Southern flounder,
Paralichthys lethostigma
Jordan & Gilbert, 1884

Gulf flounder,
Paralichthys albigutta
Jordan & Gilbert, 1882

STATUS OF FLOUNDER FISHERY RESOURCES IN FLORIDA

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Executive Summary

- In this report, we 1) reviewed biological characteristics of three flounder species commonly found in Florida; 2) provided descriptions of the commercial and recreational fisheries; 3) examined trends in landings, fishing effort, and catch rates; 4) examined trends in fisheries independent indices of abundance for juveniles and adults; 5) applied modeling approaches to assess the status of the stock given available data; and 6) provided research recommendations for future stock assessment.
- Nearly all flounders landed in Florida are one of three species in the genus *Paralichthys*: Gulf Flounder *P. albigutta;* Southern Flounder, *P. lethostigma*; or Summer Flounder, *P. dentatus*. Gulf Flounder are the only species to range along the entire Florida coast and are the most commonly caught flounder on the west coast. Southern Flounder are generally only found north of the Loxahatchee River on the Atlantic coast and north of the Caloosahatchee River on the gulf coast and are the most commonly caught species on the east coast. Summer Flounder are only a minor component of the flounder landings in northeast Florida; their center of distribution is off the U.S. Mid-Atlantic Bight.
- Statewide total landings (commercial and recreational) of flounder were 1,493,763 lbs in 2018, with 67% landed on the east coast and 33% landed on the west coast. Gulf coast landings have fluctuated yet remain stable over the time series. Landings on the Atlantic coast have shown recent lows falling below 1,000,000 lbs in 2018. The combined harvest of flounders from Florida waters has shown general declines from 2012-2018 to around 1,500,000 lbs.
- Total landings of Gulf Flounder were 506,359 lbs in 2018 with 90% occurring on the west coast and 92% coming from the recreational fishery. The combined harvest of Gulf Flounder has shown a fluctuating, yet generally increasing trend from 1992 to 2014 with a high of around 1,713,000 lbs and has shown recent declines from 2015-2018, averaging 515,000 lbs.
- Total landings of Southern Flounder were 963,997 lbs in 2018 with 96% of landings occurring on the east coast and 94% of harvest coming from the recreational fishery. The combined harvest of Southern Flounder has shown a fluctuating, yet generally declining trend since 1991. From 2004-2018 the average annual harvest of Southern Flounder was nearly 1,217,000 lbs. Landings of Southern Flounder showed a notable low in 2017 at 672,335 lbs.
- There is great divergence between observed and modeled commercial CPUE (lbs/trip) due to changes in fishing practices following the net ban. During the period leading up to the net ban flounder were often captured incidentally by gill nets resulting in many trips with small landings. Since the net ban, flounder have been mostly targeted using spears/gigs, resulting in fewer trips with higher landings per trip. This is most evident on the Gulf Coast.
- The standardized commercial CPUE of flounders on the west coast showed a sharp decline from 1992-1996. CPUE increased quickly between 1996 and 1999 and has continued a steady increase until a steep decrease from 2011-2018, where CPUE is the lowest of the time series in 2018.
- The standardized commercial CPUE of flounders on the east coast showed a decline in catch rates from 1985-1998. CPUE then showed general increases through 2011 and has since

showed declines through 2018.

- During 1990-2018, the median recreational CPUE (Total Catch, A+B1+B2) for Gulf Flounder has varied without trend on the west coast. Median recreational CPUE (Total Catch, A+B1+B2) for Southern Flounder fluctuated with declining trends on the east coast of Florida.
- Gulf Flounder catch rates from the Fishery Independent Monitoring survey (FIM) showed that catch rates of juveniles were highly variable prior to 2000 with peaks in 1993, 1997, and 1999. From 2001 to 2012 catch rates varied without trend, followed by a steep increase in 2013 with subsequent declines to a low in 2018. For adults, catch rates showed initial increases in 1996-1998, and has since fluctuated without major trend to present.
- Southern Flounder catch rates from FIM data on the east coast showed that relative abundance of juveniles showed an initial decline from 2001-2002, then fluctuated without major trend through 2018. For adults, catch rates showed initial declines from 2001-2003 and displayed a fluctuating increasing trend through 2012 with peaks in 2009 and 2011. Catch rates then showed steep declines from 2012-2016, with a slight increase through 2018 where abundance is still low.
- A catch-based MSY analysis estimated MSY of Gulf Flounder to be 752,000 lbs. Based on this estimate, landings have fluctuated above and below MSY during the entire catch history from 1981-2018 but have remained at or below the lower limit of MSY in the most recent 4 years. The same analysis estimated MSY for Southern Flounder to be 1,470,500 lbs. Based on this estimate, landings have fluctuated above and below MSY during the entire catch history from 1981-2018 but have remained at or below the lower limit of MSY in the most recent 4 years. For both species, landings declined sharply after each year in which they exceeded MSY suggesting that removals in excess of MSY are not sustainable.
- A non-equilibrium surplus production model (ASPIC) of Gulf Flounder on the west coast indicated that fishing mortality has exceeded F_{MSY} during 1994, 1999, and 2012-2013, and biomass never fell below B_{MSY}. Current B_{MSY} and F_{MSY} estimates in 2018 suggest that the stock is not overfished, and overfishing is not occurring in recent years. Although it should be noted that B/B_{MSY} has been generally declining over the time period, with an all-time low in 2015. The ASPIC model of Southern Flounder on the east coast indicated that the B/B_{MSY} ratio has been declining over the time series and in recent years is nearing or equal to 1:1 (2015-2018), and overfishing has been occurring for most of the time series. The likelihood estimates of F/F_{MSY} ratio in 2018 suggest that the F_{2018} was above F_{MSY}, which would indicate that overfishing is occurring. The likelihood estimates of B/B_{MSY} ratio in 2018 suggest that the B_{2018} is likely below B_{MSY}, which would indicate an overfished status.
- We conclude from examination of the catch and effort data, catch rates, and fisheries independent indices that the net ban and size limits may have had a positive effect on flounder stock sizes by reducing effort in the commercial fishery. For Gulf Flounder on the west coast, both the ASPIC and catch-based MSY analyses indicated that overfishing was not likely occurring during recent years (2015-2018), and that overfishing that occurred earlier in the time series may have contributed to a general decline in biomass over time. For Southern Flounder on the east coast, both the ASPIC and catch-based MSY analyses indicated that total catch has exceeded the MSY estimate intermittently and biomass has been declining

throughout the time series. Southern Flounder is currently undergoing overfishing and is likely considered to be overfished. Furthermore, the biomass ratio trendline may continue to decline below the 1:1 reference point at current fishing practices which will continue to place Southern Flounder in an overfished state.

- The simple modeling approaches applied here are informative but have serious limitations and should be viewed with caution. Because life history information and age composition data were not available, the models were primarily based on catch and effort statistics. If the flounder stocks were only lightly fished, then the time series of catch does not contain sufficient information about productivity and the catch-based MSY method is not appropriate. Also, the catch-based MSY model is sensitive to the prior ranges of the rate of population increase and carrying capacity. The model fitting the data in the ASPIC analysis was generally poor due to negative correlations between some indices, especially for Southern Flounder.
- To fully assess the flounders stocks in Florida, collection of age composition data from the fishery, for each species, with sufficient spatial and temporal resolutions is necessary.

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I. Biological Characteristics

Stock Distribution and Habitat Requirements

Gulf Flounder

The Gulf Flounder ranges from Cape Lookout, North Carolina to the Laguna Madre, Texas, usually in waters less than 92 m deep, but occasionally in waters as deep as 128 m (Ginsburg 1952; Hildebrand 1954; Simmons, 1957, Guntherz 1967). It has been recorded from the extreme western Bahamas (Bohlke and Chaplin 1968) and its center of abundance is in the eastern Gulf of Mexico along the coast of Florida (Topp and Hoff 1972). West of the Mississippi River delta it occurs in very low numbers (Matlock 1982; Miller 1965; Gunter 1945; Hildebrand 1954). Gulf Flounder is the most common flounder landed along the Gulf coast and is the only species that occurs in southwest Florida. Fisheries independent information (FWRI, unpublished data) indicate that Gulf Flounder is the most abundant, large paralichthid flounder in shallow waters of west-central Florida.

There is no information on the habitat requirements of larval Gulf Flounder. Juvenile Gulf Flounder occur over a wide range of salinities and temperatures, 13.7 - 33.7‰ and 11.2 - 32.5 ^{o}C (Springer and Woodburn 1960) but are rarely collected from waters with salinities less than 20‰. In Texas, Gulf Flounder are apparently limited to waters less than 45‰ but a few specimens have been reported at 60‰ (Simmons 1957). In Atlantic estuaries, juvenile Gulf Flounder are found at water temperatures as low as 2-4 ^{o}C (Williams and Deubler 1968). Juvenile Gulf Flounder immigrate into Texas estuaries from the Gulf of Mexico at water temperatures as low as 13.8 ^{o}C, but peak ingress occurred between 16.0 and 16.2 ^{o}C (Stokes 1977). Stokes (1977) found juvenile Gulf Flounder to be most abundant in areas of the estuary where dense patches of shoal grass (*Diplanthera wrightii*) were present (30 to 60% of area). Reid (1954) also reported juvenile Gulf Flounder to be more abundant on shallow grass flats around Cedar Key. Springer and Woodburn (1960) suggested that specimens collected in grass flats are actually taken from sandy areas within and adjacent to the grass flats.

Analyses of the distribution of adult Gulf Flounder made in the Gulf of Mexico indicates a strong preference for hard, sandy bottoms in waters with salinities of 20‰ or greater (Gunter 1945, Ginsburg 1952; Reid 1954; Springer and Woodburn 1960; Williams and Deubler 1968; Topp and Hoff 1972; Stokes 1977; Nall 1979). Adult Gulf Flounder have been found in temperatures ranging from 8.3 ^{o}C (Reid 1954) to 32.5 ^{o}C (Springer and Woodburn 1960). Gulf Flounder left Aransas Bay, Texas, when mean water temperature dropped from 23.0 ^{o}C in October to 14.1 ^{o}C in December. Maximum emigration often coincided with the passage of cold fronts, when sudden drops in temperature occurred (Stokes 1977). The distribution of adult Gulf Flounder does not appear to be related to the distribution of aquatic vegetation like juveniles. Fitzhugh et al. (2008) found that fish of both sexes in northwest Florida were older offshore than inshore.

Southern Flounder

Southern Flounder occur from Albemarle Sound, North Carolina south to the Loxahatchee River, on the lower east coast of Florida. It also occurs in the Gulf of Mexico from the Caloosahatchee River estuary on the southwest coast of Florida around to the Baja Laguna Madre del Sur in northern Mexico (Gilbert 1986). Blandon et al. (2001) determined that

Southern Flounder collected from North Carolina to Texas were genetically similar. Landings of Southern Flounder in Florida occur primarily west of Apalachee Bay. Southern Flounder are common out to depths of 47 m (Nall 1979). Springer and Woodburn (1960) did not collect Southern Flounder during an intensive study of the Tampa Bay area. The wide break in their distribution at the southern tip of Florida suggests there is a reasonable possibility of distinct subpopulations of Southern Flounder in Florida.

There is little information on the habitat requirements of larval Southern Flounder although the pelagic larval stage was observed over the continental shelf where spawning is reported to occur (Benson 1982). Post-larval and early juvenile Southern Flounder move into estuaries during the winter (Wenner et al. 1990). On the Atlantic coast, juveniles are found in estuaries when temperatures are as low as 2-4 ^{o}C (Williams and Deubler 1968) while in Texas juveniles begin to immigrate into bays when water temperatures are about 16 ^{o}C (Gilbert 1986). Southern Flounder become euryhaline at an advanced post-larval or early juvenile stage, at which time they can survive abrupt changes in salinity and thrive in waters with 5-15‰ (Deubler 1960, Stickney and White 1973). Post-larval Southern Flounder held in aquaria actively withdrew from areas with oxygen concentrations less than 3.7 ml/L (Deubler and Posner 1963).

Juvenile and adult Southern Flounder prefer soft substrates of rich organic muds, clay or silt (Gilbert 1986). This substrate preference may explain why Southern Flounder is the dominant, large paralichthid flounder in the muddier western Gulf of Mexico and why Southern Flounder is not distributed on the sandier south and west Florida shelves (Lynch 1954). Adult Southern Flounder have been found over a wide temperature and salinity range. Perret et al. (1971) reported collecting Southern Flounder in Louisiana in waters 5.0-34.9 ^{o}C, although adults appear to emigrate from estuaries when water temperatures drop rapidly during early winter (Stokes 1977). Adult Southern Flounder often ascend rivers and appear to prefer waters less than 20‰ while within estuaries (Gilbert 1986). Hickman (1968) found that adults showed seasonal changes in their osmoregulatory abilities that corresponded to migrations into and out of estuaries. The inshore-offshore patterns of movement of Southern Flounder are related to spawning activities. Tagging studies in Texas suggest only limited movement of Southern Flounder within and between Texas bays (Stokes 1977). In contrast, Music and Pafford (1984) found that Southern Flounder in Georgia moved, on average, over 50 km from where they had been tagged. The greatest movement appeared to occur during the fall and was directed toward the south, possibly indicating movement to higher salinity areas and warmer waters for the winter.

Summer Flounder

From Cape Canaveral north, Summer Flounder apparently dominate the commercial landings, followed by Southern Flounder then Gulf Flounder (Topp and Hoff 1972). However, during extensive sampling of inshore waters from Volusia county south to Brevard (FWRI unpublished data), no Summer Flounder juveniles have been captured. It is likely that juvenile Summer Flounder do not occur in inshore areas sampled by the FWRI juvenile monitoring program.

Reproductive Life History

Gulf Flounder

Adult Gulf Flounder spend most of the year in bays and estuaries, emigrating into deeper offshore waters to spawn during fall and winter. Movement appears to be triggered by drops in

water temperature associated with cold fronts. Stokes (1977) reported ripe adults leaving Aransas Bay, Texas, from mid-October through December. Spawning evidently occurs offshore, and specimens with ripe gonads have been collected at depths of 20-40 m in the eastern Gulf of Mexico between November and February (Topp and Hoff 1972). Gonad weights of Gulf Flounder from northwest Florida increased dramatically beginning in late October suggesting that fish were actively spawning in November and December (Fitzhugh et al. 2008). The gonadosomatic index (GSI), which is the ratio of gonad weight to somatic weight, was significantly higher offshore than inshore for both sexes indicating that reproduction was occurring offshore (Fitzhugh 2008). Sex ratios of Gulf Flounder in northwest Florida was estimated to be 1:2.5 males to females, however when spawning begins (Nov. and Dec.) the sex ratio offshore approaches 1:1 as males move offshore to spawn. The length at which 50% of the population is mature (L_{50}) for Gulf Flounder in the same study was 318 mm TL for females and 263 mm TL for males indicating that males mature at a smaller size. Females were determined to spawn about every day (1.29 d) with an average batch fecundity of 79,892 (Fitzhugh et al. 2008). Batch fecundity was predicted by total length (mm) and somatic weight (kg) using the following equations with the power function providing the greatest coefficient of determination:

$$\text{batch fecundity} = 568.2*\text{TL} - 157{,}793.3 \ (R^2 = 0.28)$$
$$\text{batch fecundity} = 116{,}466.6*\text{somatic weight} - 162{,}00.6 \ (R^2 = 0.35)$$
$$\text{ovary weight} = 1\text{e-}12*\text{TL}^{5.125} \ (R^2 = 0.626).$$

Southern Flounder

Southern Flounder spawn from September through April with peak activity during the period of November-January (Gunter 1945). Spawning apparently occurs at depths of 20-60 m (Benson 1982), although winter records of trawl catches indicate Southern Flounder occur out to about 140 m depths in the South Atlantic Bight area (Wenner et al. 1990). Stokes (1977) and Shepard (1986) also cite offshore spawning for Southern Flounder in the Gulf of Mexico. Female Southern Flounder in Mississippi were found to mature between 245 and 368 mm TL with an estimated L_{50} of 304 mm TL (Corey et al. 2017). Female Southern Flounder in South Carolina were found to mature between 330 and 360 mm when between 3 and 4 years old (Wenner et al. 1990) with an estimated L_{50} of 347 mm TL (Smith and Scharf 2010). For females captured in North Carolina, the L_{50} was estimated to be 385 mm TL (Smith and Scharf 2010) and 345 mm TL (Monaghan and Armstrong 2000) in the commercial gill net and recreational fisheries respectively. Topp and Hoff (1972) suggested that females mature at much smaller sizes in Florida, about 145 mm SL. Male Southern Flounder apparently reach maturity at 225-315 mm total length when between ages 2 and 3 years. These ages agree with other observations of size and age at maturity (Stokes 1977, Manooch and Raver 1984, Powell 1974), except for those reported by Nall (1979). Nall (1979) reported that maturity was first reached at 4 years and that all fish were not mature until age 6.

The only available estimates of fecundity for wild Southern Flounder are by Fischer (1999) in Louisiana where average batch fecundity was estimated at 62,473 and 44,225 in 2 separate years. Fischer (1999) also estimated spawning frequencies of about every 3 to 12 days. All other fecundity estimates are from captive spawns. Arnold et al. (1977) estimated 40,000 eggs for a 1-3 kg fish. Recent advances in aquaculture can now obtain fecundity levels as high as 3 million eggs per female (2,760,632 eggs/kg) under prescribed photothermal regimes (Watanabe et al. 2001) and 6 million eggs per female (1,924,459 egg/kg) using hormones (Smith et al. 1999). It is unknown if Southern Flounder are fractional spawners, and if so, how

frequently they spawn. No estimates have been made for the relationship of fecundity to length, weight, or age of Southern Flounder.

Growth

Gulf Flounder

Fitzhugh et al (2008) provide the only estimate of a growth function for this species (Table 1). In this study on Gulf Flounder from northwest Florida, they found obvious sexually dimorphic differences in growth with females achieving larger sizes and rapid growth within the first two years of life. Females were observed to reach sizes as large as 575 mm total length and live to be 7 years old while males were observed to reach sizes as large as 373 mm total length and live to be 11 years old. These estimates of maximum size and age for both species are larger and older than those reported in the only other published age and growth study by Stokes (1977), who concluded based on a total of 123 specimens, that female and male Gulf Flounder live only 3 and 2 years respectively. Males grew more slowly than females and never exceeded 290 mm total length (Stokes 1977). Stokes (1977) also believed that older Gulf Flounder might reside outside of his sampling area in deeper Gulf waters. Gulf Flounder generally reach smaller sizes than other paralichthid flounders in the southeastern United States and Gulf of Mexico though it is believed that they are capable of reaching the large sizes observed for Southern and Summer Flounders (Fitzhugh et al. 2008).

Southern Flounder

There is little information available on the growth of larval Southern Flounder. Moustakas et al. (2004) described the growth of larval Southern Flounder in culture and found that 1-day old larvae had a notochord length of about 3.1 mm and 15-day old larvae had a notochord length between 3.5 and 4.4 mm. They also found that growth of larval Southern Flounder was greater as a result of increased photoperiod. Early stage post-larvae grow most rapidly at high salinities (about 30‰) and are not very tolerant of lower salinities (Gilbert 1986). Growth of newly settled Southern Flounder from Galveston Bay, TX was described by an exponential model where length increased by about 2.5% each day for fish that are 30-80 days old (Glass et al. 2008) with metamorphosis complete after about 50 days (Arnold et al. 1977). Young-of-the-year Southern Flounder appear to consist of a group of fast growing, early spawned individuals and a group of more slowly growing, late spawned individuals (Wenner et al. 1990). In North Carolina, Fitzhugh *et al*. (1996) showed that female age-0 Southern Flounder were on average larger than males and that variation in growth rates of both sexes is likely due to the timing of the onset of piscivory, availability of prey, or segregation of sizes due to environmental factors.

Growth of adult Southern Flounder has been described for Mississippi (Corey et al. 2017), Louisiana (Fischer and Thompson 2004), Texas (Stunz et al. 2000), South Carolina (Wenner et al. 1990), northwest Florida (Fitzhugh et al. 1990), and the northern Gulf of Mexico (Nall 1979) (Table 1). Age and growth data for Southern Flounder collected in the northern Gulf of Mexico (Nall 1979) did not show the asymptotic growth found by other studies and therefore are unrealistic. Female growth is faster and more variable than that of males with growth rates diverging between sexes during the second year of life (Midway et al. 2015; Fischer and Thompson 2004; Fitzhugh et al. 1996; Music and Pafford 1984; Stokes 1977; Wenner et al. 1990). While few males attain ages of greater than 3 years, females continue to grow and may attain 7 years of age and 700 mm TL in the South Atlantic Bight area. Younger maximum ages

and smaller maximum sizes have been reported for the Gulf of Mexico: 494 mm at age 4 in Mississippi (Corey et al. 2017), 580 mm at age 5 in western Florida (Palko 1984), 606 mm at age 4 in Texas (Stokes 1977). In general, it appears that Southern Flounder from the South Atlantic Bight area are smaller through age 2 but tend to live longer and attain a larger maximum size than their Gulf of Mexico conspecifics (Wenner et al.1990).

Morphometrics

Gulf Flounder

Morphometric relationships of Gulf Flounder from northwest Florida were determined by Fitzhugh et al. (2008) and Nall (1979) (Table 2). The length-weight relationship generated by Nall (1979) had a low sample size and is therefore less reliable than the other, more recent study. Fitzhugh et al. (2008) found that male and female length-weight patterns were similar across all sizes and therefore developed a length-weight relationship for both sexes combined. However, the length-weight model using FIM data that provided the best fit to the data was the one which calculated parameters separately for males and females.

Southern Flounder

Regressions of Southern Flounder weight and length data were conducted on fish from Mississippi (Corey et al. 2017), South Carolina (Smith et al. unpublished ms), Georgia (Music and Pafford 1984), Northwest Florida (Nall 1979), Louisiana (Fischer and Thompson 2004), Texas (Harrington et al. 1979; Stunz et al. 2000) and Florida (FWRI unpublished data) (Table 2). Predictive equations between standard length and total length, in millimeters, are also available from these studies for Mississippi, South Carolina, Florida, and Texas. Fischer and Thompson (2004) found no significant difference in length-weight relationships between sexes of fish from Louisiana. However, Stunz et al. (2000) did find significant differences in sex-specific length-weight relations from fish captured in Matagorda Bay, Texas but give no indication as to why this difference was observed. Preliminary analysis of length-weight data collected by the FWC-FWRI Fisheries Independent Monitoring program in northwest and northeast Florida indicate no differences in length-weight relations between coasts but do show differences in weight at length between sexes based on AIC (Akaike Information Criterion) model selection criteria.

Food Habits

Gulf Flounder

Peebles and Hopkins (1993) investigated the diet of juvenile and adult Gulf Flounder from Tampa Bay. They found that Gulf Flounder switched from planktonic to epifaunal prey at about 21mm SL and consumed mostly amphipods and mysids until they reached 120 mm SL after which they fed upon fish and decapods. Other studies also found that Gulf Flounder under 45 mm TL fed primarily on amphipods and other small crustaceans and consumed fish once they reached larger sizes (Reid 1954, Springer and Woodburn 1960, Topp and Hoff 1972, Stokes 1977; Powell and Schwartz 1979). Fishes that have been found in the diet of Gulf Flounder include Pinfish (*Lagodon rhomboides*), anchovies (*Anchoa* spp.), mullet (*Mugil* spp.), menhaden (*Brevoortia* spp.), Atlantic Croaker (*Micropogonias undulatus*), searobins (*Prionotus scitulus*), and other sciaenids. (Reid 1954, Darnell 1958, Springer and Woodburn 1960, Fox and White 1969, Topp and Hoff 1972, Stokes 1977, Overstreet and Heard 1982). Decapod prey include several species of portunid crabs, xanthid crabs, alpheid shrimp, and penaeid shrimp (Peebles

and Hopkins 1993).

The FWC-FWRI FIM program routinely collects samples of various fishes from the broader Tampa Bay region for stomach content analysis. The FIM diet analysis data show that small Gulf Flounders (<100 mm SL) consume amphipods, cumaceans, small decapods such as grass shrimp, and fish (pinfish and lizardfish) (Table 3). As they grow, their diet switches more towards fish and larger decapods such as penaeid shrimp and portunid crabs. Although sample sizes are small for fish over 300 mm SL, it appears that at this size they are almost entirely piscivorous. The main fish prey according to the FIM data are pinfish, mojarra, anchovies, and lizardfish.

Southern Flounder

Food habits of larval Southern Flounder have been implied from their acceptance of copepods, Artemia nauplii, and rotifers in culture aquaria (Deubler 1958, Peters and Angelovic 1971, Lasswell et al. 1977). Houde and Taniguchi (1979) suggested that copepod nauplii dominate the food of many larval fishes, including those of the flounder genus *Pleuronectes*. Juvenile Southern Flounder eat a variety of invertebrates but become piscivorous when they reach about 200 mm TL (Gilbert 1986). Mysids and paleomonid shrimps are apparently the most abundant food items taken by smaller juveniles although larger juveniles will also consume penaeid shrimps and other decapods (Stokes 1977; Powell and Schwartz 1979; Wenner et al. 1990; Knapp 1949; Minello et al. 1989). Fishes eaten by larger juveniles or adults include mummichog (*Fundulus heteroclitus*), spot (*Leiostomus xanthurus*), striped mullet (*Mugil cephalus*), fat sleepers (*Dormitator maculatus*), menhaden (*Brevoortia* spp.), anchovies (*Anchoa* spp.), silversides (*Menidia* spp.), seatrout (*Cynoscion* spp.), Atlantic croaker (*Micropogonias undulatus*), and catfish (*Arius felis*) (Knapp 1949; Minello et al. 1989; Powell and Schwartz 1979; White 1962; Stokes 1977; Wenner et al. 1990).

II. Fishery Dependent Information

Regulatory History

Harvest of flounder was unregulated prior to 1996 although major regulations to commercial fishing gear impacted their harvest rates particularly those limiting the length, quantity, and mesh size of gill or trammel nets. In 1991, gill and trammel nets were limited to 600 yards in length and 6 inches stretched mesh with a maximum allowed possession of 2 such nets per boat. Beginning in 1995, it became unlawful to use entangling nets (i.e. gill and trammel) in Florida's waters and other nets such as seines, cast nets, and trawls were further restricted.

Regulations specific to flounder first came into effect on January 1, 1996 (CH 46-48, F.A.C.). These rules established a 12-inch minimum size limit for all harvesters, restricted the daily recreational bag limit to ten fish, and prohibited harvest by any gear other than hook and line, cast net, beach seine, haul seine, and gigs. Since 1996, no regulations, regarding either flounder or the gear used to capture them, have been enacted that would be expected to substantially affect the population or the fishery.

