3. Fisheries

3.1. Introduction

3.1.1. General Description

The LSJRB supports a diverse finfish and invertebrate community that has significant commercial and recreational value. Blue crabs account for the majority of landings comprising 82% (1,495,787 lbs) of the total landings for 2017, reduced to 59% (978,288 lbs in 2018 (**FWRI 2020a**). Commercial finfish accounted for about 38% (630,965 lbs) in 2018 compared to 15% (278,130 lbs) of the total catch in 2017. In 2018, finfish were comprised of striped (black) mullet (34%), flounders and sheepshead (1-3%), followed by menhaden, croakers, seatrout, and catfish (<1%). In 2013, Clay, Duval, Flagler, Putnam, and St. Johns Counties reported a total commercial crab harvest of 1,615,232 lbs (73%); and a fish harvest of some 570,509 lbs (**FWRI 2020a**). The oyster harvest represented about 2% of the total weight harvested in 2018 occurring in St. Johns County (Figure 3.1). Recreationally, the St. Johns River area supports high numbers of red drum, spotted seatrout, croaker, sheepshead, flounder, largemouth bass, and bluegill that are sought by both local and visiting anglers.

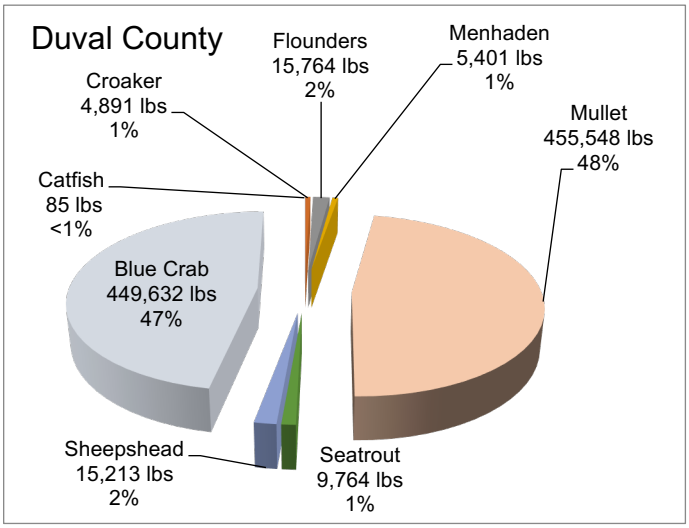
3.1.2. Data Sources & Limitations

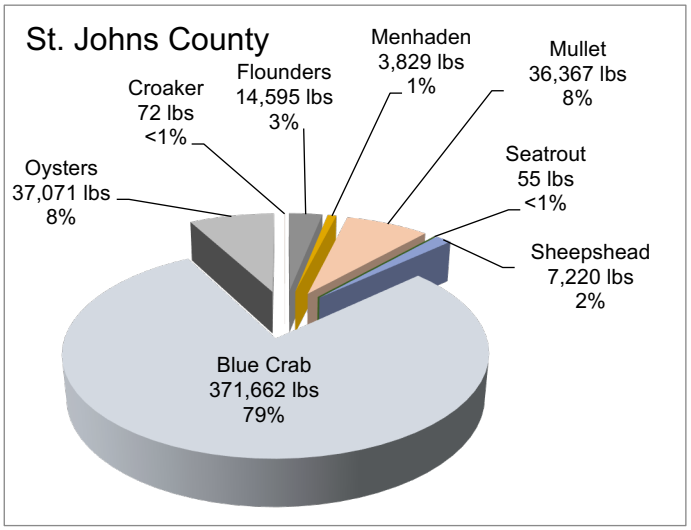
All available literature was used to examine potential long-term trends (1955-2016) in fish communities via the presence or absence of species encountered in the particular study. Although, such comparisons can give insight into whether the overall fish community was the same for the time periods compared, a major weakness of this comparison is that it gives no information on how the numbers of a given species may change with time. Also, the collection methods in these studies were not the same, thus making it difficult to draw valid conclusions.

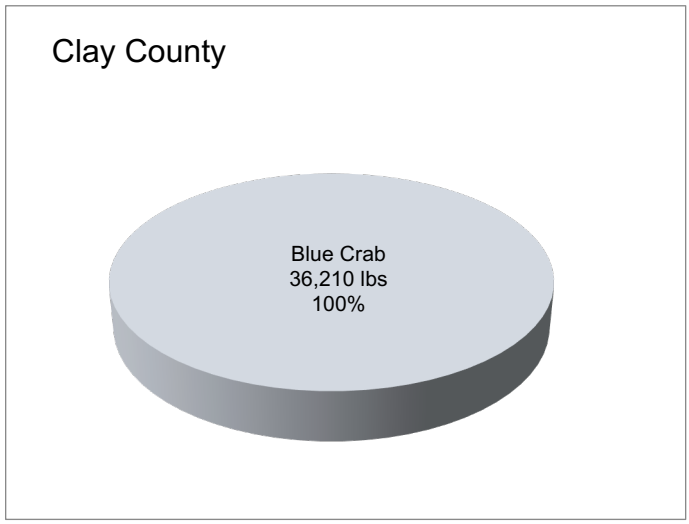
Two data sources were provided by the Florida Fish and Wildlife Research Institute (FWRI) as follows: 1) Commercial fisheries landings reports (1994-2016); and 2) data from the Fisheries Independent Monitoring (FIM) program (**FWRI 2002; FWRI 2003; FWRI 2004; FWRI 2005; FWRI 2006; FWRI 2007; FWRI 2008b; FWRI 2009; FWRI 2010; FWRI 2011; FWRI 2012b; FWRI 2013b; FWRI 2014**; **FWRI 2016**; **FWRI 2017**; **FWRI 2018a**; **FWRI 2019**; **FWRI 2020b**). For commercial landings data, there are uncertainties associated with either the exact location of where a fish was caught and/or the method of estimating total number of landings for a given area. In particular, these data do not differentiate between fish and invertebrates caught in the LSJR or the ICW. In addition, changes in fishery regulations over time limit what can be said of landings between certain time periods. For the most part, the total landings have been graphed. To best

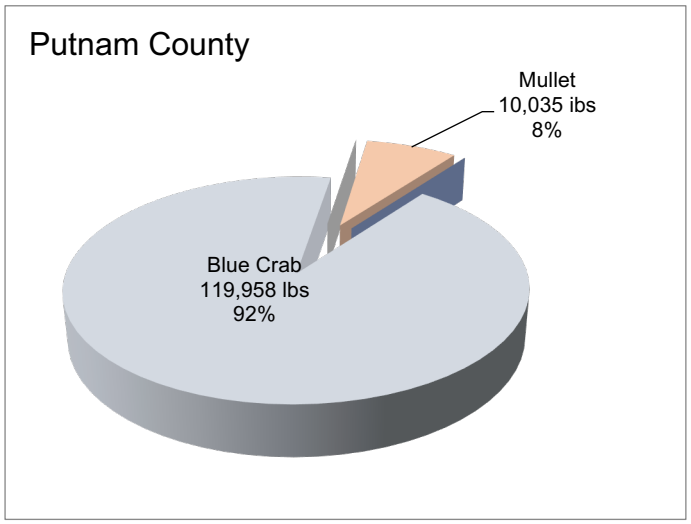
standardize comparisons of the total landings over time, we calculated landings per trip, and trends were investigated using a Kendal tau correlation analysis.

The most statistically reliable data used in this report comes from ongoing research conducted by the FWRI-FIM program. Data are presented in two forms. The first form displays for each species yearly Indices Of Abundance (IOA) for relevant age classes (young of year fish, adults; or pre-fishery and slot size limits) encountered within the lower basin of the river. The second form displays the monthly length frequency diagrams for each species for the 15-years sampling period (Appendix 3.1.1). Both forms of display allow for more specific insight into temporal trends, recruitment, and the fishery (slot size limits available to fishermen). Potential trends in all these data are investigated using Kendall tau correlation analysis. Finally, scientific literature was used where appropriate to supplement these data and form conclusions about trends and status.









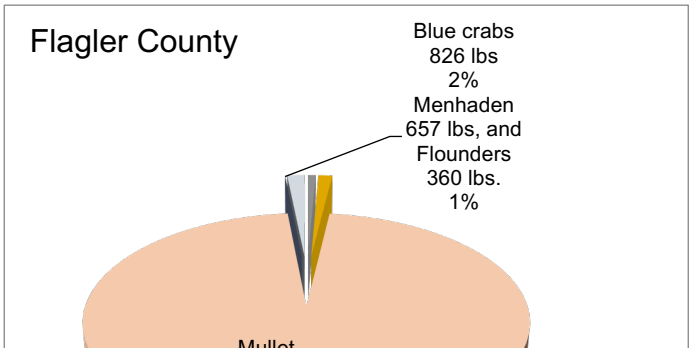


Figure 3.1 Percent comparison of commercially important fish and invertebrates caught by fisherman of five counties associated with the lower basin of the St. Johns River in 2017. These data do not differentiate between fish and invertebrates caught in the St. Johns River or the Intracoastal Waterway (ICW).

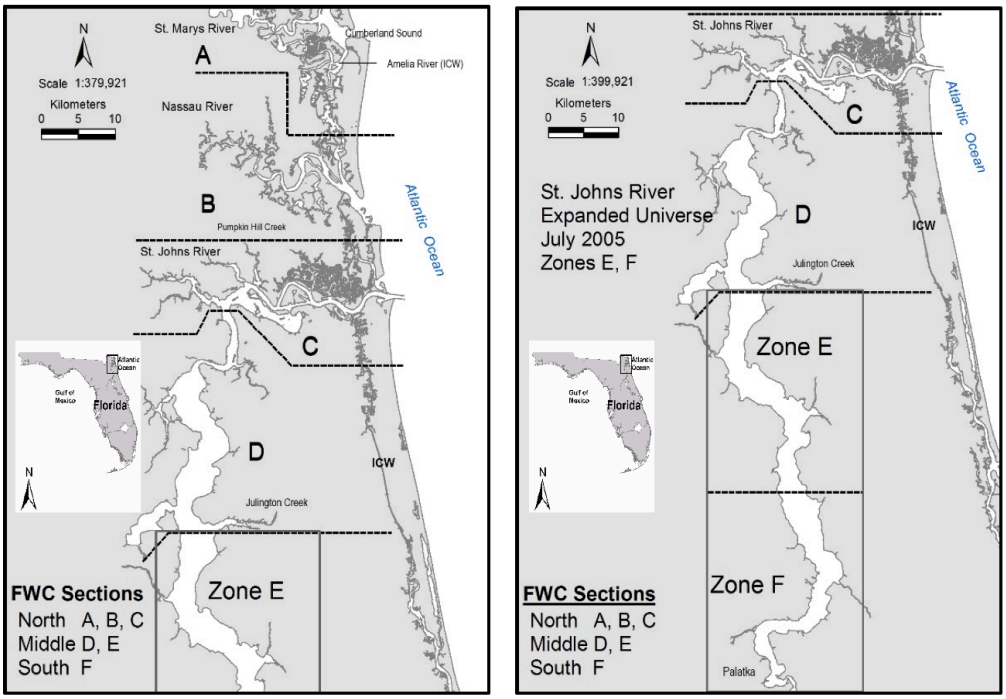


*Figure 3.2 Map of areas of St. Johns River sampled by Fish and Wildlife Institute from July 2005 to December 2019 (**FWRI 2020b**).*

3.1.3. Health of Fish and Invertebrates

There is not much information on the health of fish and invertebrates from the LSJRB. In the mid-1980s, there were concerns with fish health in the St. Johns River when high numbers of fish with external lesions (called Ulcerative Disease Syndrome (UDS)) were reported by local fishermen. A comprehensive 1987 study (**CSA 1988**) from Clapboard Creek to Lake George revealed only 73 lesioned fish out of 69,510 (0.11%). However, this study also observed a higher percentage (5%) of lesioned fish in the Talleyrand area with the main affected fish being southern flounder, weakfish, yellowfin, menhaden, southern stingray and Atlantic croaker. FWRI has data for the LSJR and the *Aphanomyces* fungus – published in part in **Sosa et al. 2007**. The latter study comprised of a statewide and historical survey of *Aphanomyces* and associated ulcerative lesions in fish. In the SJR, a number of species were confirmed with ulcerative lesions from *Aphanomyces* between 1980-2003 (time of study and retrospective analyses), including striped mullet (*Mugil*

cephalus), Gulf flounder (*Paralichthys albigutta*), menhaden (*Brevoortia* sp.), weakfish (*Cynoscion regalis*), southern flounder (*Paralichthys lethostigma*), gray snapper (*Lutjanus griseus*), Atlantic croaker (*Micropogonias undulatus*), hickory shad (*Alosa mediocris*), American shad (*Alosa sapidissima*), brown bullhead (*Ameiurus nebulosus*), silver perch (*Bairdiella chrysoura*), pinfish (*Lagodon rhomboides*), sand seatrout (*Cynoscion arenarius*), and sheepshead (*Archosargus probatocephalus*). FWRI research suggested that a major cause of the lesions is a water mold (*Aphanomyces invadans*) that is more likely to infect stressed fish. Fish can be stressed when exposed to unusual changes in salinity, temperature, and water quality.

During the summer and fall of 2010, there was a sequence of unusual events in the LSJR involving extensive fish kills, cyanobacteria blooms, foam formation, and bottlenose dolphin deaths. From late May until July 2010, there were extensive fish kills within the St. Johns River from Lake George to the downtown Jacksonville area. The mortality event lasted much longer than mortality events caused from hypoxia. While multiple species of dead fish were observed, white catfish, red drum, longnose gar, Atlantic stingrays, and menhaden were reported to be most affected by the event. Generally, most observed dead fish did not have lesions or sores. Co-occurring with the fish kill were cyanobacteria blooms of *Aphanizomenon cf. flos-aquae* followed by blooms of other algal species. Fish histopathology suggested that cyanobacteria-degrading bacteria might have played a role in this fish mortality event. During mid-October, a second, less widespread fish mortality event occurred in the river in which smaller fish, mostly menhaden, were found with lesions near the caudal fin. This later fish kill may have been because of a bloom the fungus *Aphanomyces invadans* (**Sosa et al. 2007**).

FWRI has investigated external abnormalities, such as lesions, in fish since 2000. They surveyed fish and invertebrates for the presence of abnormal growths, colors, and ulcers or gross external abnormalities (GEA). They also sampled mercury levels in muscle tissue from the shoulder area in similar sized (generally larger) spotted seatrout, red drum, southern flounder, southern kingfish (whiting), and blue crabs.

The incidence of GEAs was found to be less than one percent from 2001 to 2010 (**FWRI 2002; FWRI 2003; FWRI 2004; FWRI 2005; FWRI 2006; FWRI 2007; FWRI 2008b; FWRI 2009; FWRI 2010; FWRI 2011**). During this time period, the percent of fish affected by GEAs has varied between 0.001 to 0.4% (Figure 3.3). While 26 species of fish with GEAs have been encountered by FWRI from 2001 to 2010, the most commonly observed fish with GEAs during this time period are striped mullet, menhaden, sheepshead, and largemouth bass.

