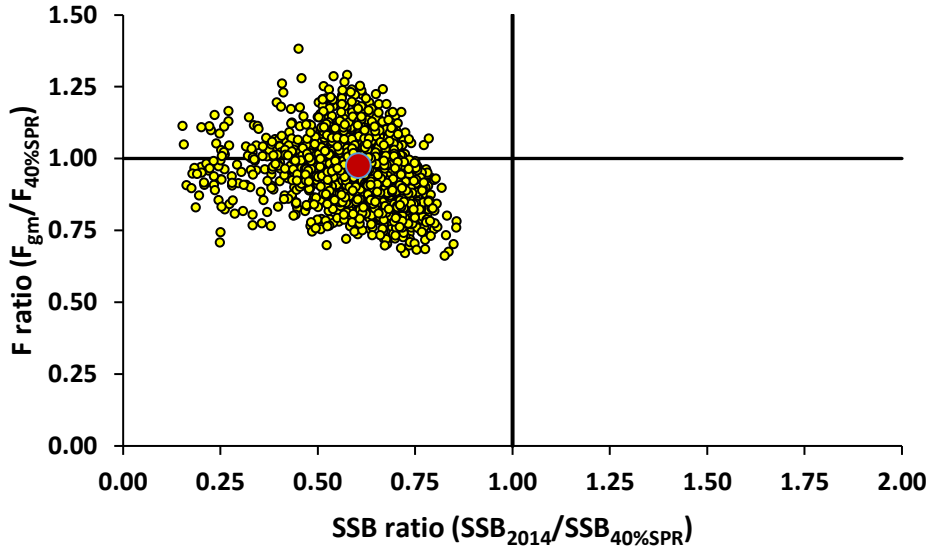


Figure 4.2.2.4.8.2. Yield per recruit and static spawning potential ratios over a range of fishing mortality rates plus the geometric mean fishing mortality rate and the transitional SPR (F_{gm} and tSPR, solid point) from ASAP with the 40% SPR goal. The average instantaneous natural mortality rates used in these analyses averaged 0.20 per year on the Atlantic coast and 0.25 per year on the Gulf coast.

a. Atlantic



b. Gulf

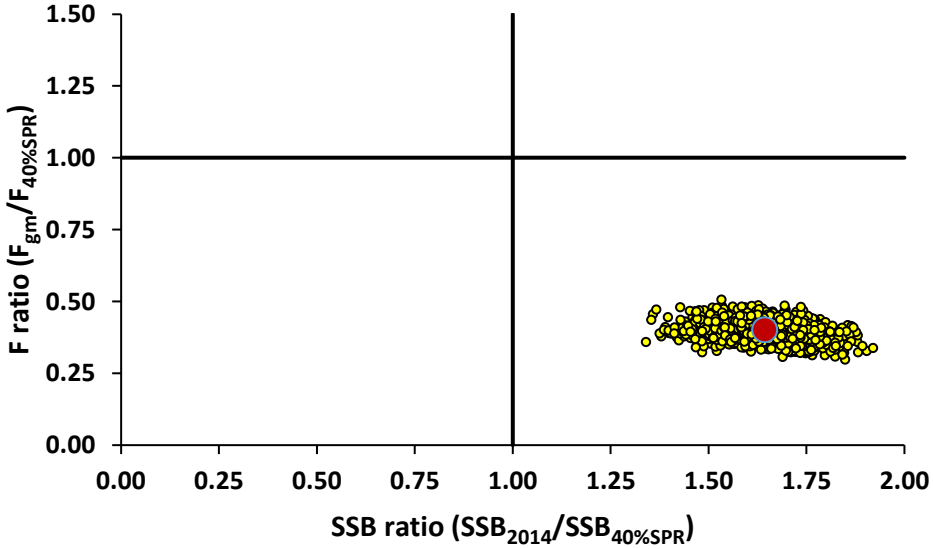
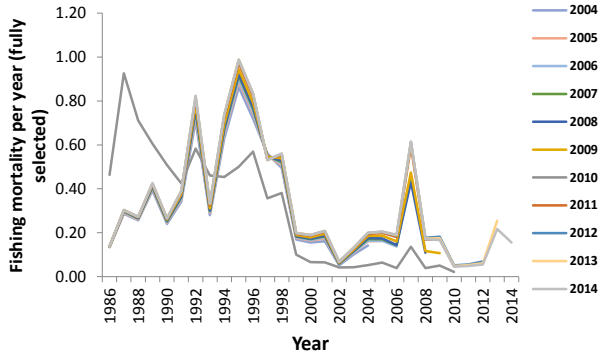


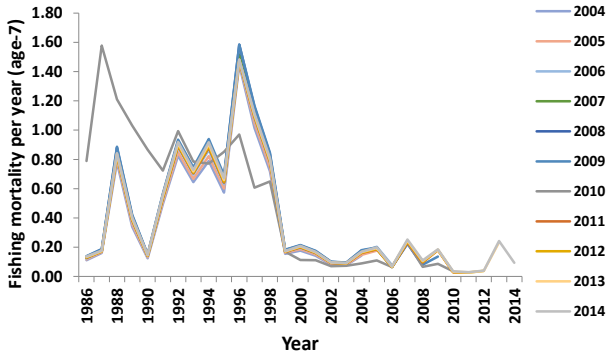
Figure 4.2.2.4.8.3. Uncertainty in ratio of the geometric mean fishing mortality rate on age-7 fish (F_{gm}) for the years (2012-2014) with respect to the fishing mortality rate corresponding to spawning potential ratio of 40% ($F_{40\%SPR}$) and the ratio of the spawning biomass in 2014 to the spawning biomass at $F_{40\%SPR}$ on the Atlantic coast (a) and on the gulf coast (b). The points are a 5% random subsample for illustration purposes. The red point represents the ASAP status.

Fishing mortality per year on Age-7 snook

a. Atlantic

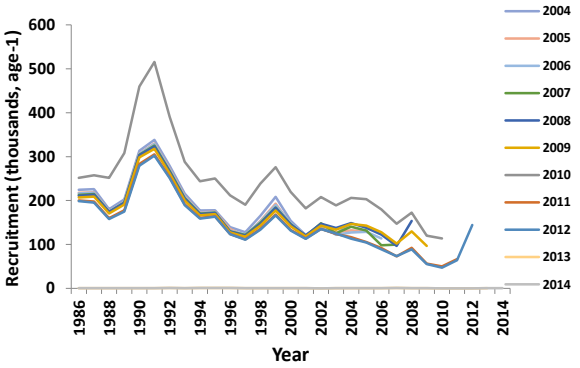


b. Gulf

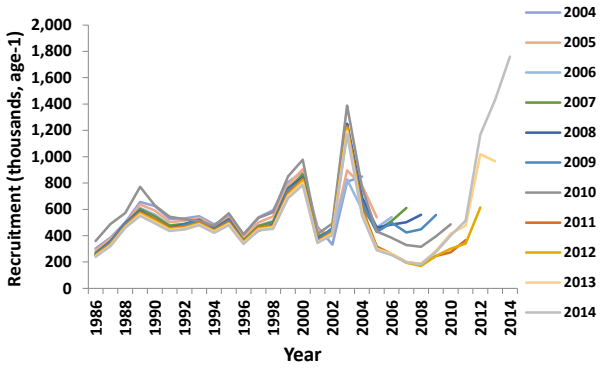


Recruitment (number of Age-1 snook)