Data Sources

Prior to 1986, commercial landings data were collected by the National Marine Fisheries Service (NMFS) from monthly dealer reports. Historical commercial landings of flounder had to be adjusted for the period 1965-1984 because of inflated landings by a Lee County dealer. For the years 1965-1977 the landings data did not contain dealer information, therefore Lee county landings were reduced based on the ratio of landings in Lee county to those in other nearby counties (Charlotte, Monroe, and Collier) calculated for years prior to the over reporting period (1950-1964). Landings data for the period 1978-1984 contained dealer information and the inflated landings were reduced only for one dealer using the ratio of landings from the over-reporting dealer to those of the remaining Lee county dealers calculated using the 2 years in which landings were not inflated (1985-1986). This correction reduced total landings by approximately 20% during the period in which over-reporting was occurring.

The Florida Marine Information System or Trip Ticket System began in 1984, which requires wholesale dealers to report each purchase of saltwater products from licensed commercial fishers on a monthly basis (weekly for quota-managed species). Each ticket requires the following information: saltwater products license number of the fisher, dealer license number, unloading date, trip duration, county landed, number of sets, traps pulled, soak time, species code, weight of catch, and gear fished (beginning in 1990). Area fished, depth, unit price, and dollar value became mandatory fields in 1995. The commercial landings information from trip tickets presented here includes edited batches 1065-1147 for the years 1985-2018.

The Florida FWC Fisheries Dependent Monitoring (FDM) program participates in the trip interview program (TIP), a cooperative effort with the NMFS Southeast Fisheries Science Center (SEFSC), in which field biologists visit docks and fish houses to conduct interviews with commercial fishers. Biologists collect data about the fishing trip such as catch and effort, as well as biological information such as length, weight, otoliths and spines (for aging), and soft tissues for mercury testing and DNA analysis. These data provide estimates of the age distribution of the commercial catch and can be used to validate the catch, effort, and species identifications in the trip ticket data.

Recreational catch estimates of flounders come from the NMFS Marine Recreational Information Program (MRIP), formerly the Marine Recreational Fisheries Statistics Survey (MRFSS). MRIP produces estimates of the number of fish caught, kept, and released as well as trips by coast, two-month period, fishing mode, and area. The Marine Recreational Information Program completed a three-year transition in 2018 (NOAA Fisheries 2018). Estimates of fishing effort for the private and shore modes are now obtained from a Fishing Effort Survey (FES) conducted via mail, which uses angler license and registration information to identify and contact anglers as well as supplemental data from the U.S. Postal Service that includes nearly all U.S. households. Effort estimates for charter and party boats are still obtained from the For-Hire Telephone Survey and are not affected by the new FES. Previously, estimates of private and shore fishing effort came from the legacy Coastal Household Telephone Survey (CHTS), which used random-digit dialing of homes in coastal counties to contact anglers. By design, the FES is reaching more anglers, getting into the right hands, providing a higher response rate, and extracting more information from anglers with an improved survey questionnaire. The MRIP transition also accounted for the 2013 design change in the Access Point Angler Intercept Survey (APAIS, Foster et al. 2018). Improved survey procedures were incorporated that better account for all types of completed trips and remove potential sources of bias from the survey design. In addition, conversion factors were developed to account for any consistent effects of the redesign

on catch rate estimates produced by the APAIS. The new APAIS design uses a sample weight adjustment method and is more statistically sound because it more strictly adheres to formal probability sampling protocols. The intercept CPUE estimates are then combined with the effort from both the APAIS and FES to produce total catch and harvest estimates. MRIP estimates for the Atlantic and Gulf coasts are available from 1981 through 2018.

Commercial Fishery

Trends

Statewide commercial landings of flounders increased from approximately 100,000 lbs in 1950 to almost 500,000 lbs in 1965 with average annual landings of approximately 220,000 lbs during this time period. From 1965 to 1991 landings remained high, fluctuating between 300,000 and 550,000 lbs and averaging about 420,000 lbs per year with the maximum landings of 546,537 lbs occurring in 1991. After 1991, landings declined sharply to 214,000 lbs in 1996 following the net ban, then increased to about 350,000 lbs in 1999, then declined to levels between 200,000 and 300,000 lbs. Statewide landings of flounder then increased sharply in 2011-2012 to around 350,000 lbs, the highest since the net ban (Table 4, Figure 1). Statewide commercial landings have since declined to between 100,000 and 200,000 in recent years, with a low of around 120,000 lbs. in 2018.

On the east coast, landings increased steadily from 60,000 lbs in 1950 to nearly 250,000 lbs in 1995 with a maximum of approximately 350,000 lbs in 1985. From 1995 to 2010, landings on the east coast varied without major trend between 100,000 and 250,000 lbs with an average of about 160,000 per year (Figure 2). In 2011 landings increased sharply to about 250,000 lbs as a result of more Southern Flounder being harvested (Figures 2 and 3). In recent years, east coast commercial landings have declined to a low in 2018 of 69,000 lbs. Overall, about 60% of flounder captured commercially in the last 10 years were landed on the east coast.

On the west coast, landings increased steadily from 45,000 lbs in 1950 to 243,000 lbs in 1963, then remained high but variable around an average of 180,000 lbs until 1991 after which landings declined to less than 100,000 lbs in 1996. From 1996 to 2012, landings on the west coast have averaged about 100,000 lbs each year and varied without trend between 70,000 and 130,000 lbs. However, recent landings appear to be decreasing steadily from 2012 to a low in 2018 of 52,000 lbs (Figure 2).

No information regarding gear was available before 1990, however prior to the 1995 net ban, trips that landed flounder also reported penaeid shrimp (on the east coast), black mullet, and Spanish mackerel indicating that most flounder landed during this time period were captured during trips that used trawls or gill nets (Murphy et al. 1994). Following the net ban, most flounder have been landed using spear or gigs, trawl, or hook and line gears. Since 1996, 67% of east coast landings were made using spear/gigs, 21% using trawls, 9% from hook and line, and 3% from other gears. On the west coast, 75% of the landings since 1996 were made using gigs, 10% using trawls, 6% using hook and line gears, and 9% by other gears (Table 5, Figure 2).

Prior to 1991, landings were not recorded by species although analysis of recent trip ticket information would indicate that the dominant species landed on the east coast is Southern Flounder and the dominant species captured on the west coast is Gulf Flounder (Table 4, Figure 3 and Figure 4). Over the last 5 years, most of the Gulf Flounder were landed on the panhandle between Escambia and Dixie counties with the majority of Gulf Flounders being brought to dealers in Franklin (117,000 lbs), Wakulla (32,000 lbs), and Escambia (17,000 lbs) counties (Table 6). Over the same recent time period, Southern Flounder were landed on the east coast

between Nassau and Indian River counties with greater than 100,000 lbs being landed in Volusia (176,000 lbs) and St. Johns (118,000 lbs) counties. Apart from St. Johns county (12,000 lbs), only small amounts of Gulf Flounder were landed on any east coast county. Landings of Southern Flounder occurred in the extreme western counties with Santa Rosa (23,000 lbs) and Escambia (21,000 lbs) counties during 2014-2018. Few Summer Flounder were landed anywhere in the state between 2014 and 2018 other than Volusia county (14,000 lbs).

Commercial landings of flounder on both coasts, from 2007 to 2018, were highest during the spring and summer with similar peaks evident during the late fall (Figure 4). Nearly 44% of Southern Flounder, the dominant species landed on the Atlantic coast, were captured between May and August and 35% were captured between September and December. Gulf Flounder, the dominant species landed on the west coast, were captured during the spring and summer with 55% of landings occurring between April and August. Thirty-four percent of Gulf Flounder landings still occur during the fall on the gulf coast. Murphy et al. (1994) reported commercial landings to be highest during the fall when fishers targeted the stock migrating offshore to spawn. This shift in landings from fall to spring is likely a result of the net ban that limited gill nets once used to target fall aggregations of mullet. It appears that fishers have increased effort during the spring run, when the stock migrates back to the bays and estuaries, using gigs.

Commercial CPUE

A standardized index of average annual commercial CPUE (lbs per trip) was generated using a generalized linear model (GLM) assuming a lognormal distribution and identity link. Explanatory variables considered in the model were year, month, gear, time fished, and region. Time fished, in days, was categorized into 3 groups: one day or less, between one and seven days, and greater than seven days. Counties were grouped into 5 broader regions: northeast, southeast, southwest, west central, and panhandle. On the Atlantic Coast, the division between the northeast and southeast regions was the Brevard-Indian River county line. On the Gulf Coast, the panhandle region included all counties west of the Taylor-Dixie county line and the west central region included all counties south of this line to the Sarasota-Charlotte county line. Counties south of this line on the Gulf Coast were grouped into the southwest region.

The final model was chosen using stepwise forward selection based on AIC where k = log (n) rather than 2. This is thought to be more conservative than genuine AIC, especially when n is large, and usually retains only the variables that explain a large portion of the deviance. The final models consisted of year, followed by each significant explanatory variable ordered by decreasing deviance explained. The GLM was conducted on each coast for all flounders combined. Because flounder landed commercially were not identified to species until 1991, and then only rarely, we found it inappropriate to conduct standardized CPUE indices for each species separately. Gulf Flounder are mostly landed on the west coast and Southern Flounder on the east coast (Figure 3), therefore we assume the by-coast GLMs are representative of each species.

On the Gulf Coast (i.e. Gulf Flounder), observed landings per trip remained low from 1985 to 1994 at about 10 lbs/trip, increased sharply at an average about 30 lbs/trip from 2002-2009, after which have shown a slight declining trend through 2018 at around 25 lbs/trip (Table 7, Figure 5). However, the standardized CPUE index resulting from the GLM procedure resulted in a drastically different pattern (Figure 5) showing a steady but variable trend from 1985-2014 followed by a slight decline over the next three years. The large divergence between the modeled and observed indices is likely due to changes in fishing practices that took place following the net ban. During the period leading up to the net ban, flounder on average accounted for less than

10% of the total trip landings because they were not a species targeted or efficiently captured by gill nets. Because gill nets were the gear used most often prior to the net ban, there were numerous trips in which flounder were captured incidentally in small numbers thus pulling down the observed average pounds/trip. Following the prohibition of gill nets, the total number of trips that landed flounder decreased (Table 7) while the pounds/trip increased dramatically because incidental landings by gill nets were no longer flooding the data. This is evident in the plot of landings by gear where spear/gig fishing sustained high landings throughout the entire time period (Figure 2). The final model for west coast flounder consisted of year, gear, and region (Table 7).

On the Atlantic Coast (i.e. Southern Flounder), observed mean lbs per trip of flounder declined from 45 lbs in 1985 to 31 lbs in 1986, remained relatively stable until 1998, then showed a steep increasing trend to a high in 2011 at 59 lbs, followed by a decreasing trend in recent years to around 40 lbs/trip in 2018 (Table 8; Figure 8). However, the standardized CPUE index resulting from the GLM procedure resulted in a drastically different pattern. The standardization process resulted in a CPUE that generally predicted higher than observed mean CPUE during the pre-net ban era and lower than observed CPUE since (Figure 6). Differences between observed and modeled CPUE on the Atlantic coast occur for the same reasons as described above for the Gulf coast, but the difference is less severe because there were more trips which caught flounder using trawls. In comparison, trawls produced more lbs per trip than those taken with gill nets on the west coast such that the observed mean was not influenced as strongly by many small value trips. The final model for the Atlantic coast consisted of all variables with gear and region being the most significant (Table 10). The model suffered from slight over dispersion (residual deviance/residual *df* >1) suggesting that there is random variation not accounted for by the variables considered.

Size Distribution

Gulf Flounder captured in the commercial fishery were measured on both coasts from 1993 to 2018 with 76% (3,564) of lengths coming from the west coast of Florida and 48% (1,707) of those were captured by using spears (Table 11). Across all years, total lengths of Gulf Flounder ranged from 20 - 64.8 cm with a median of 37.15 cm and a mean of 37.98 cm (Figure 7). Gill/Trammel nets produced the smallest sized Gulf Flounder (mean TL = 34.66 cm) while hook and line (mean TL = 36.98 cm, max TL = 61.7 cm) and spears (mean TL = 37.85 cm, max TL = 64.8 cm) captured the largest Gulf Flounder. The median total length across all gears varied without major trend between 1993 and 2018 (Figure 9).

A total of 13,953 Southern Flounder were measured for length by port samplers between 1993 and 2018 with no fish measured from the commercial fishery in 2010 (Table 12). The majority (86%) of Southern Flounder measured were from the east coast with 43% of those coming from trawls and 53% captured using spear. Across all years and gears, Southern Flounder ranged in size from 10.7-77.8 cm TL with a mean TL of 40.14 cm and a median TL of 39.00 cm (Figure 7). Trawling, on average, captured much smaller Southern Flounder (mean TL = 34.77) than spears (mean TL = 42.14 cm). The median total length across all gears showed an increasing trend from 1997-2009 and has since remained relatively stable through 2018 (Figure 9).

Recreational Fishery

For this report, landings trends for flounders are reported based on the new, fully calibrated (FCAL) MRIP estimates (1981-2018). Several species of flounders were identified in the recreational catch landed between 1981 and 2018. While flounders are targeted by sport fishermen using various methods (hook and line, still fishing, drift fishing, casting from shore) one of the more popular methods for catching these fish is by "gigging" at night in shallow water, using a long-handled, three-pronged spear and a torch or flashlight (DeSylva 1965). Sport fishing usually begins in spring (when fish return from deeper waters offshore) and continues into fall. Based on the numbers of fish intercepted within MRIP, over 93% of the flounder on the Atlantic coast and 96% of the flounder sampled from the West coast were captured using hook-and-line gear. Spears apparently represent a frequently used gear; 7% of the flounder sampled on the Atlantic and 4% sampled on the Gulf coast were reported to be captured by spear. Spearfishing is a popular method for the recreational fishery targeting adult flounders offshore when they have moved to deeper ocean waters in the fall/winter for spawning.

Trends

The annual recreational harvest (A+B1) of all flounders on the east coast fluctuated widely during 1980s and 1990s, with peak landings around 3,600,000 lbs in 1982 and 2,600,000 lbs in 1994 (Figure 11). Harvest estimates stabilized from 1995-2014 around an average of 1,600,000 pounds, and in recent years have shown declines to around 930,000 lbs in 2018. On the west coast, the annual recreational harvest of flounders has fluctuated with a long-term average of around 700,000 lbs with lows in 1981, 1988, 1992, 1995, 2006, and 2017-2018 and peaks in 1985, 1991, 1994, 1999, 2007, and 2012. Harvest estimates of Gulf Flounders on the east coast peaked at 926,000 lbs in 2006, but they were generally small and highly variable (Figure 11; Table 13). On the gulf coast, estimated harvest of Gulf Flounder showed a fluctuating, general increase from 1981 to 2004 at 745,000 lbs, where estimates drop significantly in 2006 at 172,000 lbs, then steeply increase through 2012 at a peak of around 1,300,000 lbs, and in recent years have decreased to 414,000 lbs in 2018 (Table 13). Harvest estimates for Southern Flounder on the east coast were substantially higher than the west coast (Table 14). Large harvest estimates of Southern Flounders were observed in the early 1980s and mid-1990s on the east coast, followed by a gradual decline since the early 2000s. The Summer Flounder harvest was sparse on the east coast and no harvest of Summer Flounders was reported for the west coast (Table 15). The annual harvest estimates of Summer Flounder on the east coast were small averaging about 13,000 lbs annually in the past 15 years.

On the gulf coast, most harvested Gulf Flounder occurred during the second half of the year. Gulf Flounder estimates on the Atlantic coast showed peaks during every other wave, March-April, July-August, and November-December (Figure 12). Southern Flounder harvest seems to be greatest in the fall on the Atlantic coast and in the summer on the gulf coast. Estimated recreational harvest of flounders in Florida were highest in the northeast sub region along the Atlantic coast (Figure 13).

Recreational CPUE

The recreational fishing effort directed at Gulf Flounder on the east coast remained low in the 1980’s and increased just after the gill net ban to a peak in 2007, where it has shown a declining trend in recent years since (Figure 14). Gulf Flounder effort on the west coast fluctuated considerably with no discernable trends. The recreational fishing effort directed at

Southern Flounder on the east coast fluctuated widely with no particular pattern through the time series until the late 2000's and in recent years where effort is lower but stable (Figure 14). Southern Flounder effort on the west coast shows a steady declining trend from 1982-1995, where it has remained low but stable throughout the remainder of the time series. The mean annual number of angler trips for Flounders during 1982-2018 was 571,000 trips on the east coast and 449,000 trips on the west coast. The total catch (A+B1+B2) per trip for the gulf and Southern Flounders are shown in Figures 15 and 16. During 1990-2018, median CPUE for Gulf Flounder has varied without major trend on the west coast. Median CPUE for Southern Flounder fluctuated with a declining trend on the east coast of Florida.

Size Distribution

Size-frequency distributions of flounders caught by anglers during 2004-2018 are shown in Figure 17. On the Atlantic coast, the mean size (fork length) ranged from 34.9 to 45.4 cm (13.7 to 17.9 inches) for Gulf Flounder, from 37.0 to 40.7 cm (14.6 to 16.0 inches) for Southern Flounder, and from 33.0 to 50.7 cm (13.0 to 20.0 inches) for Summer Flounder (note that Summer Flounder length data on the Atlantic coast have a very low sample size and are rarely measured on the Gulf coast). The mean size on the gulf coast was between 35.3 and 37.2 cm (13.9 to 14.6 inches) for Gulf Flounder and between 34.6 and 42.3 cm (13.6 to 16.7 inches) for Southern Flounder.

Combined Harvest

No recreational harvest information was collected for the years prior to 1981 thus combined harvest for earlier years was not available. Statewide total landings of flounder were 1,493,763 lbs in 2018, with 996,497 lbs landed on the east coast and 497,266 lbs landed on the west coast. Gulf coast landings were lowest in 2006, increased through 2012, but have declined in recent years (Table 16). Since the net ban in 1995, Atlantic coast landings have been relatively stable, and have shown a recent declining trend from 2014-2018. The combined recreational and commercial harvest of flounders from Florida waters has declined from nearly 4.6 million lbs in 1982 to just over 760,000 lbs in 1989, back up to 4.4 million lbs in 1994, stabilized from 1995-2014 at an average of 2.6 million lbs, and in recent years combined harvest has decreased to 1.5 million lbs in 2018 (Table 16; Figure 18). Prior to the net ban in 1995, the recreational sector accounted for approximately 80% of the total landings but has risen to over 89% in the years after 1995 (Figure 19).

Total landings of Gulf Flounder were 506,359 lbs in 2018 with 90% occurring on the west coast and 93% coming from the recreational fishery (Table 17). The combined harvest of Gulf Flounder has shown increases from 1991-2012, with a subsequent declining trend through 2018 (Table 17; Figure 19) from an average of around 650,000 lbs/year during the period of 1991-1995 to a peak in 2012 at just over 1,700,000 lbs to a recent low of around 360,000 lbs in 2017. Total landings of Southern Flounder were 963,997 lbs since 2018 with 96% of landings occurring on the east coast and 94% of harvest coming from the recreational fishery (Table 18). The combined harvest of Southern Flounder has shown a fluctuating trend with peaks in 1994, 1999, 2003, 2011, and 2014, and with lows in 1991, 1996, 2005-2009, and recently in 2015-2018. From 1991 to 1995, annual harvest of Southern Flounder averaged over 2,000,000 lbs while from 2005-2009 the average annual harvest was nearly 1,100,000 lbs, with a recent high of 2,100,000 lbs in 2014, and an average harvest of 980,000 lbs from 2015-2018 (Table 17; Figure 22).

III. Fisheries Independent Information

Sampling Methods

The FIM program uses a suite of gears capable of capturing a broad range of fish species and sizes from a variety of habitats. A 21.3-m center bag seine targets YOY and juvenile fishes in shallow water (≤1.8-m) and a 183-m haul seine targets sub-adult and adult fish along shorelines in water depths ≤2.5-m. The program began in 1989 with a focus on collecting young-of-the-year (YOY) fishes that could be used to develop recruitment indices. The program expanded its efforts to monitor larger-sized fishes in Tampa Bay by deploying a 183-m haul seine (year-round stratified-random sampling implemented in 1996). The 183-m haul seine gear was implemented as part of the SRS component of the program in Charlotte Harbor during 1996, in the northern and southern Indian River Lagoon and Cedar Key during 1997, in Apalachicola Bay during 1998, and in northeast Florida during 2001.

Two deployment techniques were used for the 21.3-m center bag seine. The bay seine technique was used in all estuaries except northeast Florida to sample shallow areas and was pre-stratified by the presence or absence of bottom vegetation (except in the Cedar Key area) or the presence of a shoreline. The river seine technique was used in all estuaries to sample the shorelines of creeks and rivers. River seine deployments in Tampa Bay and Charlotte Harbor were pre-stratified by the presence or absence of overhanging shoreline vegetation. River seine deployments in the northern Indian River Lagoon, Cedar Key, Apalachicola Bay, and northeast Florida were not pre-stratified by habitat type. Samples collected with 183-m haul seines were pre-stratified by the presence or absence of overhanging shoreline vegetation in Tampa Bay and Charlotte Harbor, and post-stratified by the presence or absence of overhanging shoreline vegetation in the northern and southern Indian River Lagoon and not stratified in Cedar Key, Apalachicola Bay, and northeast Florida.

Sites were selected following a stratified-random sampling (SRS) design in all study areas. Each study area was divided into sampling zones and each zone was further subdivided into 1-nm^2 grids that were randomly selected for sampling. A single sample was collected at each randomly selected site with the number of monthly samples collected in each zone proportional to the number of grids cells in the zone that could be sampled with a particular gear. The sample work-up technique was similar for all samples, regardless of gear type or sampling regime. Environmental data consisting of water chemistry, habitat characteristics, and physical parameters such as current and tidal conditions were recorded for each sample. All fish were identified to the lowest practical taxonomic level, counted, and a random sample of at least 10 individuals was measured. All samples were collected during daytime hours (one hour after sunrise to one hour before sunset). Additional sampling details are described in the FIM program's Procedure Manual (FWC-FWRI 2019).

Indices of Abundance

Using data from stratified-random sampling (SRS), juvenile and adult indices of abundance were developed for gulf and Southern Flounders separately for each bay, region, or coast. Study areas included in the analyses were selected based upon adequate sample sizes of

the target species or years of available data, and separate indices of abundance (IOA) were calculated for each study area. The specific time periods and sizes of specimens included in the analyses varied among species based upon their individual patterns of recruitment and availability to the gear. Length-frequency histograms were examined to determine the time period and size at which the target species was available to capture. In general, only months of peak abundance were included in the analyses.

The IOAs were computed using a generalized linear model (GLM) to reduce spatial and temporal variability between sets. The stratified random sampling design employed here generates count data that is often highly non-normal. Therefore, the delta method (Lo *et al.* 1992) was used to standardize the FIM indices; One model estimated the probability that a haul seine set would catch a flounder assuming a binomial distribution and the other model estimated the number of flounder caught in successful hauls using a log-normal distribution. The annual index is the product of these two terms by year after they each have been back-calculated from their linear values. Potential variables of location, time, and environment were treated as either classification (bay zone, year, month, gear, shore type, sediment type, and presence / absence of bottom vegetation) or covariate (water temperature, salinity, and depth) explanatory variables in the analyses. The GENMOD procedure (SAS Institute Inc. 2006) was used to complete all analyses. For a variable to be included in the final model, the variable had to meet two criteria: it had to be significant at the 0.05 level and it had to reduce the deviation (a measure of the variability) by at least 0.5%. With the exception of year, all variables that were not significant ($P>0.05$) were dropped and the analysis was repeated. Least squares adjusted means and standard errors were calculated for each year.

We used a Monte Carlo simulation approach with 10,000 iterations that used the least-squares mean estimates and their standard errors from the GLM model. Each iteration used the annual least-squares mean catch rate and added offsets that were calculated by multiplying the standard error by a random normal deviate ($\mu=0$, $\sigma=1$). As described above, these values were converted back from their linear scale and multiplied together.

Gulf Flounder

The Gulf Flounder YOY index was generated as an aggregate index for West Florida (Apalachicola, Cedar Key, Tampa Bay, and Charlotte Harbor). This index was generated using CPUE data collected with 21.3 m seines from January to June of each year because this is the period in which juveniles are recruiting to the gear. East coast field labs rarely caught Gulf Flounder and therefore those standalone indices are highly unreliable. Because of low CPUE at each field lab, the aggregate west coast index was determined to be the most informative trend in abundance available from the FIM data. Prior to 1996, the number of YOY Gulf Flounder captured in each seine was highly variable with a peak in 1993-1994 (Figure 20). From 1996 to 2018 the index has varied without major trend with small peaks in 1997, 1999, and 2013.

Gulf Flounder adult indices of abundance were generated using the FIM 183-m seine samples from the same field labs as the YOY index. As with the YOY index, the east coast sampling produced relatively few adult Gulf Flounder. Therefore, the aggregate west coast index was determined to be the most reliable index of abundance for adult Gulf Flounder (Figure 21). From 1997 to 2018 catch rates varied without major trend with small peaks in 1998 and 2010.

Southern Flounder

CPUE was low for Southern Flounder of all sizes and therefore these indices are not very reliable because the gear either are not effective at capturing Southern Flounder or are not

deployed in their habitat. The Southern Flounder YOY index was generated as an aggregate index for East Florida (Jacksonville region, Indian River, and Tequesta). Because of low sample sizes, we determined the aggregate east coast YOY index to be the most informative (Figure 22) descriptor of juvenile population trends. Based on limited data, CPUE of juvenile Southern Flounder on the east coast of Florida varied without major trend from 2002-2018 with peaks in 2008, 2010, and 2017.

We determined the aggregate east coast index to be the most reliable index of adult Southern Flounder because they are more abundant on the east coast and there were low sample sizes at individual field labs. According to these collections, adult Southern Flounder CPUE declined from 2001-2003, increased from 2003-2009, fluctuated until 2011, then subsequently trended downward through 2017 (Figure 23).