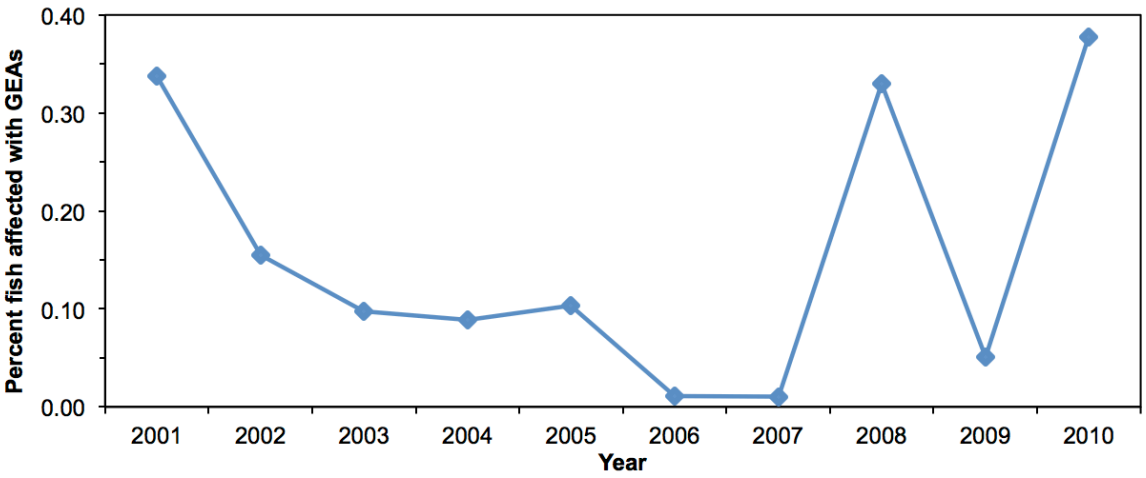


Figure 3.3 The percent of fish encountered with gross external abnormalities (GEAs) for each year of the ongoing FWRI study. A Kendall tau correlation revealed no significant trend over time (τ = -0.400; not statistically significant) in the percent fish encountered with GEAs from 2001 to 2010.

Mercury has been detected in a number of freshwater, estuarine and marine species in the state of Florida. The Florida Department of Health (FDOH) issues consumption advisories for a number of marine and estuarine fish (**FDOH 2016**). Generally, these are large, long-lived predatory species, which bioaccumulate high concentrations of mercury, over their lifetimes. Consumption advisories recommend the amount of the affected fish species that can safely be eaten in a given time span. It is recommended that fish that exceed a concentration of 1.5 parts per million (ppm) of mercury not be eaten by anyone. The general population can still eat fish with a 0.3 ppm mercury concentration, although there are more limiting human consumption advisories for children and women of child-bearing age (sensitive populations) when concentrations in fish exceed 0.1 ppm (**Goff 2010**).

In the LSJR, the FDOH advises limited consumption (1-8 meals per month – depends on the species) of Atlantic croaker, Atlantic thread herring, Atlantic weakfish, black drum, brown bullhead, redbreast sunfish, bluegill, black crappie, gulf and southern flounder, jack crevalle, hardhead catfish, red drum, sand seatrout, sheepshead, spotted seatrout, southern kingfish, striped and white mullet, spot, warmouth, largemouth bass, bowfin, and/or gar. Everyone is advised to eat no king mackerel larger than 31 inches, and no sharks larger than 43 inches (**FDOH 2020**). Note that more restricted consumption is recommended for children and pregnant/lactating women. For more information about consuming fish, see the FDOH website (**FDOH 2020**). For more information about mercury in fish and other species, see Section 5.4.4.

3.2. Finfish Fishery

3.2.1. General description

The LSJRB supports a fish community of great ecological, commercial and recreational value to the public. Most of the fish sought after are predaceous fish that are important in maintaining community balance in the areas where they occur. Historically, American eels and shad were huge fisheries in the St. Johns, although populations have decreased to such low levels that they are now not the focus of most commercial fisherman (**McBride 2000**). Currently, the premier commercially harvested estuarine or marine fish in the lower basin are striped mullet, flounder, sheepshead, menhaden, black drum, croaker and whiting. However, American eels, spotted seatrout, and weakfish are also commercially harvested. In freshwater sections of the river, important species commercially harvested include catfish, gar, shad, American eels,

and non-native tilapia. Of the five counties studied, Duval County had the overall highest landings (714,344 lbs. in 2014), and the generally most fish species caught per year except for flounder and menhaden mostly caught in St. Johns County (only includes fish caught within the river and ICW). Furthermore, Duval County ranks second largest among Florida counties in seafood harvested, predominantly shrimp caught in off shore coastal waters (**FWC 2020b**).

The St. Johns River supports a diverse recreational fishery in the lower basin. Within the different sections of the river, significant fisheries exist for freshwater, estuarine or saltwater fish. Popular saltwater species sought after are red drum, spotted seatrout, flounder and sheepshead. Premier freshwater species include largemouth bass, blue gill, and catfish. The abundance of some of these fish species in the river has resulted in a number of very high profile fishing tournaments occurring each year – red drum and bass tournaments being among the most popular.

3.2.2. Long-term trends

For many years, humans have benefited from the thriving fish communities that utilize the LSJR. Indeed, a number of the species sought after today, such as spotted seatrout and sheepshead, were commented on by the naturalist William Bartram as far back as the late 1700s. However, despite the importance of river fisheries over the years, only a few studies have rigorously sampled fish populations in the SJR. In response to this need for more information, the FWRI started a monthly fish-sampling program in 2001 that is designed to understand fish population changes with time in estuarine areas of northeast Florida.

The available long-term research suggests that many of the same species present today (~170 species total) were present in the river back in the late 1960s (**McLane 1955**; **Tagatz 1968b**; **FWRI 2008b**). However, it is unclear whether the numbers of individual species have changed during this time period because of different sampling methods used in these studies. Currently, the most numerically dominant species in the lower basin include anchovy, striped mullet, killifish, menhaden, Atlantic croaker, spot, silversides, and silver perch.

A preliminary study by L. McCloud with SJRWMD (**McCloud 2010**) compared current FWRI fish data with those collected by Tagatz in 1968 (**Tagatz 1968b**). Her research suggested that at some areas of the river, observed fish communities were 50% different between 1968 and the 2001-2006 time period. She further suggests that the observed differences in fish communities in these areas may have been the result of a transition zone between marine and freshwater moving further upstream. One of the unique aspects of the St. Johns Estuary is the ability of some marine fish to ascend far upstream into freshwater. For instance, stingrays are abundant in a number of freshwater areas in the river. However, most fish are sensitive to their environment, and can move from an area in response to unsuitable changes in important environmental factors, such salinity, dissolved oxygen, and temperature.

3.2.3. Red Drum (Sciaenops ocellatus)

http://myfwc.com/marine/fish/reddrum.jpg

3.2.3.1. General Life History

Red drum (also called puppy drum, channel bass, spottail bass, red bass, and redfish (**FWRI 2015**) are predatory fish that are found in the estuarine sections of the St. Johns River. During the fall and winter, they spawn at dusk in coastal waters near passes, inlets and bays. Newly hatched young live in the water column for 20 days before settling to the sea floor bottom, where they will develop into juveniles that live within estuary creeks and rivers. Young fish will become reproductively mature fish at around three years of age and may ultimately live for approximately 40 years (**Murphy and Taylor 1990**), and reach a maximum length of 45 inches.

3.2.3.2. Significance

Red drum are ecologically important as both a predator and prey in the food web of the St. Johns River. They are bottom feeders that eat crabs, shrimp, worms, and small fish. Their predators include larger fish, birds, and turtles.

A strong recreational fishery exists for red drum. The recreational fishery for red drum is an estuarine and near-shore fishery, targeting small, "puppy drum," and large trophy fish. Trophy-size fish are caught along the mid- and south coastal barrier islands, while smaller red drum are taken in shallow estuarine waters. Red drum has not been commercially harvested since 1988 to minimize impacts to natural populations.

3.2.3.3. Trend

Kendall tau correlation analyses of the FWRI data revealed a decreasing trend in number per set for young of year (YOY) fish (τ = -0.451; p = 0.01; n = 14); and adults from 2006 to 2019 (τ = -0.648; p = 0.0006; n = 134). However, 2019 only includes data from September to December and does not include January of 2020 (Figure 3.4). Young of year fish appear in the river from September to January and become juveniles in approximately one year (Appendix 3.2.3a). It is important to note that statistically significant trends may not translate into ecological significance due to interannual variations like the presence of “exceptional” years (e.g., 2012 for YOY red drum).

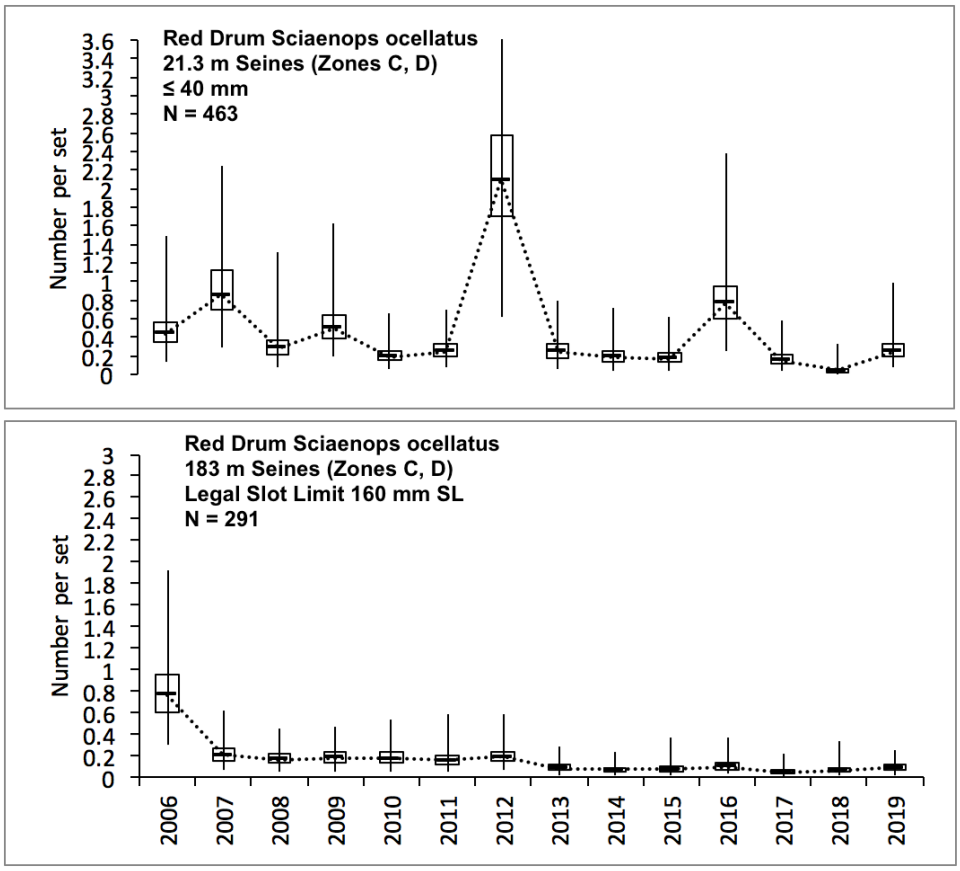


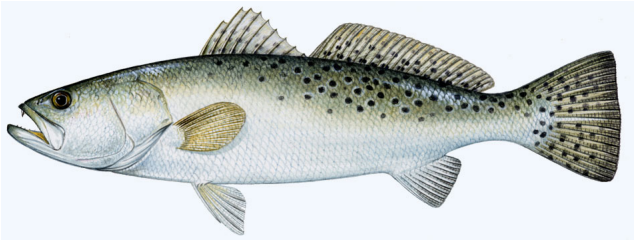
*Figure 3.4 Number of young of year and adult red drum caught within the lower basin of the St. Johns River from 2006-2019.The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). Young of year red drum were sampled over a split year recruitment window from September to January with 21.3 m seins and a mesh size of 3.2 mm. YOY were caught in zones C, & D, at shallow depth (≤1.8 m). Legal sized fish were sampled from January through December with 183 m haul seins (mesh size 38 mm). Slot limit fish were caught in zones C & D along shorelines (Figure 3.2 Sampling Zone Map).*

3.2.3.4. Current Status and Future Outlook

Red drum represent an important recreational fishery in the LSJR and appear to be safe from overexploitation (**Murphy and Munyandorero 2008**). There is concern that increased fishing activity in the future may cause decreases in fish numbers through direct loss of fish captured, and mortality of "returned" fish. Consequently, close monitoring of reproduction and abundance in local populations is essential for ensuring the long-term maintenance of red drum in LSJRB. Taking everything into account, the current **STATUS** of red drum is ***Satisfactory***, and the **TREND** is ***Unchanged***.

Recreationally, a maximum of two red drum may be caught per person per day throughout the year. Individual fish must be between 18 and 27 inches in length, and no red drum may be sold for profit (**FWC 2020b**).

3.2.4. Spotted Seatrout (Cynoscion nebulosus)



http://www.floridasportfishing.com/magazine/images

3.2.4.1. General Life History

The spotted seatrout is a bottom-dwelling predator that is common in estuarine and shallow coastal habitats in northeast Florida. It is a carnivore that preys on a number of small fish species, such as anchovies, pinfish and menhaden. Reproduction tends to occur during the night within the river from spring through fall with a peak during April through July. The young often form schools of up to 30-50 individuals. Individual fish will become sexually mature in 2-3 years. Their expected lifespan is 8-10 years. They may reach a maximum length of three feet.

3.2.4.2. Significance

Spotted seatrout are very important in both the benthic and planktonic food webs in the St. Johns. As newly hatched young they are planktivores, feeding primarily on copepods within the plankton. As they grow, they shift to larger prey, including shrimp, and eventually a number of smaller fish within the river. A number of predators feed on seatrout, including Atlantic croaker, cormorants, brown pelicans, bottlenose dolphin, and sharks.

There are recreational and commercial spotted seatrout fisheries within the St. Johns River. Recreationally, the fish is the premier game fish in the area for visiting and local anglers. Annual commercial landings for the state of Florida were over 4 million lbs in the 1950s and 1960s, and down to 45,000 lbs in 2006 (**Murphy et al. 2011**). Out of this value, the LSJR (and the neighboring ICW) accounts for approximately 5,000 lbs harvested annually. Reductions in landings since the 1950s and 1960 have been in large part due to more stringent fishing regulations.

3.2.4.3. Trend

Commercial landings decreased substantially in the mid-1980s and again in the mid-1990s (Figure 3.5; Appendix 3.2.4a). However, landings have generally remained variable but consistent for the whole river since 1996 (Appendix 3.2.4a). The substantial mid-1990s decrease may be due to the impact of the gill net ban (**Murphy et al. 2011**). The FWRI data set shows consistent trends in abundance from 2006 to 2019 (Figure 3.6). Kendall tau correlation analyses revealed a decreasing trend in number per set for young of year (τ =-0.363; p = 0.04; n = 14), and the adults (τ = -0.604; p = 0.001; n = 14). In addition, there was a small peak in the number of young of year fish (SL ≤ 100 mm) caught in 2007, and again in 2012. Young of year fish appear in the river from May to November and become juveniles within one year (Appendix 3.2.4b). It is important to note that statistically significant trends may not translate into ecological significance due to interannual variations like the presence of "exceptional" years.