c. Atlantic

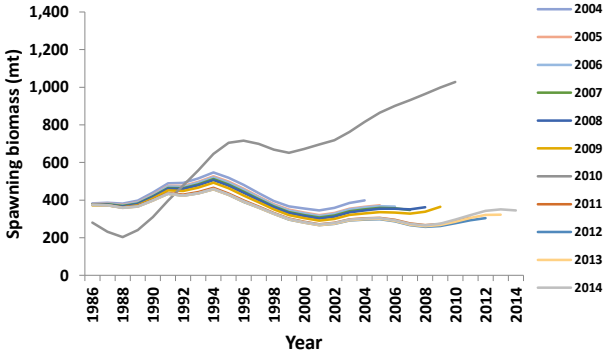


d. Gulf



Spawning biomass (mt)

e. Atlantic



f. Gulf

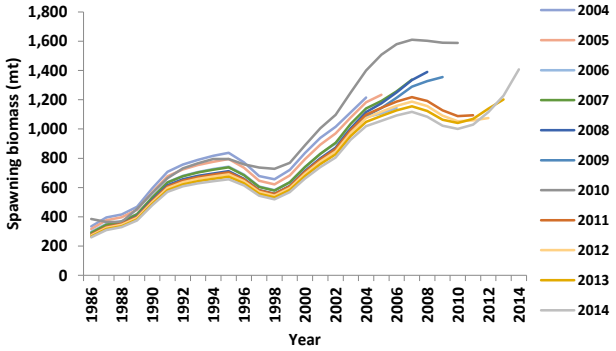


Figure 4.2.2.4.9.1. Retrospective analyses of population parameters by coast using terminal years from 2004 through 2014.

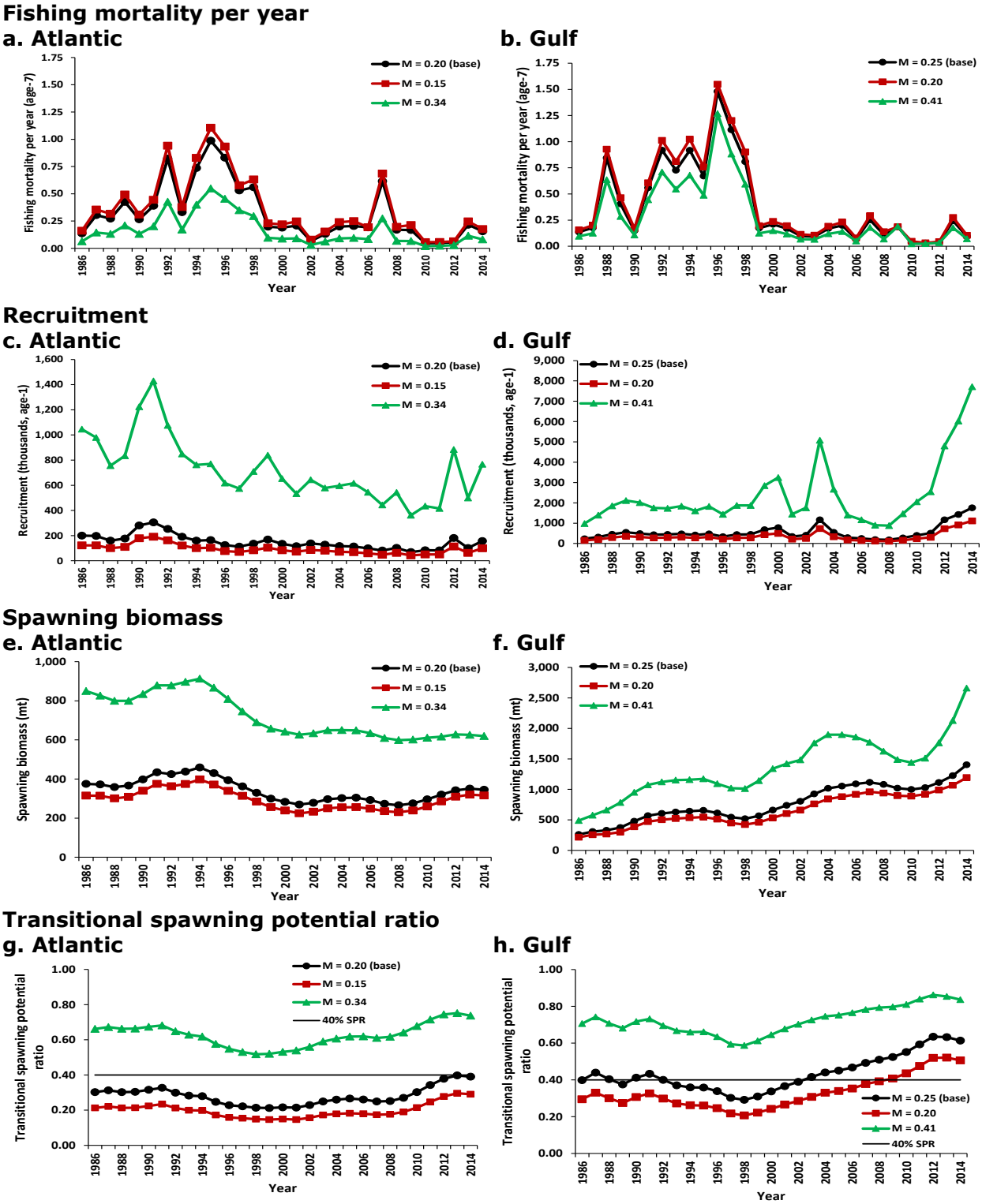


Figure 4.2.2.4.9.2.1. Annual population parameters from sensitivity runs with natural mortality rates of 0.15 per year and 0.34 per year as compared to 0.20 per year on the Atlantic coast (a, c, e, g).and 0.20 per year and 0.41 per year as compared to 0.25 per year on the gulf coast (b, d, f, h).

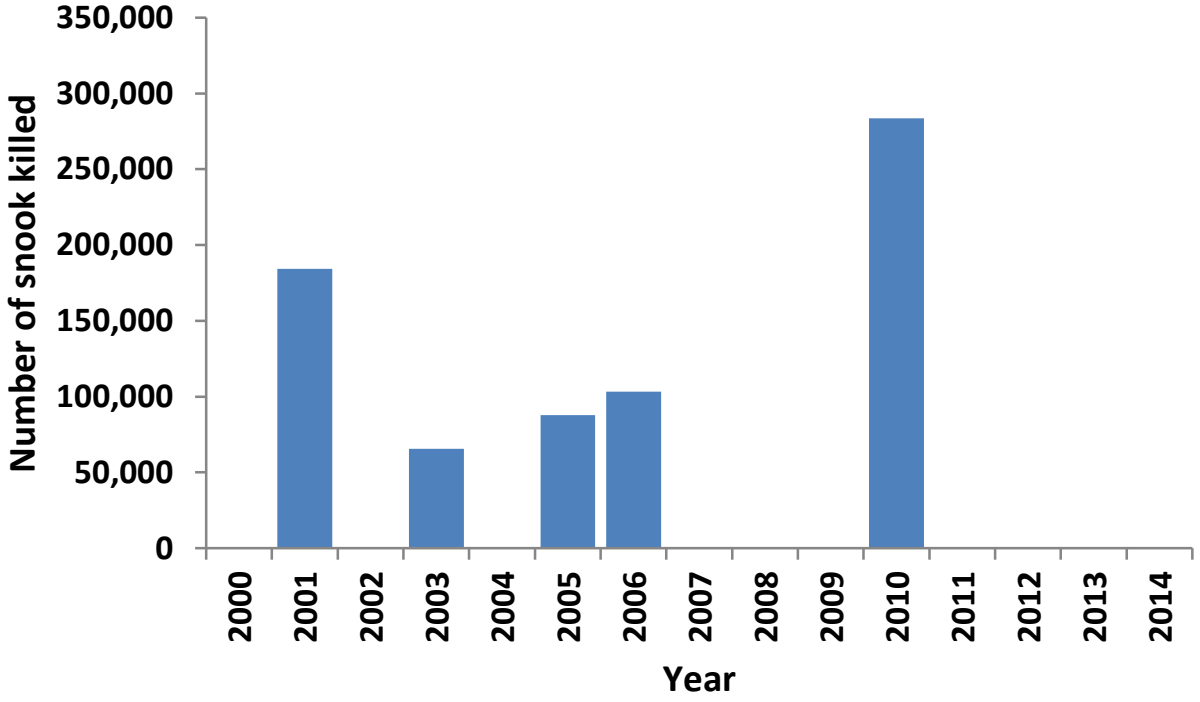


Figure. 4.2.2.4.9.2.2. Estimated number of fish killed by cold kills and red tides on the gulf coast from Muller and Taylor (2012).

