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COMMUNITY CLIMATE CHANGE VULNERABILITY IN THE SOUTH ATLANTIC, FLORIDA KEYS AND GULF OF MEXICO

BY

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Introduction

As climate change continues to affect both the human and natural ecosystems within the Southeast, challenges that fishing dependent communities will face are difficult to predict. Sea level rise, ocean acidification, changing currents and upwellings will all have varying degrees of impacts on species that fishermen rely on and their habitats. Migratory species will move, sedentary species will disappear, and others will move deeper and into other areas of the ocean. How fishing communities can respond to these changes will be an important component of their ability to adapt and remain resilient in an uncertain future. Two regional assessments of climate change, including sea level rise, have examined the projected impact on fishing communities in the Northeast Region (Colburn et. al. 2016) and Alaska (Himes, Cornell and Kasperski 2015). Here we begin to build the components of climate vulnerability for Gulf and South Atlantic fishing communities by assessing dependence upon climate vulnerable species.

This report examines how a select group of commercial fishing communities in the Southeast rely on specific marine species and how those species are vulnerable to climate change. The objective of the community climate vulnerability indicators project is to forecast the possible effects of climate change on a coastal fishing community's marine resource base and how that change may affect the businesses and people that work there. The following analysis contributes to that objective by providing a graphic presentation of species landed within coastal fishing communities in the Gulf of Mexico and South Atlantic from 2000 to 2018 and showing how community vulnerability is related to the mix and the diversity of landed species over time.

Methods and Analyses

The data used for this analysis and development of the community-level indices consists of dealer pounds and value of landings reported to NOAA Fisheries Southeast Science Center and aggregated at the community level by dealer address. Contribution to value landed by community between 2000 and 2018 for species classified by their climate vulnerability was used to develop indicators of community climate change vulnerability. A total of 71species were included for the South Atlantic[1] and 75 for the Florida Keys and Gulf of Mexico[2] (Appendix I).

The species climate vulnerability scores used in this analysis were developed by NOAA scientists at the Southeast Fisheries Science Center (SEFSC) as part of a national effort to classify species by climate vulnerability using a methodology developed by Morrison et al. (2015)[3]. Their methodology relies on expert knowledge using species profiles and scientific

[1] Seven of the classified species did not have landings recorded for the South Atlantic between 2000 and 2018: Atlantic and Gulf Sturgeon, Blueback Herring, Cubbyu, Dusky Shark, Emerald Parrotfish, Goliath Grouper, and Snook.

[2] Eight of the classified species did not have landings recorded for the South Atlantic between 2000 and 2018: Atlantic Stingray, Dusky Shark, Goliath Grouper, Gulf Menhaden, Gulf Sturgeon, Smalltooth Sawfish, Snook, Tarpon.

[3] Information on the methodology used can be found at: https://www.fisheries.noaa.gov/national/climate/climate-vulnerability-assessments

literature to score species for different sensitivity attributes and exposure factors. Sensitivity attributes refer to the biological characteristics of the species that are indicative of their ability/inability to respond to potential environmental changes. Exposure factors are defined as the overlap between the species geographic distribution and the magnitude of the expected change in climate. Species scores for both sensitivity attributes and exposure factors are region specific (Morrison et al. 2015).

To calculate the community climate change vulnerability scores, the percent contribution to total value landed for the community of each classified species was multiplied by that species' vulnerability score for three sensitivity attributes: Stock Size/Status, Ocean Acidification, and Water Temperature ("Temperature" hereafter) (Table 1). Similarly, community percent contribution was also multiplied by overall sensitivity (including all 12 sensitivity attributes) and total vulnerability (including all sensitivity attributes and exposure factors) to climate change (see Morrison et al. (2015) and Hare et al. (2016) for more details and a complete list of sensitivity attributes and exposure factors). The community climate change vulnerability scores were calculated using the species landings' value in dollars, instead of weight in pounds, to reflect the relative importance of certain species to generate revenue and, thus, relate community socio-economic dependence on species to their vulnerability to climate change.