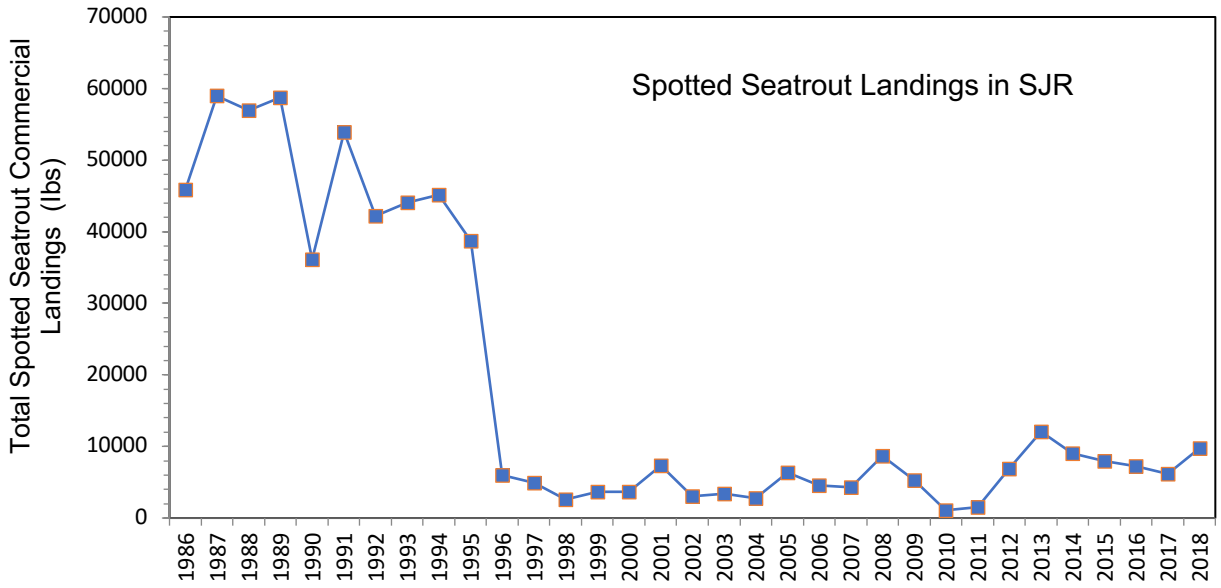


*Figure 3.5 Commercial landings (in lbs) of spotted seatrout within the lower basin of the St. Johns River from 1986 to 2018. Note that gill nets were banned in 1995 (**FWRI 2020a**).*

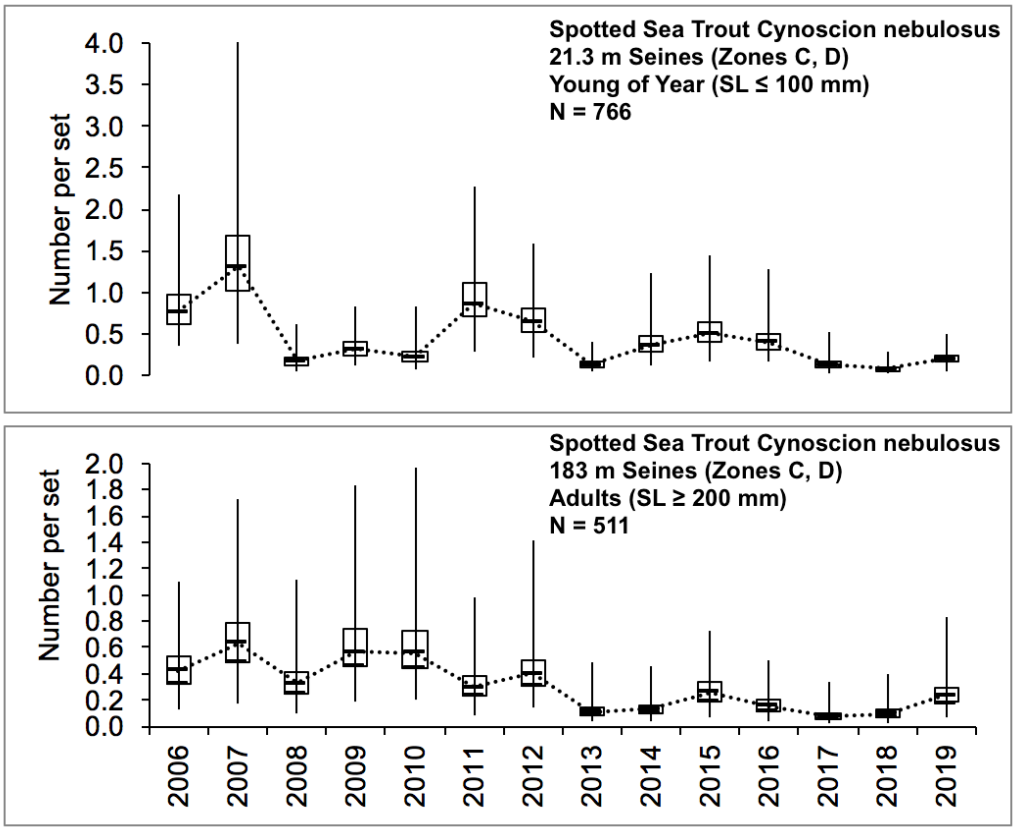


*Figure 3.6 Number of young of year and adults of spotted seatrout caught within the lower basin of the St. Johns River from 2006-2019. The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). Young of year spotted seatrout were sampled during a recruitment window from May to November with 21.3 m seins and a mesh size of 3.2 mm. YOY were caught in zones C, and D at shallow depth*

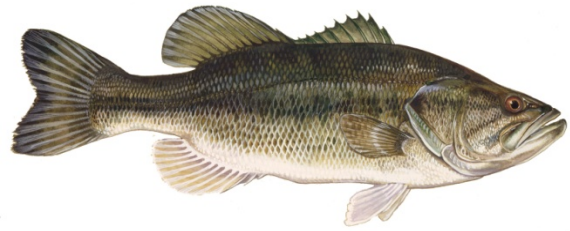
(≤1.8 m). Reproductively mature fish reside in zone C, but adults representing the legal slot limit of SL 325-434 mm yielded low numbers (n ≤ 110) and were not included in the analysis. Adults SL ≥ 200 mm included in the analysis (n=482). Adults were sampled from January through December with 183 m haul seines (mesh size 38 mm). These fish were caught in zones C and D along shorelines (Figure 3.2 Sampling Zone Map).

3.2.4.4. Current Status & Future Outlook

The spotted seatrout recreational fishery has grown in the last 15 years, while the commercial fishery has remained somewhat stable. There has been concern that there could be a decrease in landings with time that may be related to: 1) changes in fishing regulations, 2) coastal development, and 3) fishing pressure (**Murphy et al. 2011**). Despite this concern, a recent FWRI stock assessment suggests that spotted seatrout are not being overfished within the northeast Florida region (**Murphy et al. 2011**). Taking everything into account, the current **STATUS** of spotted seatrout is ***Satisfactory***, and the **TREND** is ***Unchanged***.

Recreationally, spotted seatrout are considered a restricted species (**Murphy et al. 2011**). However, they can be caught all months of the year. The legal size range is 15 to 20 inches (slot limit) with a daily limit of six per person, and each person is allowed to keep one fish (included in the daily bag limit) that exceeds the slot limit of 20 inches. The season is open year round (**FWC 2020b**).

3.2.5. Largemouth Bass (Micropterus salmoides)



http://www.usbr.gov/.../activities_largemouth_bass.jpg

3.2.5.1. General Life History

Largemouth bass are predatory fish that occupy shallow brackish to freshwater habitats, including upper estuaries, rivers, ponds, and lakes. When young, they are carnivores feeding on zooplankton, insects and crustaceans, including crayfish. As they get older, they feed on a variety of organisms, such as larger fish, crayfish, crabs, frogs, and salamanders. They reproduce from December through May (**FWC 2016**). The male builds nests in hard-bottom areas along shallow shorelines. The female then lays her eggs in the nest, where they are fertilized as they enter the nest. The male will guard the nest, and later, the young fry. The fry initially swim in tight schools and then disperse when they reach about one inch in size. Largemouth bass may live up to 16 years, growing in excess of 22 inches in length.

3.2.5.2. Significance

Largemouth bass are very important in freshwater benthic food webs in the lower St. Johns River. Their willingness and aggressiveness to feed on any appropriately sized prey is significant in affecting the abundance of many organisms in the same habitat. Recreationally, bass are a popular game fish in the area for visiting and local anglers.

3.2.5.3. Trend

FWRI research in the past 14 years shows fairly similar yearly abundances from 2006 to 2019 (Figure 3.7). Kendall tau correlation analyses revealed no temporal trend in number per set for young of year. Young of

year fish appear in the river from April to August and become juveniles within one year (Appendix 3.2.5a). Primary abundances occur in zones F, E, and since sufficient numbers were caught in zone D too, it was included in the analysis. Note that the analysis started in 2006 with the FWC expanded sampling zones. Also, SL ≤ 100 mm was chosen to follow the same cohort through a longer time frame. Gear used targets the small fish, and there is limited data about the adults.

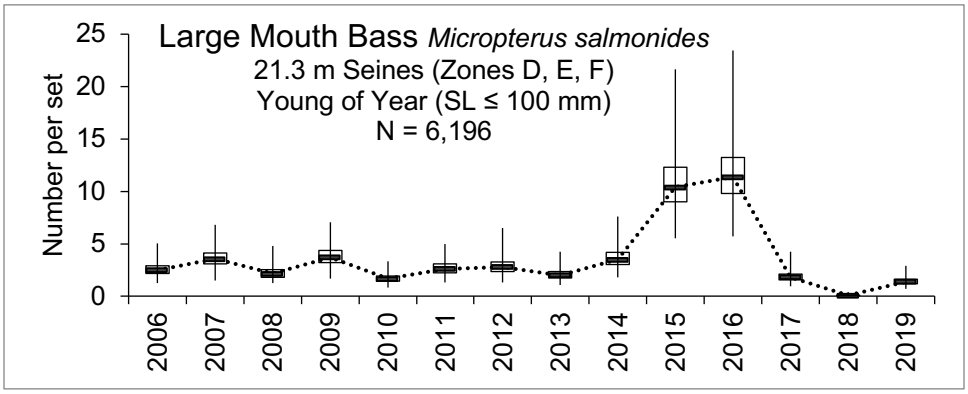


*Figure 3.7 Number of young of year largemouth bass caught within the lower basin of the St. Johns River from 2006-2019. The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). Young of year LMB were sampled during a recruitment window from April to August with 21.3 m seins and a mesh size of 3.2 mm (this gear targets the small fish). YOY were caught in zones D, E, and F at shallow depths ≤1.8 m (Figure 3.2 Sampling Zone Map).*

3.2.5.4. Current Status & Future Outlook

There is not enough information to assess the status of the recreational fishery associated with largemouth bass in the lower St. Johns River. However, they are not likely to be overfished in the near future. Bass are commonly raised in hatcheries and stocked in lakes and ponds throughout Florida. Taking everything into account, the current **STATUS** of Largemouth Bass is ***Uncertain***, and the **TREND** is ***Unchanged***.

Recreational fishermen are permitted to take largemouth bass all months of the year. As of July 2016, a daily limit of five per person is allowed with no minimum size limit and only one of the five being more than 16 inches in total length (**FWC 2020a**).

3.2.6. Channel & White Catfish (Ictalurus punctatus & Ameiurus catus)

http://myfwc.com/.../images/raverart/White-Catfish.jpg

http://myfwc.com/.../images/raverart/White-Catfish.jpg

3.2.6.1. General Life History

Channel and white catfish are omnivorous fish that can be found in primarily freshwater rivers, streams, ponds and lakes. During their lifetime, they may feed on insects, crustaceans (including crayfish), mollusks, and fish. They reproduce in the river in the spring and summer months. The male builds nests where the female lays the eggs and fertilization occurs. The male will guard the nest and, later, the young fry. The fry will leave the nest one week after hatching. As they mature, catfish will tend to occupy bottom areas with slow moving currents. Individuals may live 11-14 years.

3.2.6.2. Significance

Both catfish species are very important in benthic food webs in the more freshwater sections of the LSJR. They are abundant, and feed on a wide variety of organisms during their lifetime (**DeMort 1990**). They are a major component of the freshwater commercial fishery in Florida. There is also a large recreational catfish fishery within the river. Channel catfish are often stocked in ponds and lakes to maintain population numbers.

3.2.6.3. Trend

Commercial landings of catfish decreased substantially in the mid-1990s (Figure 3.8). This mid-1990s decrease may be due to the impact of the Florida gill net ban. Since this time period, landings have been decreasing in the north sections of the river - landings mostly likely from tributaries (τ = -0.504; p = 0.0002; n = 25) (Appendix 3.2.6a).

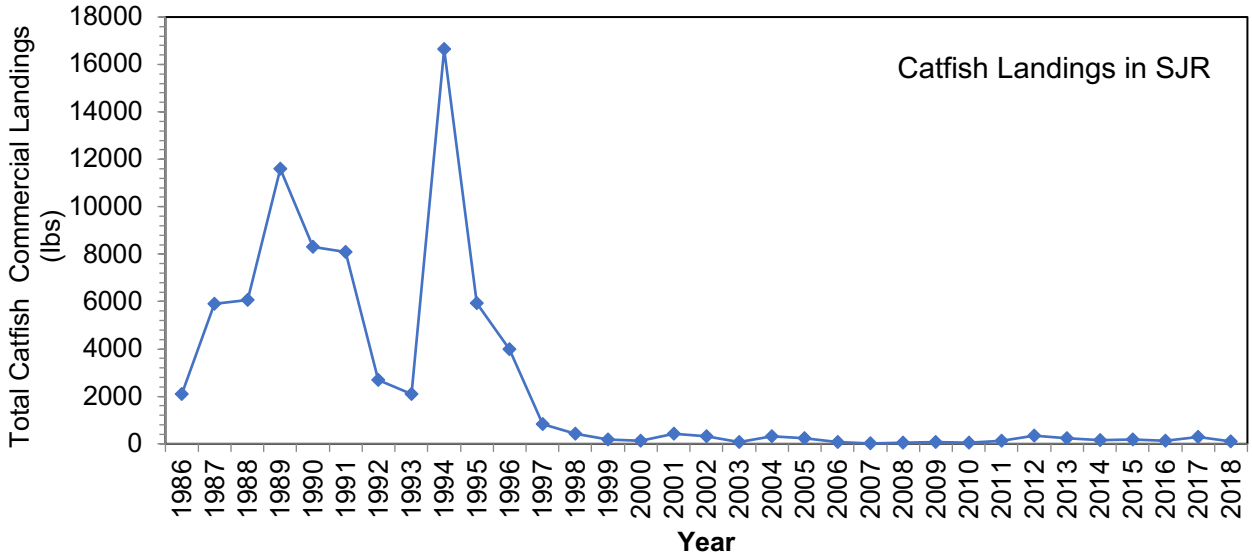


*Figure 3.8 Commercial landings (in lbs) of catfish within the lower basin of the St. Johns River from 1986 to 2018. Note that the gill net ban went into effect in 1995 (**FWRI 2020a**).*

The FWRI data set shows variable but consistent trends in abundance for both the channel and white catfish from 2006 to 2019 (Figures 3.9 and 3.10). Kendall tau correlation analyses revealed positive correlations over this time period for young of year channel catfish, and a negative correlation for adults, but neither was significant (young of year fish (τ = 0.231; NS) and adult fish (τ = -0.297; NS). However, there did appear to be an increase in young of year fish in 2009 and 2018, and adults in 2010, otherwise the trend is relatively similar (Figure 3.9). While somewhat variable, YOY Channel Catfish appear in the river from September to December and become juveniles in approximately one year (Appendix 3.2.6b).

Primary abundances occur in zones E and F. Note that the analysis started in 2006 with the FWC expanded sampling zones. In addition, SL ≤ 100 mm was chosen to follow the same cohort through a longer period. Gear used targets the small fish and limited data exist about the adults.