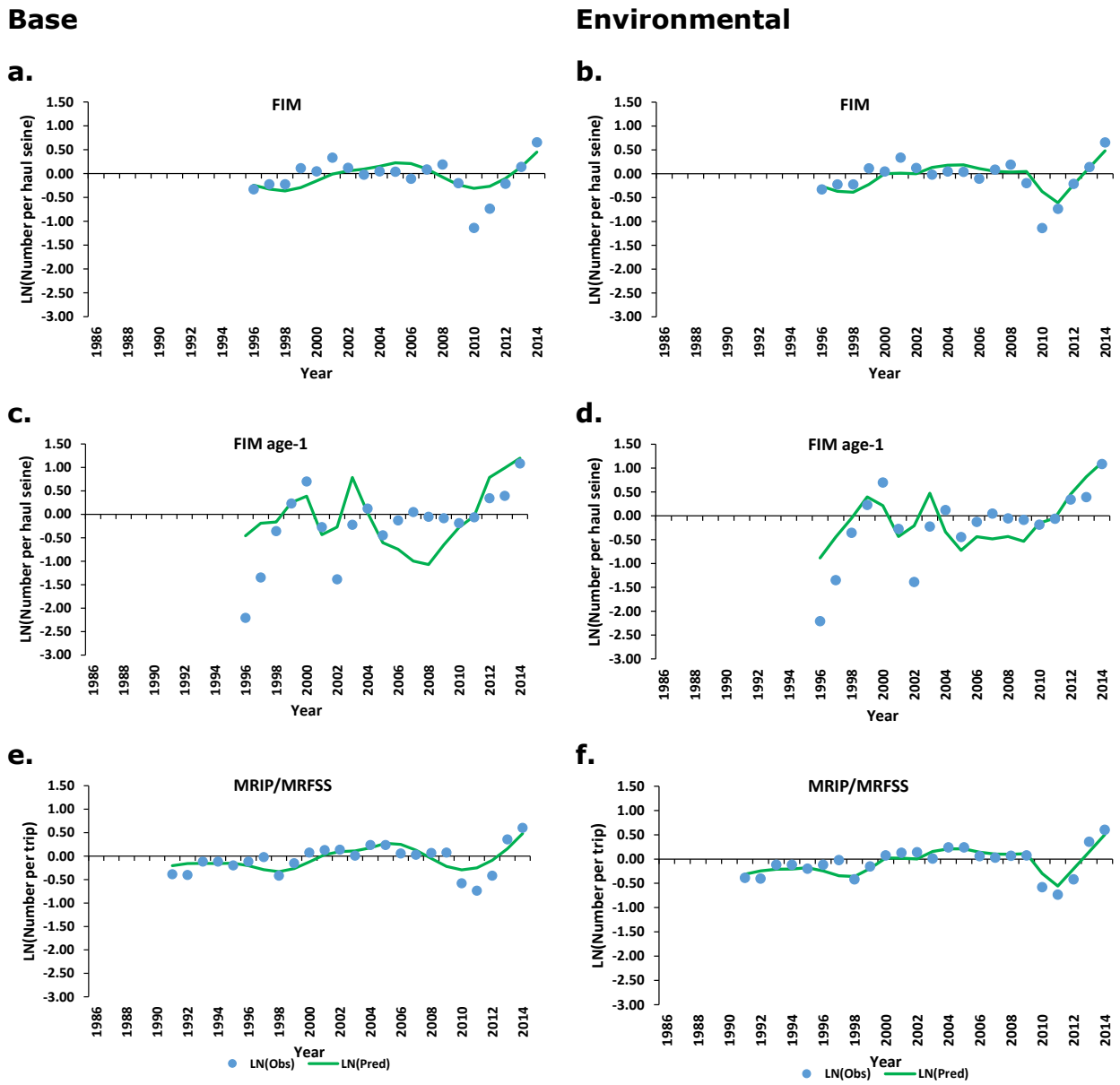
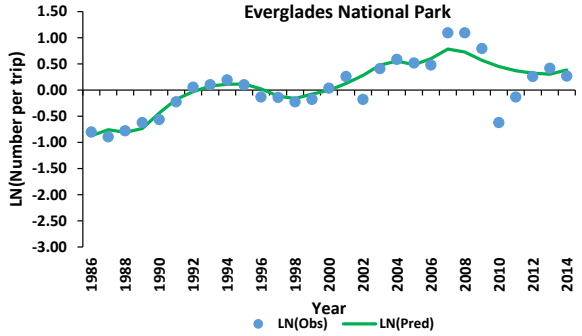
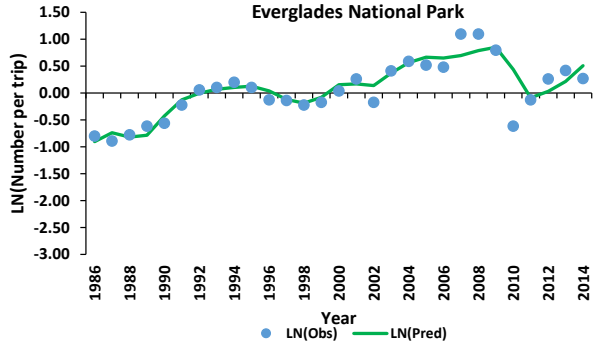


Figure 4.2.2.4.9.2.3. Comparison of the model fit of the indices from the base run and from the sensitivity run with environmental effects. The observed (ellipses) and predicted (line) tuning index values. All indices were equally weighted in the analyses.