IV. Models and Analysis

Catch-based Maximum Sustainable Yield Analysis

Model Description

The catch-based MSY analysis (Catch-MSY) uses the Schaefer production model and is a simple method for estimating MSY that does not require estimates of abundance that are often uncertain and/or difficult to obtain (Martell and Froese 2012). As input data, it requires a time series of removals, prior ranges of maximum rate of population increase *r* and carrying capacity *k*, and possible ranges of relative stock sizes in the first and final years of the time series. This approach assumes that in order to produce the historical catch the stocks must have had certain productivity, for which MSY is an appropriate measure. MSY is a function of *r* and *k*, which are negatively correlated such that the observed catches may have been produced by either a small productive population (low *k*, high *r*) or a large unproductive population (high *k*, low *r*). The model proceeds by drawing many (e.g. 10,000) combinations of *r* and *k* from their prior ranges, assuming a uniform distribution, and using them to parameterize the Schaefer production model. Only those cases where combinations of *r* and *k* did not cause the population to go extinct or exceed carrying capacity were deemed viable and used to approximate the MSY management quantities. It is important to note that this analysis does not estimate current or historic stock size or stock status, it only provides an estimate of MSY as it relates to total removals.

We ran this analysis based on the total removal of all flounders from 1950-2018 separately for the east coast (i.e. Southern Flounder) and west coast (i.e. Gulf Flounder). Because this model relies heavily on the magnitude of historical landings, it was not appropriate to conduct species-specific analyses that would have shortened the time series to only the last 20 years when flounder landings were first differentiated into species. This would have omitted the critical time period of peak landings. Recreational landings prior to 1982 were estimated as a function of the human population in Florida over those years. Resilience has been categorized based on the von Bertalanffy growth parameter *k*, fecundity, maximum age, and age at maturity (Musick 1999). The prior range of *r* was set to 0.15-1.25 and is characteristic of species with a medium to high resilience to fishing. For carrying capacity, the prior range was set to the maximum of historical catches and 25 times the maximum historical catch. Biomass in 1950 was assumed to be at least half of but not greater than carrying capacity and biomass in 2018 was assumed to range between 10% and 75% of the carrying capacity.

Gulf Flounder - West Coast

The MSY for flounders on the west coast was estimated to be about 764,000 lbs (95% CI low 601,000 lbs and high 941,000 lbs; Table 19; Figure 24). Based on this estimate, landings reached the lower limit of MSY in the early 1980s and fluctuated frequently over and under the MSY limits throughout the time series. Although MSY was overshot frequently over the time series, it doesn't appear that it led to declines in stock size, however catch has declined in recent years. Landings from 2017-2018 have remained below the lower limit of MSY.

Southern Flounder - East Coast

The MSY for flounders on the east coast was estimated to be about 1,505,000 lbs (95% CI low 1,088,000 lbs and high 1,745,000 lbs;Table 19; Figure 25). Based on this estimate, landings dramatically exceeded and fell below the MSY limits during the 1980s, then tightened closer to the limits in the 1990's and 2000's, although in many years either exceeding or falling below limits. The landings have trended below the lower MSY limit on the east coast in recent years. It is possible that frequently overshooting MSY during the timeseries led to declines in stock size for the years following. Landings exceeded MSY in 1992-1994, 2003-2004, 2006-2007, 2011-2012, 2014 and each time the landings then declined sharply for the following year. This observation would suggest that landings in excess of the estimated MSY are not sustainable. Landings over the last 4 years have been below estimated MSY.

Non-Equilibrium Surplus Production Model

Model Description

Surplus production models are used to describe the dynamics of a fished stock in terms of biomass by simply using the previous year's biomass, growth in biomass in that year, and catch

$$B_{t+1} = B_t + r\, B_t (1 - B_t / K) - C_t$$

where B_t = biomass at time t, r=rate of growth in biomass, K= maximum population size, C_t = catch during time t. The predicted CPUE was calculated by the model,

$$\mathrm{CPUE}_{\mathrm{pred}} = q\, B_t$$

where q = catchability coefficient linking CPUE to biomass. We used the logistic formulation available in ASPIC-version5 to solve for biomass B_1, K, and q by minimizing the differences between observed and predicted CPUE. ASPIC then calculates the biological reference points such as maximum sustainable yield (*MSY*), B_{MSY} (the biomass that could produce maximum sustainable yield), F_{MSY} (the fishing mortality rate that would produce the maximum sustainable yield), and F/F_{MSY} and B/B_{MSY} ratios.

Separate model runs were developed for the west coast Gulf Flounder and the east coast Southern Flounder. Input data for each run included the annual commercial and recreational landings (1981-2018), standardized commercial CPUE for the pre (1985-1995) and post (1996-2018) net ban periods, standardized recreational catch rate (1982-2018), standardized adult catch rate from the fishery independent seine survey (1996-2018), and initial starting values for B_1/K, K, q, and *MSY*. The qs were estimated for each fishery for different time periods. This was accomplished by putting the periods of time in separate data series of catch and standardized CPUE. This approach allowed q to change reflecting changes in the gear composition after the

net ban. Only estimates of F/F_{MSY}, and B/B_{MSY} were used to evaluate the condition of flounder stocks. These relative measures are the most robust parameters generated by the model for evaluating the stock condition (Prager 2004).

The ASPIC model measures the uncertainty associated with the F/F_{MSY} and B/B_{MSY} estimates using a bootstrapping routine. In this routine, the catch and residual estimates from the initial run are used to generate new predicted catches using randomly-chosen adjusted residuals. The model is then refit and process is repeated 1000 times to generate a bias corrected 80% confidence intervals. Sensitivity of the model runs was tested for different random seed numbers.

Gulf Flounder - West Coast

The surplus production model fits to the commercial and recreational catch rates and FIM adult index series were reasonable (Figure 26). The estimates of fishing mortality rate were generally below F_{MSY} (F/F_{MSY} >1) and biomass estimates were above B_{MSY} during the pre-net ban period (1981-1995) (Figure 27a). After the net ban, the F/F_{MSY} generally showed the same trajectory, with some years exceeding the 1:1 ratio, and B/B_{MSY} trajectories continued a declining trend throughout the time series. The F/F_{MSY} have been consistently below 1 and the B/B_{MSY} were consistently above 1 during 2014-2018, which seems to indicate that Gulf Flounder stock on the west coast is not overfished and overfishing was not occurring in recent years. The likelihood estimates for F/F_{MSY} and B/B_{MSY} ratios in 2018 suggest with a high level of certainty that the F_{2018}/F_{MSY} was less than 1 (Figure 27b) and B_{2018}/B_{MSY} was greater than 1 (Figure 27c). The ASPIC model parameters estimates were robust given different starting random seed values.

Southern Flounder - East Coast

The surplus production method predicted the variability in the pre net-ban commercial catch rate and recreational catch rate series reasonably well but the fits to the post net-ban commercial catch rate and FIM adult index series were poor (Figure 28). The F/F_{MSY} and B/B_{MSY} trajectories showed that the fishing mortality rates were estimated at or above the F_{MSY} level through most of the time series and biomass estimates were above B_{MSY} yet declining to the 1:1 threshold by the end of the time series. The likelihood estimates of B/B_{MSY} ratio in 2018 suggest that B_{2018}/B_{MSY} was below 1 (Figure 29c). The likelihood estimates of F/F_{MSY} ratio in 2018 suggest with a reasonably high level of certainty that the F_{2018}/F_{MSY} was at or larger than 1 (Figure 29b). The ASPIC model parameters estimates were robust given different starting random seed values.

The results from the ASPIC model runs are preliminary and should be viewed with caution. The model fit to data was generally poor especially for the Southern Flounder given negative correlations between some indices. A fundamental assumption of ASPIC is that all indices represent the abundance of the stock. The surplus production method was sensitive to the starting biomass (B_0) values. In the absence of the fishery-independent estimates of B_0, we allowed the model to calculate this parameter using the catch and effort time series.

V. Assessment History and Management

In Florida, Murphy et al. (1994) found that adequate information was not available to assess the condition of Southern or Gulf Flounder stocks. A rough characterization of Gulf Flounder's population dynamics suggested it was unlikely that they were being fished at a maximum level of yield-per-recruit. Chagaris et al. (2012) using similar model approaches

applied in this report proposed that the net ban and size limits may have had a positive effect on flounder stock sizes by reducing effort in the commercial fishery. Both the ASPIC and catch-based MSY analyses indicated that overfishing was likely occurring during the period leading up to those regulations and that fishing mortality has decreased and stock sizes increased during the period after their implementation. Additionally, an equilibrium spawner-per-recruit analysis of gulf flounder indicated that a minimum size limit of 12 inches combined with a harvest rate at or below 0.6 would result in an SPR of at least 30%.

The North Carolina Division of Marine Fisheries completed a benchmark stock assessment of Southern Flounder occurring in the South Atlantic in 2018 (Flowers et al. 2019). A forward-projecting, statistical catch-at-age model implemented in the Age Structured Assessment Program (ASAP) software was applied to the data to estimate population parameters and fishing mortality reference points. The model results showed that spawning stock biomass had generally decreased since 2006 and recruitment, while variable among years, had a generally declining trend. Fishing mortality did not exhibit much inter-annual variability and suggested a decrease in 2017. The ASAP model estimated a value of 0.35 for *F*35% (fishing mortality target) and a value of 0.53 for *F*25% (fishing mortality threshold). The estimate of *F* in 2017 is 0.91, which is above the threshold (*F*25% = 0.53) and suggests overfishing is currently occurring. The probability the 2017 fishing mortality is above the threshold value of 0.53 is 96%. The estimate of SSB35% (target) was 5,452 mt and the estimate of SSB25% (threshold) was 3,900 mt. The ASAP model of SSB in 2017 was 1,031 mt, which is below the threshold and suggests the stock is currently overfished. The probability that the 2017 estimate of SSB is below the threshold value of 3,900 mt is 100%.

The Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan for Summer Flounder defines the management unit as from the southern border of North Carolina to the northeast to the US-Canada border. The 2018 benchmark stock assessment for Summer Flounder was conducted by the Northeast Fisheries Science Center and was peer-reviewed by an independent panel of scientific experts at the 66th Northeast Regional Stock Assessment Workshop/Stock Assessment Review Committee (SAW/SARC 66) meeting in November 2018 (NEFSC 2019). The SAW/SARC-66 of 2018 concluded that Summer Flounder (*Paralichthys dentatus*) stock status was not overfished and overfishing was not occurring in 2017 relative to the new biological reference points from the assessment. However, the assessment shows that current mortality from all sources is greater than recent recruitment inputs to the stock, which has resulted in a declining stock trend.

VI. Research Recommendations

1) Identification of unclassified species reported in the fishery statistics
2) Age composition of the catch by species by gear with sufficient spatial and temporal resolution for development of age-structured population models
3) Life history parameters estimates for summer and Southern Flounders from Florida waters
4) Mixing rates of the Florida east coast northern population of southern and Summer Flounders
5) Evaluation of environmental factors and habitat condition affecting species growth, distribution, and abundance

VII. Literature Cited

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VIII. Tables

Table 1. Von Bertalanffy growth parameters and length-weight relations for gulf and Southern Flounders. The equation predicting length from age is: Inches TL = L∞ (1-e-K(age-t0)).

sex	location	K	L_∞ (inches TL)	t_0 (yrs)	Source
			Southern Flounder		
female	Mississippi	0.67	20.22	-0.50	Corey et al. (2017)
male	South Carolina	0.25	20.40	-1.07	Wenner et al. (1990)
female	South Carolina	0.23	29.90	-0.57	Wenner et al. (1990)
male	NW Florida	0.32	13.50	-5.20	Fitzhugh et al. (1996)
female	NW Florida	1.67	18.00	-0.75	Fitzhugh et al. (1996)
male	Louisiana	1.03	13.10	-0.25	Fischer and Thompson (2004)
female	Louisiana	0.51	21.90	-0.62	Fischer and Thompson (2004)
male	Texas	0.50	15.10	-1.38	Stunz et al. (2000)
female	Texas	0.75	19.00	-0.31	Stunz et al. (2000)
			Gulf Flounder		
male	NW Florida	0.64	13.58	-1.46	Fitzhugh et al. (2008)
female	NW Florida	0.52	19.04	-0.97	Fitzhugh et al. (2008)

Table 2. Length – weight and length – length conversion equations for southern and Gulf Flounders.

sex	y	x	Equation	Location	Source
			Southern Flounder		
females	Wt (g)	TL (mm)	y = 2.82e-6(x)^3.24	MS	Corey et al. (2017)
combined	Wt (g)	SL (mm)	log(y) = 3.10 log(x) - 4.92	NW FL/AL	Nall (1979)
males	Wt (g)	TL (mm)	log(y) = 3.17 log(x) - 5.38	SC	Smith et al. (unpublished ms)
males	Wt (g)	TL (mm)	log(y) = 2.98 log(x) - 4.89	GA	Music and Pafford (1984)
males	Wt (g)	TL (mm)	y = -5.6853(x)^3.3087	TX	Stunz et al. (2000)
males	Wt (g)	SL (mm)	y = 2.88e-6(x)^3.35	FL	FWRI (unpublished data)
females	Wt (g)	SL (mm)	y = 1.42e-5(x)^3.06	FL	FWRI (unpublished data)
females	Wt (g)	TL (mm)	log(y) = 3.15 log(x) - 5.33	SC	Smith et al. (unpublished ms)
females	Wt (g)	TL (mm)	log(y) = 2.97 log(x) - 4.84	GA	Music and Pafford (1984)
females	Wt (g)	TL (mm)	y = -5.6644(x)^3.2963	TX	Stunz et al. (2000)
combined	Wt (g)	TL (mm)	log(y) = 3.14 log(x) - 5.31	SC	Smith et al. (unpublished ms)
combined	Wt (g)	TL (mm)	log(y) = 3.09 log(x) - 5.16	GA	Music and Pafford (1984)
combined	Wt (g)	TL (mm)	log(y) = 3.13 log(x) - 5.26	TX	Harrington et al. (1979)
combined	Wt (g)	TL (mm)	y = -5.6067(x)^3.2734	TX	Stunz et al. (2000)
combined	Wt (g)	TL (mm)	y = 3.47e-6(x)^3.21	LA	Fischer and Thompson (2004)
combined	TL (mm)	SL (mm)	y = 1.19 + 8.45x	SC	Smith et al. (unpublished ms)
combined	TL (mm)	SL (mm)	y = 1.17 + 8.96x	TX	Harrington et al. (1979)
combined	SL (mm)	TL (mm)	y = 5.34 + 0.82x	NW FL/AL	Nall (1979)
combined	TL (mm)	SL (mm)	y = 1.18 + 8.04x	FL	FWRI (unpublished data)
			Gulf Flounder		
combined	Wt (g)	SL (mm)	log(y) = 2.81 log(x) - 4.23	NW FL/AL	Nall (1979)
combined	SL (mm)	TL (mm)	y = -4.82 + .833x	NW FL/AL	Nall (1979)
combined	Wt (g)	TL (mm)	y = 3e-6(x)^3.22	NW FL	Fitzhugh et al. (2008)
males	Wt (g)	SL (mm)	y = 1.02e-4(x)^2.712	FL	FWRI (unpublished data)
females	Wt (g)	SL (mm)	y = 1.99e-5(x)^3.008	FL	FWRI (unpublished data)
combined	TL (mm)	SL (mm)	y = 1.20 + 3.88x	FL	FWRI (unpublished data)

Table 3. Diet composition (% volume) of Gulf Flounder from Tampa Bay collected by the FWRI FIM program.

size class (mm SL)	**0-100**	**101-200**	**201-300**	**301-400**	**401-500**
N stomachs (non empty)	**13**	**25**	**27**	**4**	**1**
amphipods					
Ameroculodes miltoni	0.05				
Ampelisca holmesi	6.42				
Ampelisca spp.		0.46			
Amphipoda, unidentified		0.00			
Gammaridae		0.01			
Gammaridea	0.15				
Lepidactylus dytiscus	0.88				
Lepidactylus spp.	0.63				
Metharpinia floridana	0.20				
Phoxocephalidae	0.03				
copepods					
Harpacticoida	0.00	0.00			
Pseudodiaptomus coronatus		0.00			
crustacean, other					
Cirripedia, cypris		0.14			
Crustacea, unidentified	0.03	0.00			
Peracarida, unidentified	0.01				
cumaceans					
Cumacea, unidentified	0.04				
Oxyurostylis smithi	14.59				
decapods					
Anomura, juvenile			0.00		
Calappidae			0.86		
crab, unidentified, zoea		0.00			
decapod, unidentified, juvenile		0.90			
Decapoda, unidentified		0.35	0.01		
Farfantepenaeus duorarum		3.80	7.13		
Farfantepenaeus spp.		4.75			
Hippolyte zostericola	3.66	0.01			
Leptalpheus forceps		0.04			
Neopanope spp.		0.40			
Palaemonetes spp.		0.04			
Palaemonidae				2.69	
Pasiphaeidae	2.54				
Penaeidae		0.03	0.60		
Penaeidea			0.09	4.46	
Periclimenes spp.		0.02			
Pinnixa sayana	1.06				
Portunidae		0.96		10.76	
Portunus spp., juvenile			0.48		
shrimp, unidentified		7.06	0.03		
fish					
Actinopterygii, unidentified	3.41	19.00	21.48	82.09	
Actinopterygii, unidentified, larva		0.01			
Anchoa spp.		12.13			
Bairdiella chrysoura			6.81		
Blenniidae		6.34			
Clupeidae			0.49		
Eucinostomus gula			2.08		
Eucinostomus spp.		31.70			
Gobiidae		4.88			
Gobiosoma spp.		1.04			
Hippocampus spp.	0.47				
Hippocampus zosterae	1.85				
Lagodon rhomboides	50.61		14.28		98.89

size class (mm SL)	0-100	101-200	201-300	301-400	401-500
N stomachs (non empty)	13	25	27	4	1
Microgobius gulosus			0.24		
Ophichthidae			21.39		
Prionotus spp.		3.17			
Sciaenidae		1.65			
Stephanolepis setifer			0.48		
Synodus foetens	12.62		8.36		
Triglidae		0.10	4.16		
mantis shrimps					
Squilla rugosa			9.50		
Squilla spp.			1.54		
molluscs, other					
Loliginidae			0.01		
mysids					
Americamysis almyra		0.35			
Mysida, unidentified	0.06	0.00			
Mysidopsis mortenseni complex	0.40				
Taphromysis bowmani	0.28				
ostracods					
Ostracoda, unidentified		0.00			
polychaetes					
Polychaeta, unidentified		0.64			
seagrass					
Halodule wrightii					1.11

Table 4. Commercial landings (pounds) of flounder in Florida waters. Landings from 1950-1984 are from the NMFS accumulated landings system, landings from 1986-2018 are from the Florida trip ticket program.

year	southern	gulf	summer	uncl. flounders	total
1950				104,032	104,032
1951				67,235	67,235
1952				154,446	154,446
1953				97,497	97,497
1954				94,085	94,085
1955				103,698	103,698
1956				184,769	184,769
1957				247,700	247,700
1958				198,243	198,243
1959				251,317	251,317
1960				271,732	271,732
1961				316,072	316,072
1962				329,113	329,113
1963				432,600	432,600
1964				374,257	374,257
1965				495,175	495,175
1966				384,190	384,190
1967				307,025	307,025
1968				304,739	304,739
1969				335,505	335,505
1970				394,651	394,651
1971				460,957	460,957
1972				513,263	513,263
1973				394,183	394,183
1974				360,607	360,607
1975				337,576	337,576
1976				278,091	278,091
1977				364,716	364,716
1978				310,844	310,844
1979				325,132	325,132
1980				308,238	308,238
1981				272,020	272,020
1982				381,756	381,756
1983				279,410	279,410
1984				306,698	306,698
1985				461,458	461,458
1986				388,625	388,625
1987				404,980	404,980
1988				441,194	441,194
1989				451,860	451,860
1990	1	291		471,870	472,162
1991	35,451	23,494	520	487,072	546,537
1992	13,024	35,172	901	404,697	453,794
1993	10,894	29,195	678	372,442	413,209
1994	13,904	41,206	764	386,951	442,825
1995	16,560	35,702	1,013	336,052	389,327
1996	15,282	32,567	576	166,055	214,480
1997	23,276	54,894	4,059	204,339	286,568
1998	23,809	36,894	2,764	169,648	233,115
1999	55,025	32,346	460	270,528	358,359
2000	44,405	42,381	8,839	192,671	288,296
2001	31,741	60,151	4,640	169,503	266,035
2002	24,588	61,509	12,358	175,090	273,546
2003	33,099	84,630	19,923	119,307	256,960
2004	81,303	73,348	16,376	116,526	287,553
2005	82,985	66,563	7,117	111,505	268,170
2006	128,566	45,984	9,955	75,650	260,155
2007	120,322	37,578	24,596	72,018	254,513
2008	107,472	38,986	25,066	44,222	215,746
2009	76,313	61,972	22,624	43,794	204,704
2010	78,927	56,233	18,981	40,255	194,396
2011	207,476	78,733	28,391	48,866	363,466
2012	235,730	60,382	3,416	43,346	342,875

year	southern	gulf	summer	uncl. flounders	total
2013	150,606	62,350	6,415	31,856	251,227
2014	130,576	55,894	7,800	28,955	223,226
2015	87,987	47,887	7,629	28,147	171,650
2016	113,324	37,557	2,947	32,036	185,864
2017	86,097	46,705	783	34,772	168,357
2018	59,789	37,908	816	22,591	121,103

Table 5. Commercial statewide landings of flounders (pounds) by gear type, all species combined. The ‘other-unknown’ type includes unspecified gears, cast nets, traps, long lines, and seines.

year	gill/trammel nets	hook and line	spear/gig	trawl	other/unknown	total
1950					104,032	104,032
1951					67,235	67,235
1952					154,446	154,446
1953					97,497	97,497
1954					94,085	94,085
1955					103,698	103,698
1956					184,769	184,769
1957					247,700	247,700
1958					198,243	198,243
1959					251,317	251,317
1960					271,732	271,732
1961					316,072	316,072
1962					329,113	329,113
1963					432,600	432,600
1964					374,257	374,257
1965					495,175	495,175
1966					384,190	384,190
1967					307,025	307,025
1968					304,739	304,739
1969					335,505	335,505
1970					394,651	394,651
1971					460,957	460,957
1972					513,263	513,263
1973					394,183	394,183
1974					360,607	360,607
1975					337,576	337,576
1976					278,091	278,091
1977					364,716	364,716
1978					310,844	310,844
1979					325,132	325,132
1980					308,238	308,238
1981					272,020	272,020
1982					381,756	381,756
1983					279,410	279,410
1984					306,698	306,698
1985					461,458	461,458
1986					388,625	388,625
1987					404,980	404,980
1988					441,194	441,194
1989					451,860	451,860
1990	7	14		15	472,126	472,162
1991	106,974	25,794	48,547	94,181	271,041	546,537
1992	117,322	25,839	77,500	154,478	78,655	453,794
1993	103,653	36,795	124,865	108,090	39,806	413,209
1994	95,460	33,567	146,992	143,458	23,348	442,825
1995	33,125	34,285	197,619	101,319	22,979	389,327
1996	1,262	14,768	119,689	63,458	15,303	214,480
1997	239	31,547	174,464	57,190	23,128	286,568
1998	727	25,270	128,975	54,659	23,484	233,115
1999	611	22,914	221,355	90,419	23,060	358,359
2000	193	25,423	193,916	48,205	20,560	288,296
2001	232	17,477	162,070	75,633	10,623	266,035
2002	83	16,961	209,123	37,147	10,231	273,546
2003	33	16,093	194,703	36,597	9,534	256,960
2004	1,380	23,116	195,849	60,318	6,890	287,553
2005	460	20,388	212,277	28,490	6,555	268,170
2006	300	18,884	214,950	20,452	5,569	260,155
2007	614	17,537	187,760	39,626	8,977	254,513
2008	464	20,386	153,348	35,179	6,369	215,746
2009	123	21,445	151,733	22,942	8,461	204,704
2010	164	21,692	140,347	23,992	8,201	194,396
2011	140	49,314	237,381	51,052	25,579	363,466

year	gill/trammel nets	hook and line	spear/gig	trawl	other/unknown	total
2012	168	34,215	240,317	41,408	26,767	342,875
2013	211	40,386	169,632	25,620	15,377	251,227
2014	69	14,582	160,483	33,091	15,001	223,226
2015	48	7,527	130,777	23,287	10,011	171,650
2016	19	5,870	137,161	30,623	12,192	185,864
2017	21	5,068	124,834	30,554	7,880	168,357
2018	21	5,253	91,253	18,508	6,068	121,103

Table 6. Top ten Florida counties for total commercial landings (pounds) of flounder by species for the years 2014-2018.

Rank	County	GULF FLOUNDER		County	SOUTHERN FLOUNDER		County	SUMMER FLOUNDER
1	Franklin	116,891		Volusia	176,212		Volusia	14,207
2	Wakulla	31,884		St Johns	118,487		Wakulla	2,191
3	Escambia	17,268		Duval	79,544		Duval	1,078
4	St Johns	12,066		Brevard	28,994		Flagler	726
5	Taylor	10,772		Santa Rosa	23,543		St Johns	422
6	Okaloosa	6,323		Escambia	20,623		Palm Beach	308
7	Gulf	6,304		Indian River	7,143		Indian River	285
8	Bay	4,337		Bay	4,848		Martin	242
9	Dixie	3,368		Nassau	4,424		Escambia	173
10	Citrus	2,023		Gulf	3,987		St Lucie	152

Rank	County	UNCLASSIFIED FLOUNDERS		County	ALL FLOUNDERS
1	Franklin	41,352		Volusia	211,154
2	Duval	31,221		Franklin	158,243
3	Volusia	20,316		St Johns	131,071
4	Bay	15,331		Duval	111,937
5	St Lucie	14,125		Escambia	38,064
6	Nassau	5,477		Wakulla	37,443
7	Pinellas	4,406		Brevard	33,423
8	Brevard	3,443		Santa Rosa	25,367
9	Wakulla	3,368		Bay	24,518
10	Palm Beach	2,153		St Lucie	15,230

Table 7. Observed and standardized commercial CPUE (lbs/trip) for all flounder species on the Gulf Coast. Standardized Index is scaled to the mean.