Table 1. Sensitivity attributes used to calculate community climate vulnerability scores, including the goal of the attribute and descriptions of what is considered a low and a high score (Based on Morrison et al. 2015).

Sensitivity Attribute	Goal	Low Score	High Score
Stock Size/Status	To determine if the stock's resilience is compromised due to low abundance	Low abundance	High abundance
Ocean Acidification	Determine the stock's relationship to "sensitive taxa"	Is not a sensitive taxa* or rely on a sensitive taxa for food or shelter	Stock is a sensitive taxa
Temperature	Known temperature of occurrence or distribution as a proxy for sensitivity to temperature	Species found in wide temperature range or has a distribution across wide latitudinal range and depths	Species found in limited temperature range or has a limited distribution across latitude and depths

* Sensitive taxa have shown negative effects from OA, e.g., hard corals, mollusks, calcified algae, and echinoderms.

The species vulnerability scores range from 1 to 4 for all sensitivity and total vulnerability scores. This scale is a qualitative scale ranging from low (1) to very high vulnerability (4). The resulting community scores also range between 1 and 4 and reflect the relationship between species contributions to value landed in a community and their vulnerability to climate change by multiplying species vulnerability scores by their percent contribution to value landed in the community. Thus, high percent contributions (0 to 1) of high vulnerability species (1 to 4) will result in higher community level scores (e.g., 100% contribution of a species with a very high climate change vulnerability score for a certain sensitivity factor will result in a very high (4) community climate change vulnerability score: 1 x 4 = 4). To obtain overall yearly community climate change vulnerability scores, community scores for all the classified species landed in a given community in a given year were summed. Note that this relationship is not linear. Different combinations of percent contribution and species vulnerability scores can result in similar community scores. However, the resulting total score provides a meaningful representation of a community's climate change vulnerability based on the relationship between species landed, contributions to value and their climate change vulnerability (Figure 1).

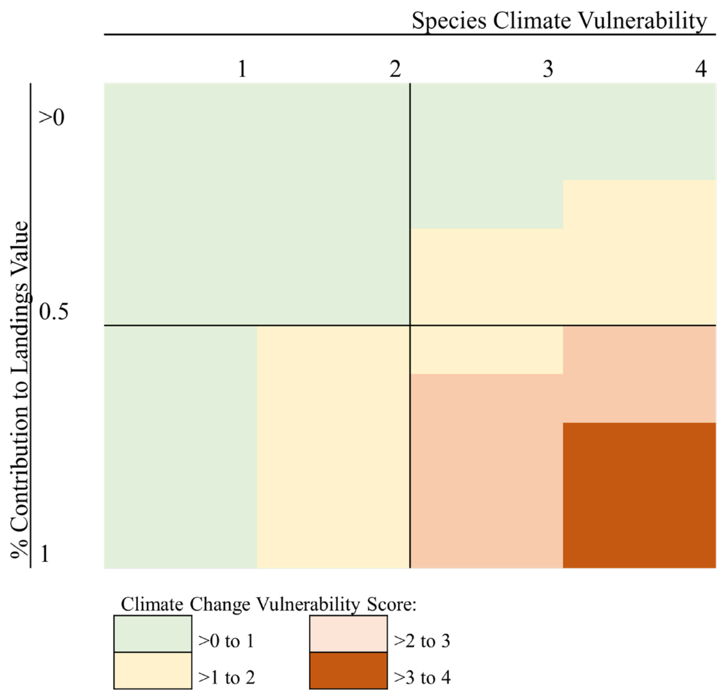

Figure 1. Relationship between species climate vulnerability and percent contribution of each species to value landed used to calculate community climate vulnerability scores by summing each species climate vulnerability scored weighted by its contribution to value.