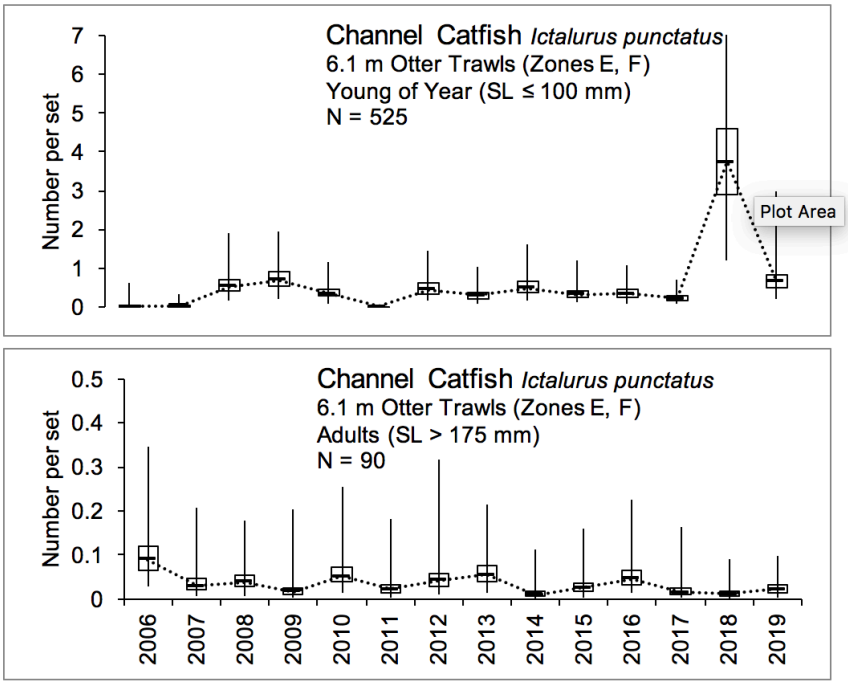


*Figure 3.9 Number of young of year channel catfish caught within the lower basin of the St. Johns River from 2006-2019. The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). Young of year channel catfish were sampled during a recruitment window from September to December with 6.1 m otter trawls that have a cod end with a mesh size of 3.2 mm (this gear targets the small fish). YOY were caught in zones E and F (Figure 3.2 Sampling Zone Map).*

In terms of white catfish, there were also no trends observed in number per set for young of year ($\tau = 0.099$; $p = 0.311$; $n = 14$). However, the temporal patterns were particularly variable for young of year fish with peaks encountered during 2008/2009, 2012, and 2018. While also variable, young of year, appear in the river in June, recruit more fully from July to October, and become juveniles in approximately one year (Appendix 3.2.6c). Primary abundances occur in zones, E and F. Note that the analysis started in 2006 with the FWC expanded sampling zones. Gear used targets the small fish and limited data exists about the adults.

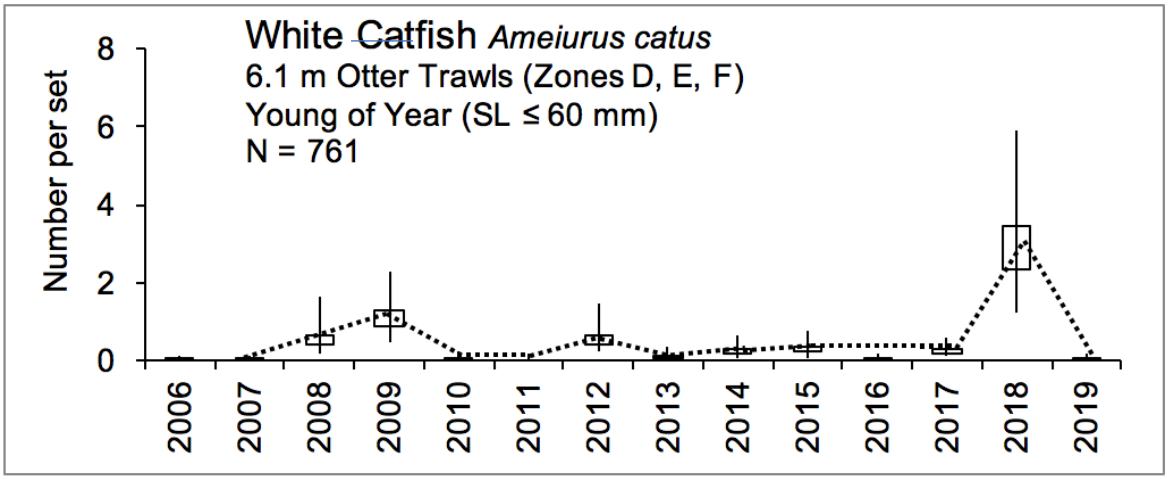
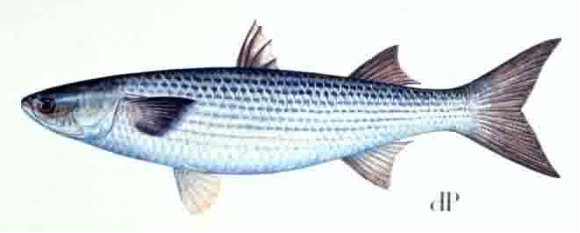


*Figure 3.10 Number of young of year white catfish caught within the lower basin of the St. Johns River from 2006-2019. The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). Young of year white catfish were sampled during a recruitment window from July to October with 6.1 m otter trawls that have a cod end with a mesh size of 3.2 mm (this gear targets the small fish). YOY were caught in zones D, E, and F (Figure 3.2 Sampling Zone Map).*

3.2.6.4. Current Status and Future Outlook

Both species of catfish are generally common in the St. Johns River. The decrease in commercial landings may be more related to changes in fishing regulations over the years, although this is not known for sure. Further, both species of catfish are commonly raised in hatcheries and stocked in lakes and ponds throughout Florida. If future research suggests that their abundance is decreasing to unacceptable levels, areas of the river can be re-stocked. FWC is in the process of implementing freshwater species into its marine trip ticket program to more effectively assess freshwater landings in various parts of Florida. Consequently, the potential exists for overfishing of these species in the future and with the exception of Fish Management Areas, there is a bag limit of 6 fish per person on channel catfish, no bag limit for white catfish (**FWC 2020a**). Although there seems to be a slight increase in young of year white catfish, this was not statistically significant. There are limited data about adults in general, and the commercial data suggest a decreasing trend in the northern section. Taking everything into account, the current **STATUS** of freshwater catfish is ***Uncertain***, and the **TREND** is ***Uncertain***.

3.2.7. Striped Mullet (Mugil cephalus)



http://www.floridafishandhunt.com/.../stripemul.jpg

3.2.7.1. General Life History

Striped mullet (also known as black mullet) are detritivores that have a wide salinity range. They are abundant in freshwater and inshore coastal environments often being found near mud bottoms feeding on algae, and decaying plant material. Mullet migrate offshore to spawn with their resultant larvae eventually drifting back to coastal waters and marsh estuaries. Developing individuals will become sexually mature at three years and live from 4-16 years. Older fish may ultimately reach lengths of up to three feet.

3.2.7.2. Significance

Mullet are considered extremely important in benthic food webs in all sections of the LSJR. They are abundant and significant in the transfer of energy from the detrital matter they feed on to their predators such as birds, seatrout, sharks, and marine mammals. The commercial mullet fishery has been the largest among all fisheries in the St. Johns for many years with over 100,000 lbs. harvested annually. Additionally, mullet are sought after recreationally for their food and bait value.

3.2.7.3. Trend

Commercial landings ($\tau = 0.424$; $p = 0.03$; $n = 12$) and landings per trip ($\tau = 0.545$; $p = 0.007$; $n = 12$) have been variable since the 1980s but showed an increasing trend for the period 2007-2018 (Figure 3.11). This trend was observed in the northern sections of the river sections. In 2017, mullet harvest decline because of major storms lowering the salinity in the river for many months, followed by a rebound in 2018 to a new high

(Appendix 3.2.7a). The FWRI data set shows variable yearly abundances from 2006 to 2019, with major abundance peaks in 2010/11, and 2018 (Figure 3.12). Kendall tau correlation analyses revealed a negative trend in number per set for the young of year fish, but this was not significant (τ = -0.231; p = 0.125; n = 14). Young of year fish appear in the river from January through April and become juveniles within one year (Appendix 3.2.7b). Primary abundances occur in zones C, D, E and F. The observable peaks in recruitment during 2006, 2008, 2010, 2011, 2015, and 2018, possibly influenced by drought conditions in those years. Note that the analysis started in 2006 because there was no FWC expanded sampling in zones E and F in January to April 2005. Gear used targets the small fish, and limited data exists about the adults.

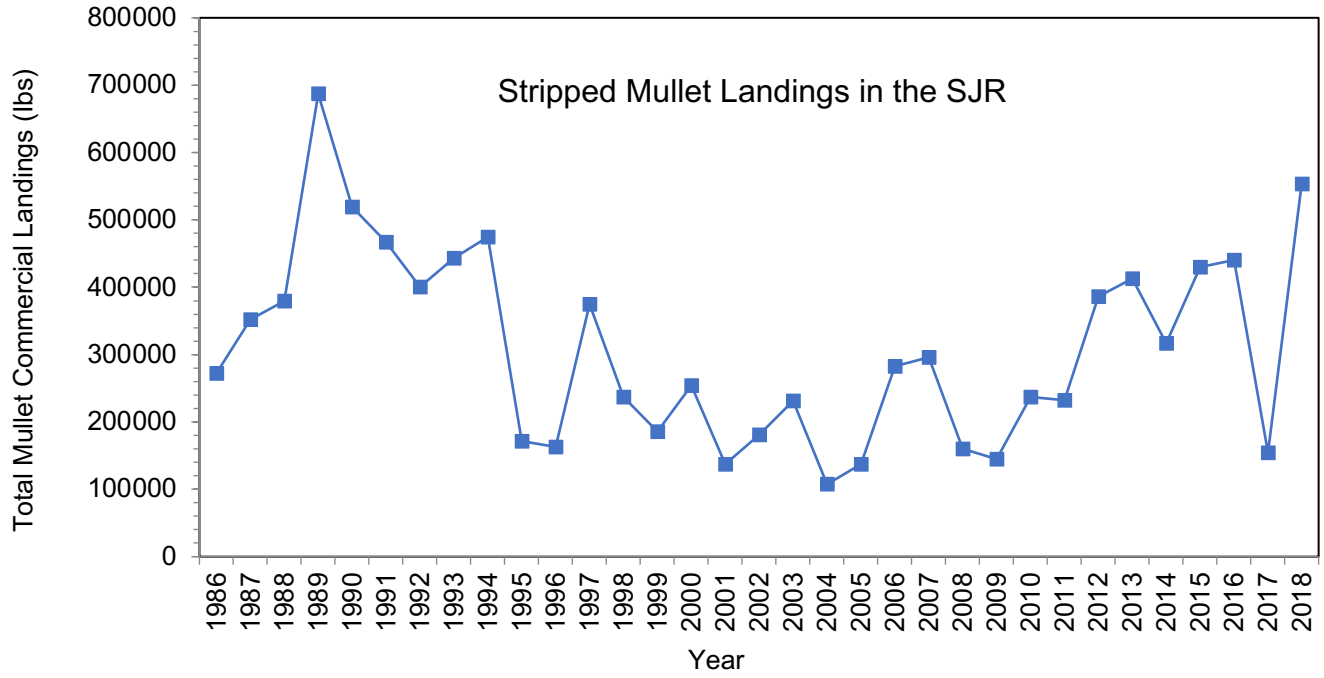


*Figure 3.11 Commercial landings (in lbs) of striped mullet within the lower basin of the St. Johns River from 1986 to 2018 (**FWRI 2020a**).*

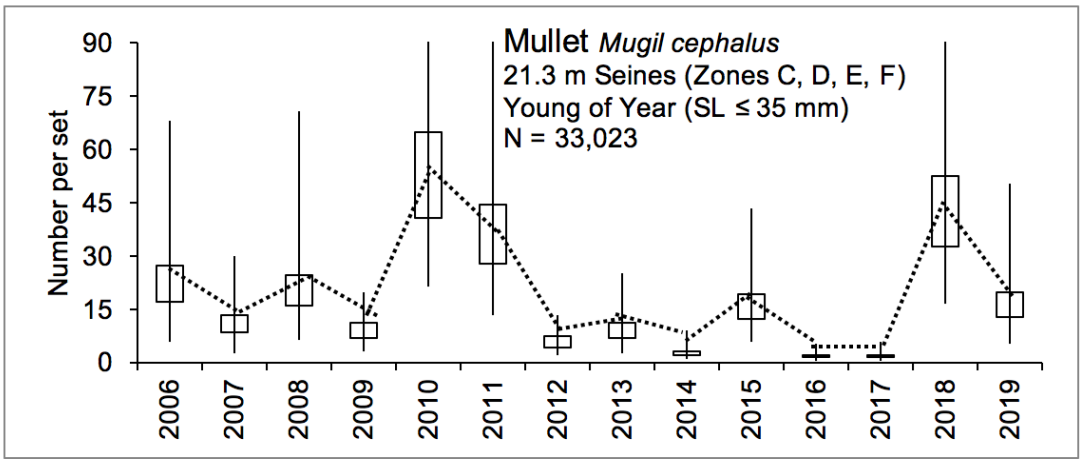


*Figure 3.12 Number of young of year striped mullet caught within the lower basin of the St. Johns River from 2006-2019. The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). Young of year striped mullet were sampled during a*

*recruitment window from January to April with 21.3 m seines (mesh size of 3.2 mm) that target the small fish. YOY were caught in zones C, D, E, and F (Figure 3.2 Sampling Zone Map). *Starts in 2006 due to no expansion sampling in Zones E and F in Jan-Apr 2005.*

3.2.7.4. Current Status & Future Outlook

Striped mullet in the St. Johns River continue to be important commercially and recreationally. Populations appear to be healthy and sustainable along the east coast of Florida (**Mahmoudi 2005**). Recreational fishing limitations are 50 fish per person per day (includes Striped (black) and Silver mullet). There is a vessel limit of 50 fish (September 1st to January 31st, and 100 fish from February 1st to August 31st). There is no closed season (**FWC 2020b**). Taking everything into account, the current **STATUS** of Striped Mullet is ***Satisfactory***, and the **TREND** is ***Improving***.

3.2.8. Southern Flounder (Paralichthys lethostigma)

http://www.uvm.edu/~jbartlet/nr260/animal%20life/marine/southernflounder.gif

3.2.8.1. General Life History

The southern flounder is common in and around inshore channels estuaries associated with the St. Johns River. It is a bottom-dwelling predator that feeds on shrimp, crabs, snails, bivalves, and small fish. During the fall and winter, it moves offshore to spawn. Larvae will develop and drift in the plankton while being transported (primarily via wind driven currents) back to estuaries and lagoons, where they will settle and develop into juveniles and then adults. The southern flounder may grow up to 36 inches and live to approximately three years of age.

3.2.8.2. Significance

Flounder are important ecologically, recreationally, and commercially to humans in the lower St. Johns River area. They are abundant and important in maintaining ecological balance in their roles as both predator and prey. They feed on small invertebrates, such as bivalves and snails, and are preyed on by sharks, marine mammals, and birds. The commercial flounder fishery is one of the larger ones in northeast Florida. Flounder are also highly sought after recreationally for their excellent food value.