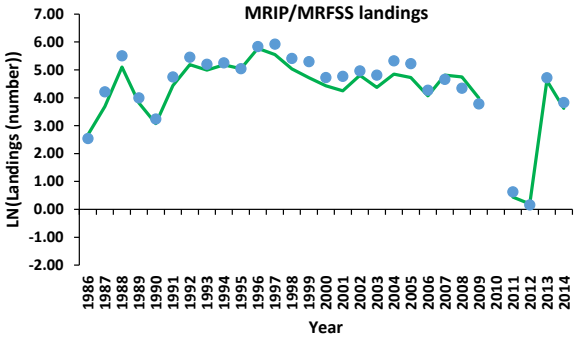
Base **Environmental effects**

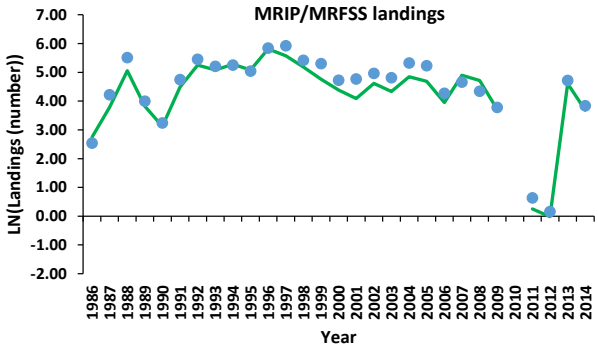
g. **h.**



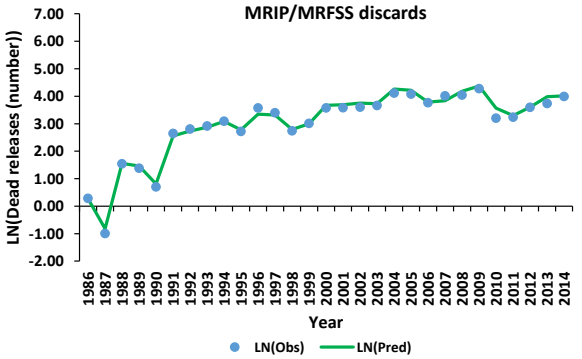


i. **j.**





k. **l.**



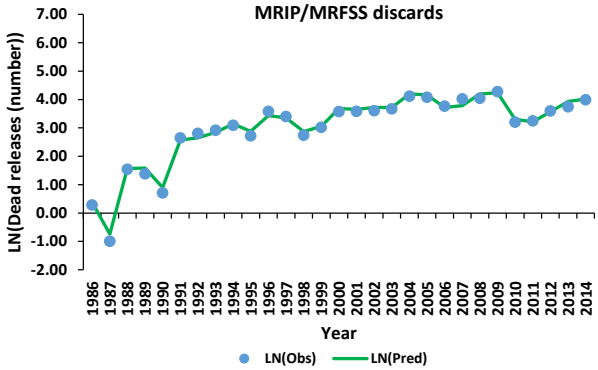
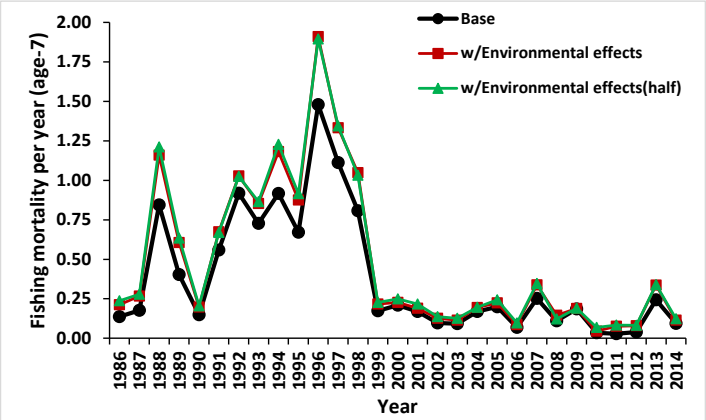
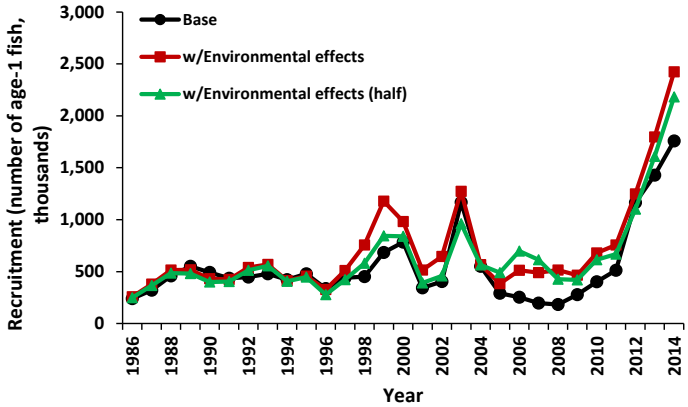


Figure 4.2.2.4.9.2.3 (continued). Comparison of the model fit of the indices from the base run and from the sensitivity run with environmental effects. The observed (ellipses) and predicted (line) tuning index values. All indices were equally weighted in the analyses.

a. Fishing mortality



b. Recruitment



c. Spawning biomass

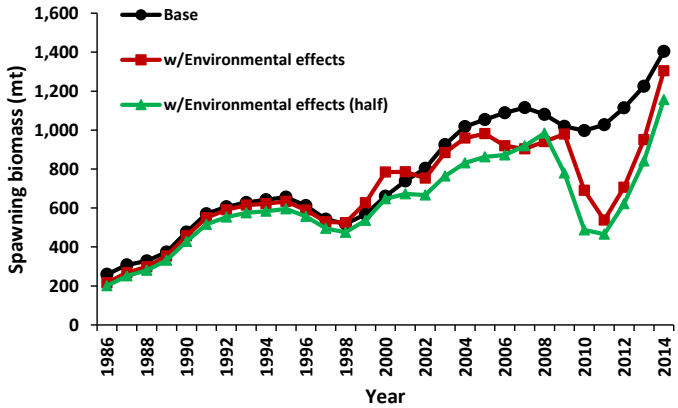
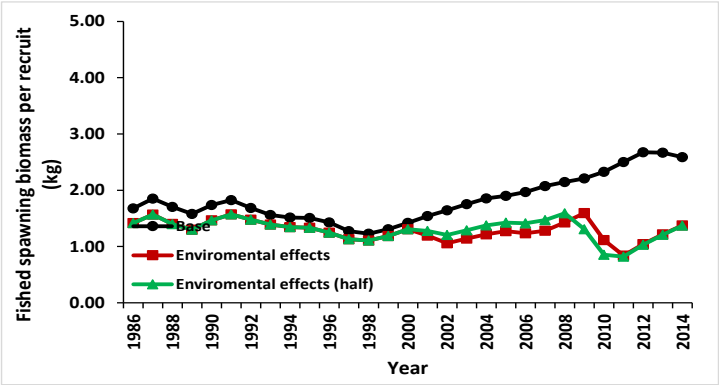
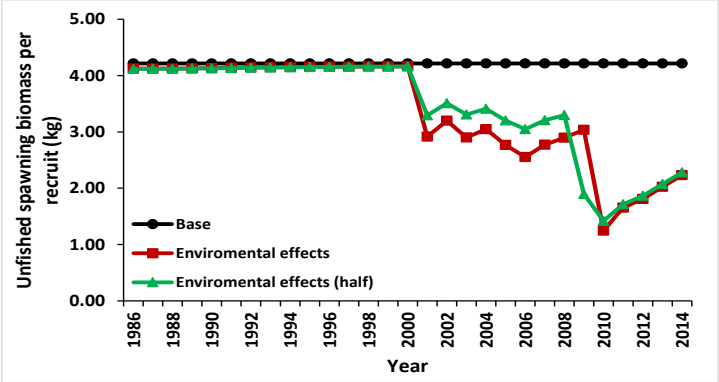


Figure 4.2.2.4.9.2.4. Fishing mortality rates (a), recruitment (b) and spawning biomass (c) from the sensitivity run that accounted for cold kills and red tide effects (w/Environmental) together with the equivalent values from the base run. Also included is the sensitivity run with the number of fish killed by the environment reduced by half (w/Environmental half).

a. Fished spawning biomass per recruit (kg)



b. Unfished spawning biomass per recruit (kg)



c. Transitional spawning potential ratio

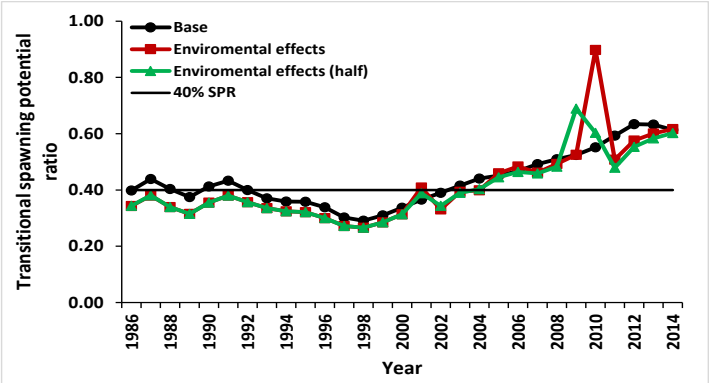
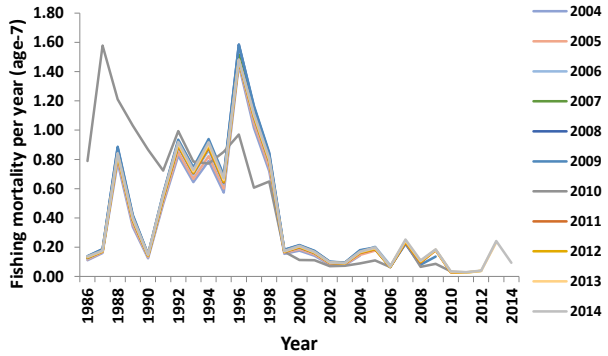