Although the species classified by NOAA SEFSC scientists represent a significant portion of the commercial landings in the regions studied, the list does not include all species with regional and local importance and catch composition varies considerably among different communities. To ensure that community climate change vulnerability scores range between 1 and 4 to aid in interpretation of results, contribution (percentage) of each classified species to landings value was calculated based only on classified species and non-classified species were excluded. In addition, in order to generate scores that reliably reflect a community's climate change vulnerability based on their dependency on different species, only communities with a high dependency on classified species indicated by the fact that the classified species represent a significant portion of the total value landed were selected for further analysis. A threshold of approximately 80% contribution annually to value landed from classified species for the 19-year time period analyzed was considered appropriate. Some communities that did not meet the criteria but were considered of significant regional importance as fishing communities were also selected for further analysis.

Community Profiles

Eleven communities representing each state in each of the three regions studied were selected for further analyses (Table 2). Community selection criteria for profiling included a combination of regional significance, high percentage of classified species landed, and representation of a region's catch variability. The community profiles include time series graphs of climate vulnerability scores for each of the three sensitivity attributes, a measure of total sensitivity calculated as the average between all three attributes, and total vulnerability which considers all sensitivity attributes and exposure factors as calculated by NOAA SEFSC scientists (see Morrison et al. 2015). Graphs displaying community climate vulnerability scores include regional average scores for each sensitivity attribute as well as for total sensitivity and total vulnerability as a means of comparison. Regional climate vulnerability scores were calculated as the 5-year average (2014-2018) (Table 3 and Appendix II) among all communities with a contribution of at least 50% of classified species in each region. Community profiles also include time series graphs of the contribution of species to value landed and a measure of diversity (Simpson's Reciprocal Index).[4] Species contribution graphs include both classified and non-

Table 2. List of communities selected for detailed profiling, including average percent contribution of classified species to value landed, 5-year average regional quotient (value), and 5-year average diversity for value and pounds.

Region[5]	**Community**	**St**	**Mean % Classified Species ($)**	**5 Year Regional Quotient ($)**	**5 Year Diversity ($)**	**5 Year Diversity (lb)**
Florida Keys	Key West	FL	0.93	0.29	2.72	4.30
Gulf of Mexico	Cortez	FL	0.72	0.01	6.11	4.55
	Bayou La Batre	AL	0.97	0.05	2.43	2.88
	Biloxi	MS	1.00	0.02	2.13	1.91
	Houma	LA	0.81	0.02	2.70	3.93
	Galveston	TX	0.94	0.03	3.35	3.64
South Atlantic	Wanchese	NC	0.56	0.07	11.40	9.87
	Little River	SC	0.84	0.01	7.74	9.13
	Savannah	GA	0.95	0.01	2.30	1.93
	Miami	FL	0.80	0.05	2.16	4.98
	Fernandina Beach	FL	0.95	0.01	1.75	2.54

[4] The index is calculated as 1/D, where: D=Σ(n/N)2, n=value landed for a given species, and N=total value landed. Higher value represents more diversity.

[5] The Florida Keys were considered a separate region and metrics for Key West were calculated with only Keys communities included.

classified species with an average contribution to total value of more than 1% across the period analyzed. Species with low average contribution were grouped under the category SPECIES<1%. The categories OTHER and OTHER SHELLFISH include non-specific species groupings (e.g., groupers) as well as other database nomenclature not identifiable as specific species.

Table 3. Five-year (2014-2018) average scores for each sensitivity attribute, overall sensitivity, and total vulnerability for profiled communities ranked by overall sensitivity.