3.2.8.3. Trend

Commercially, total landings of all flounders have decreased after 1995 (Figure 3.13; Appendix 3.2.8a). Total flounder landings have decreased significantly for the north river section ($\tau = -0.230$; $p = 0.05$; $n = 25$) and increase in the southern section of the river ($\tau = 0.237$; $p = 0.05$; $n = 25$) (Appendix 3.2.8a).

However, the commercial catch per trip increased in the northern section of the river ($\tau = 0.393$; $p = 0.0002$; $n = 25$) and a decrease in the southern section of the river ($\tau = -0.527$; $p = 0.0001$; $n = 25$). The mid-1990s decrease in commercial landings may be due to the impact of the gill net ban. The FWRI data set shows slight increases in young of year fish in 2003, 2005, 2010, and 2011, otherwise a relatively flat trend in abundance from 2006 to 2018 (Figure 3.14).

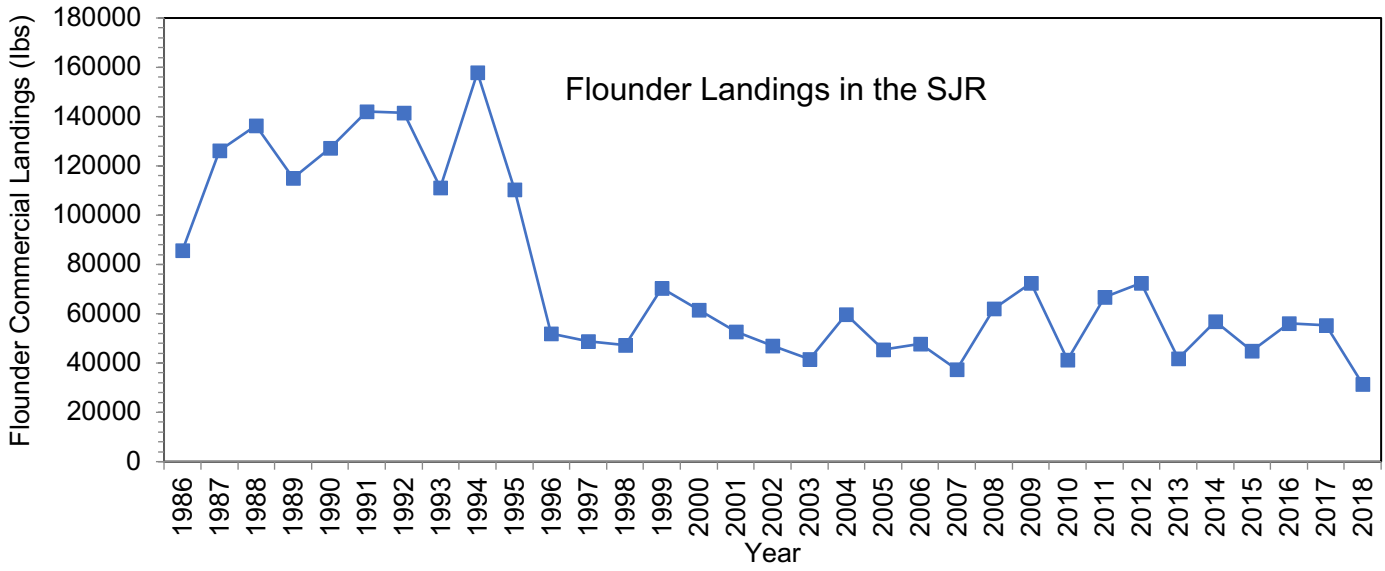


*Figure 3.13 Commercial landings (in lbs) of southern flounder within the Lower Basin of the St. Johns River from 1986-2018 (**FWRI 2020a**).*

Kendall tau correlation analyses revealed no temporal trend in number per set for young of year fish using two different gear types (Seines: τ = -0.055; N.S: Trawls τ = -0.077; N.S.) Young of year fish appear in the river from February to June and become juveniles within approximately one year (Appendix 3.2.8b). Primary abundances occur in zones C, D, E, and F, with a noticeable peak in recruitment during 2010, reason unknown at this time. Note that the analysis started in 2006 because there was no sampling done from January to April 2005. Both gear types used targeted the small fish, and limited data exists about the adults.

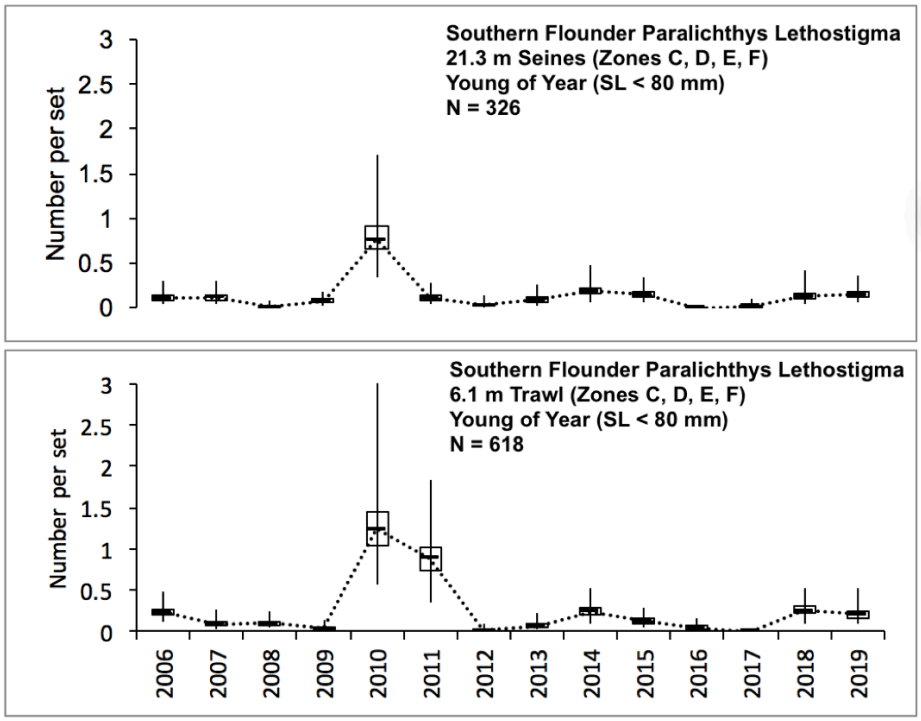


Figure 3.14 Number of young of year southern flounder caught within the lower basin of the St. Johns River from 2006-2019 (two gear types compared).

*The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). Young of year southern flounder were sampled during a recruitment window from February to June with 21.3 m seines and 6.1 m otter trawls (mesh size of 3.2 mm) that both target the small fish. YOY were caught in zones C, D, E, and F. (Figure 3.2 Sampling Zone Map).*

3.2.8.4. Current Status & Future Outlook

The southern flounder continues to be important recreationally and commercially in the LSJR. They are fairly common in the St. Johns River and appear to have no short-term risk of being overfished along the Florida east coast (**FWRI 2008c**). However, to help ensure their maintenance, it is important to have a better understanding of the reproductive and life history ecology of populations within the river. Recreationally, flounder can be caught all months of the year. Legal minimum size limit is 12 inches with a daily limit of ten fish per person (**FWC 2020b**). Taking everything into account, the current **STATUS** of Southern Flounder is ***Uncertain***, and the **TREND** is ***Uncertain***.

3.2.9. Sheepshead (Archosargus probatocephalus)

http://myfwc.com/marine/fish/sheepshead.jpg

3.2.9.1. General Life History

Sheepshead are common nearshore and estuarine fish that are very often associated with pilings, docks and jetties. They have an impressive and strong set of incisor teeth that are used to break apart prey, such as bivalves, crabs and barnacles. Adults will migrate offshore during the spring to spawn. Fertilized eggs will develop into larvae offshore and be carried towards the coast by currents primarily driven by the wind. The larvae will enter the mouths of inlets and settle in shallow grassy areas. Developing individuals may reach a maximum length of 3 feet.

3.2.9.2. Significance

Sheepshead are ecologically, recreationally, and commercially important in northeast Florida. They are important in maintaining the estuarine and coastal food web as both a predator and prey. They feed on bottom dwelling invertebrates (i.e., bivalves and barnacles) and are fed on by larger predators such as sharks and marine mammals. The commercial fishery is one of the larger ones within the river. Recreationally, sheepshead are valued by fisherman in the area for their high food value.

3.2.9.3. Trend

Commercial landings seemed stable from 1997 to 2003, then declined until 2008. Since 2008, the trend has been increasing but remains below 2003 levels (Figure 3.15). Total landings over time showed a declining trend for the north (τ = -0.240; p = 0.05; n = 25), south (τ = -0.50; p = 0.0002; n = 25) and the whole river (τ = -0.433; p = 0.002; n = 25). There was no trend for landings per trip for the north (τ = 0.207; p = 0.07; n = 25) and whole river (τ = 0.153; p = 0.141; n = 25) (Appendix 3.2.9a). Note that data from the southern counties most likely includes a significant number of fish caught in the ICW.

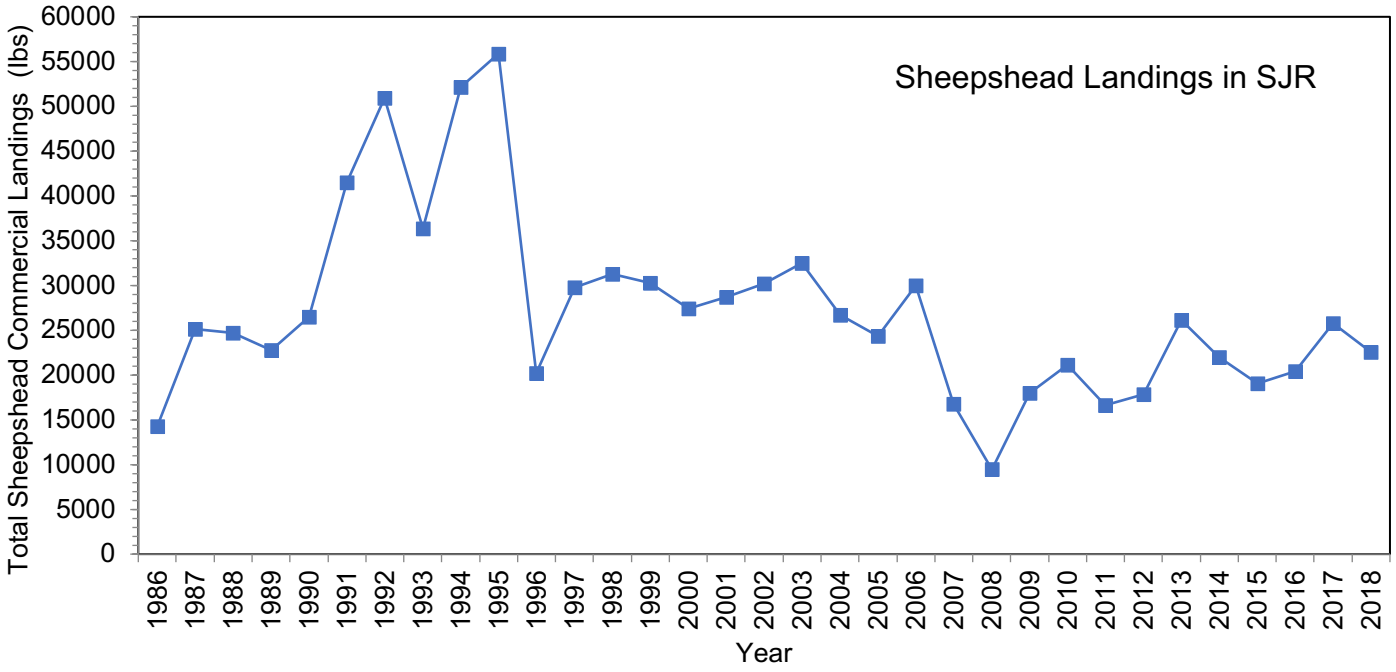


*Figure 3.15 Commercial landings (in lbs) of sheepshead within the lower basin of the St. Johns River from 1986 to 2018 (**FWRI 2020a**).*

The FWRI data set shows a decreasing trend in abundance from 2006 to 2018 for harvestable fish ($\tau = -0.385$; $p = 0.027$; $n = 14$) (Figure 3.16). Kendall tau correlation analyses revealed that there was no trend in number per sets for pre-fishery fish. Young of year fish appear in the river in May and become juveniles within approximately one year. Unfortunately, it was not possible to analyze young of year fish due to low sample numbers (SL ≤ 130 mm) (Appendix 3.2.9b). These fish reach 1 year of age at 130 mm SL and are fully recruited to the fishery at 268 mm SL. As a result, size classes were chosen based on the FIM Annual Reports (**FWRI 2020b**) that include pre-fishery 131-267 mm SL and legally harvestable fish SL ≥ 268 mm.

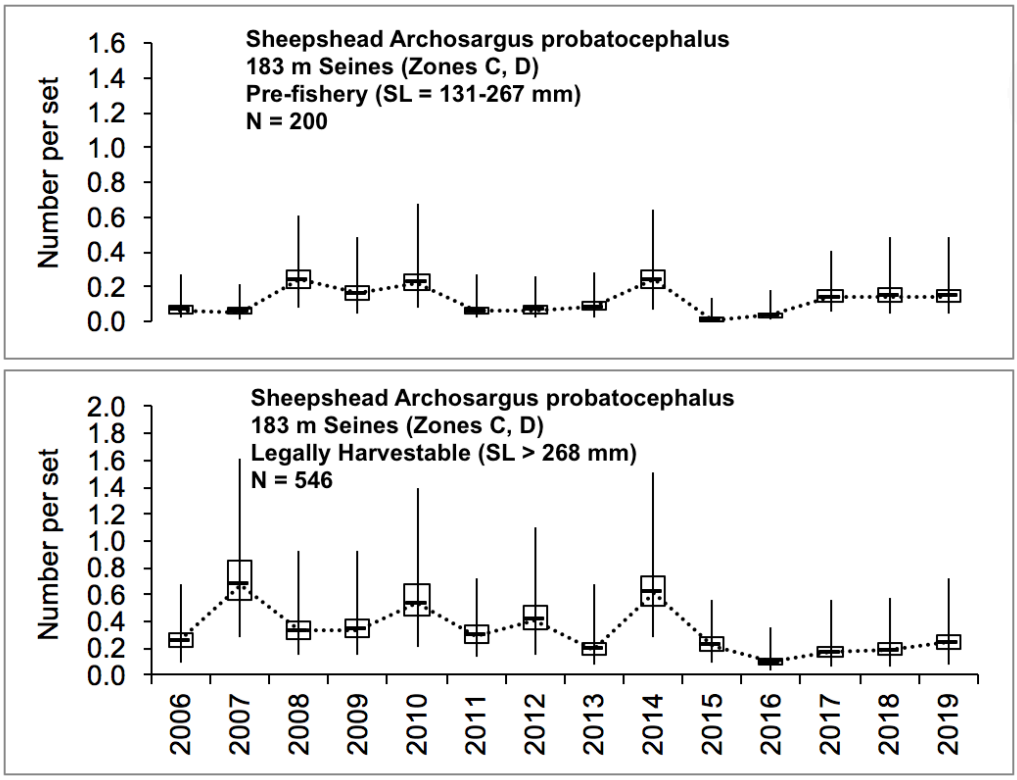


*Figure 3.16 Number of pre-fishery and harvestable sheepshead caught within the lower basin of the St. Johns River from 2006-2019. The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). Sheepshead were sampled during a recruitment window from January to December with 183 m haul seines (mesh size of 38 mm) that target the larger fish. Pre-fishery and harvestable sheepshead were caught in zones C and D (Figure 3.2 Sampling Zone Map).*

3.2.9.4. Current Status & Future Outlook

Sheepshead continue to be important to both recreational fishermen and commercial fisheries. The fish are usually relatively common in the St. Johns River, although the data suggested a decreasing trend. In the past, sheepshead appeared to be abundant enough along the Florida east coast to maintain populations at the then current levels of harvest (**Munyandorero et al. 2006**). They can be caught all months of the year. Legal minimum size limit is 12 inches with a daily limit of eight fish per person, (was 15 fish in 2016) (**FWC 2020b**). In addition, there is now a vessel limit of 50 fish during March and April. Taking everything into account, the current **STATUS** of Sheepshead is ***Uncertain***, and the **TREND** is ***Uncertain***.