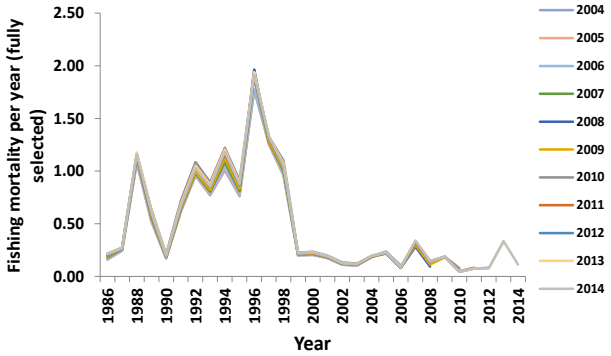
Figure 4.2.2.4.9.2.5. Fished (a), unfished (b) spawning biomass per recruit, and transitional spawning potential ratio (c) from the sensitivity run that accounted for cold kills and red tide effects (w/Environmental) together with the equivalent values from the base run. Also included is the sensitivity run with the number of fish killed by the environment reduced by half (w/Environmental half).

Fishing mortality per year on Age-7 snook

a. Base

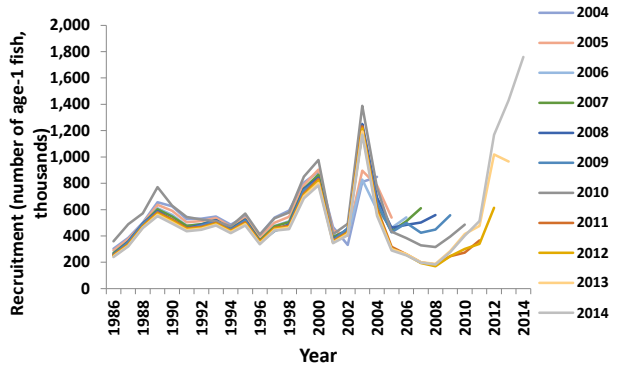


b. With environmental effects

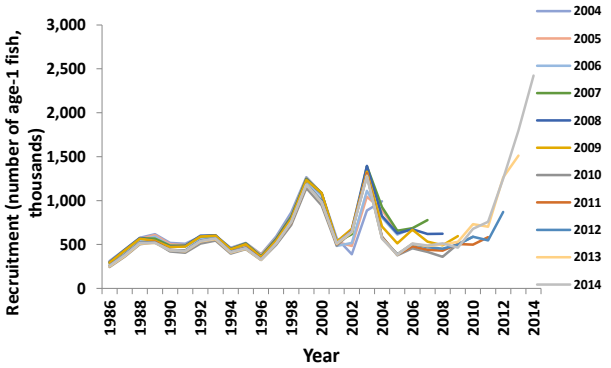


Recruitment (number of Age-1 snook)

c. Base

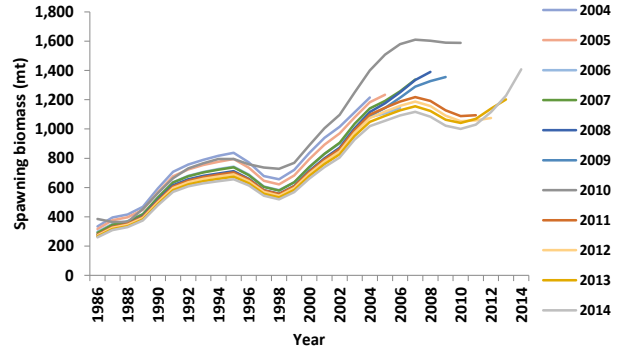


d. With environmental effects



Spawning biomass (mt)

e. Base



f. With environmental effects

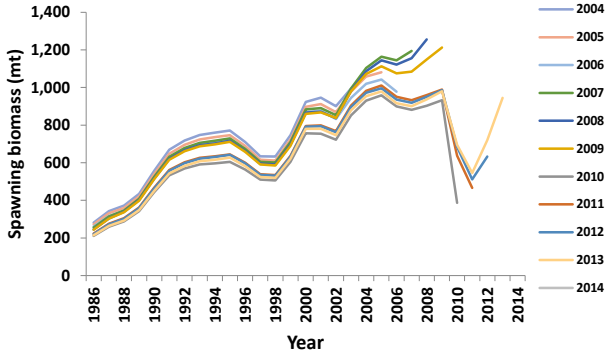
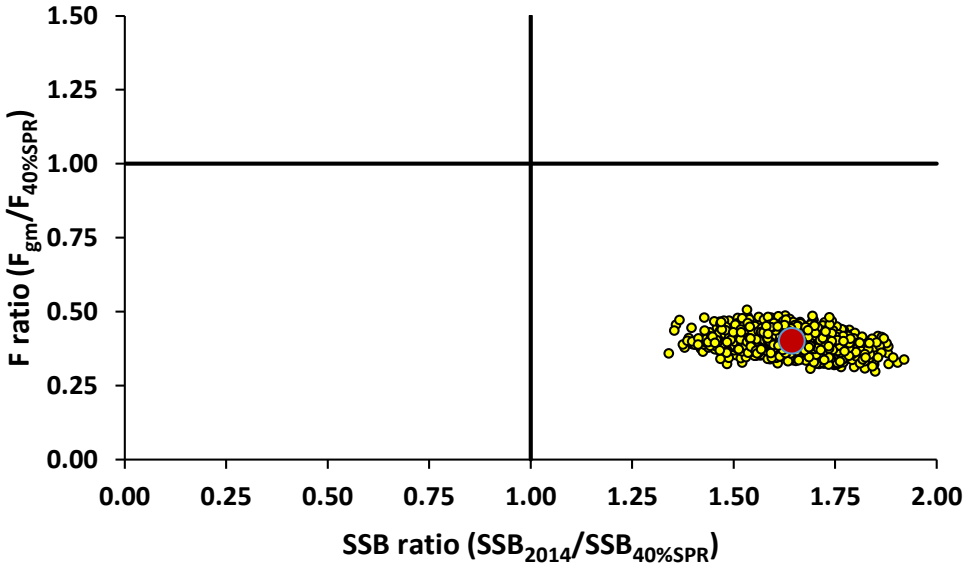


Figure 4.2.2.4.9.2.6. Comparing the retrospective analyses of population parameters by coast of the base run and the sensitivity run accounting for environmental effects using terminal years from 2004 through 2014.