Year	Observed CPUE (lbs/trip)	Std Index CPUE (lbs/trip)	CV Index	number of positive trips
1985	9.820	1.100	0.365	6,876
1986	10.954	1.127	0.365	9,444
1987	8.750	1.003	0.365	11,918
1988	8.848	0.980	0.365	11,394
1989	8.872	1.006	0.365	13,513
1990	8.626	0.994	0.365	14,246
1991	8.134	1.086	0.365	19,269
1992	7.856	1.136	0.365	16,316
1993	8.294	1.078	0.365	13,759
1994	8.864	1.044	0.365	11,329
1995	11.916	1.005	0.366	7,470
1996	13.757	0.864	0.365	3,837
1997	16.927	0.932	0.365	4,835
1998	16.182	1.003	0.366	4,250
1999	20.723	1.066	0.366	3,823
2000	21.322	0.979	0.366	2,906
2001	24.066	1.013	0.366	3,037
2002	25.396	0.979	0.366	2,781
2003	29.791	1.044	0.366	2,262
2004	27.693	0.970	0.366	2,342
2005	29.486	1.076	0.366	2,224
2006	29.838	1.017	0.366	1,610
2007	29.466	1.087	0.366	1,415
2008	31.605	1.013	0.366	1,462
2009	31.318	1.080	0.366	1,965
2010	29.459	1.038	0.365	1,899
2011	27.514	1.093	0.365	2,732
2012	26.058	1.025	0.366	2,978
2013	22.108	1.013	0.366	2,922
2014	25.432	0.985	0.366	2,166
2015	20.950	0.817	0.366	2,766
2016	19.567	0.800	0.366	2,599
2017	24.340	0.798	0.366	2,386
2018	24.853	0.749	0.365	1,720

Table 8. Model statistics for the standardized index of commercial CPUE (pounds/trip) on the west coast.

variable	df	Deviance	Resid. Df	Resid. Dev	% Dev. Explained
year	33	31,115	196417	239259	11.49
gear2	6	67,074	196411	172184	24.81
reg	4	22,453	196407	149730	8.31
tfcat2	2	4,241	196405	145489	1.57

Table 9. Observed and standardized commercial CPUE (lbs/trip) for all flounder species on the Atlantic Coast. Standardized Index is scaled to the mean.

Year	Observed CPUE (lbs/trip)	Std Index CPUE (lbs/trip)	CV Index	number of positive trips
1985	45.361	1.446	0.027	6,018
1986	30.898	1.113	0.027	6,162
1987	31.268	1.055	0.026	5,780
1988	35.309	1.140	0.026	6,950
1989	32.555	1.104	0.026	7,943
1990	29.985	1.069	0.023	8,735
1991	28.862	1.137	0.023	9,773
1992	27.818	1.144	0.023	8,501
1993	27.563	0.963	0.022	7,874
1994	28.699	0.994	0.023	9,358
1995	35.088	0.970	0.025	6,395
1996	31.508	0.806	0.024	3,846
1997	29.660	0.807	0.024	4,636
1998	28.535	0.789	0.024	4,488
1999	42.590	0.990	0.025	4,561
2000	42.541	0.993	0.026	3,758
2001	38.022	0.872	0.026	2,970
2002	42.391	0.890	0.026	2,849
2003	40.957	0.892	0.027	3,005
2004	54.183	1.175	0.027	2,642
2005	51.024	1.140	0.027	2,593
2006	54.930	1.083	0.026	2,760
2007	49.115	1.093	0.028	3,197
2008	43.821	0.967	0.029	2,373
2009	43.258	0.878	0.029	2,068
2010	44.737	0.883	0.027	1,999
2011	58.830	1.248	0.026	2,818
2012	51.540	1.128	0.026	3,264
2013	46.166	1.000	0.028	2,931
2014	47.096	0.886	0.028	2,521
2015	38.606	0.793	0.028	2,225
2016	45.336	0.900	0.030	2,277
2017	41.869	0.826	0.031	1,805
2018	40.292	0.825	0.027	1,626

Table 10. Model statistics for the standardized index of commercial CPUE (pounds/trip) on the Atlantic coast.

variable	df	Deviance	Resid. Df	Resid. Dev	% Dev. Explained
year	33	7,644	150,667	225,086	3.26
gear2	6	34,073	150,661	191,013	14.64
reg	1	15,170	150,660	175,843	6.52
tfcat	2	9,856	150,658	165,986	4.24
month	11	4,737	150,647	161,249	2.03

Table 6. Number of **Gulf Flounder** length measurements from TIP data by coast, gear, and year.

	West					East				
year	**gill/ trammel**	**H&L**	**spear/ gig**	**trawl**	**unknown/ other**	**gill/ trammel**	**H&L**	**spear / gig**	**trawl**	**unknown/ other**
1993	12	13	58	79	0	2	0	0	0	0
1994	13	3	46	0	0	7	0	0	0	0
1995	4	3	81	0	0	0	0	16	0	0
1996	1	6	10	20	24	0	0	0	30	1
1997	0	0	103	1	3	0	1	1	0	3
1998	3	0	103	6	10	0	1	0	0	1
1999	0	0	165	0	5	0	0	12	0	0
2000	0	0	153	13	16	0	0	0	0	0
2001	1	68	138	5	6	0	0	9	8	1
2002	1	0	63	7	47	0	0	0	0	0
2003	0	13	112	0	1	0	0	0	0	0
2004	0	0	27	0	26	0	0	0	0	0
2005	2	0	87	0	143	0	0	2	0	0
2006	0	0	0	0	216	0	3	0	0	2
2007	0	1	0	0	162	0	0	0	0	0
2008	0	3	0	0	213	0	0	0	0	0
2009	0	0	41	0	132	0	0	0	0	10
2010	0	1	1	0	149	0	0	1	0	80
2011	0	11	33	17	162	0	0	6	0	322
2012	0	5	57	0	96	0	0	0	0	27
2013	0	35	121	0	5	0	1	1	0	41
2014	0	1	78	0	33	0	0	0	0	123
2015	0	0	37	0	22	0	0	0	0	191
2016	0	1	128	0	3	0	0	0	0	78
2017	0	1	64	0	1	0	0	1	114	41
2018	0	0	1	0	32	0	0	17	0	0
Total	**37**	**165**	**1707**	**148**	**1507**	**9**	**6**	**66**	**152**	**921**

Table 7. Number of **Southern Flounder** length measurements from TIP data by coast, gear, and year.

	West					East				
year	**gill/ trammel**	**H&L**	**spear/ gig**	**trawl**	**unknown/ other**	**gill/ trammel**	**H&L**	**spear/ gig**	**trawl**	**unknown/ other**
1993	0	0	0	0	0	27	0	8	12	0
1994	1	0	0	0	0	39	0	0	112	0
1995	0	0	3	0	0	10	0	0	16	2
1996	0	0	8	5	26	1	3	11	30	1
1997	0	0	37	0	2	0	0	133	315	14
1998	2	0	41	0	7	0	3	91	386	23
1999	0	0	146	0	0	0	1	132	437	5
2000	0	12	64	3	2	0	0	269	9	8
2001	0	10	36	5	2	0	4	352	165	5
2002	0	0	40	2	23	0	1	269	6	0
2003	0	0	112	0	0	0	0	88	0	4
2004	0	0	77	0	95	0	0	0	0	57
2005	0	0	0	0	30	0	0	1	6	0
2006	0	0	0	0	21	1	8	73	30	54
2007	0	0	0	0	97	0	53	82	0	1
2008	0	0	0	0	166	0	0	1	0	45
2009	0	0	0	0	86	0	11	0	0	297
2010	0	0	0	0	114	0	0	0	0	761
2011	0	0	47	0	263	0	0	51	0	895
2012	0	1	93	0	196	0	10	35	0	1500
2013	0	0	42	0	17	0	4	2	0	1116
2014	0	1	0	0	0	0	0	2	0	944
2015	0	1	28	0	2	0	0	0	0	794
2016	0	0	7	0	0	0	0	0	0	964
2017	0	0	2	0	0	0	0	342	190	447
2018	0	0	28	0	7	0	4	168	0	2
Total	**3**	**25**	**811**	**15**	**1156**	**78**	**102**	**2110**	**1714**	**7939**

Table 13. Recreational landings of **Gulf Flounder** from the east and west coasts of Florida based on FCAL MRIP estimates. Mortality rate of discards (B2) was assumed to be 0.15.

	West Coast							East Coast					
Year	A+B1 (lbs)	mean weight (lbs)	B2 (num)	B2 dead (num)	B2 dead (lbs)	Total Killed (lbs)		A+B1 (lbs)	mean weight (lbs)	B2 (num)	B2 dead (num)	B2 dead (lbs)	Total Killed (lbs)
1981	29,108	0.779				29,108		24,824	0.927				24,824
1982	130,002	0.864	12,238	1,836	1,585	131,587		66,315	0.887				66,315
1983	180,479	0.690	15,065	2,260	1,558	182,037		7,092	1.047				7,092
1984	390,228	1.174	894,769	134,215	157,597	547,825				9,461	1,419		
1985	515,160	1.327	250,781	37,617	49,916	565,076		57,532	1.102				57,532
1986	547,726	1.351	199,013	29,852	40,322	588,048							
1987	636,454	1.584	96,765	14,515	22,987	659,441							
1988	139,989	0.437	179,526	26,929	11,765	151,754							
1989	411,794	1.286	204,181	30,627	39,398	451,192							
1990	309,626	0.820	203,377	30,507	25,019	334,645							
1991	642,912	1.331	137,008	20,551	27,350	670,262							
1992	336,116	1.297	84,120	12,618	16,367	352,483		4,878	2.003				4,878
1993	382,172	1.253	81,671	12,251	15,352	397,524		8,870	0.930	2,105	316	294	9,164
1994	428,947	1.341	4,464,871	669,731	897,825	1,326,772				3,970	596		
1995	239,439	1.301	107,008	16,051	20,876	260,315		57,304	1.336				57,304
1996	409,598	1.562	76,891	11,534	18,020	427,618		31,224	2.272	17,940	2,691	6,113	37,337
1997	449,368	1.191	232,429	34,864	41,517	490,885		55,150	1.700	2,345	352	598	55,748
1998	364,449	1.314	252,540	37,881	49,773	414,222		22,446	0.978	37,196	5,579	5,455	27,901
1999	993,976	1.586	390,095	58,514	92,775	1,086,751		81,434	1.667	32,473	4,871	8,120	89,554
2000	390,979	1.608	241,523	36,228	58,241	449,220		193,901	1.620	43,494	6,524	10,570	204,471
2001	582,842	1.529	339,054	50,858	77,754	660,596		130,416	1.484	34,060	5,109	7,584	138,000
2002	448,662	1.491	291,543	43,731	65,198	513,860		103,214	1.102	32,004	4,801	5,288	108,502
2003	571,423	1.141	829,512	124,427	141,926	713,349		97,146	1.427	97,970	14,696	20,968	118,114
2004	744,800	1.402	712,158	106,824	149,809	894,609		282,167	1.732	25,762	3,864	6,691	288,858
2005	390,943	1.228	381,629	57,244	70,324	461,267		164,620	1.992	42,089	6,313	12,578	177,198
2006	172,340	1.216	138,608	20,791	25,278	197,618		916,435	2.321	26,511	3,977	9,228	925,663
2007	695,453	1.498	165,092	24,764	37,106	732,559		583,300	1.739	152,272	22,841	39,711	623,011
2008	359,776	1.354	345,004	51,751	70,069	429,845		354,128	1.770	37,418	5,613	9,933	364,061
2009	510,596	1.184	441,537	66,231	78,450	589,046		47,746	1.032	1,994	299	309	48,055
2010	476,137	1.374	570,669	85,600	117,616	593,753		201,406	1.334	18,012	2,702	3,604	205,010
2011	677,335	1.181	271,724	40,759	48,122	725,457		146,206	1.204				146,206
2012	1,283,562	1.318	267,480	40,122	52,869	1,336,431		315,698	2.465				315,698
2013	1,068,411	1.145	230,683	34,602	39,635	1,108,046		48,726	1.619	15,417	2,313	3,744	52,470
2014	810,328	1.302	143,944	21,592	28,112	838,440		117,930	1.235				117,930
2015	446,119	1.218	54,606	8,191	9,974	456,093		61,861	1.247	386	58	72	61,933
2016	571,299	1.272	75,253	11,288	14,353	585,652		4,137	0.833	1,904	286	238	4,375
2017	284,957	1.174	127,598	19,140	22,478	307,435		8,658	1.235				8,658
2018	413,971	1.372	38,033	5,705	7,826	421,797		46,233	1.059	2,650	398	421	46,654

Table 8. Recreational landings of **Southern Flounder** from the east and west coasts of Florida based on FCAL MRIP estimates. Mortality rate of discards (B2) was assumed to be 0.15.

	West Coast							East Coast					
Year	A+B1 (lbs)	mean weight (lbs)	B2 (num)	B2 dead (num)	B2 dead (lbs)	Total Killed (lbs)		A+B1 (lbs)	mean weight (lbs)	B2 (num)	B2 dead (num)	B2 dead (lbs)	Total Killed (lbs)
1981	176,203	1.056	109,191	16,379	17,294	193,497		510,439	1.256				510,439
1982	460,236	1.300	82,341	12,351	16,062	476,298		3,481,506	1.342	76,654	11,498	15,434	3,496,940
1983	296,711	1.171	82,248	12,337	14,442	311,153		1,352,902	1.157	121,824	18,274	21,136	1,374,038
1984	261,887	0.920	161,404	24,211	22,285	284,172		1,066,835	0.951	62,063	9,309	8,853	1,075,688
1985	454,375	1.209	52,003	7,800	9,428	463,803		1,141,920	1.164	71,428	10,714	12,473	1,154,393
1986	349,739	1.354	28,576	4,286	5,803	355,542		302,920	0.820	24,801	3,720	3,050	305,970
1987	239,770	1.478	47,322	7,098	10,488	250,258		191,293	0.917	5,937	891	817	192,110
1988	134,692	0.394	65,184	9,778	3,851	138,543		31,591	0.092	47,434	7,115	655	32,246
1989	125,573	1.243	7,476	1,121	1,394	126,967		1,590,293	1.715	137,972	20,696	35,496	1,625,789
1990	153,013	1.642	16,793	2,519	4,137	157,150		1,114,199	1.456	189,952	28,493	41,500	1,155,699
1991	572,630	1.662	70,387	10,558	17,552	590,182		885,144	1.675	164,598	24,690	41,356	926,500
1992	50,904	1.420	9,798	1,470	2,087	52,991		1,835,741	1.887	169,260	25,389	47,917	1,883,658
1993	337,865	0.905	52,549	7,882	7,130	344,995		1,742,677	1.717	340,123	51,018	87,609	1,830,286
1994	33,272	0.931	26,024	3,904	3,636	36,908		2,534,002	1.719	386,978	58,047	99,774	2,633,776
1995	56,434	1.239	5,757	864	1,070	57,504		1,542,803	1.610	720,720	108,108	174,039	1,716,842
1996	128,702	1.224	38,180	5,727	7,007	135,709		647,361	1.642	669,800	100,470	164,983	812,344
1997	131,772	1.812	26,396	3,959	7,175	138,947		1,206,867	1.855	629,620	94,443	175,188	1,382,055
1998	68,868	1.684	12,708	1,906	3,209	72,077		1,253,808	1.685	606,321	90,948	153,290	1,407,098
1999	65,672	1.716	8,771	1,316	2,257	67,929		1,874,946	2.086	254,677	38,202	79,703	1,954,649
2000	80,684	1.543	3,688	553	854	81,538		1,635,424	2.147	69,664	10,450	22,436	1,657,860
2001	124,270	2.046	33,057	4,959	10,144	134,414		1,122,942	2.024	87,215	13,082	26,477	1,149,419
2002	53,104	1.369	12,907	1,936	2,651	55,755		1,599,645	1.936	42,470	6,371	12,333	1,611,978
2003	57,811	1.537	3,086	463	712	58,523		2,002,474	1.443	748,629	112,294	162,092	2,164,566
2004	126,680	1.717	32,320	4,848	8,326	135,006		1,745,748	2.082	117,953	17,693	36,834	1,782,582
2005	97,054	1.318	10,144	1,522	2,005	99,059		696,839	1.633	126,052	18,908	30,884	727,723
2006	28,414	1.305	30,107	4,516	5,892	34,306		660,183	1.773	51,526	7,729	13,702	673,885
2007	374,922	2.284	450,959	67,644	154,526	529,448		1,083,968	1.764	7,783	1,167	2,059	1,086,027
2008	108,865	2.112	2,825	424	895	109,760		684,180	1.375				684,180
2009	27,008	1.272	2,754	413	526	27,534		1,201,056	1.527	16,205	2,431	3,713	1,204,769
2010	17,775	1.408	13,727	2,059	2,899	20,674		1,433,295	2.020	2,299	345	697	1,433,992
2011	121,599	2.032	4,204	631	1,282	122,881		1,679,591	2.084	18,849	2,827	5,891	1,685,482
2012	100,939	1.243	12,140	1,821	2,263	103,202		1,445,325	1.881				1,445,325
2013	107,572	1.425	6,755	1,013	1,444	109,016		1,035,054	1.547	35,266	5,290	8,184	1,043,238
2014	29,806	1.560	1,627	244	381	30,187		1,985,854	1.895				1,985,854
2015	8,740	1.258	1,973	296	372	9,112		873,630	1.315				873,630
2016	32,483	1.374	8,177	1,227	1,686	34,169		1,163,990	1.623	84,858	12,729	20,657	1,184,647
2017	25,835	0.989	4,770	716	708	26,543		558,981	1.718	2,773	416	714	559,695
2018	23,223	1.125				23,223		880,242	1.558	3,180	477	743	880,985

Table 15. Recreational landings of **Summer Flounder** from the east coast of Florida based on FCAL MRIP estimates. Mortality rate of discards (B2) was assumed to be 0.15.

	East Coast					
Year	A+B1 (lbs)	mean weight (lbs)	B2 (num)	B2 dead (num)	B2 dead (lbs)	Total Killed (lbs)
1981						
1982						
1983						
1984						
1985						
1986	43,464	1.026				43,464
1987			4,403	660		
1988						
1989						
1990						
1991						
1992						
1993	10,345	1.351	3,469	520	703	11,048
1994	15,613	1.349				15,613
1995						
1996						
1997	2,722	1.855				2,722
1998	247,537	1.776	743	111	198	247,735
1999	12,416	1.637				12,416
2000	236,089	3.925	55,566	8,335	32,716	268,805
2001	65,321	2.193				65,321
2002	1,548	1.596	31,026	4,654	7,427	8,975
2003	6,556	0.894				6,556
2004						
2005						
2006	15,655	0.933				15,655
2007	7,636	0.827				7,636
2008	1,717	0.970				1,717
2009	10,989	1.014				10,989
2010	38,475	1.852				38,475
2011	16,811	0.774				16,811
2012						
2013	13,204	1.455				13,204
2014						
2015						
2016						
2017						
2018	2,096	3.955				2,096

Table 16. Combined commercial (pounds) and recreational landings (total dead catch, pounds) of **all flounder** species on the east and west coasts of Florida. Recreational landings are based on FCAL MRIP estimates.

	east coast				west coast			statewide total
Year	com.	rec.	total		com.	rec.	total	
1981	143,322	535,263	678,585		128,698	222,605	351,303	1,029,888
1982	199,275	3,563,255	3,762,530		182,481	607,886	790,367	4,552,897
1983	124,800	1,381,130	1,505,930		154,610	493,190	647,800	2,153,730
1984	150,773	1,075,688	1,226,461		155,925	831,997	987,922	2,214,383
1985	353,841	1,211,925	1,565,766		107,617	1,028,879	1,136,496	2,702,262
1986	215,449	305,970	521,419		173,176	943,591	1,116,767	1,638,186
1987	225,093	192,110	417,203		179,887	909,699	1,089,586	1,506,789
1988	288,379	32,246	320,625		152,815	290,297	443,112	763,737
1989	283,134	1,625,789	1,908,923		168,726	578,159	746,885	2,655,808
1990	282,109	1,155,699	1,437,808		190,053	491,795	681,848	2,119,656
1991	311,251	926,500	1,237,751		235,286	1,260,443	1,495,729	2,733,480
1992	268,702	1,888,536	2,157,238		185,092	405,474	590,566	2,747,804
1993	242,308	1,839,449	2,081,757		170,901	742,519	913,420	2,995,177
1994	292,102	2,633,776	2,925,878		150,723	1,363,680	1,514,403	4,440,281
1995	253,289	1,774,146	2,027,435		136,038	317,819	453,857	2,481,292
1996	130,513	849,681	980,194		83,967	563,327	647,294	1,627,488
1997	161,069	1,437,803	1,598,872		125,499	629,832	755,331	2,354,203
1998	137,756	1,435,000	1,572,756		95,359	486,299	581,658	2,154,414
1999	245,485	2,044,203	2,289,688		112,874	1,154,680	1,267,554	3,557,242
2000	197,205	1,862,330	2,059,535		91,091	530,758	621,849	2,681,384
2001	140,172	1,287,418	1,427,590		125,862	795,010	920,872	2,348,462
2002	161,977	1,720,480	1,882,457		111,567	569,615	681,182	2,563,639
2003	137,042	2,282,680	2,419,722		119,918	771,872	891,790	3,311,512
2004	179,436	2,071,440	2,250,876		108,118	1,029,614	1,137,732	3,388,608
2005	163,874	904,921	1,068,795		104,297	560,326	664,623	1,733,418
2006	181,635	1,599,548	1,781,183		78,519	231,924	310,443	2,091,626
2007	184,269	1,709,038	1,893,307		70,244	1,262,007	1,332,251	3,225,558
2008	139,628	1,048,241	1,187,869		76,119	539,605	615,724	1,803,593
2009	104,621	1,252,824	1,357,445		100,083	616,579	716,662	2,074,107
2010	105,113	1,639,002	1,744,115		89,283	614,426	703,709	2,447,824
2011	250,818	1,831,688	2,082,506		112,648	848,338	960,986	3,043,492
2012	225,987	1,761,023	1,987,010		116,888	1,439,633	1,556,521	3,543,531
2013	159,778	1,095,708	1,255,486		91,449	1,217,062	1,308,511	2,563,997
2014	148,516	2,103,784	2,252,300		74,710	868,626	943,336	3,195,636
2015	96,862	935,563	1,032,425		74,788	465,205	539,993	1,572,418
2016	122,115	1,189,022	1,311,137		63,749	619,820	683,569	1,994,706
2017	93,164	568,353	661,517		75,192	333,978	409,170	1,070,687
2018	68,858	927,639	996,497		52,246	445,020	497,266	1,493,763

Table 9. Combined commercial (pounds) and recreational landings (total dead catch, pounds) of **Gulf Flounder** on the east and west coasts of Florida. Recreational landings are based on FCAL MRIP estimates.

	east coast				west coast			statewide total
Year	**com.**	**rec.**	**total**		**com.**	**rec.**	**total**	
1991	513		513		22,981	670,262	693,243	693,756
1992	566	4878	5,444		34,606	352,483	387,089	392,533
1993	403	9164	9567		28,792	397,524	426,316	435,883
1994	1,542		1,542		39,664	1,326,772	1,366,436	1,367,978
1995	1,828	57,304	59,132		33,874	260,315	294,189	353,321
1996	178	37,337	37,515		32,389	427,618	460,007	497,522
1997	294	55,748	56,042		54,600	490,885	545,485	601,527
1998	344	27,901	28,245		36,550	414,222	450,772	479,017
1999	693	89,554	90,247		31,653	1,086,751	1,118,404	1,208,651
2000	1,799	204,471	206,270		40,582	449,220	489,802	696,072
2001	314	138,000	138,314		59,836	660,596	720,432	858,746
2002	172	108,502	108,674		61,337	513,860	575,197	683,871
2003	7,019	118,114	125,133		77,612	713,349	790,961	916,094
2004	1,558	288,858	290,416		71,790	894,609	966,399	1,256,815
2005	1,026	177,198	178,224		65,537	461,267	526,804	705,028
2006	504	925,663	926,167		45,480	197,618	243,098	1,169,265
2007	417	623,011	623,428		37,160	732,559	769,719	1,393,147
2008	758	364,061	364,819		38,229	429,845	468,074	832,893
2009	265	48,055	48,320		61,707	589,046	650,753	699,073
2010	678	205,010	205,688		55,555	593,753	649,308	854,996
2011	858	146,206	147,064		77,875	725,457	803,332	950,396
2012	695	315,698	316,393		59,687	1,336,431	1,396,118	1,712,511
2013	1,213	52,470	53,683		61,137	1,108,046	1,169,183	1,222,866
2014	3,089	117,930	121,019		52,805	838,440	891,245	1,012,264
2015	3,123	61,933	65,056		44,764	456,093	500,857	565,913
2016	2,992	4,375	7,367		34,565	585,652	620,217	627,584
2017	2,834	8,658	11,492		43,870	307,435	351,305	362,797
2018	2,822	46,654	49,476		35,086	421,797	456,883	506,359

Table 10. Combined commercial (pounds) and recreational landings (total dead catch, pounds) of **Southern Flounder** on the east and west coasts of Florida. Recreational landings are based on FCAL MRIP estimates.

	east coast				west coast			statewide total
Year	**com.**	**rec.**	**total**		**com.**	**rec.**	**total**	
1991	32,882	926,500	959,382		2,569	590,182	592,751	1,552,133
1992	12,864	1,883,658	1,896,522		160	52,991	53,151	1,949,673
1993	10,667	1,830,286	1,840,953		227	344,995	345,222	2,186,175
1994	13,280	2,633,776	2,647,056		624	36,908	37,532	2,684,588
1995	15,691	1,716,842	1,732,533		869	57,504	58,373	1,790,906
1996	14,672	812,344	827,016		610	135,709	136,319	963,335
1997	21,440	1,382,055	1,403,495		1,836	138,947	140,783	1,544,278
1998	20,632	1,407,098	1,427,730		3,177	72,077	75,254	1,502,984
1999	51,617	1,954,649	2,006,266		3,408	67,929	71,337	2,077,603
2000	41,353	1,657,860	1,699,213		3,052	81,538	84,590	1,783,803
2001	28,896	1,149,419	1,178,315		2,845	134,414	137,259	1,315,574
2002	21,467	1,611,978	1,633,445		3,121	55,755	58,876	1,692,321
2003	28,826	2,164,566	2,193,392		4,273	58,523	62,796	2,256,188
2004	75,953	1,782,582	1,858,535		5,350	135,006	140,356	1,998,891
2005	74,060	727,723	801,783		8,925	99,059	107,984	909,767
2006	122,028	673,885	795,913		6,538	34,306	40,844	836,757
2007	116,171	1,086,027	1,202,198		4,151	529,448	533,599	1,735,797
2008	89,474	684,180	773,654		17,997	109,760	127,757	901,411
2009	61,403	1,204,769	1,266,172		14,910	27,534	42,444	1,308,616
2010	66,564	1,433,992	1,500,556		12,364	20,674	33,038	1,533,594
2011	194,665	1,685,482	1,880,147		12,810	122,881	135,691	2,015,838
2012	207,112	1,445,325	1,652,437		28,618	103,202	131,820	1,784,257
2013	139,681	1,043,238	1,182,919		10,925	109,016	119,941	1,302,860
2014	122,558	1,985,854	2,108,412		8,019	30,187	38,206	2,146,618
2015	72,994	873,630	946,624		14,993	9,112	24,105	970,729
2016	98,993	1,184,647	1,283,640		14,331	34,169	48,500	1,332,140
2017	75,628	559,695	635,323		10,469	26,543	37,012	672,335
2018	49,075	880,985	930,060		10,714	23,223	33,937	963,997

Table 19. Parameter estimates from the Catch-MSY analysis for the west coast (i.e. Gulf Flounder) and the east coast (i.e. Southern Flounder).