Region	Community	St.	Temperature	Ocean Acidification	Stock Size/Status	Overall Sensitivity	Total Vulnerability
S. Atlantic	Fernandina Beach	FL	1.80	3.51	1.13	2.96	3.96
S. Atlantic	Savannah	GA	1.52	3.19	1.49	2.53	3.53
Gulf	Houma	LA	1.67	3.02	1.88	2.42	2.42
S. Atlantic	Wanchese	NC	1.45	2.52	1.76	2.02	3.02
S. Atlantic	Miami	FL	1.76	3.44	1.53	2.76	3.76
S. Atlantic	Little River	SC	2.04	2.13	2.13	1.85	2.85
Gulf	Cortez	FL	1.89	1.90	2.42	1.63	1.65
FL Keys	Key West	FL	1.60	2.31	1.77	1.60	1.64
Gulf	Galveston	TX	1.72	1.68	1.98	1.55	1.55
Gulf	Bayou La Batre	AL	1.95	1.87	1.20	1.01	1.02
Gulf	Biloxi	MS	1.96	1.88	1.18	1.01	1.01

Profiled Communities in the Florida Keys and Gulf of Mexico

Key West, Florida

The community of Key West sits at the very end of the Florida Keys, a little over 90 miles north of Cuba. Key West has a long and colorful history of pirates, turbulent storms, shipwrecks and lost treasures. Commercial fishing has also always been an important part of the local economy. In the late 1800s, sponges were the primary product, but other fisheries were important as fishermen from the US East Coast and Bahamas would travel to the Keys and fish for grouper and spiny lobster. In the 1950s, shrimp from the Dry Tortugas became one of the major species landed in the community, but today spiny lobster dominates landings followed by pink shrimp and yellowtail snapper. While commercial fishing is still important, tourism and recreational fishing have become the more dominant sectors within the local economy (Jepson et al. 2005).

For those species landed in Key West, sensitivity to temperature, ocean acidification and stock size/status are all near the average for the Florida Keys region or slightly below with minor variation between 2000 and 2018 (Figure 2). Total climate sensitivity and vulnerability are just slightly above the regional average (Figure 3). The low overall variation in these metrics reflects the stability regarding the mix of species landed within the community over time.

Figure 4, which provides a time series of landings of important species for Key West from 2000 to 2018, illustrates this point. Over that time, spiny lobster has been the predominant species landed with pink shrimp the second most prevalent. Yellowtail snapper follows as the third major species landed during the time series with rock shrimp having an important role in the early 2000s. In terms of diversity, Key West has a relatively low diversity score. Notably the diversity of value and landings has declined since 2004, largely due to the disappearance of the rock shrimp fishery.

Overall, Key West is near the average for other Florida Keys communities in terms of sensitivity to climate change with relatively low sensitivity, but it also has a lower diversification score that has declined over recent years, making the community increasingly vulnerable to climate or non-climate related disruptions of its primary fisheries, especially spiny lobster.