a. Gulf



c. Environmental effects

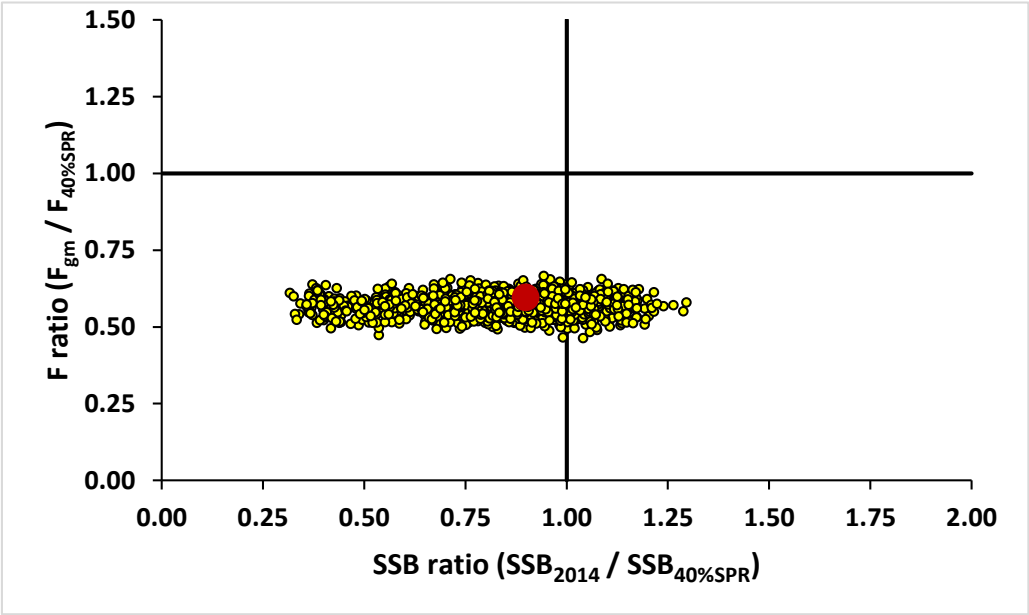


Figure 4.2.2.4.9.2.7. Uncertainty in ratio of the geometric mean fishing mortality rate on age-7 fish (F_{gm}) for the years (2012-2014) with respect to the fishing mortality rate corresponding to spawning potential ratio of 40% ($F_{40\%SPR}$) and the ratio of the spawning biomass in 2014 to the spawning biomass at $F_{40\%SPR}$ on the gulf coast base run (a) and accounting for environmental effects (b). The points are a 5% random subsample for illustration purposes. The red point represents the ASAP status.

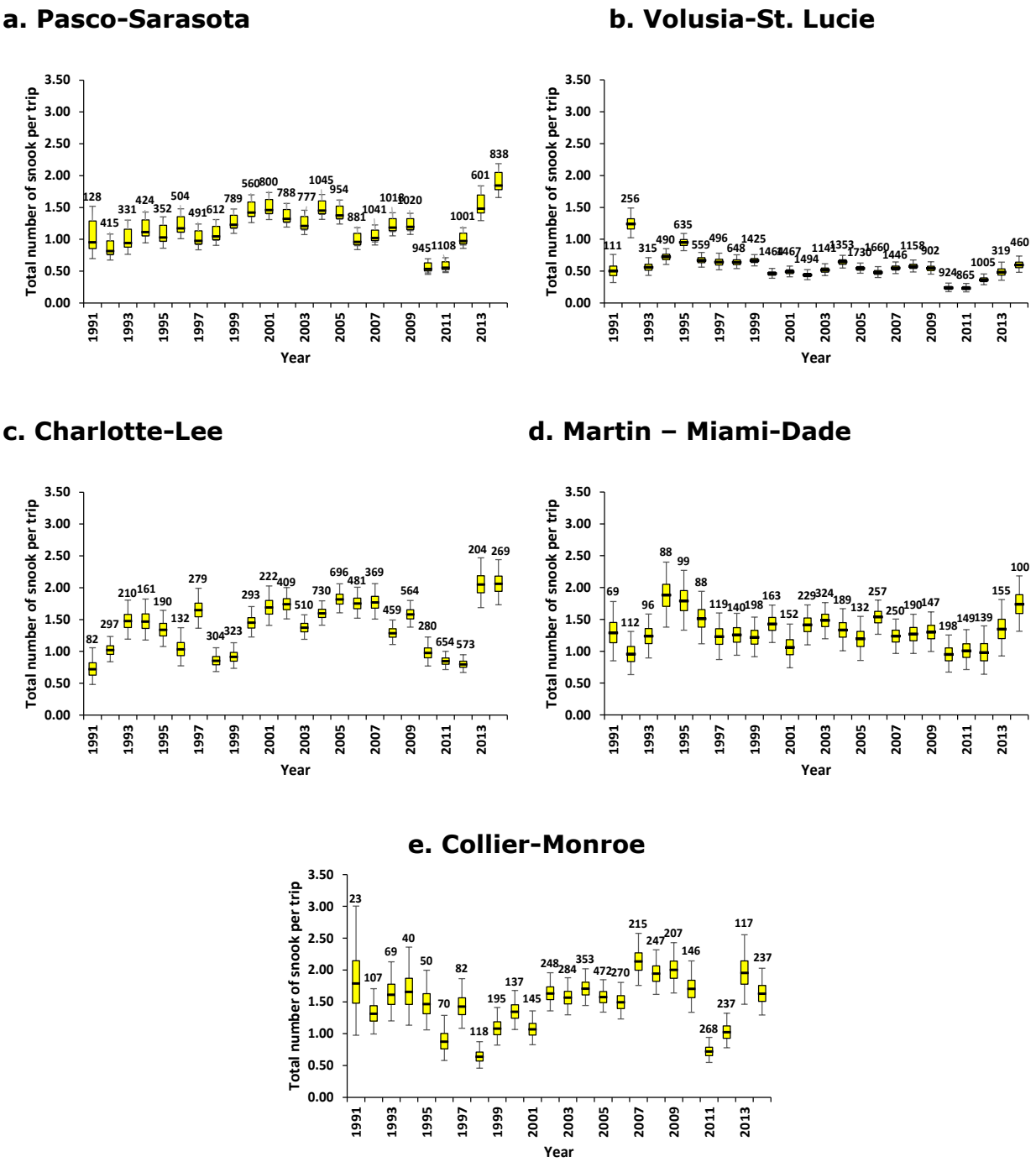
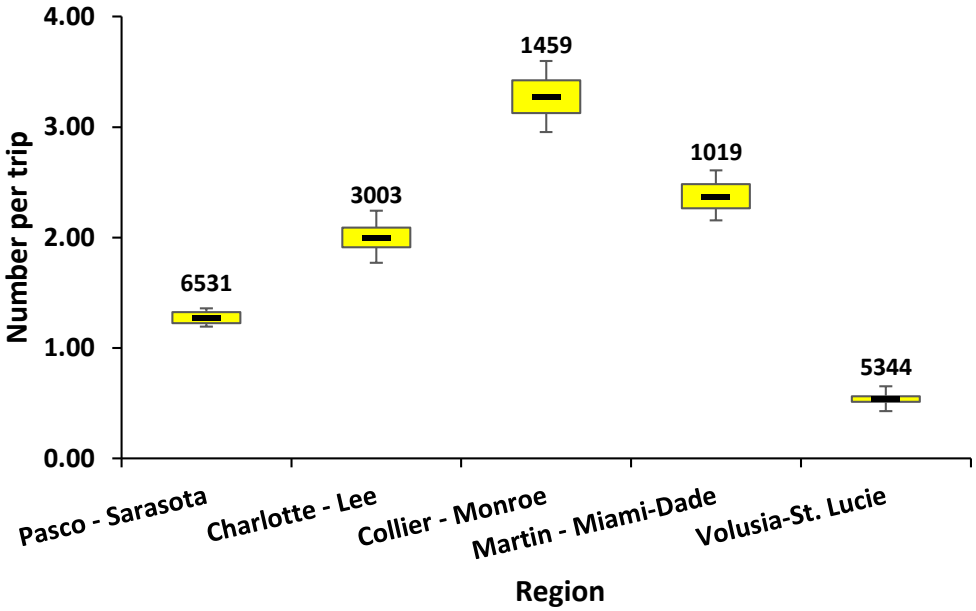


Figure 4.5.1. Distribution of angler total catch rates from MRFSS/MRIP intercepts by year and region. The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval. The number of intercepts by year is shown above the confidence interval.