Parameter	**West Coast**	**East Coast**
r	0.37	0.30
r 95% CI	0.155-1.033	0.161-0.637
k (1,000 lbs)	8,210	19,773
k 95% CI	3,241 – 17,376	10,144 – 33,342
MSY (1,000 lbs)	764	1,505
MSY 95% CI	601 - 941	1088 - 1745

IX. Figures

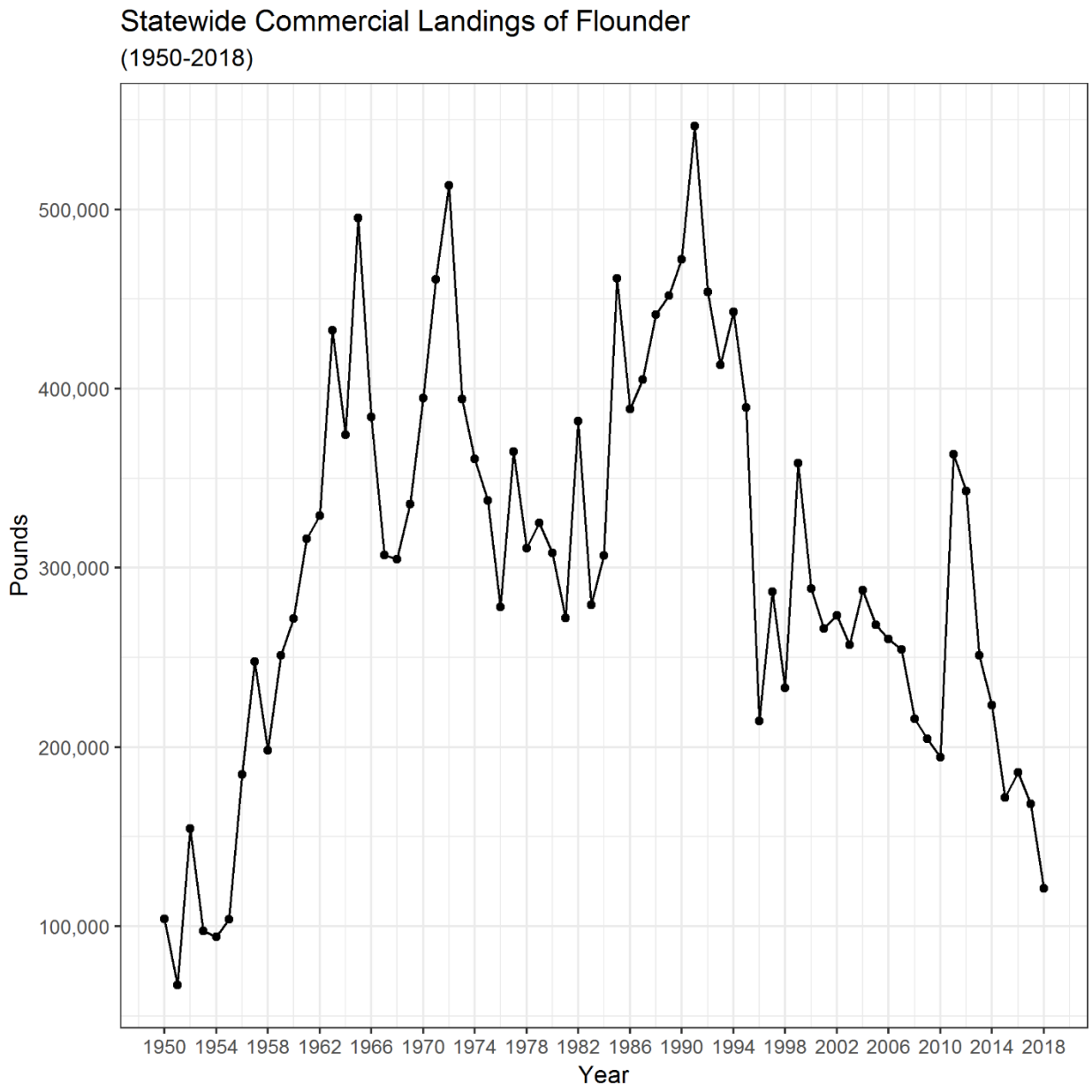


Figure 1. Total commercial landings of flounders in Florida, 1950-2018.

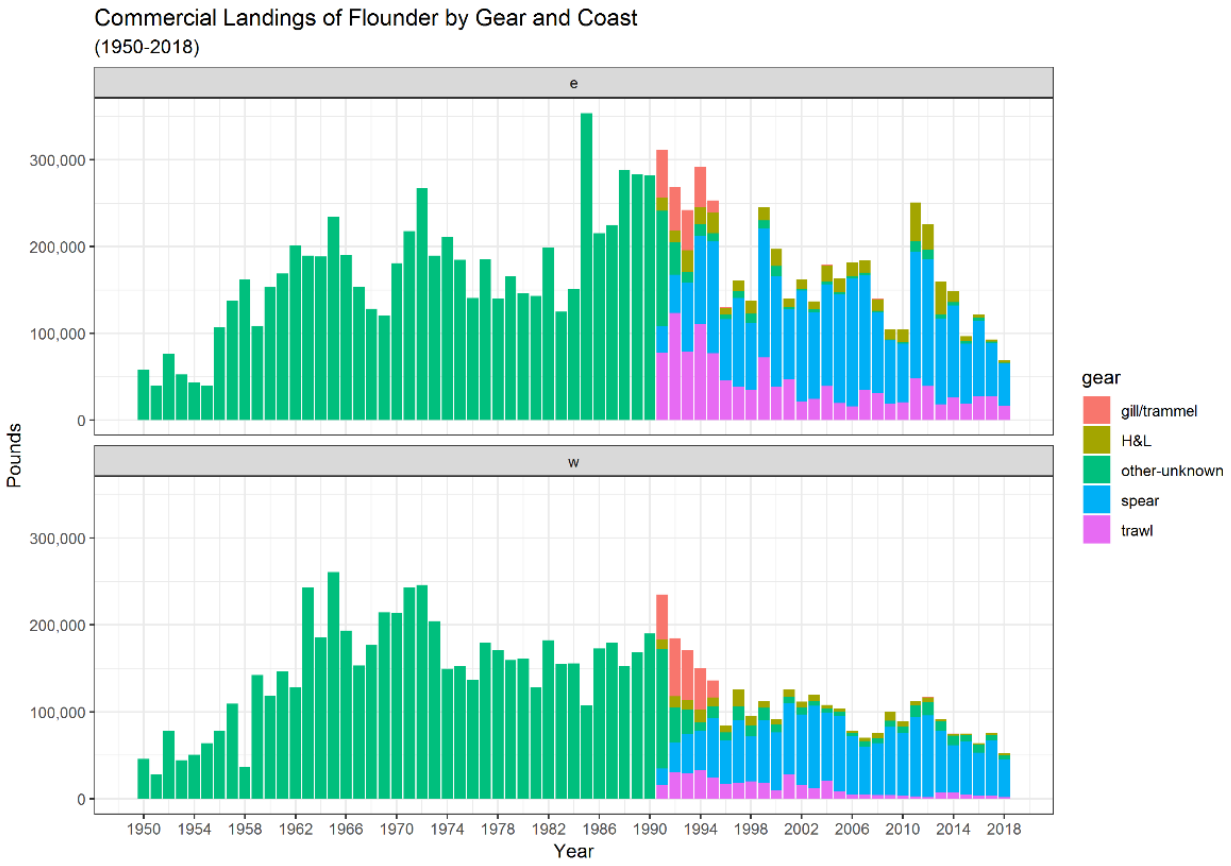


Figure 2. Commercial landings of flounder by gear and coast.

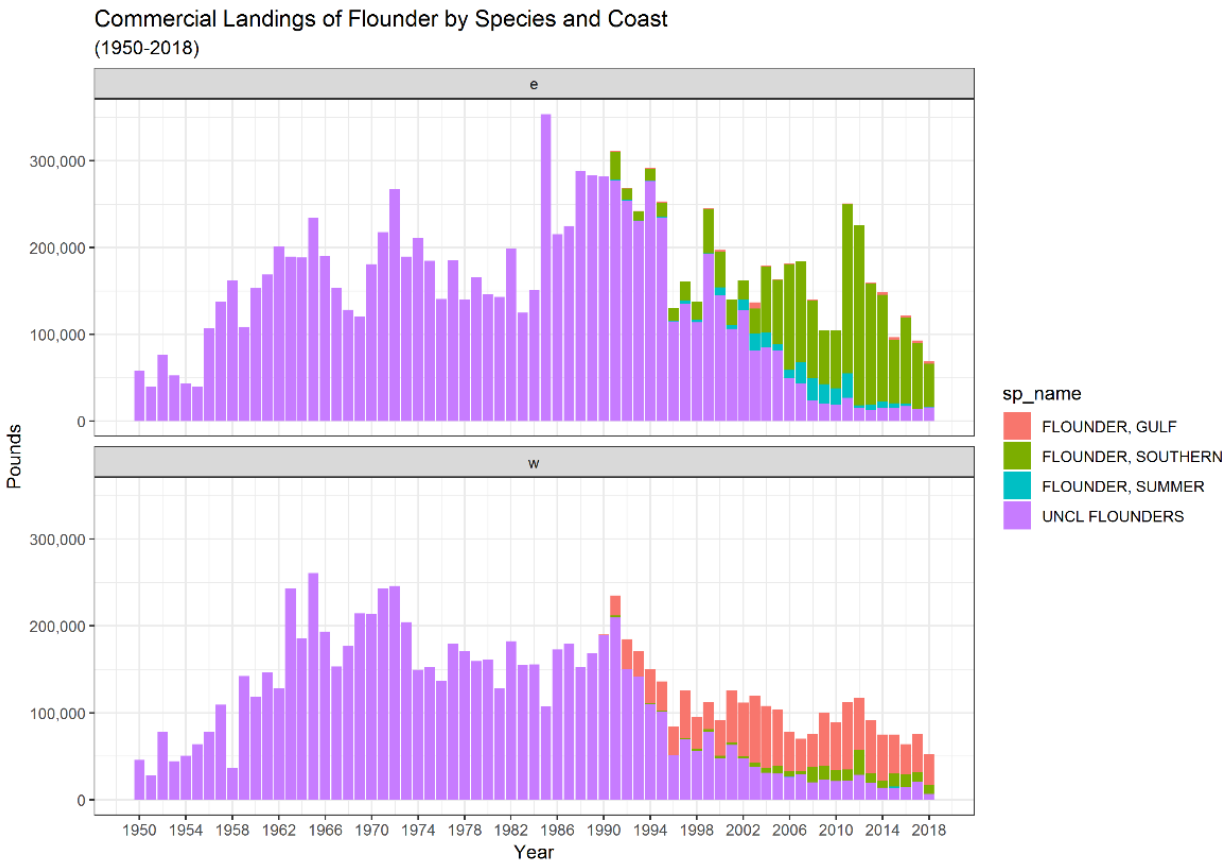


Figure 3. Commercial landings of flounder by species and coast.

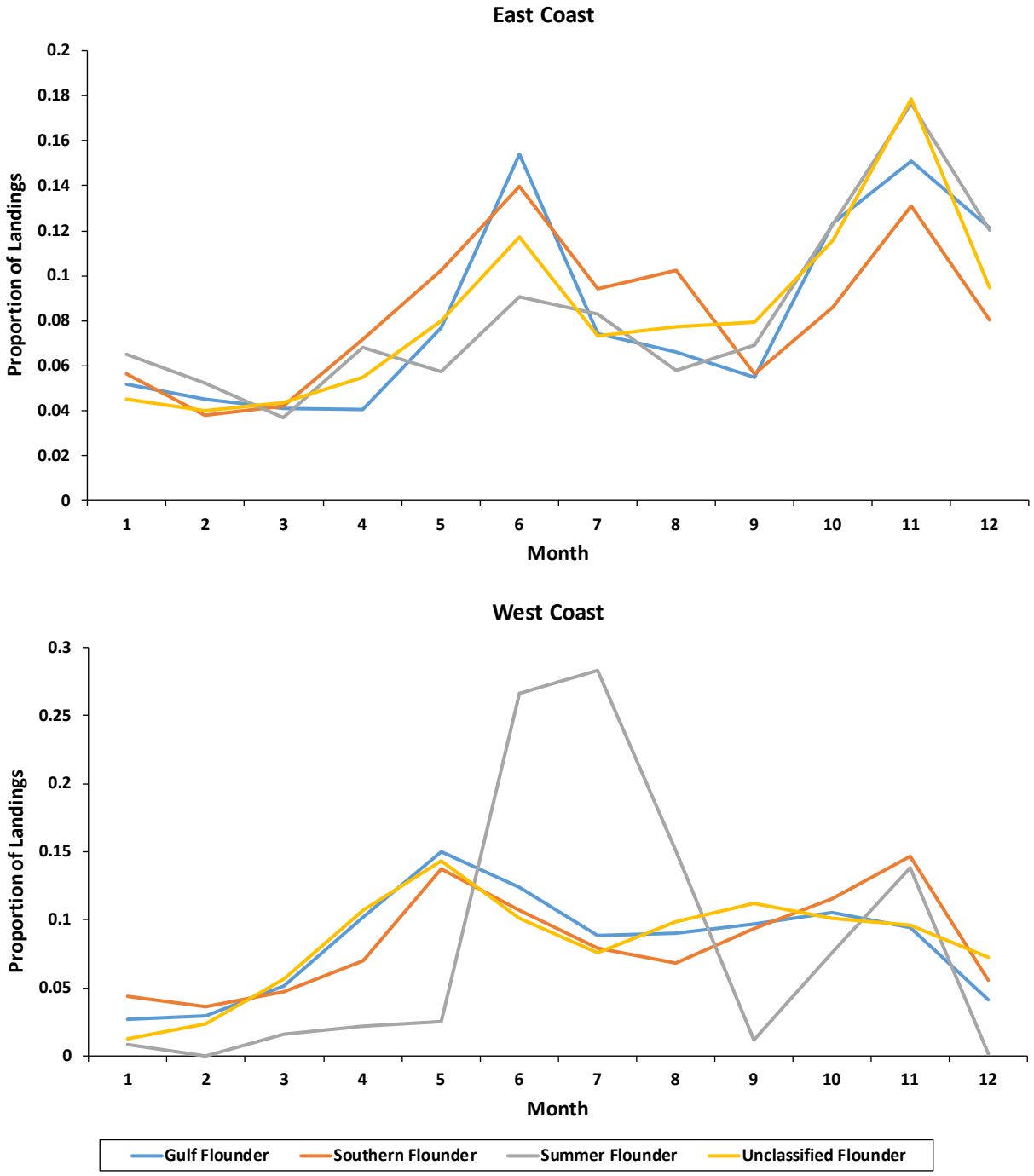


Figure 4. Proportion of lbs landed each month by species and coast, in the commercial fishery for the years 2007-2018.

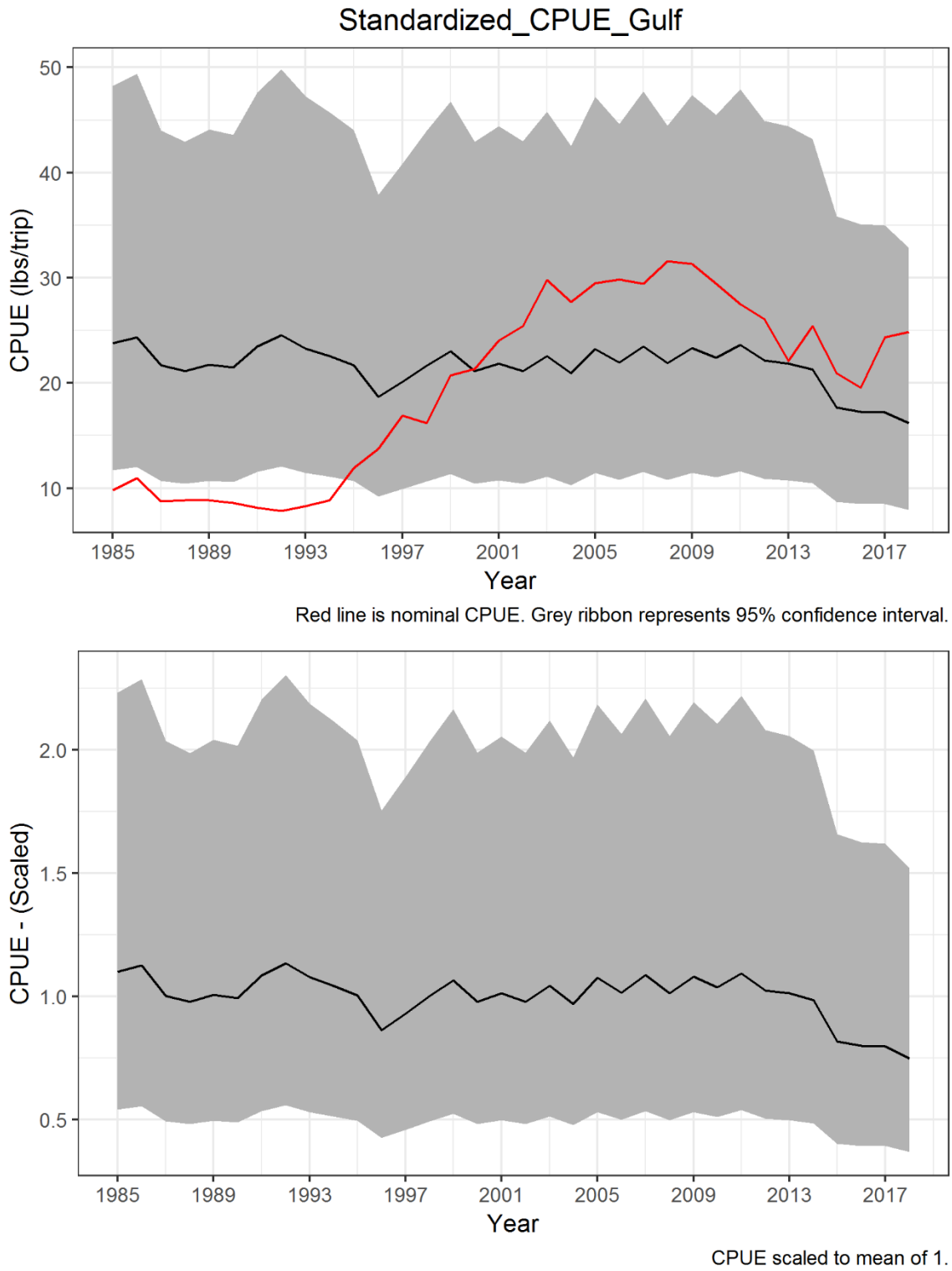


Figure 5. Modeled and observed commercial CPUE (lbs/trip, scaled to a mean of 1), with 95% confidence intervals, for all flounders landed on the west coast, 1985-2018.

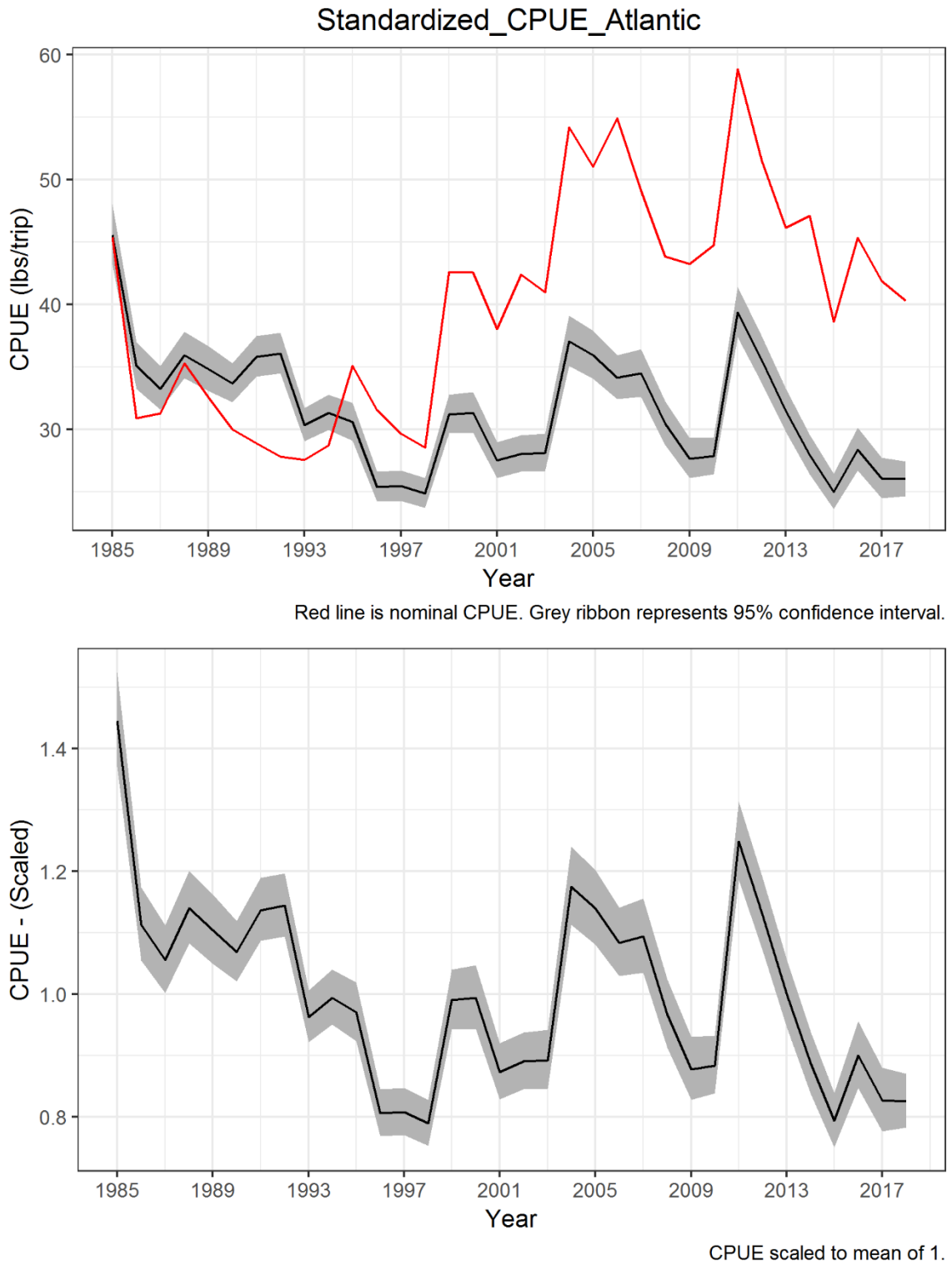


Figure 6. Modeled and observed commercial CPUE (lbs/trip, scaled to a mean of 1), with 95% confidence intervals, for all flounders landed on the east coast, 1985-2018.

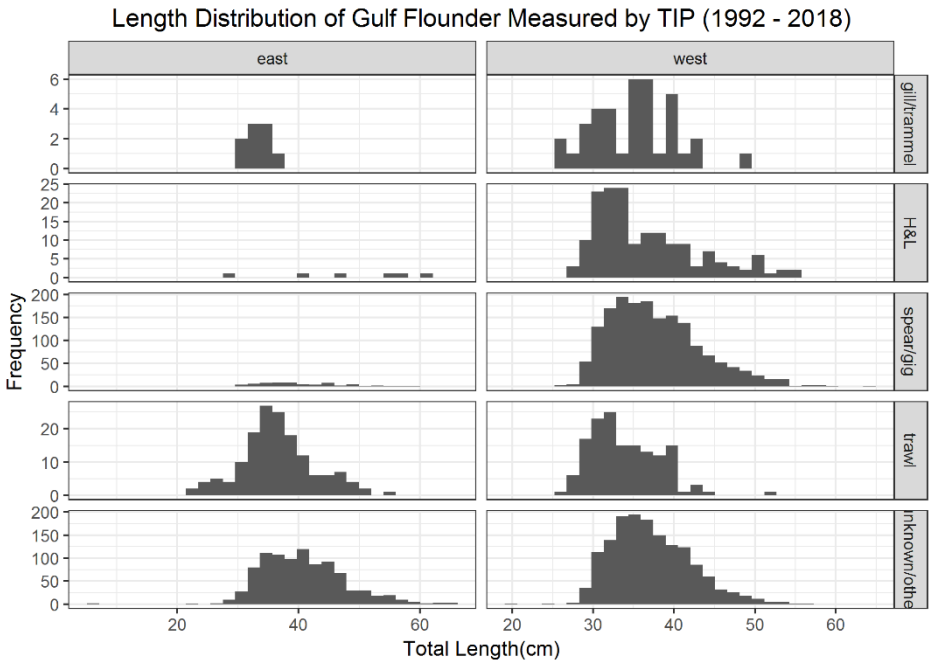


Figure 7. Length distribution of Gulf Flounder measured by TIP for all gears combined and each gear separately for the years 1992-2018.