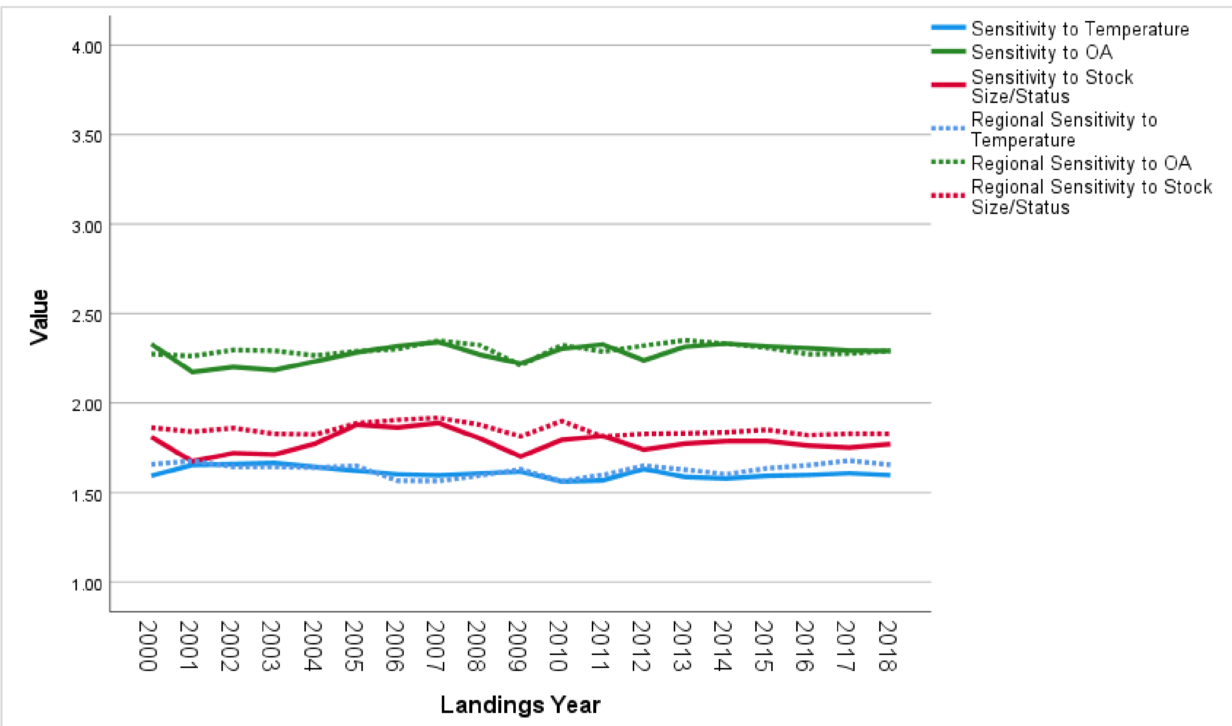

Figure 2. Yearly community climate sensitivity scores for Key West FL with regional averages.