a. MRFSS/MRIP recreational intercepts



b. Fishery Independent haul seines

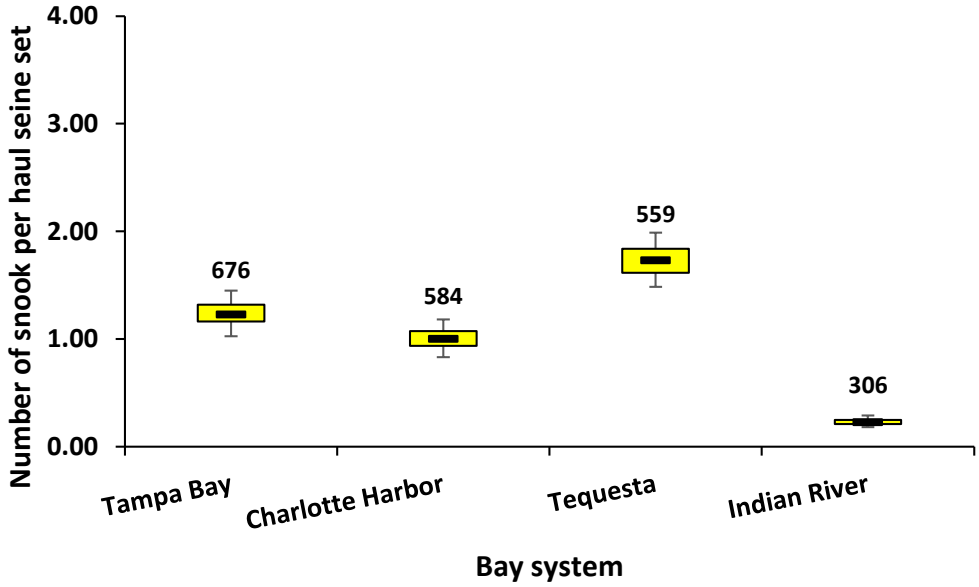


Figure 4.5.2. Comparisons of the total number of snook caught per recreational trip by anglers by region during the open season in 2008-2014 (a) and by fishery independent haul seine sets (b). The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval. The number of observations by region is shown above the confidence interval.

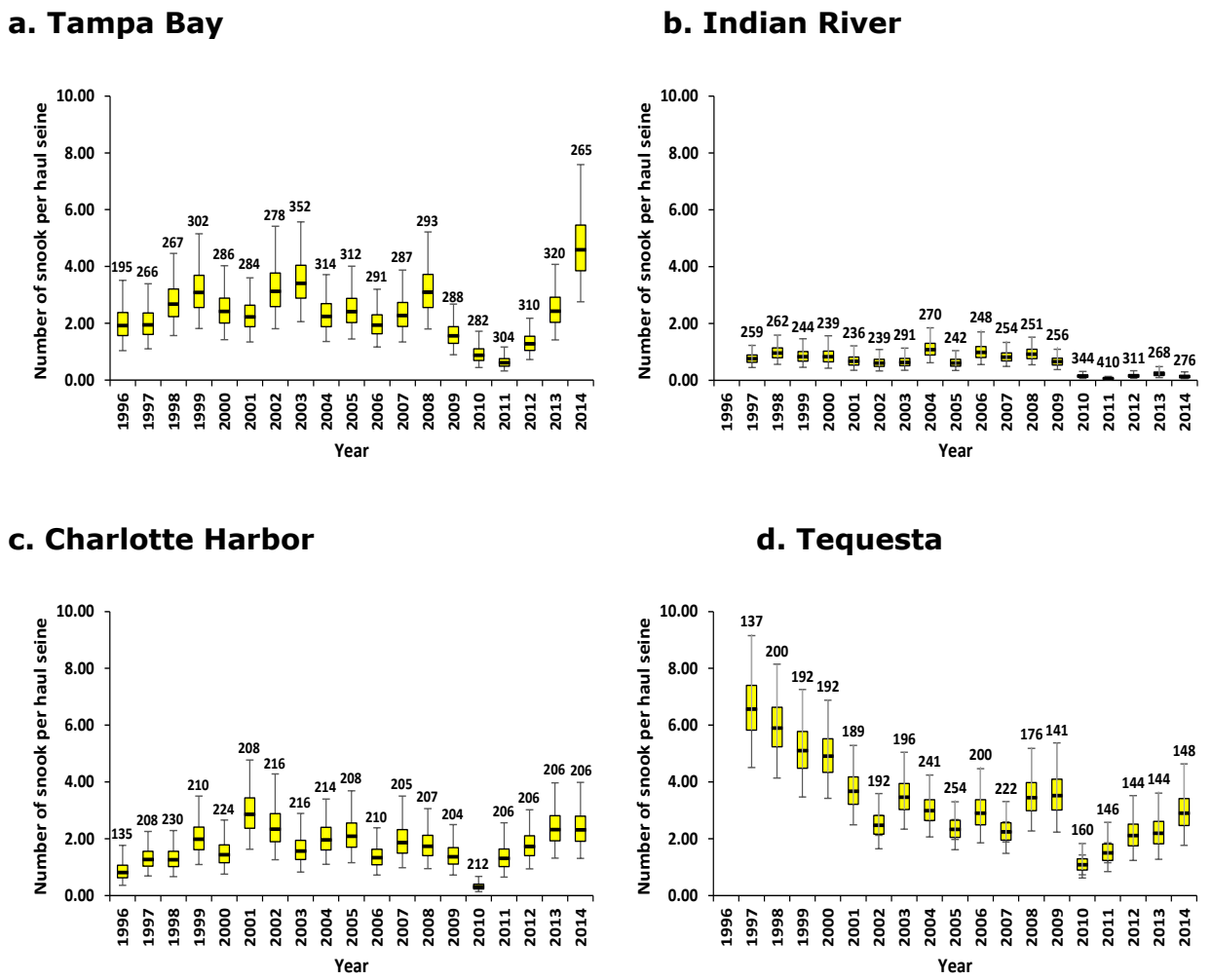
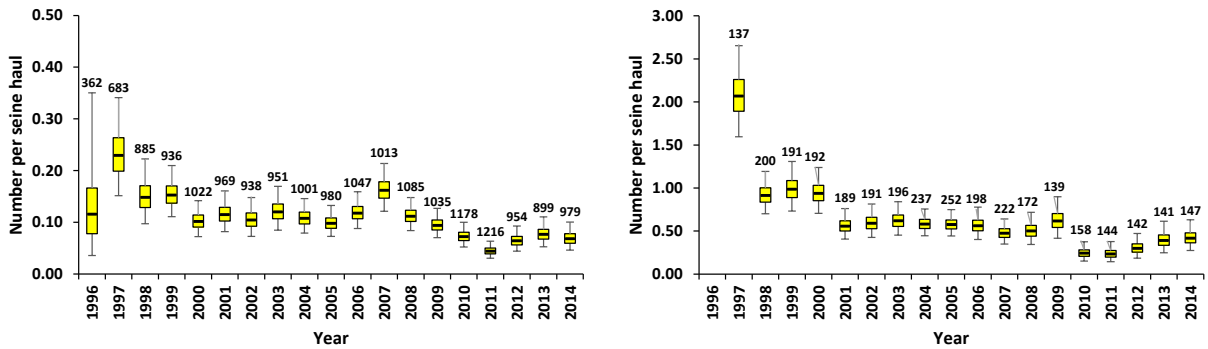


Figure 4.5.3. Distribution of number of snook caught per fishery independent 183 m haul seine sets by bay system and year. The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval. The number of intercepts by year is shown above the confidence interval.