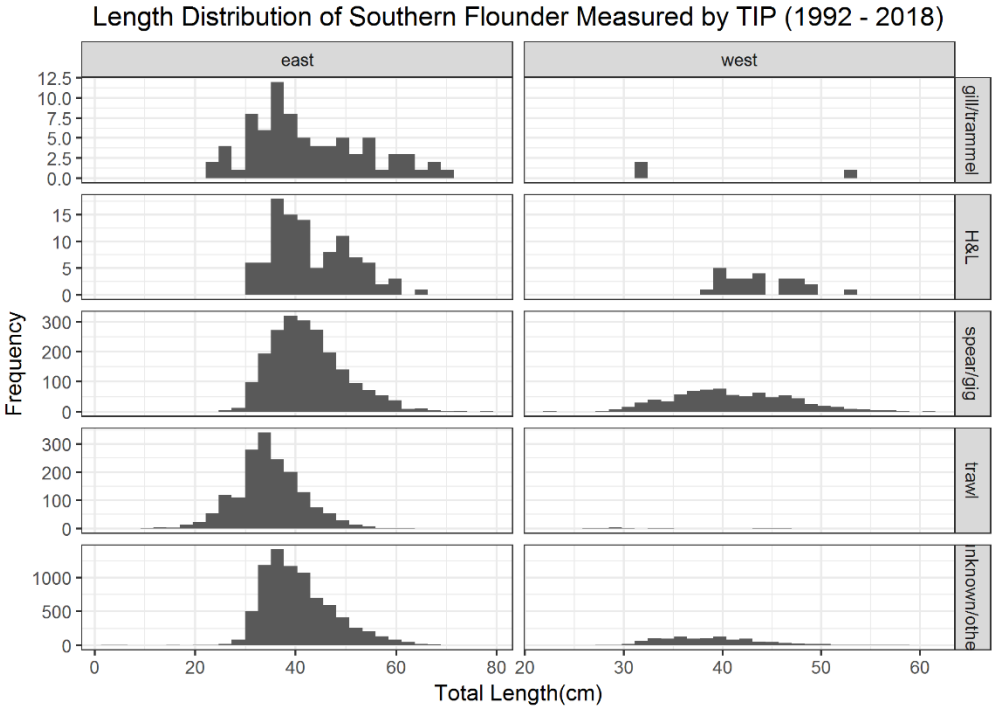
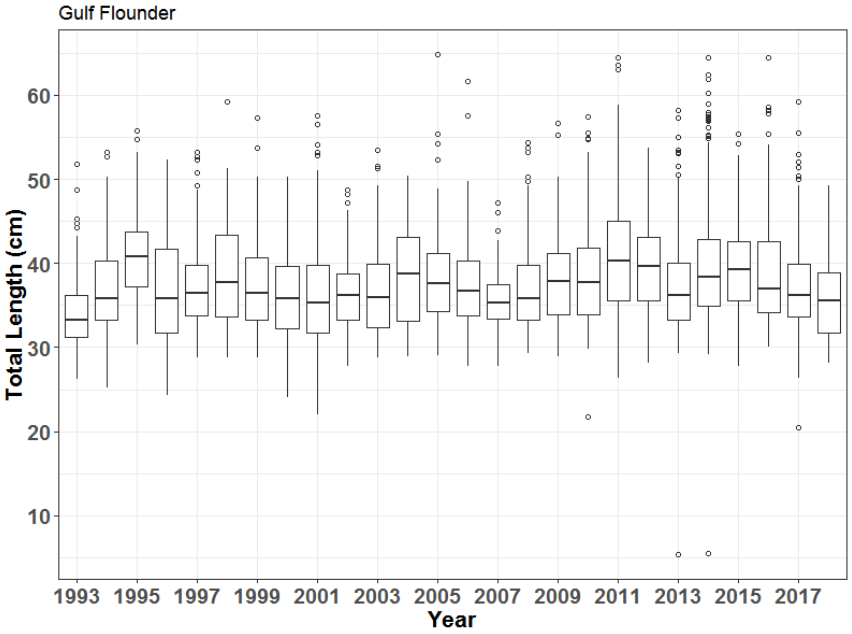


Figure 8. Length distribution of Southern Flounder measured by TIP for all gears combined and each gear separately for the years 1992-2018.



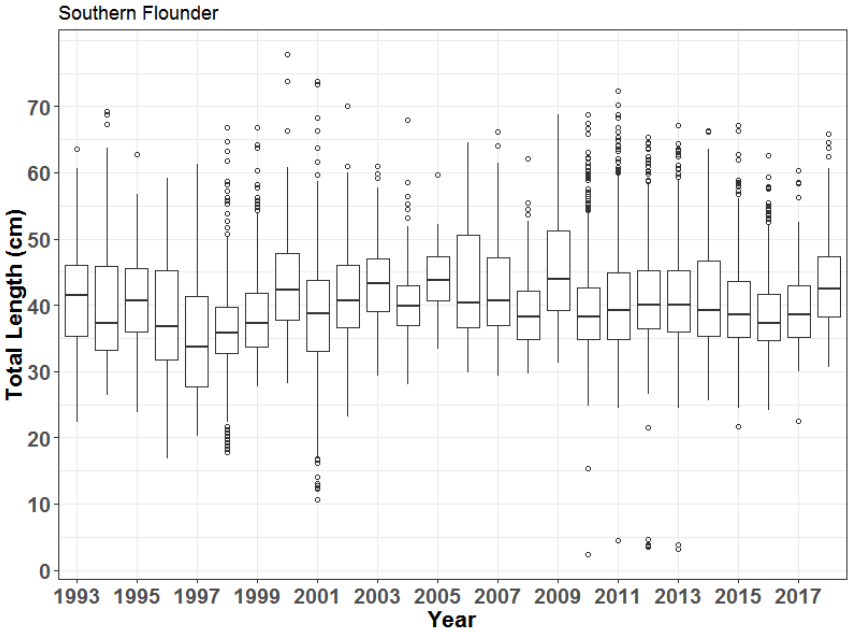


Figure 9. Median, 25th and 75th percentiles, and interquartile range of total lengths measured by the TIP program by species by year.

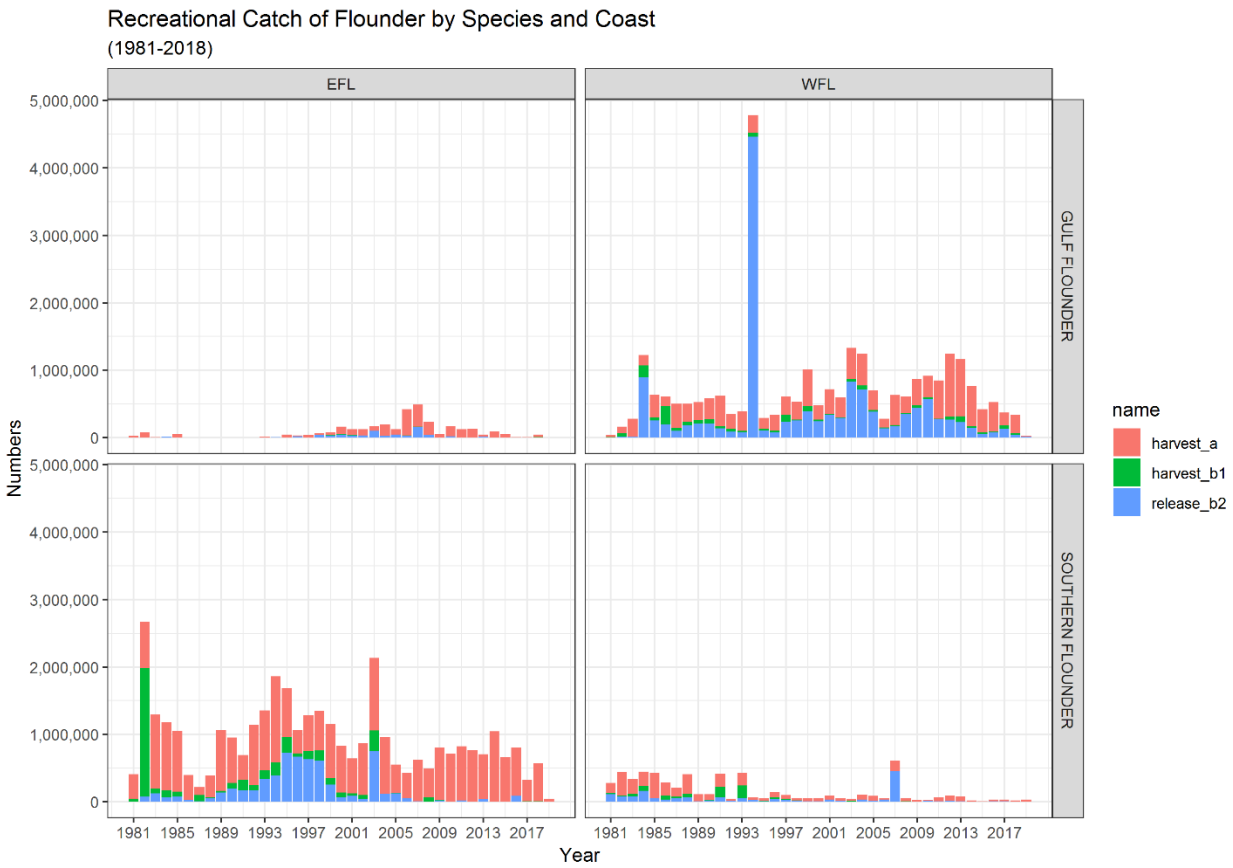


Figure 10. Estimated annual recreational catch (A, B1, and B2 in numbers) of flounder by species (Gulf Flounder and Southern Flounder) and by coast (EFL, East Florida; WFL, West Florida) based on fully calibrated (FCAL) MRIP estimates, 1981-2018.

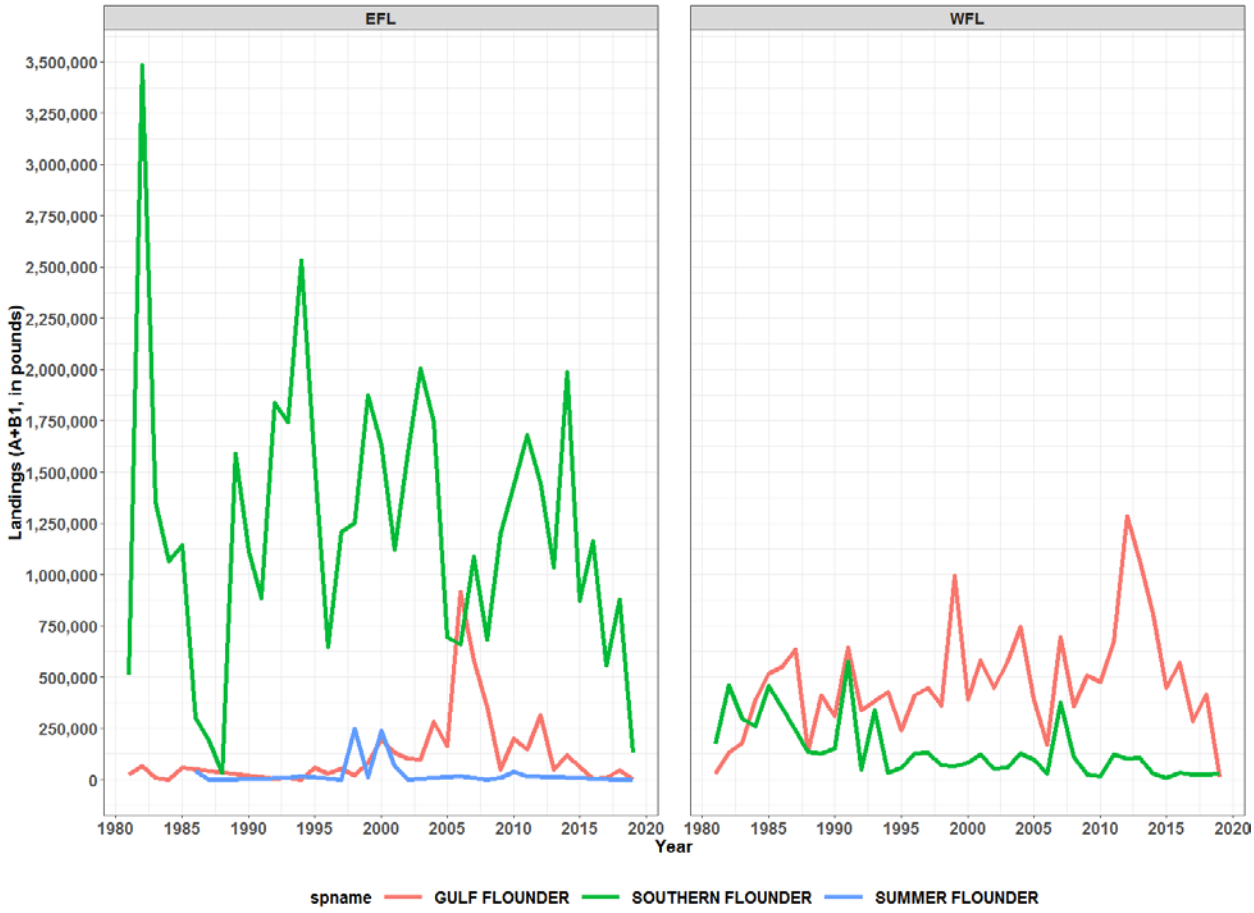


Figure 11. Estimated annual recreational harvest (A+B1, pounds) of flounder by species and by coast (EFL, East Florida; WFL, West Florida) based on fully calibrated (FCAL) MRIP estimates, 1981-2018.

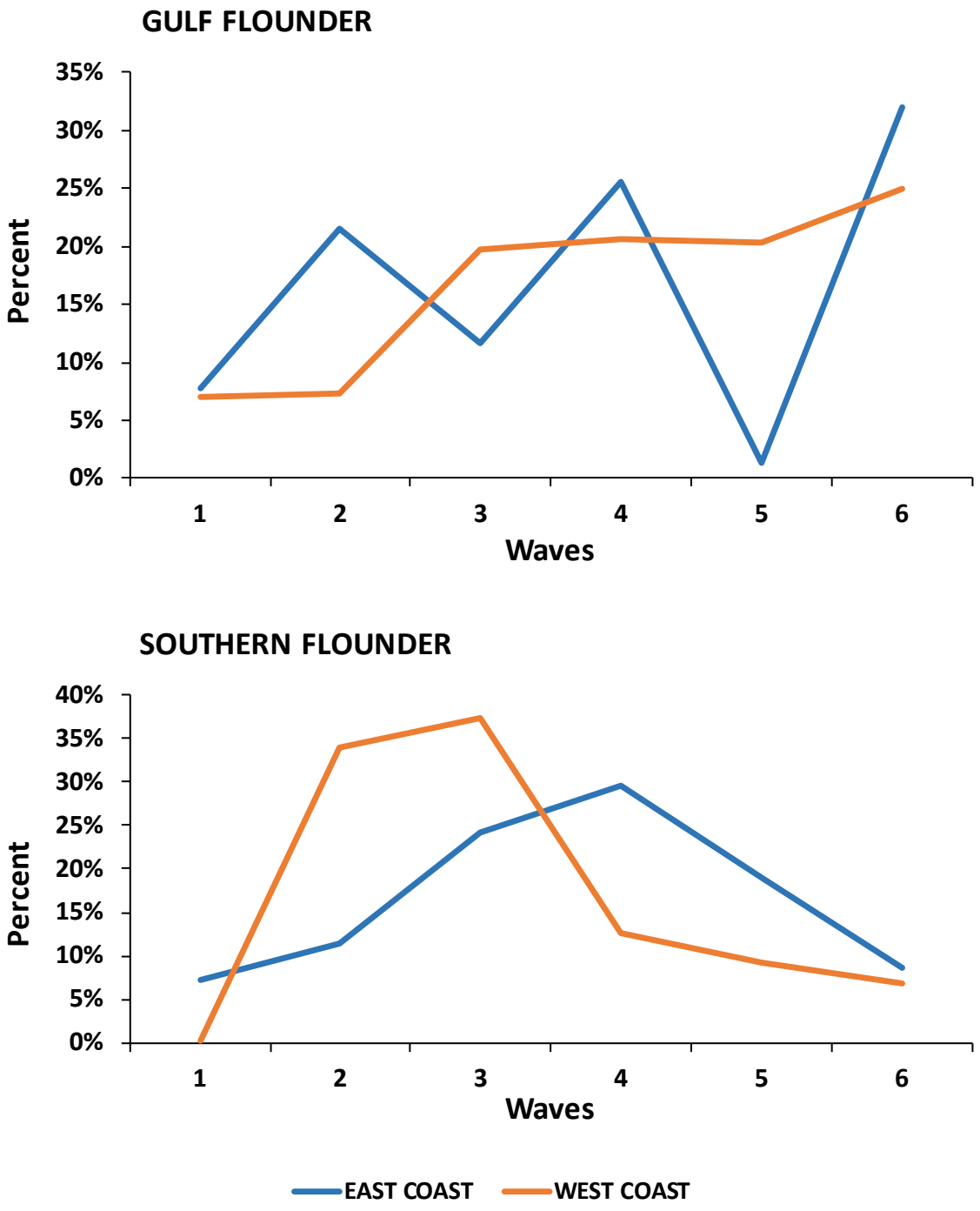


Figure 12. Estimated percentage of flounders harvested (Type A + B1) during each two-month sampling wave along the east and west coasts of Florida during the period 2014-2018.

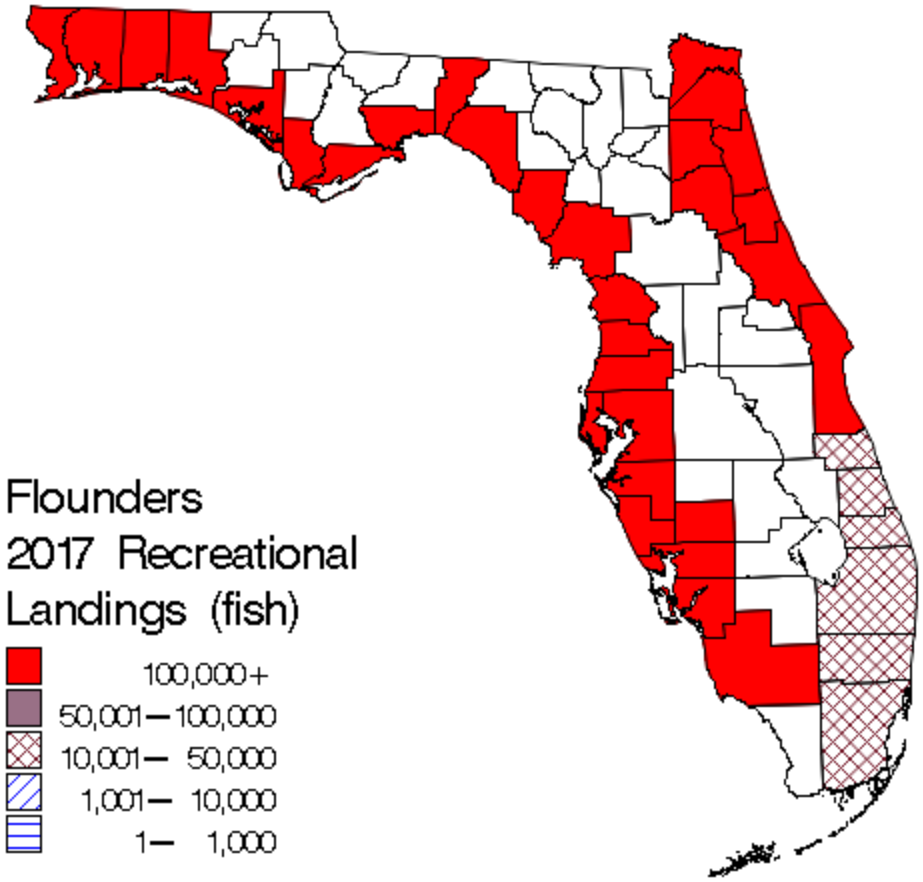
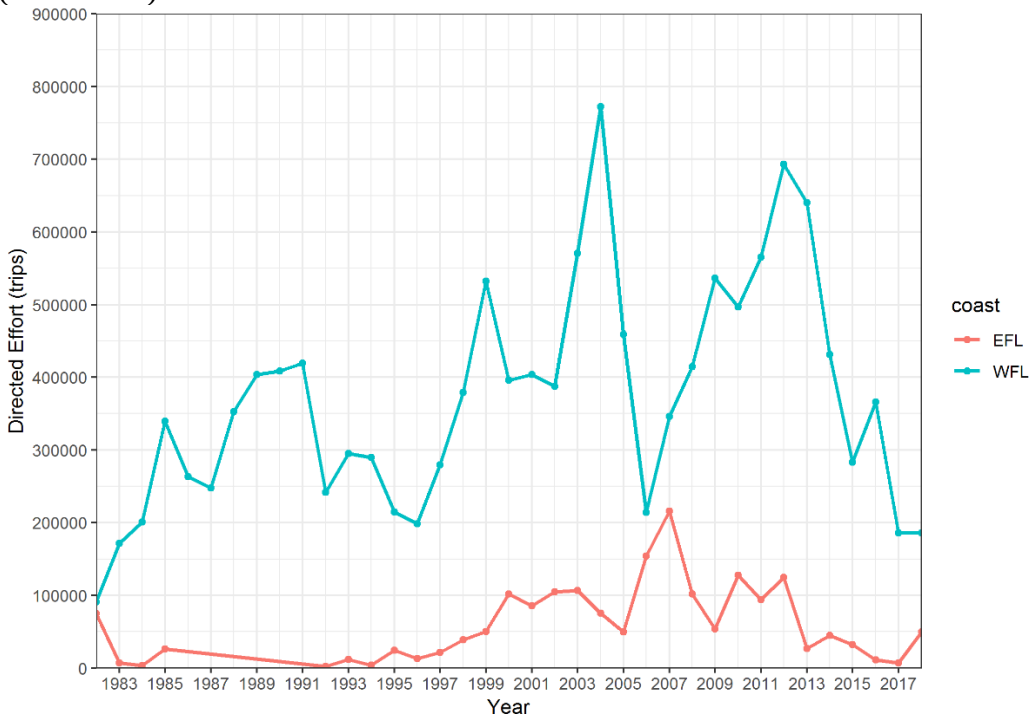


Figure 13. Geographic distribution of recreational landings of flounders (A+B1, number of fish) during 2017 by county.

Gulf Flounder Directed Effort
(1982-2018)



Southern Flounder Directed Effort
(1982-2018)

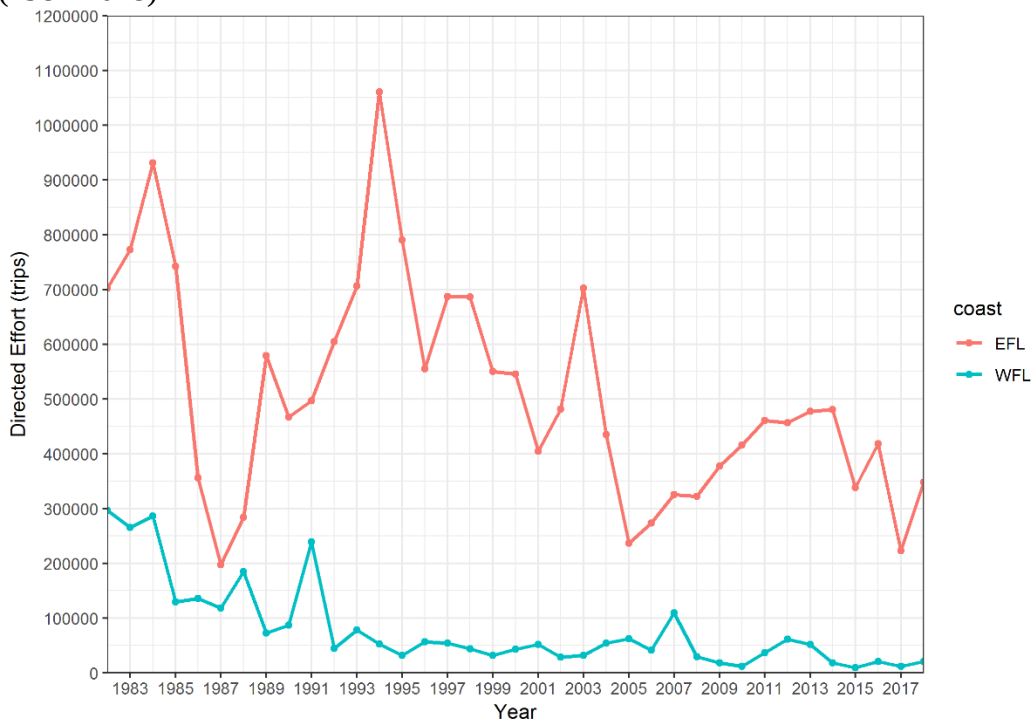


Figure 14. Estimated number of recreational angler trips directed at Gulf Flounder and Southern Flounder along the East (EFL) and West (WFL) coasts of Florida.

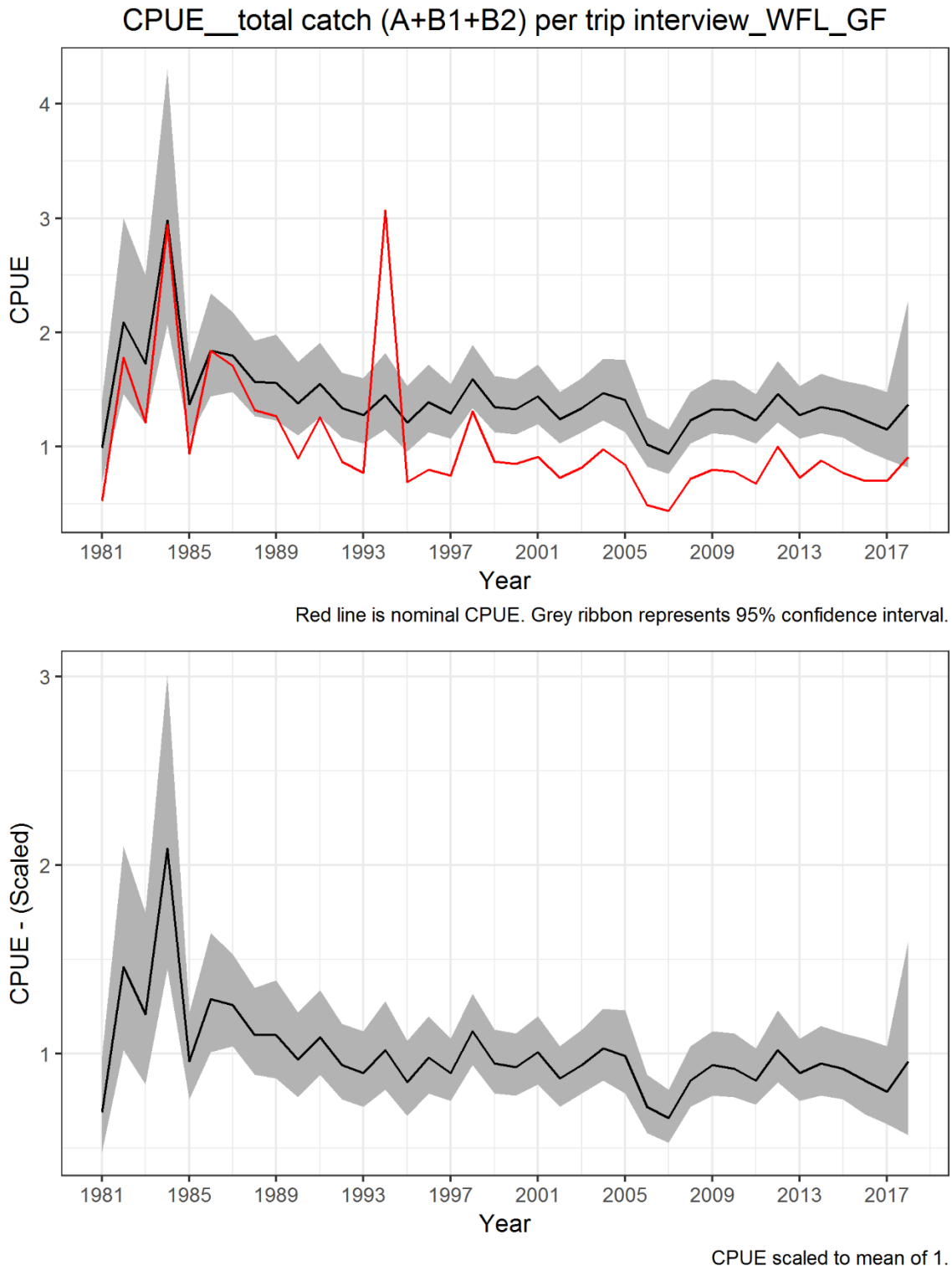


Figure 15. Standardized recreational catch rates for Gulf Flounders caught by anglers along the west coast of Florida, 1981-2018.