3.2.10. Atlantic Croaker (Micropogonias undulatus)

http://www.floridafishandhunt.com/.../atlcroaker.jpg

3.2.10.1. General Life History

The Atlantic croaker is a bottom-dwelling predator that is commonly encountered around rocks and pilings in estuarine habitats. They are named for the croaking sound they make which is accomplished by scraping muscles against their swim bladder. They use their barbels to sense prey, such as large invertebrates and fish. Adults will migrate offshore during winter and spring to spawn. Their offspring will develop in the plankton and be transported back inshore, where they will settle in vegetated shallow marsh areas. They grow rapidly and may attain a maximum length of 20 inches.

3.2.10.2. Significance

Croakers are important to the LSJR in a number of ways. They are very abundant and consequently extremely important in the food web as both predator and particularly as prey. They feed on small invertebrates, and are fed on by red drum, seatrout, and sharks. For many years, their commercial fishery has been one of the biggest in the LSJR. Additionally, they are recreationally caught for their food value.

3.2.10.3. Trends

Commercially, total landings from 1986-2018 have a decreasing trend for the northern section of the river (τ = -0.197; p = 0.05; n = 33) and whole river (τ = -0.197; p = 0.05; n = 33); however, landings increased from 2011 to 2014, but began to fall again after that (Figure 3.17; Appendix 3.2.10a). Catch per trip had an increasing trend for the north (τ = 0.428; p = 0.0002; n = 33), and whole river (τ = 0.367; p = 0.001; n = 33), but this was not statistically significant for the south (τ = 0.083; NS). In both sets of commercial data, landings are lower in the southern sections of the river (Appendix 3.2.10a).

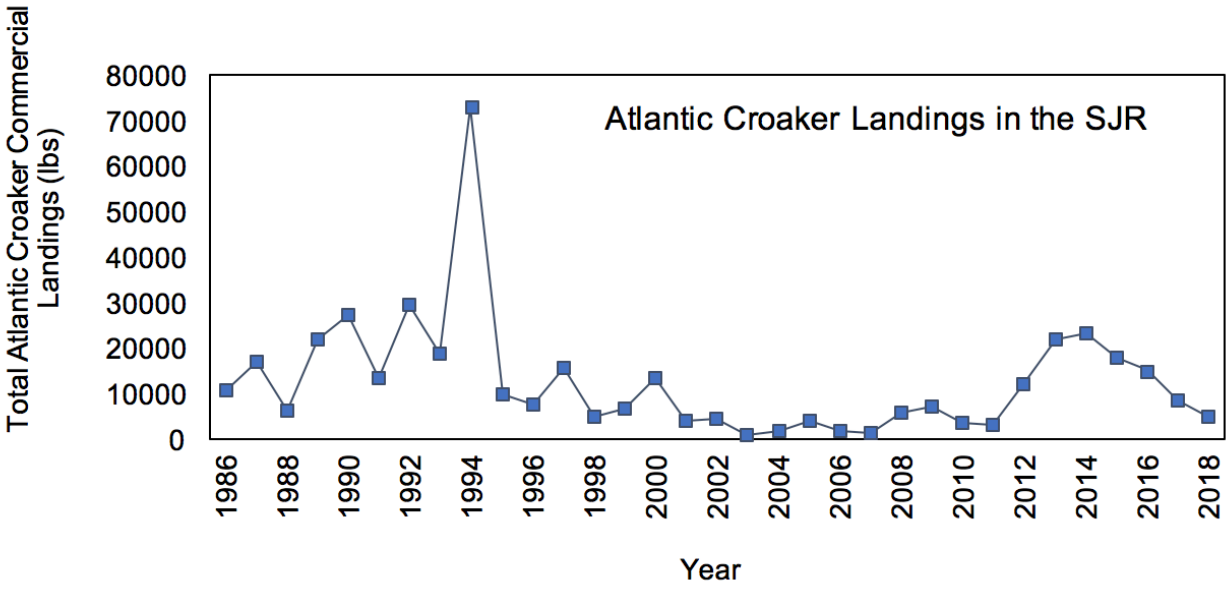


*Figure 3.17 Commercial landings (in lbs) of Atlantic croaker within the lower basin of the St. Johns River from 1986 to 2018 (**FWRI 2020a**).*

The FWRI data set shows consistent trends in abundance from 2006 to 2019 (Figure 3.18). Kendall tau correlation analyses revealed a decreasing trend in number per set for young of year fish (τ = -0.385; p = 0.028; n = 14). Young of year fish appear in the river over a split year from October to April and become juveniles in approximately one year (Appendix 3.2.10b). Generally, smaller Atlantic croaker have been

observed in more freshwater areas of the river and appear to move to more estuarine areas as they get larger (**Brodie 2009**).

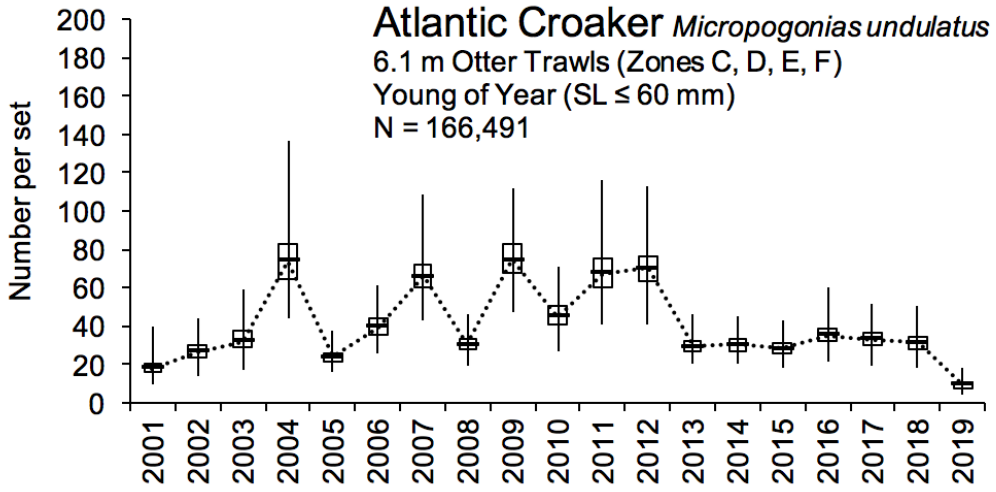


*Figure 3.18 Number of young of year Atlantic croaker caught within the lower basin of the St. Johns River from 2001-2019. The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). Young of year red drum were sampled over a split year recruitment window from October to April with 6.1 m otter trawls (cod end mesh size of 3.2 mm). Note that 2017 includes October to December but not Jan-April 2018. YOY were caught in zones C, D, E, and F. (Figure 3.2 Sampling Zone Map).*

3.2.10.4. Current Status & Future Outlook

Atlantic croaker are common in the LSJR and continue to be important commercially and recreationally. While there does not appear to be a major risk of landings decreasing significantly in the next few years, there has never been a stock assessment performed on any Florida population (**FWRI 2008a**). Recreationally, they can be caught all months of the year, and there is currently no legal size limit (**FWC 2020b**). Taking everything into account, the current **STATUS** of Atlantic croaker is ***Satisfactory***, and the **TREND** is ***Unchanged***

3.2.11. Baitfish

http://floridasportfishing.com/magazine/baifish

3.2.11.1. General Life History

Baitfish encompass the multitude of small schooling fish that are the most abundant fishes in the lower St. Johns River. There are at least two-dozen species of baitfish in Florida, including anchovies, menhaden, herring, killifish, sheepshead minnows, and sardines. Many of the baitfish species, such as Spanish sardines and thread herring, are planktivores. However, many may also eat small animals, such as crabs, worms, shrimp and fish.

There is high diversity in life history patterns among baitfish species in the LSJR. However, most migrate seasonally either along the coast and/or away from shore. Many become sexually mature at about one year, reproducing by spawning externally at either the mouth of estuaries (menhaden) or offshore (sardines, anchovy). In both cases, larvae hatch out and are carried by currents to estuaries, where the young will eventually join large schools of juvenile and adult fish. In most cases, individuals do not live longer than four years.

3.2.11.2. Significance

Baitfish are very important to the LSJR because they are extremely important in the food web as prey for a number of larger fish species. They are also important as omnivores that recycle plant and/or animal material that is then available for higher trophic levels. Baitfish are commercially and recreationally utilized for their bait value. Recreational use includes bait for fishing, whereas commercial uses may include products, such as fertilizers, fishmeal, oil, and pet food. The primary fisheries in this group are focused on anchovy, menhaden, sardines, and herring (**FWC 2000**). However, smaller fisheries catch killifish, sheepshead, minnows, and sardines.

3.2.11.3. Trends

Commercial landings decreased in the mid-1990s and have been sporadic since (Figure 3.19; Appendix 3.2.11). The decrease during the mid-1990s may have been due to the Florida gill net ban. While landings of baitfish have remained temporally consistent, the catch per landing showed significant decreasing trends for the north section of the river ($\tau = -0.227$; $p = 0.03$; $n = 33$), and a positive trend in the south river section, but this was not significant ($\tau = 0.165$; $p = 0.09$; $n = 33$). Further, baitfish landings seem to be higher in the southern sections of the river. Catch per trip since 2009, showed a significant increasing trend for the whole river section ($\tau = 0.467$; $p = 0.03$; $n = 10$). Greater variability in the past few years has been likely due to increased storm impacts on the St. Johns River ecosystem.

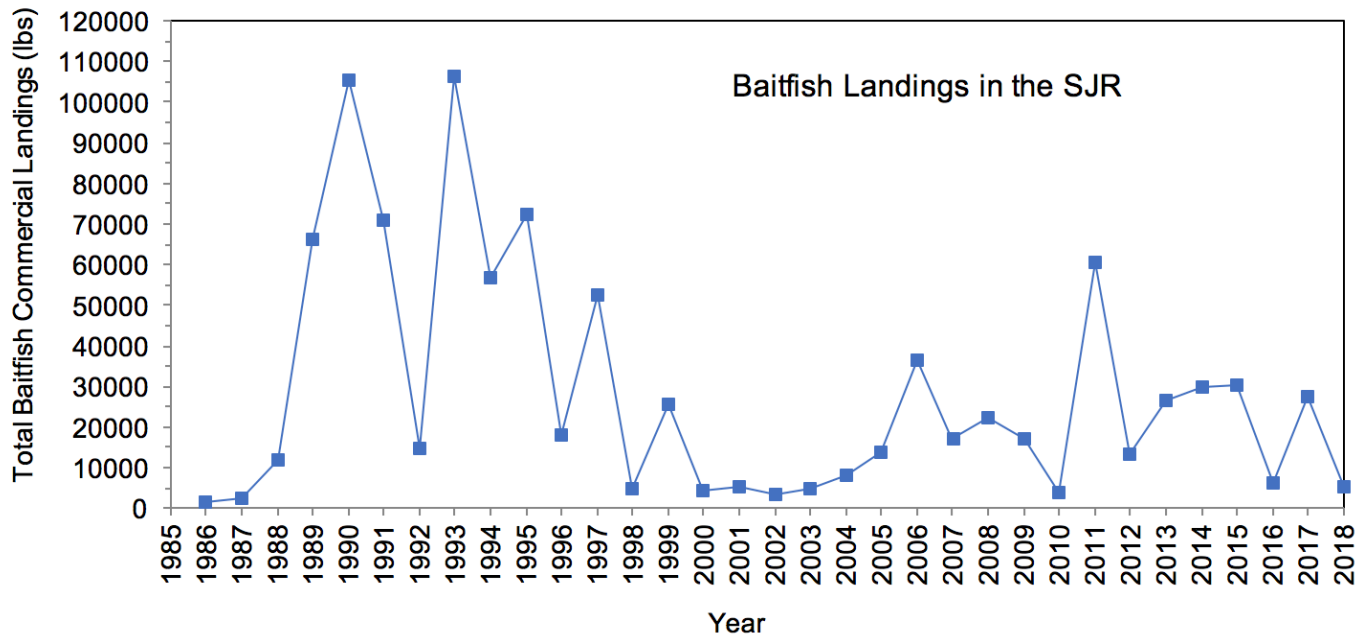


*Figure 3.19 Commercial landings (in lbs) of baitfish within the lower basin of the St. Johns River from 1986 to 2018 (**FWRI 2020a**).*

3.2.11.4. Current Status & Future Outlook

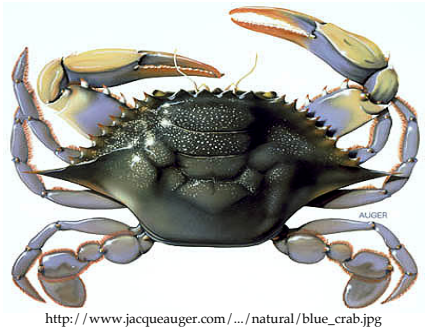
Baitfish are very abundant in the LSJR and continue to be important commercially and recreationally. They are likely to be sustainable into the foreseeable future. However, researchers at the Fish and Wildlife Research Institute (FWRI) currently are monitoring and assessing the effects of their fisheries management efforts. Recreationally, they can be caught all months of the year. There is no legal size limit (**FWC 2020b**). Taking everything into account, the current **STATUS** of baitfish is ***Satisfactory***, and the **TREND** is ***Unchanged***.

3.3. Invertebrate Fishery

3.3.1. General description

The invertebrate community is very important to the overall ecology of the LSJRB. It is also important economically for commercial and recreational fisheries. Commercially harvested invertebrates in the lower basin include blue crabs, bait shrimp, and stone crabs. Of the five counties studied (2007-2018), Duval County generally reported the highest catch of crabs (mean 567,447 lbs. per year; SD = ± 155,664 lbs. per year). Recreational fisheries in the area are probably significant for the species mentioned although the level of significance is unclear since there are few reports on recreational landings.

3.3.2. Blue Crab (Callinectes sapidus)



http://www.jacqueauger.com/.../natural/blue_crab.jpg

3.3.2.1. General Life History

The blue crab (**FWRI 2013a**) is a very common benthic predator that inhabits estuarine and nearshore coastal habitats in northeast Florida. They are general feeders (omnivores) that will eat fish, aquatic vegetation, molluscs, crustaceans, and worms (**FWRI 2002**). In the St. Johns River, they reproduce from March to July and then again from October to December (**Tagatz 1965**; **Tagatz 1968a**; **Tagatz 1968c**). Females carry fertilized eggs and migrate towards the more marine waters near the mouth of the river where they will release their eggs into the water. At this point, the young are called zoea, and they drift and develop along the continental shelf for 30-45 days. Wind and currents eventually transport the larger megalops larvae back to the estuarine parts of the river where they will settle in submerged aquatic vegetation (SAV) that serves as a nursery for them. Within 6-20 days of landing at this location, the young will molt and become what is recognizable as a blue crab. In 12-18 months, young crabs will then become sexually mature, ultimately reaching a width of eight inches.