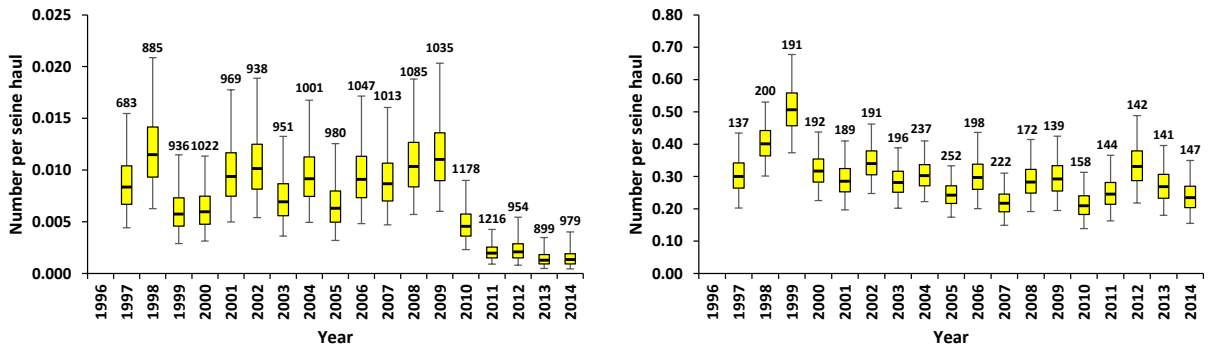
Atlantic

Indian River (IR) **Tequesta (TQ)**

a. Less than 24 inches **b. Less than 24 inches**



c. IR 24 - 34 inches **d. TQ 24 – 34 inches**



e. IR Greater than 34 inches **f. TQ Greater than 34 inches**

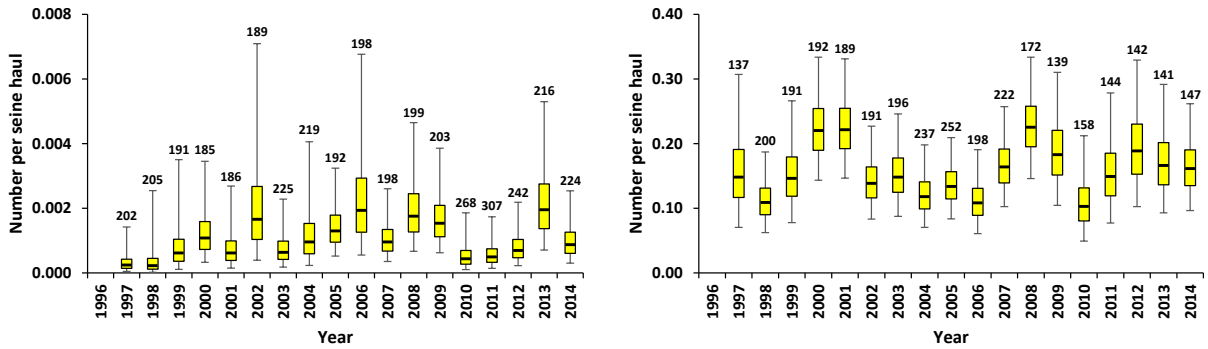
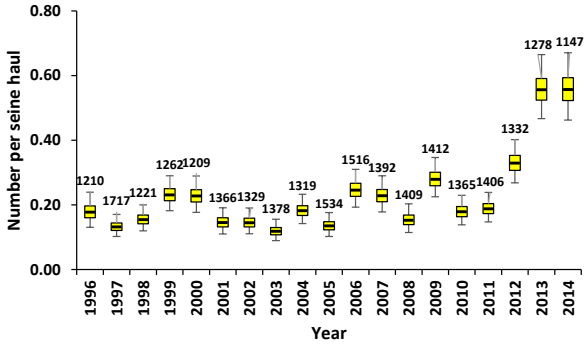


Figure 4.5.4. Distributions of the numbers of fish per seine haul by coast, bay (Indian River, Tequesta, Tampa Bay, and Charlotte Harbor), and size categories from the FIM 183 m haul seines. The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval. The number of seine hauls by year is shown above the confidence interval.

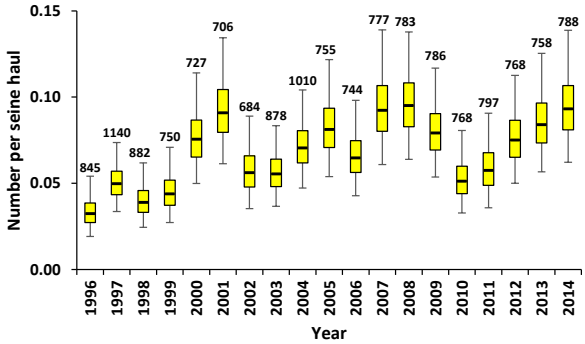
Gulf

Tampa Bay (TB) **Charlotte Harbor (CH)**

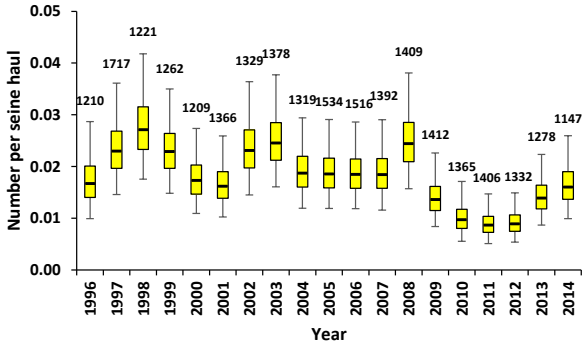
g. Less than 24 inches



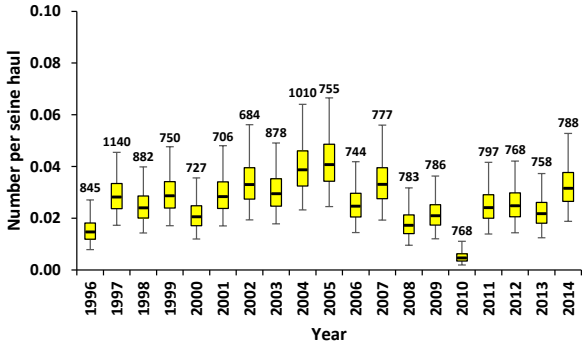
h. Less than 24 inches



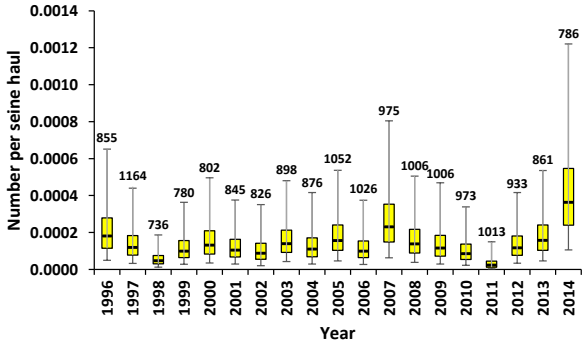
i. TB 24 - 34 inches



j. CH 24 – 34 inches



k. TB Greater than 34 inches



l. CH Greater than 34 inches

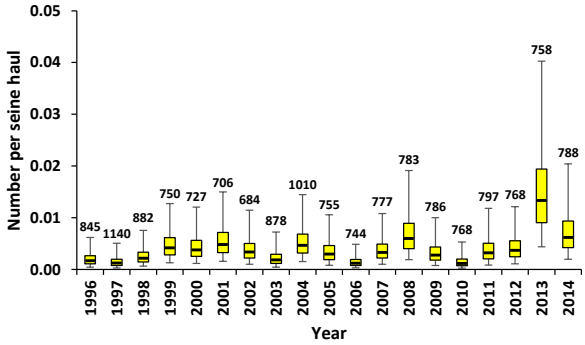


Figure 4.5.4 continued. Distributions of the numbers of fish per seine haul by coast, bay (Indian River, Tequesta, Tampa Bay, and Charlotte Harbor), and size categories from the FIM 183 m haul seines. The horizontal line is the median estimate; the box is the inter-quartile range, and the vertical line is the 95% confidence interval. The number of seine hauls by year is shown above the confidence interval.