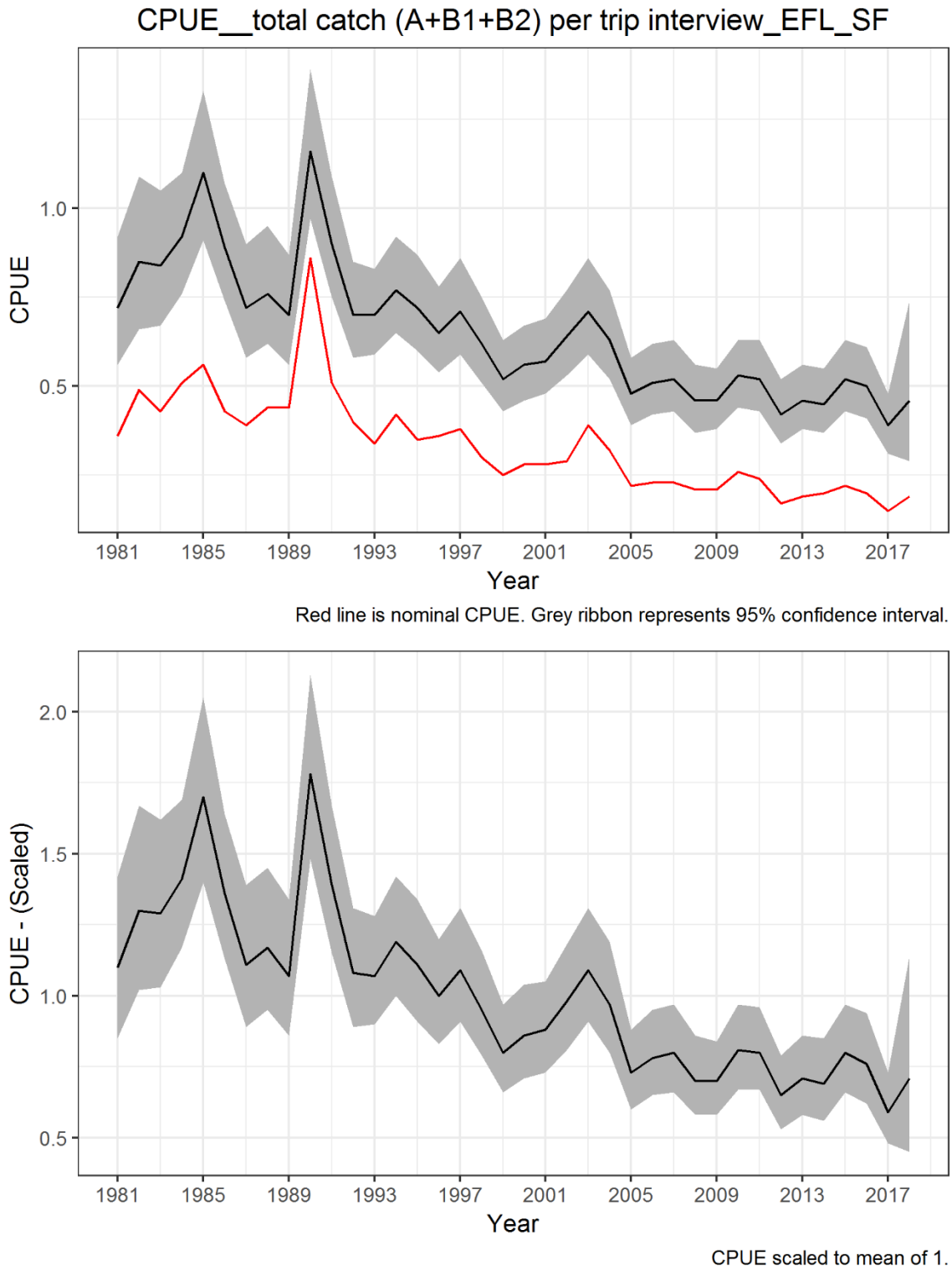
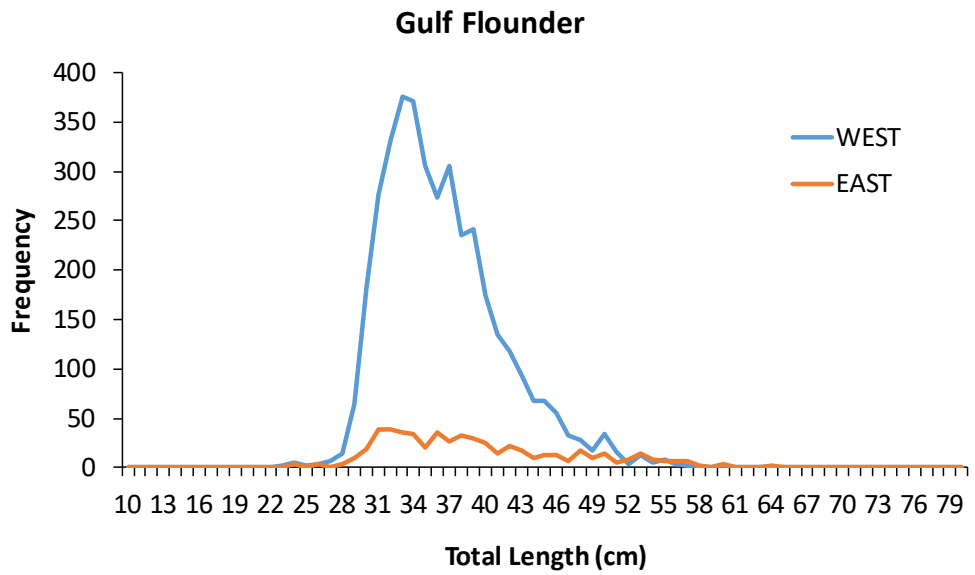


Figure 16. Standardized recreational catch rates for Southern Flounders caught by anglers along the east coast of Florida, 1981-2018.



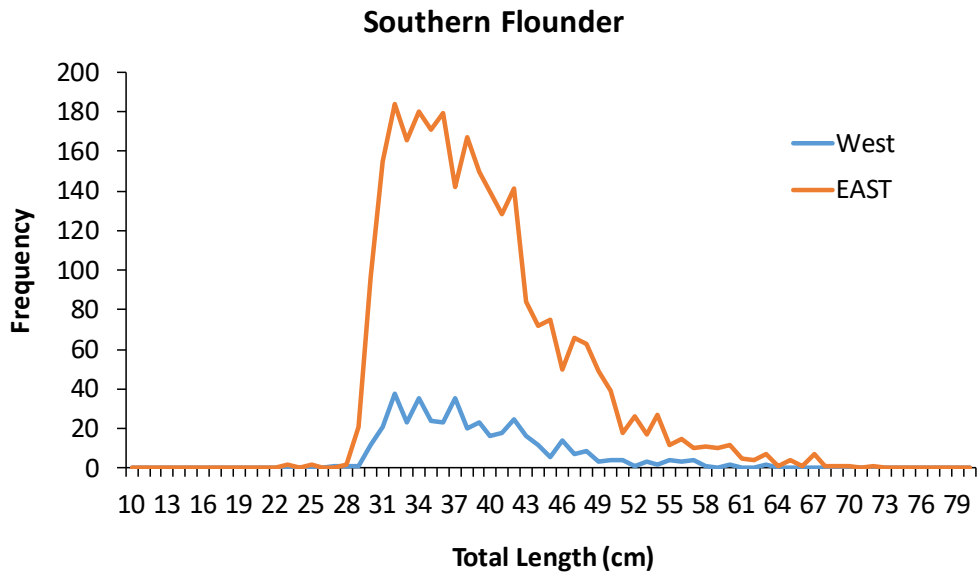


Figure 17. Lengths of flounders sampled from MRIP recreational angler interviews on the east and west coasts of Florida during 2004-2018.

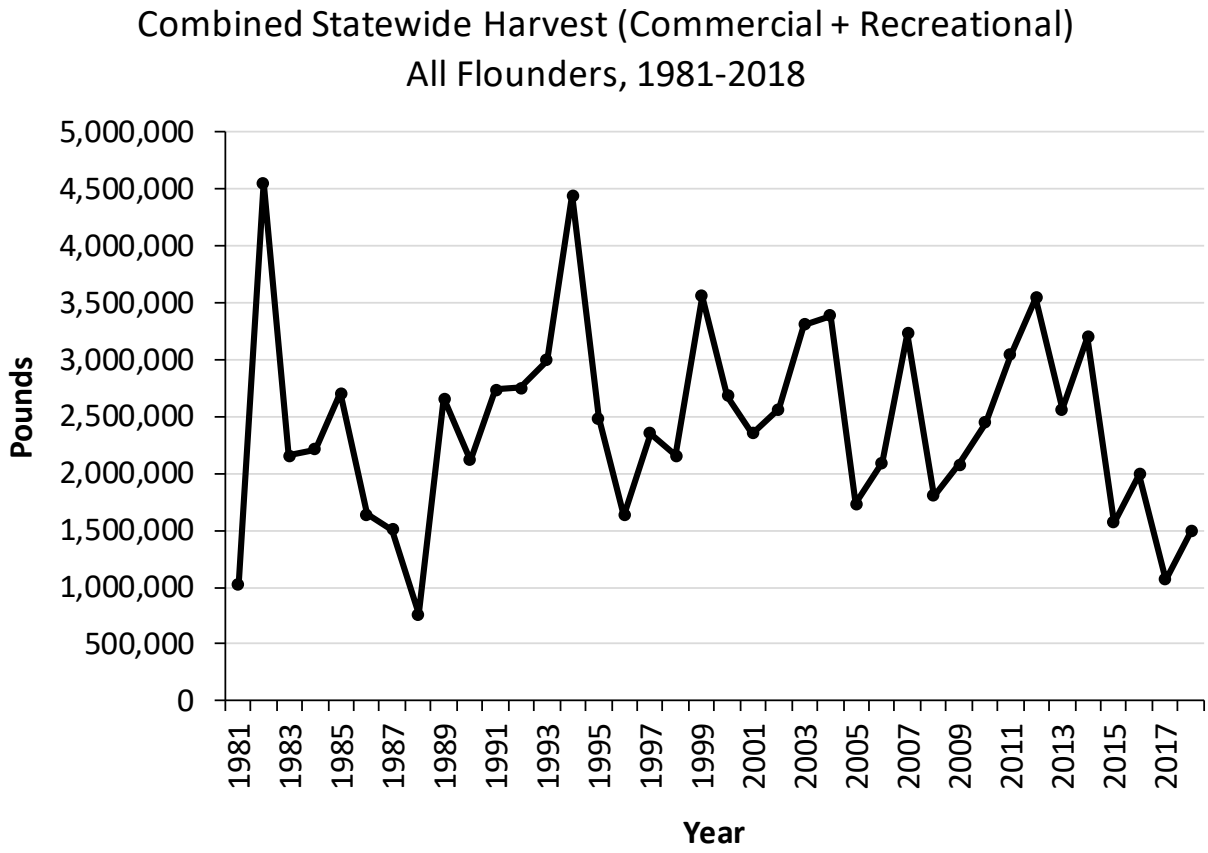


Figure 18. Combined commercial (pounds) and recreational landings (total dead catch, pounds) of all flounders in Florida, 1981-2018.

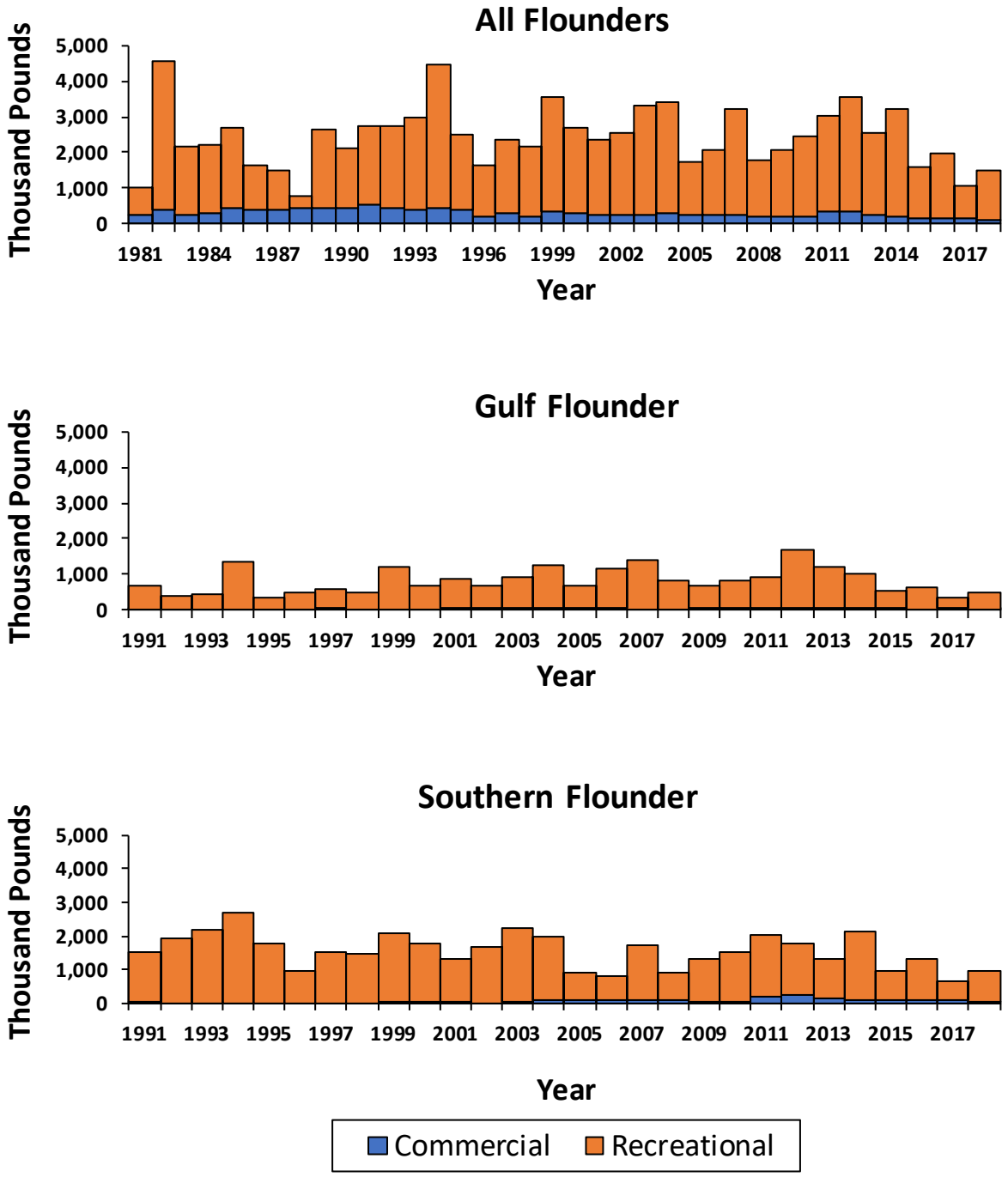


Figure 19. Harvest of flounders (1,000 lbs) by species and sector (Commercial, Recreational harvest (A+B1) plus dead releases (B2*0.15), in pounds) through 2018. Flounder were not identified to species in commercial data prior to 1991.

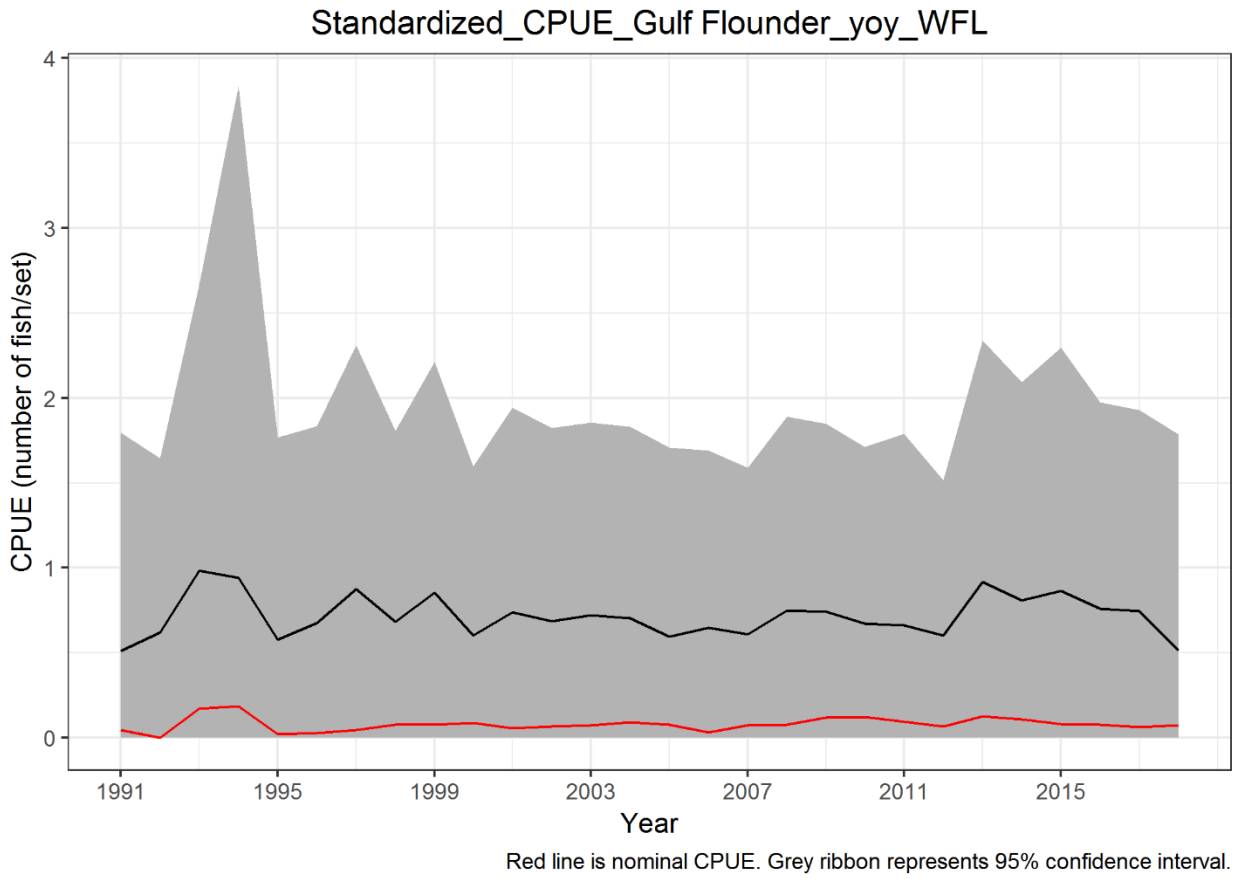


Figure 20. FIM young-of-year (YOY) index for Gulf Flounder on the west coast of Florida, 1991-2018. Median, 25th and 75th percentiles, and interquartile range are shown.

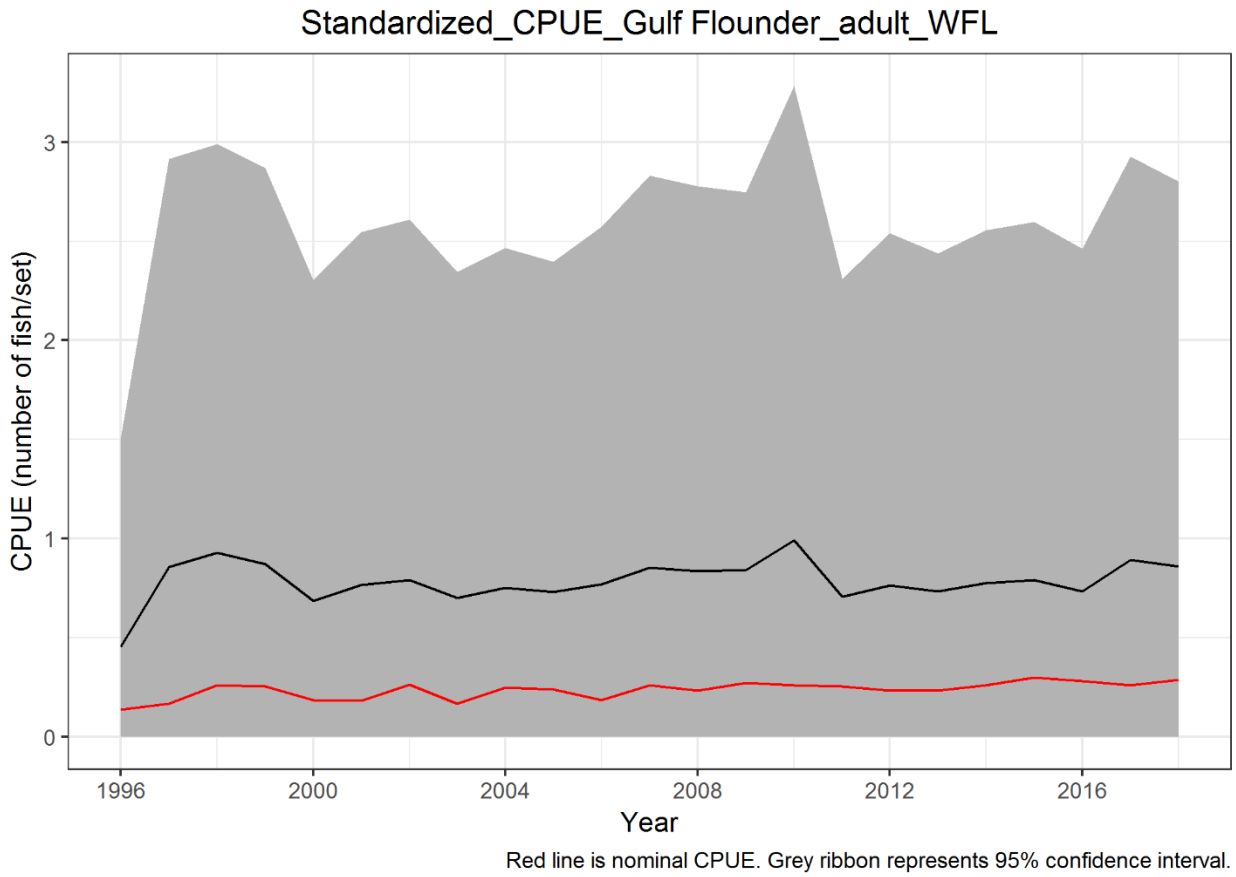


Figure 21. Gulf Flounder adult FIM index of abundance for the Florida west coast, 1996-2018. Median, 25th and 75th percentiles, and interquartile range are shown.

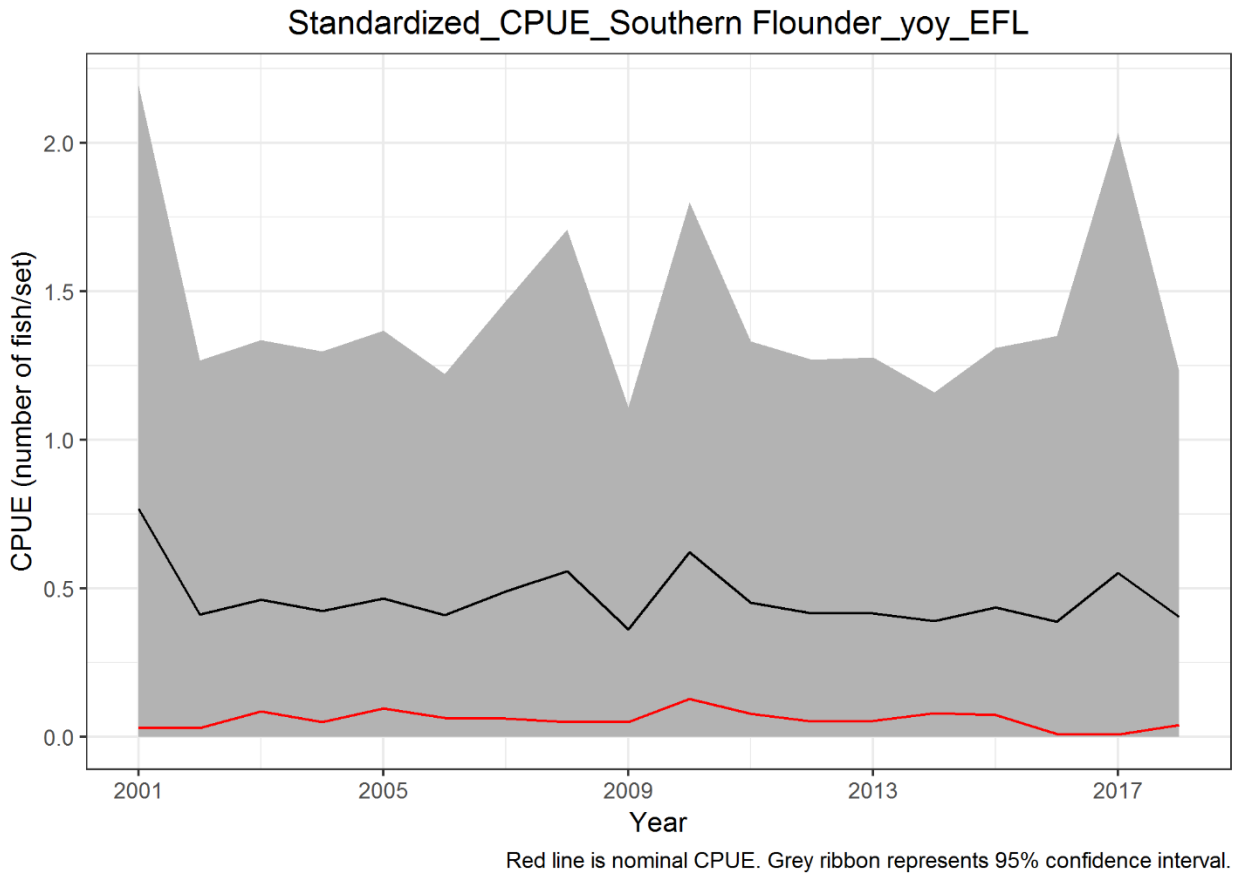


Figure 22. Southern Flounder YOY FIM index from Florida east coast, 2001-2018. Median, 25th and 75th percentiles, and interquartile range are shown.