3.3.2.2. Significance

Blue crabs are very important in both the benthic and planktonic food webs in the St. Johns River. They are important predators that can affect the abundance of many macroinvertebrates, such as bivalves, smaller crabs, and worms. They are also important prey for many species. Smaller crabs provide food for drum, spot, croaker, seatrout, and catfish, while sharks and rays eat larger individuals.

A strong recreational blue crab fishery exists, although there are relatively few data on it. The blue crab fishery is the largest commercial fishery in the LSJRB (Figure 3.1). In 2017, it accounted for 82% of commercial fisheries in the river with 1,495,787 lbs harvested. Duval County reported the highest number of crab landings (562,043 lbs), followed by St. Johns (531,502 lbs), Putnam (276,163 lbs), Clay (117,159 lbs), and Flagler County (8,920 lbs). The fishery was affected by significant storm activity in in late 2017 and into 2018, it accounted for 59% of commercial fisheries in the river with 978,288 lbs of blue crabs harvested (a drop of 517,499 lbs from the previous year). In 2018, Duval County reported the highest number of crab landings (499,632 lbs), followed by St. Johns (371,662 lbs), Putnam (119,958 lbs), Clay (36,210 lbs), and Flagler County (826 lbs).

3.3.2.3. Data Sources

Blue crab data were collected from commercial reports (1994 to 2018) of landings made to the state and research (2006-2018) from the FWRI. The 2018 data are finalized, whereas the 2019 data are considered preliminary (therefore not included).

3.3.2.4. Limitations

The primary limitation with the commercial landing data is that it does not account for young crabs that are too small to be harvested. Additionally, there may be uncertainties regarding location of where the crabs are collected. For instance, fisherman (crabbers) landings reports are made from their home counties,

although it is uncertain what part of the river the crabs were actually caught. Changes in harvesting regulations through the years limit what can be said of landings between certain time periods. In this report, total landings are graphed. However, in order to best assess comparison of landings over the years, landings per trip are calculated, and trends investigated using Kendall tau analysis. In terms of the FWRI collection methods assessed in this study, the subsequent data are likely to not have caught the complete size range of crabs that exist within the river.

3.3.2.5. Trend

Commercial landings of blue crabs have been variable, but from 1986 to 2018, trended downward for northern river (τ = -0.223; p = 0.03; n = 33), and significantly for the southern river section (τ = -0.449; p = 0.0001; n = 33). However, from 2011 to 2012, landings increased more than over the past decade, but decreased sharply from 2013-2018 (Figure 3.20). Additionally, more landings occur in the southern versus northern section of the river (Appendix 3.3.2a). There was a significant decrease in the amount of blue crabs landed per trip over time for the north section of the river (1986-2018) (τ = -0.371; p = 0.001; n = 33), and an increasing trend for the south river (τ = 0.235; p = 0.03; n = 33). From 2009 to 2018, no significant trend was observed in landings, however, catch per trip increased in the whole river (τ = 0.555; p = 0.01; n = 10), but decreased in the northern section of the river (τ = -0.689; p = 0.003; n = 10).

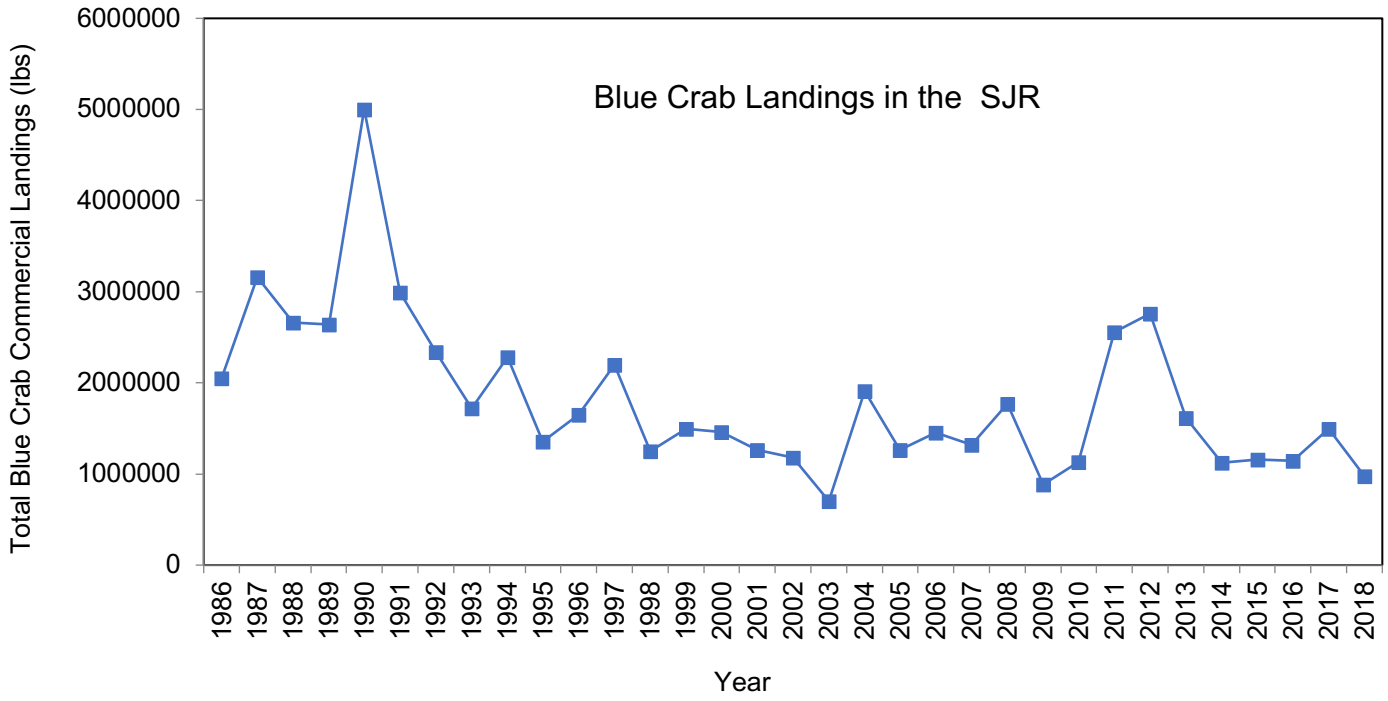


*Figure 3.20 Commercial landings (in lbs.) of blue crabs within the lower basin of the St. Johns River from 1986 to 2018 (**FWRI 2020a**).*

The FWRI data set shows consistent trends in abundance from 2006 to 2019 (Figure 3.21). Kendall tau correlation analyses revealed a decreasing trend in number per set for juveniles caught with seines (τ = -0.385; p = 0.03; n = 14)' however, there was not significant trend for juveniles caught with trawls. There was a decreasing trend in the number per set of mature adult crabs (τ = -0.407; p = 0.02; n = 14). From trawl catch data, the abundance of juveniles seems to peak in June and is lowest in November (Appendix 3.3.2b). Blue crabs were sampled from January to December with 23.1 m seines and 6.1 m otter trawls both with a mesh size of 3.2 mm. Carapace Width (CW) size classes used follow the FIM Annual Report (**FWRI 2020b**).

Blue crabs were caught in zones C, D, E, and F. Adult crabs are usually sampled with 183 m haul seines (mesh size 38 mm), but since mature crab numbers were higher in the otter trawls, these data were analyzed instead. In addition, some individuals classified as adults may still have been reproductively immature due to individual variation in growth rates and timing of maturity (**Brodie 2016**).

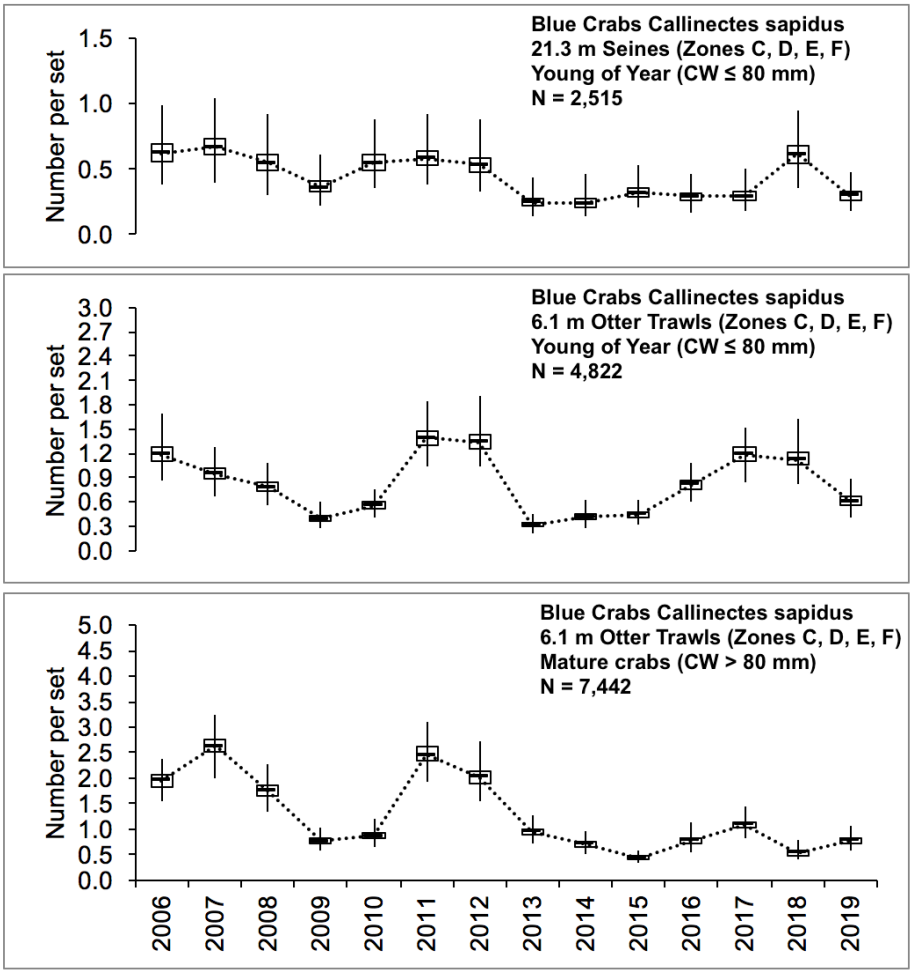


*Figure 3.21 Number of juveniles and adults of blue crabs caught within the lower basin of the St. Johns River from 2006-2019. The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). Blue crabs were sampled from January to December with 23.1 m seines and 6.1 m otter trawls both with a mesh size of 3.2 mm. Carapace Width (CW) size classes used follows the FIM Annual Report (**FWRI 2019**). Blue crabs were caught in zones C, D, E and F. (Figure 3.2 Sampling Zone Map).*

3.3.2.6. Current Status & Future Outlook

The blue crab commercial fishery continues to be the premier invertebrate fishery within the LSJRB. The recreational fishery is also likely to be very large, although there is no information available on it.

While common within the river, there is uncertainty regarding whether blue crabs are being overfished or not in Florida. This uncertainty is because the maximum age of blue crabs in Florida is not known. Maximum age is one component that is used in a stock assessment model. Depending on the value used, it can affect whether the model suggests crabs are overharvested or not (**Murphy et al. 2007**). Consequently, this piece of information is needed to more accurately assess blue crab stocks in Florida. Currently, there is no required license to fish recreationally using five or fewer traps. In the St. Johns River, five or fewer traps can be used to recreationally catch blue crabs throughout the year (ten gallons whole per harvester per day) except from January 16th to 25th on even years. Crabs can also be caught using dip nets, crab pots, and hand-lines. Although it is illegal to harvest egg-bearing females, it is not against the law to harvest non-egg bearing females; however, since female crabs are critically important to ensuring the survival of subsequent generations of crabs, releasing them helps the fishery to be more sustainable in the future. While male crabs can reproduce many times, females only mate once when mature and can store sperm for several months before actually spawning eggs. Beginning January 1st 2020, recreational blue crab fishers (≥16 years of age) will be required to have a valid trap registration (**FWC 2020b**).

> *"If a mature female is harvested, though she may not exhibit eggs, there is no certainty that she has spawned" (**FWRI 2020a**).*

The statistical analysis did reveal a significantly decreasing trend in the FWRI data for adults and young of year crabs since 2006. Commercial catch data indicated a decreasing trend overall (north/south sections of the river combined) and just in the north section of the river; no significant trend occurred in the southern section where most crabs are harvested. Taking everything into account, the current **STATUS** of blue crab is ***Uncertain***, and the **TREND** is ***Uncertain***.

3.3.3. Penaeid shrimp - White, pink, & brown (Litopenaeus setiferus, Farfantepenaeus duorarum & F. aztecus)

3.3.3.1. General Life History

There are three penaeid shrimp species that exist within the estuaries and nearshore waters of the northeast Florida region. They are the white, pink, and brown shrimp. The white shrimp is the most common species in local waters. All three are omnivorous feeding on worms, amphipods, molluscs, copepods, isopods and organic detritus. White shrimp reproduce during April to October, whereas pink and brown shrimp can spawn year round (**FWRI 2007**). However, peak spawning for brown shrimp is from February to March

and from spring through fall for pink shrimp. All species spawn offshore in deeper waters with larvae developing in the plankton and eventually settling in salt marsh tidal creeks within estuaries. From there, young will develop for approximately 2-3 months. As they get larger, they start to migrate towards the more marine waters of the ocean where they will become sexually mature when they reach lengths between 3-5 inches. While they generally do not live long (a maximum 1.5 years), they may reach maximum lengths of up to seven inches.

3.3.3.2. Significance

Penaeid shrimp are very important in both the benthic and planktonic food webs in the St. Johns. They are important predators that can affect the abundance of many small macroinvertebrates (see list above). They are also important prey for many species. As smaller individuals, such as post-larvae and juveniles, they provide food for sheepshead minnows, insect larvae, killifish, and blue crabs. As adult shrimp, they are preyed on by a number of the finfish found within the river.

The LSJR supports both recreational and commercial shrimp fisheries. The recreational fishery is likely to be large although there is relatively little information on it. In contrast, the commercial shrimp fishery is one of the largest fisheries in the region. However, most shrimp obtained for human consumption are caught by trawlers offshore. Commercial trawling in the LSJR represents a much smaller fishery.

3.3.3.3. Data Sources

Penaeid shrimp data were collected from commercial reports made to the state (1986 to 2015). These comprised of total bait shrimp landings that were generally collected within the river. These data likely include white, brown, and pink shrimp, although their relative proportions are unknown. Data for only white shrimp were also collected and assessed from research (2001-2016) from the FWRI.

3.3.3.4. Limitations

The primary limitation with the commercial landing data is that there are uncertainties regarding the location of where shrimp are collected. For instance, shrimp-fisherman-landings reports are made from their home counties, although it is sometimes uncertain what part of the river shrimp were actually caught in. Additionally, changes in harvesting regulations through the years may limit what can be said of landings between certain time periods. In this report, total landings are graphed. However, in order to best assess comparison of landings over the years, landings per trip are calculated and trends investigated using Kendall tau analysis. In terms of the FWRI data set, the collection methods assessed in this study may not have caught the complete size range of shrimp that exist within the river.