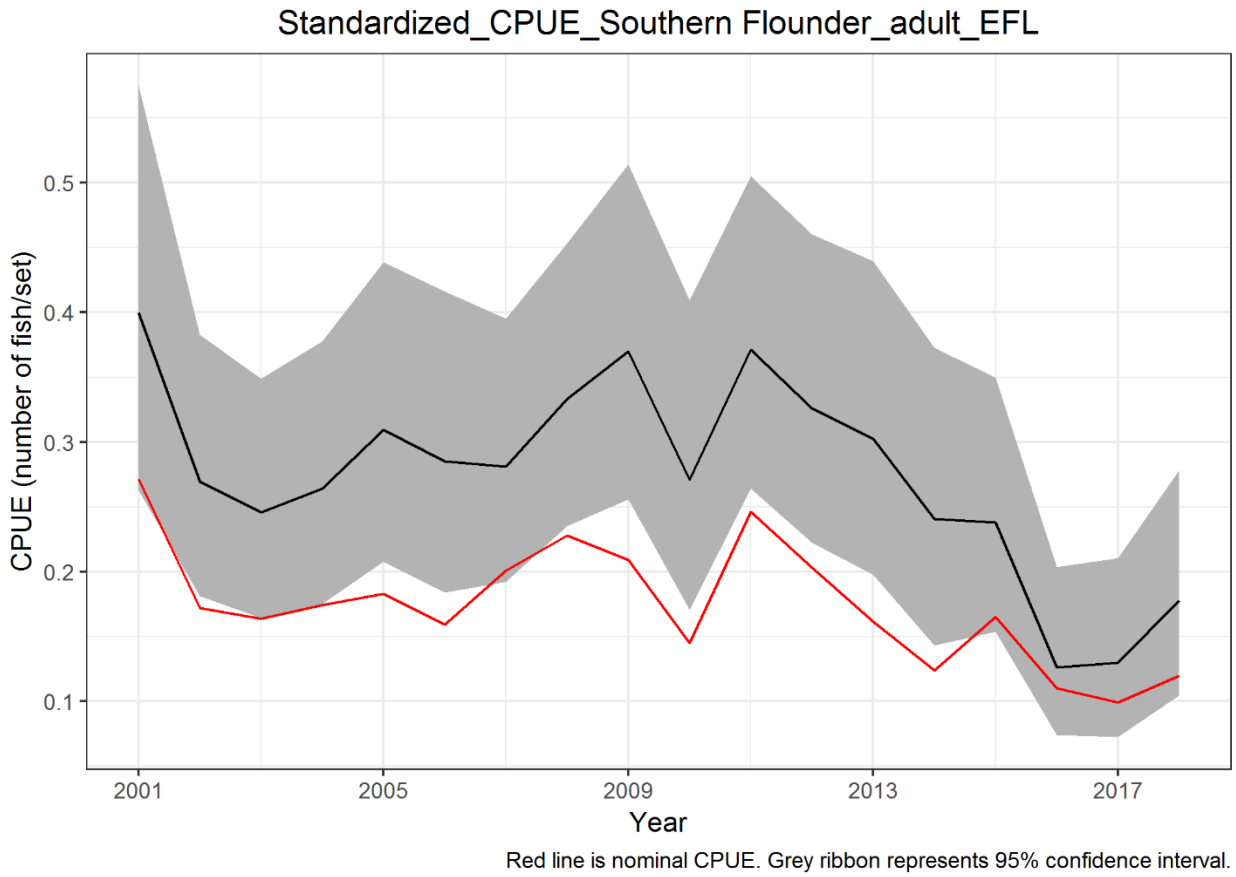


Figure 23. Adult Southern Flounder FIM index of abundance on the east coast of Florida, 1997-2018. Median, 25th and 75th percentiles, and interquartile range are shown.

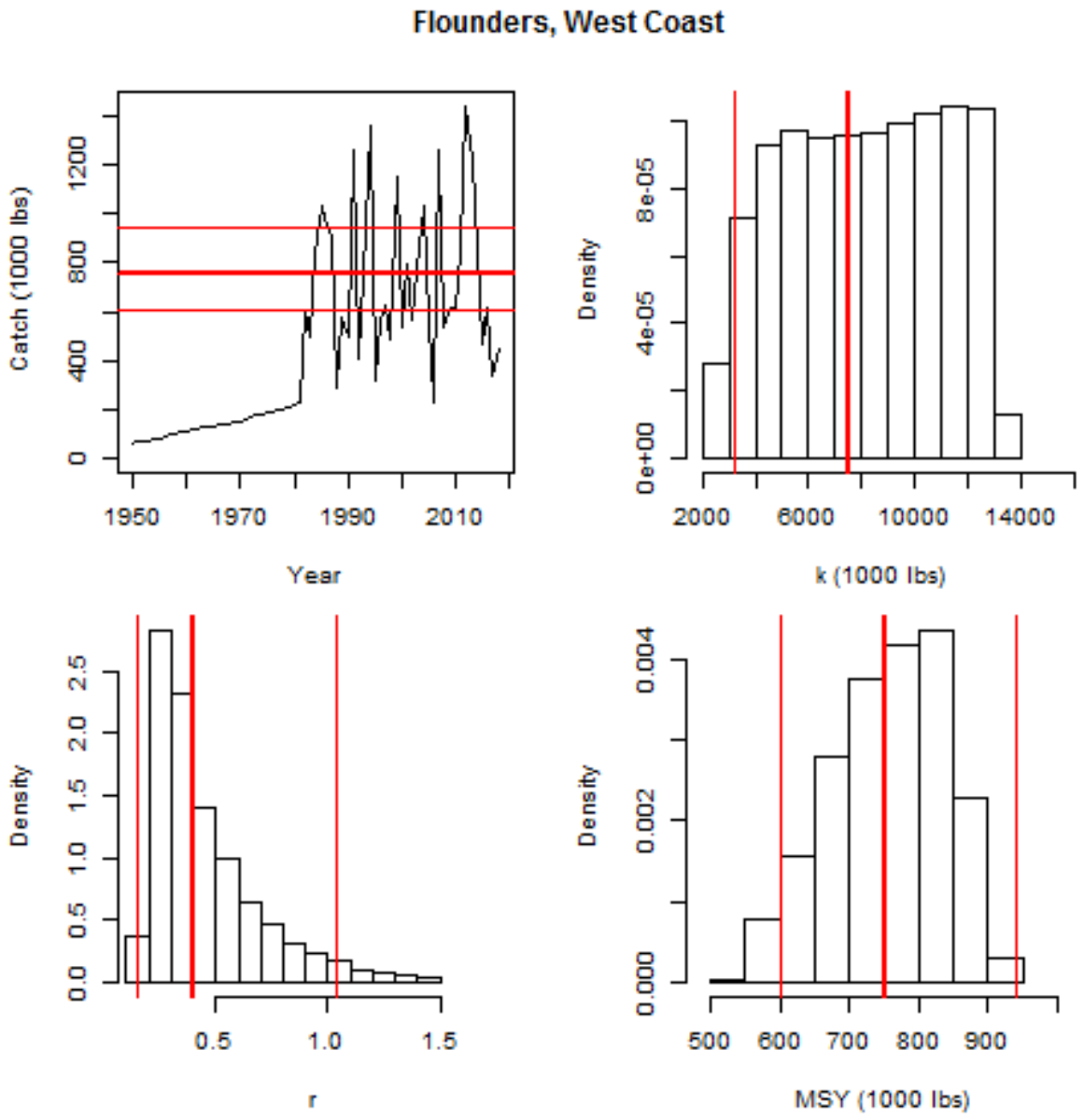


Figure 24. Estimated distributions of *MSY*, *r*, and *k* with mean and 95% confidence intervals from the CatchMSY analysis of west coast flounders (i.e. Gulf Flounder)

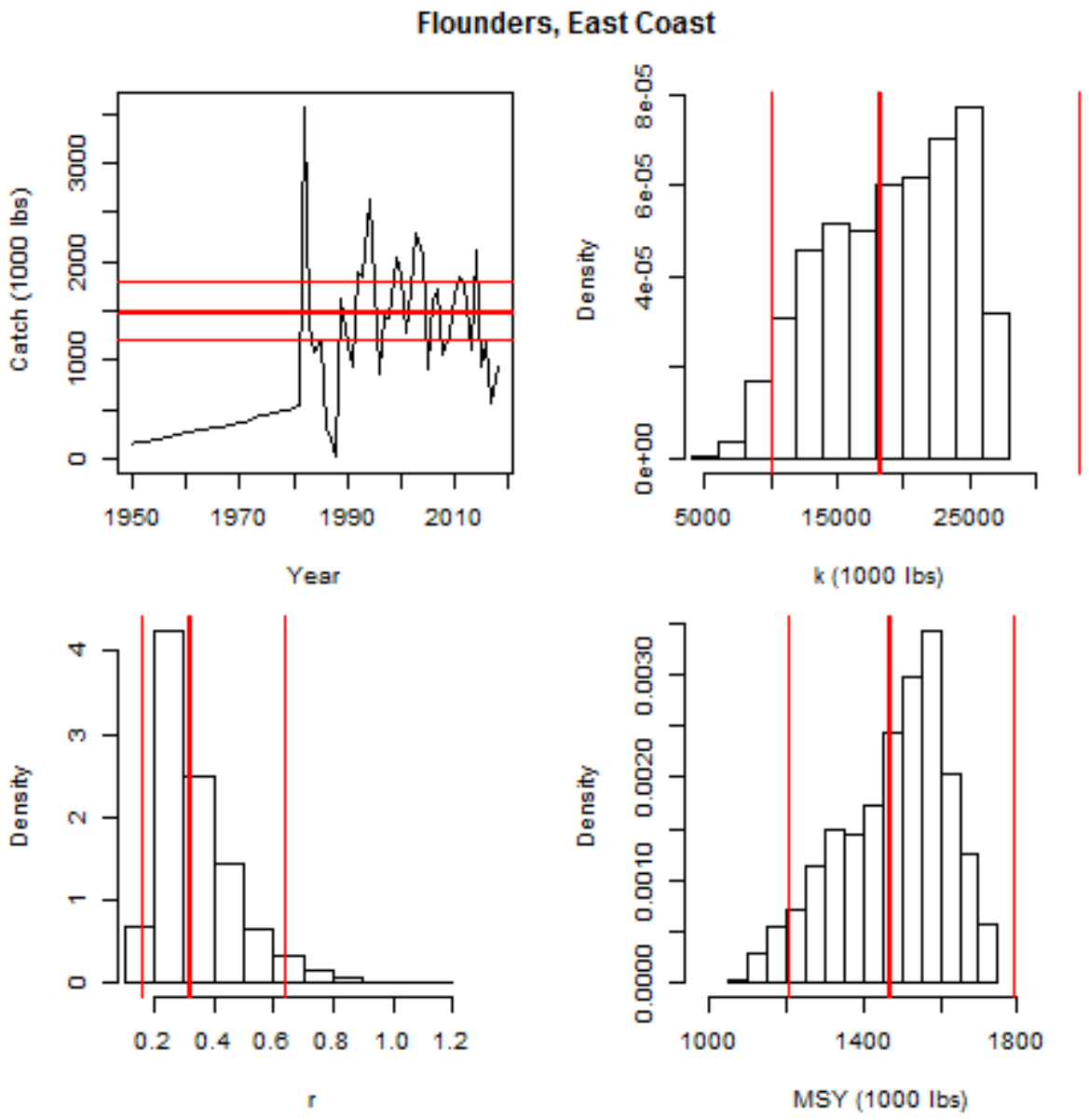


Figure 25. Estimated distributions of *MSY*, *r*, and *k* with mean and 95% confidence intervals from the CatchMSY analysis of east coast flounders (i.e. Southern Flounder)

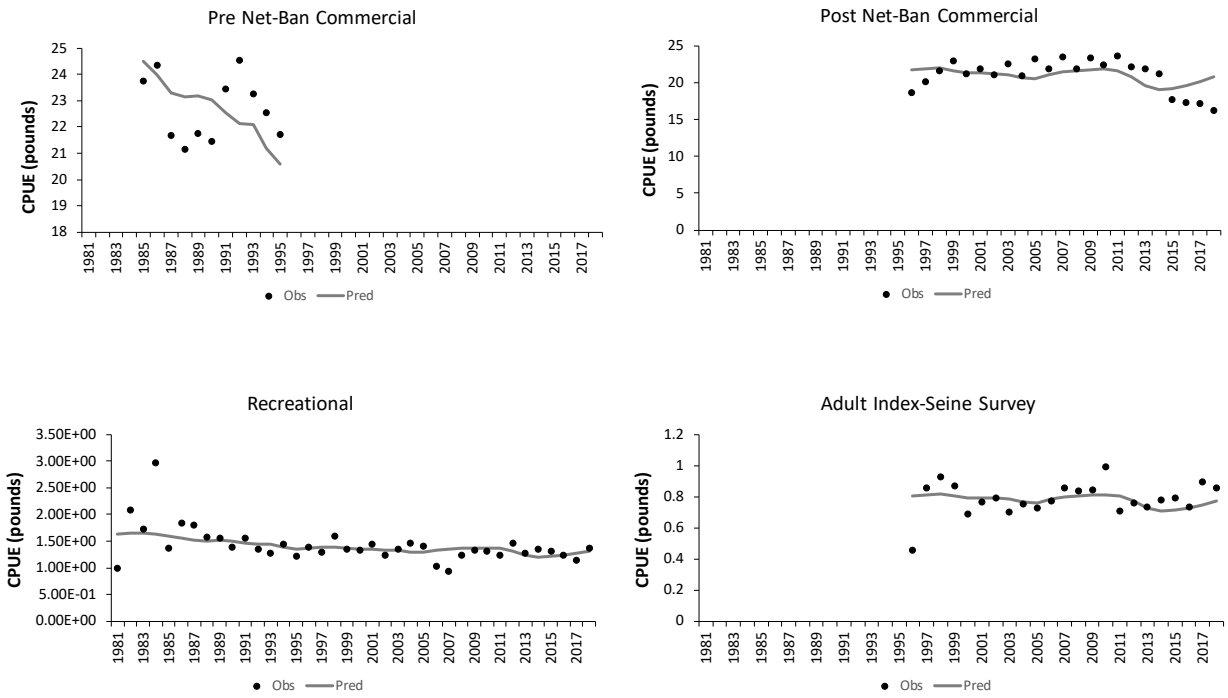


Figure 26. ASPIC model fits to the commercial catch rate (pre and post net-ban periods), recreational catch rate, and fishery-independent adult index series for Gulf Flounder on the west coast of Florida.

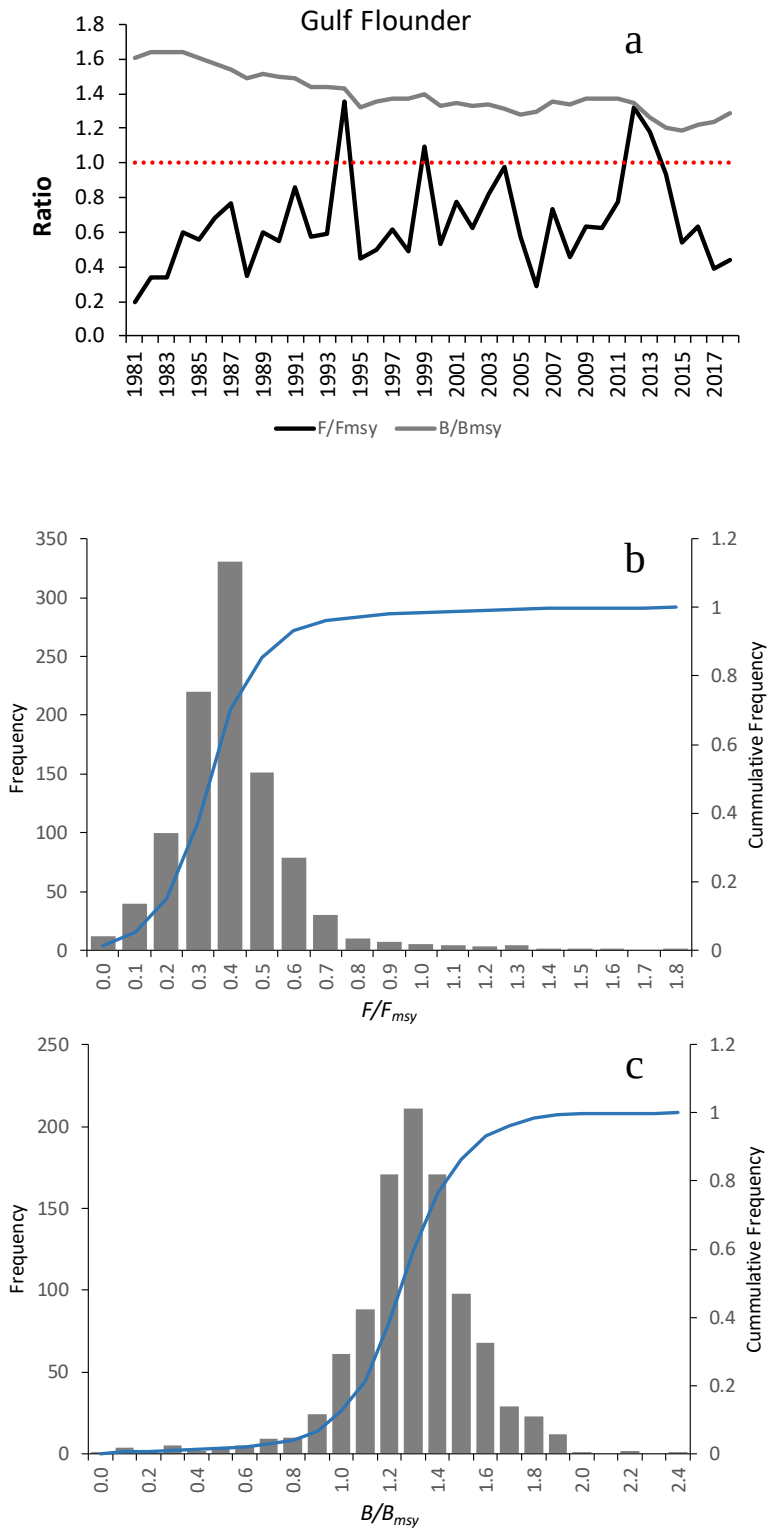


Figure 27. The ASPIC Gulf Flounder model estimates of F/F_{MSY} and B/B_{MSY} (a) likelihood (bootstrap, 1000 runs) estimates of F/F_{MSY} for Gulf Flounder in 2018(b) and likelihood (bootstrap, 1000 runs) estimates of B/B_{MSY} for Gulf Flounder in 2018 (c).

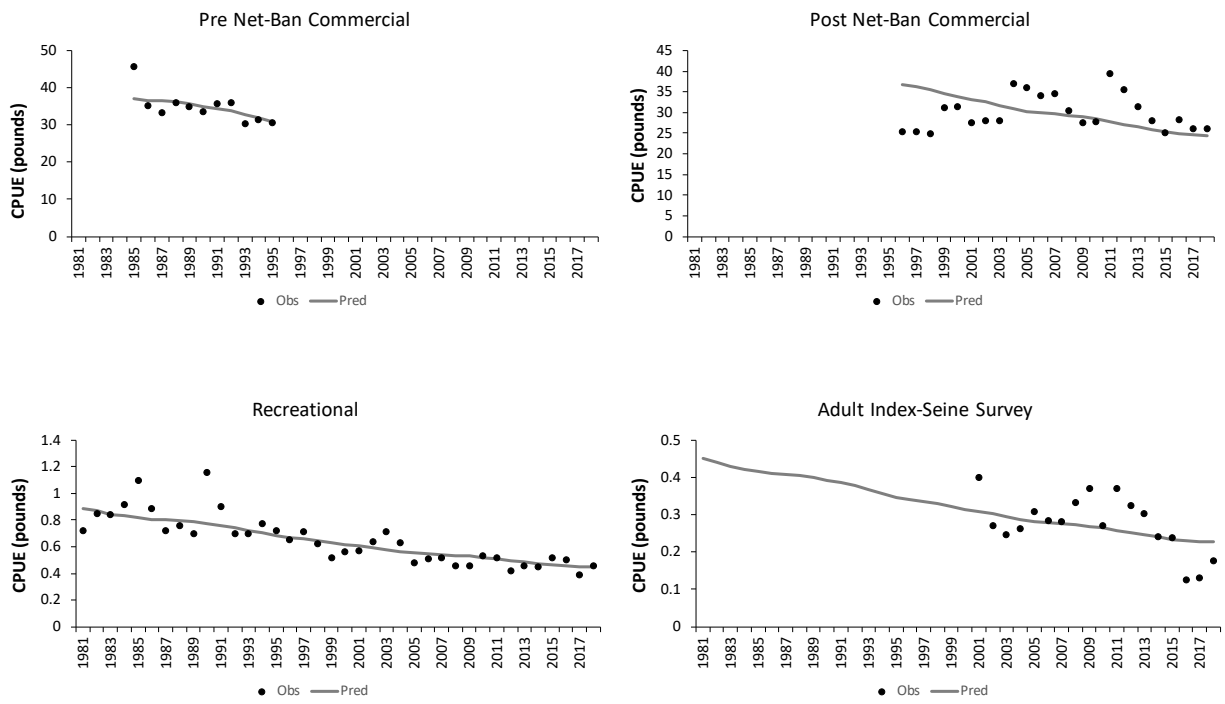


Figure 28. ASPIC model fits to the commercial catch rate (pre and post net-ban periods), recreational catch rate, and fishery-independent survey adult index series for Southern Flounder on the east coast of Florida.

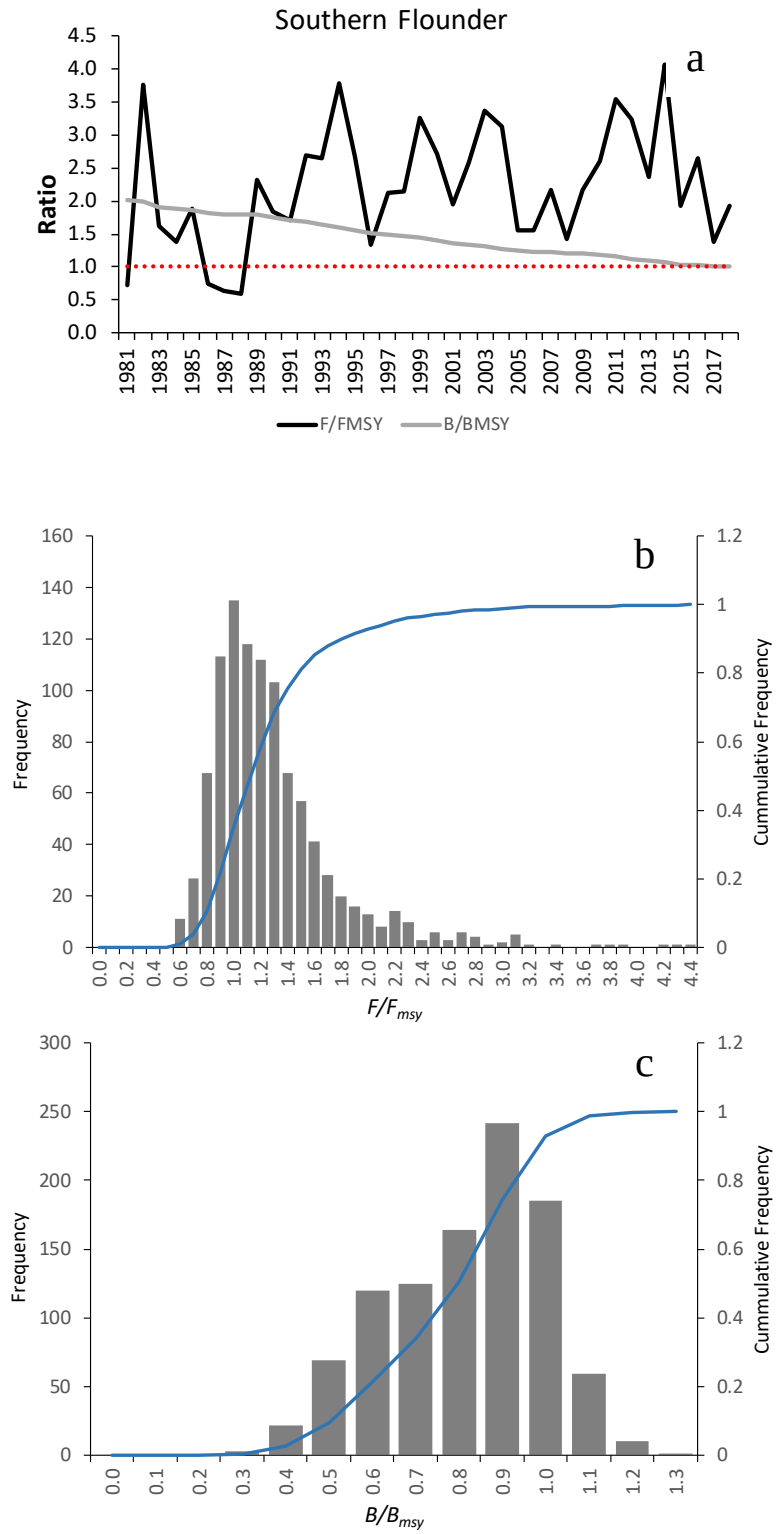


Figure 29. The ASPIC Southern Flounder model estimates of F/F_{MSY} and B/B_{MSY} (a), likelihood (bootstrap) estimates of F/F_{MSY} for Southern Flounder in 2018(b), and likelihood (bootstrap, 1000 runs) estimates of B/B_{MSY} for Southern Flounder in 2018 (c).