3.3.3.5. Trend

There was no significant trend for total commercial landings or landings per trip of bait shrimp in the river from 1986 to 2018 (Figure 3.22). However, from 2001 to 2012, there have been drastic fluctuations among the years with peak landings occurring in 2004. Less fluctuation has occurred in recent years, but the catch per trip appears to have decreased particularly in the north section of the river where more bait shrimp are reported versus southern sections of the LSJR (2007-2018) (Appendix 3.3.3a).

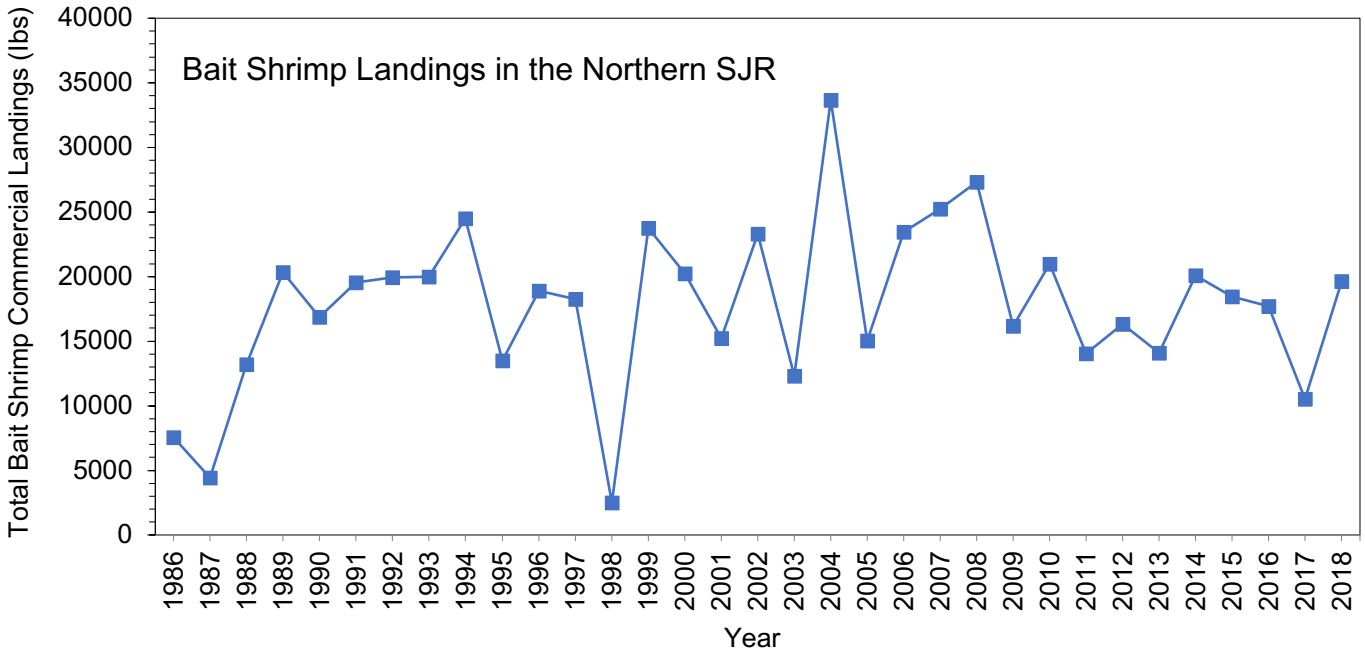


*Figure 3.22 Commercial landings (in lbs) of bait shrimp within the lower basin of the St. Johns River from 1986 to 2018 (**FWRI 2020a**).*

The FWRI data set shows consistent trends in abundance for white shrimp from 2006 to 2019 (Figure 3.23). Kendall tau correlation analyses revealed no trend in the number of YOY white shrimp captured per set from seines ($\tau = 0.077$; NS), but that there was an increasing trend in data from trawls ($\tau = 0.363$; $p = 0.04$; $n = 14$). The highest numbers of small white shrimp were encountered in the river from May to August (Appendix 3.3.3b). With seines, nearshore abundance was seen in zones C and D, and fewer numbers occurred in E and F. In contrast, with trawls, a high number was seen in all 4 zones (**Swanson 2016**).

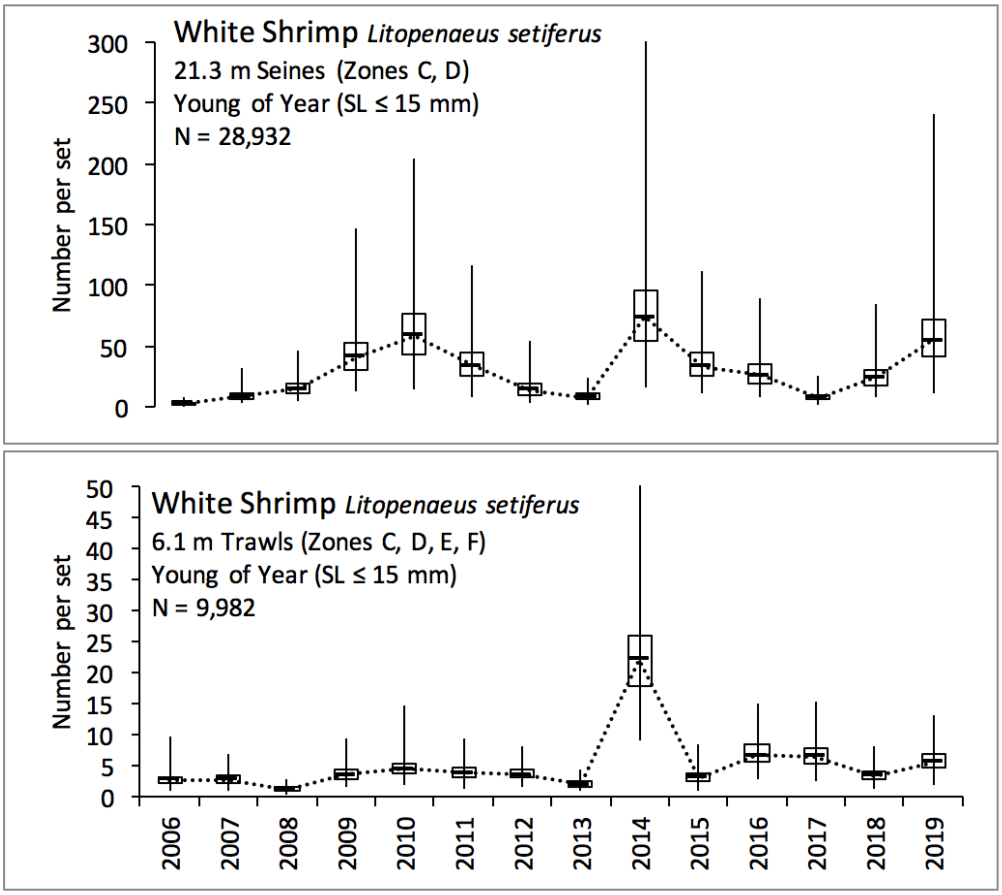


*Figure 3.23 Number of juveniles of white shrimp caught within the lower basin of the St. Johns River from 2006-2019. The N value indicates the total number of sets completed for the time period (**FWRI 2020a**). White Shrimp were sampled from May to August with 23.1 m seines and 6.1 m otter trawls both with a mesh size of 3.2 mm. White shrimp were caught in zones C, D, E and F depending on the gear type used. (Figure 3.2 Sampling Zone Map).*

3.3.3.6. Current Status & Future Outlook

Commercial harvesting of penaeid shrimp for bait is a relatively small fishery in the LSJR. The recreational fishery is probably moderately sized, although there are no available data about it. Generally, penaeid shrimp are very abundant in the region and may be at slight risk of being overfished in the south Atlantic region (see **FWRI 2008d** for a review). However, the South Atlantic Fishery Management Council, and Gulf of Mexico Fishery Management Council have established fishery management plans for shrimp to try to ensure they are not overharvested (**FWRI 2008d**). Recreational shrimping regulations include no size limit; however, there is a bag limit of five gallons (heads on) per person each day and a possession limit of no more than five gallons (heads on) per vessel at any time regardless of the number of people onboard. Allowable harvesting methods that comply with the FWC regulations include dip net, cast net, push net, one frame net, or beach sein. The season is closed during April and May in Nassau, Duval, St. Johns, Putnam, Flagler, and Clay Counties (**FWC 2020b**).

Statistically, there appears to be no trend in young of year shrimp. However, commercial data indicated a decreasing trend overall and high annual variability. Most shrimp are caught in the northern section of the river and this section has a decreasing trend for catch. In addition, the southern section of the river also exhibited a decreasing trend in catch.

Taking everything into account, the current **STATUS** of shrimp is ***Uncertain***, and the **TREND** is ***Uncertain***.

3.3.4. Stone Crabs (Menippe mercenaria)

http://www.ocean.udel.edu/.../species_stonecr.gif

3.3.4.1. General Life History

The stone crab is a fairly common benthic predator that inhabits hard bottoms (such as oyster reefs) and grass beds in the northeast Florida area. Stone crabs are opportunistic carnivores feeding on oysters, barnacles, snails, clams, etc. In Florida, stone crabs reproduce from April through September (**FWRI 2007**). It is unclear where stone crabs sexually reproduce, and females will carry eggs for approximately two weeks before the eggs hatch. The larvae will drift in the plankton and settle and metamorphose into juvenile forms of the adult in about four weeks. In approximately two years, the crabs will then become sexually mature and reach a width of 2.5 inches. They may live as long as seven years.

3.3.4.2. Significance

Stone crabs are important predators and prey in the estuarine community in the St. Johns River. As important predators, they can affect the abundance of many macroinvertebrates, such as bivalves, smaller crabs, and worms. They are also important prey when both young and older. As larvae in the plankton, they are preyed on by filter-feeding fish, larval fish, and other zooplankton. As adults, they are preyed on by many larger predators in the river.

The stone crab fishery is unique in that the crab is not killed. The claws are removed (it is recommended to only take one claw so the animal has a better chance of survival), and the animal is returned to its habitat. While there probably is a recreational stone crab fishery in the area, there is relatively little information on it. The stone crab commercial fishery is relatively new and small in the LSJR. The highest number of claw landings within the river basin likely comes from Duval County. Claw landings from other counties of the LSJR most likely come from collections made in the ICW.

3.3.4.3. Data Sources

Stone crab data were collected from commercial reports of landings made to the State between 1986 and 2016. There were no available recreational landings data.

3.3.4.4. Limitations

The primary limitation with the commercial landing data is it does not account for young crabs that are too small to be harvested. Additionally, there are uncertainties regarding location of where crab claws are collected. For instance, fisherman (crabbers) landings reports are made from their home counties although the crab claws may have been collected elsewhere. For stone crabs reported by southern counties of the lower basin, it is more likely that the claws were collected in the Intracoastal Waterway (ICW) than the river itself. Additionally, changes in harvesting regulations through the years may limit what can be said

of landings between certain time periods. Total landings are shown in this report. However, in order to best assess comparison of landings over the years, landings per trip are calculated, and trends investigated using Kendall tau analysis.

3.3.4.5. Trend

Commercial landings of stone crabs have been variable despite an increase in the number of deployed traps (**FWRI 2002**). Peak landings occurred in 1994 and 1997 with generally low landings occurring from 1998 to 2006 (Figure 3.24). From 1994 to 2018, landings for the north and south sections increased ($\tau = 0.033$; $p = 0.01$; $n = 25$), landings per trip decreased significantly in the south ($\tau = -0.493$; $p = 0.0003$; $n = 25$).

Most landings were reported by the more southern counties of the LSJRB (Appendix 3.3.4a). However, this is most likely a reflection of crab claws caught in the Intracoastal Waterway of the more southern counties than in the river itself.

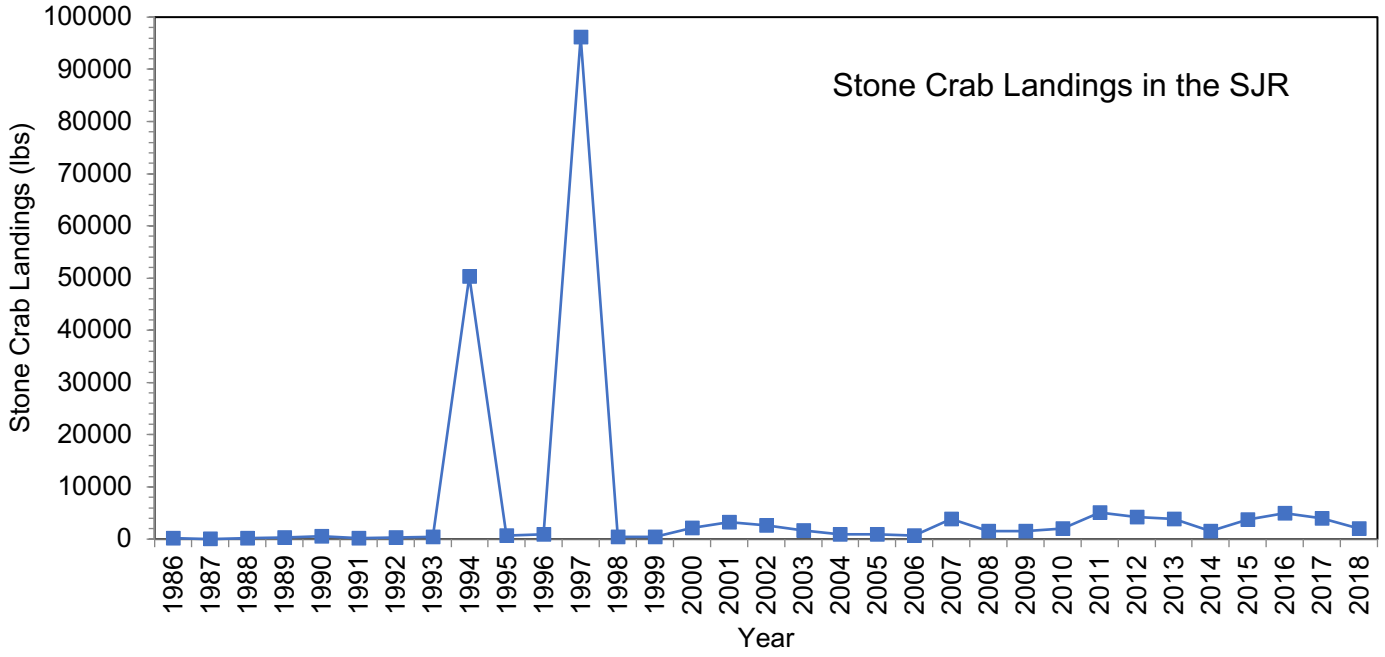


*Figure 3.24 Commercial landings (in lbs) of stone crab claws within the lower basin of the St. Johns River from 1986 to 2018 (**FWRI 2020a**).*

3.3.4.6. Current Status & Future Outlook

Stone crabs are not currently at risk of being overfished but are probably now at a level of landings that is all that can be harvested under current conditions along the Florida east coast (**Muller et al. 2006**). To minimize negative impacts from commercial fisherman, the Florida legislature implemented a crab trap reduction program in 2002. Currently, there is a daily limit of one gallon per person, or two gallons per vessel, of minimum-sized 2 ¾-inch claws (tip to elbow) to only be collected during the season from October 15 to May 15. Although it is not against the law to harvest both claws from legal sized crabs, the common practice is to leave one claw intact before returning the crab to the water. As a result, crabs can feed and defend themselves more effectively while re-growing the removed claw (**FWC 2020b**).

Taking everything into account, the current **STATUS** of stone crab is ***Satisfactory***, and the **TREND** is ***Unchanged***.