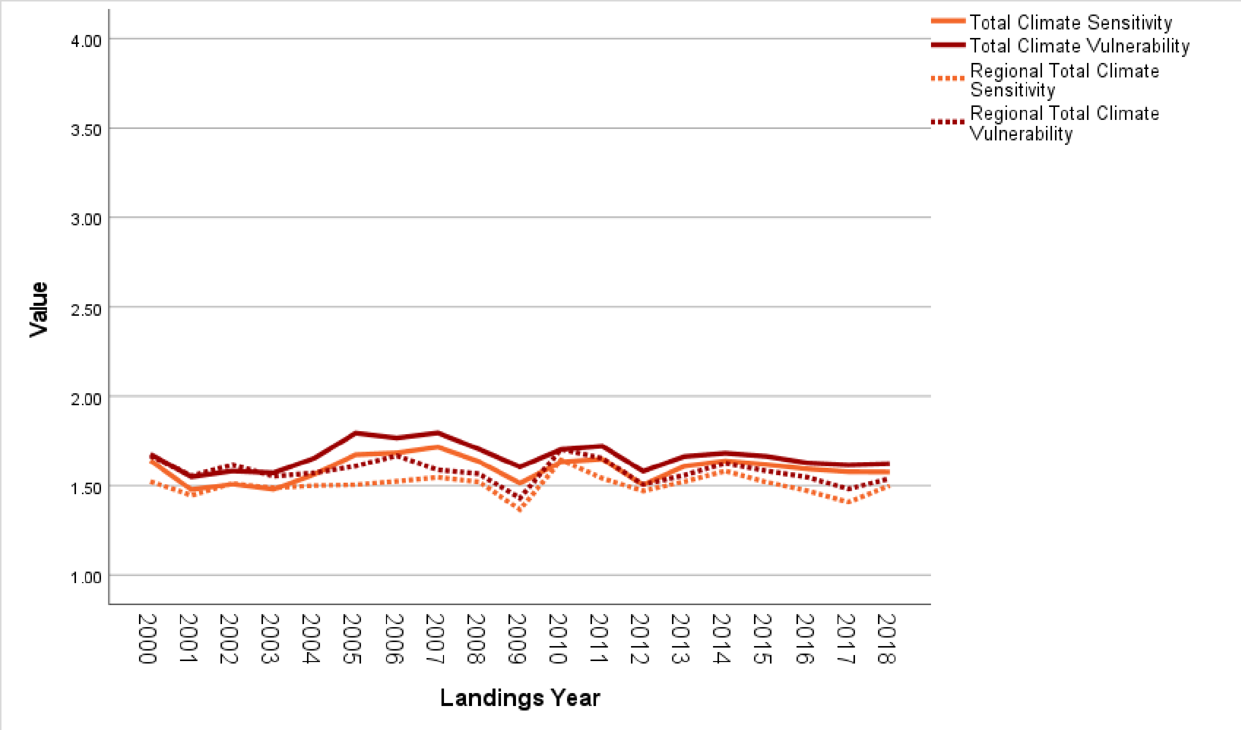

Figure 3. Yearly total community climate sensitivity and vulnerability scores for Key West FL with regional averages.

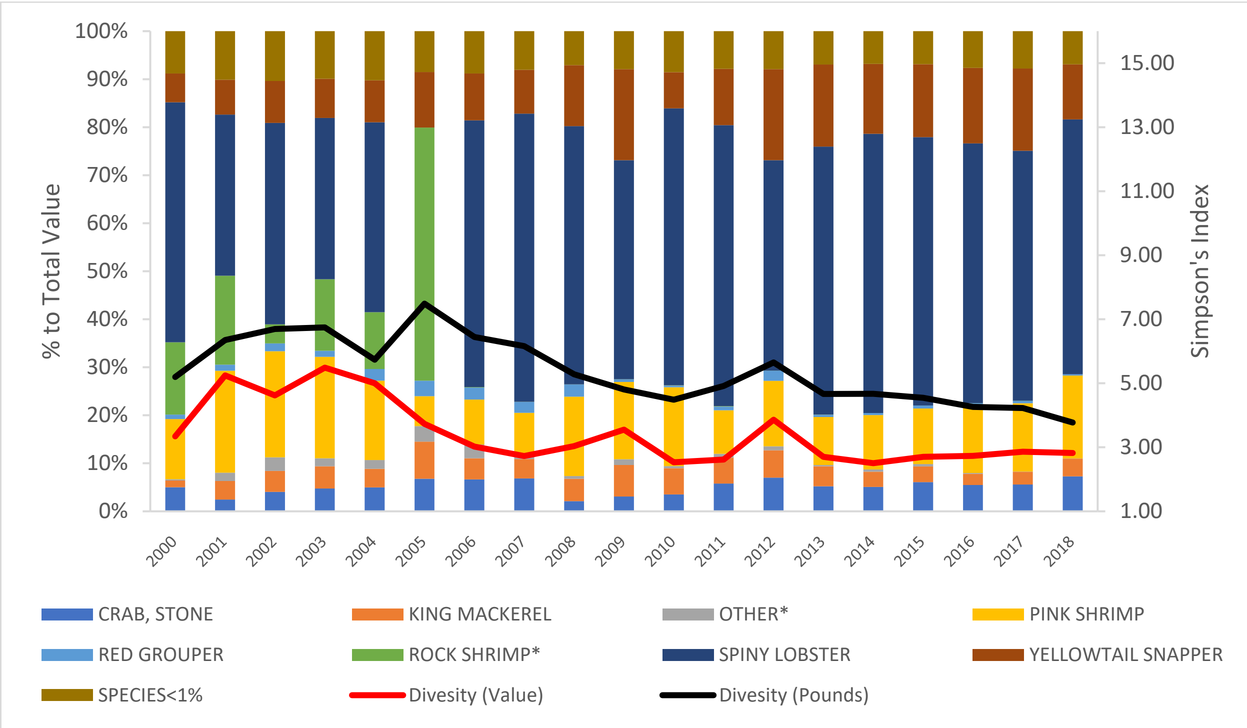

Figure 4. Composition of primary species landed and diversity index score for pounds and value for Key West FL.
*Non-classified species

Cortez, Florida

Cortez is located at the northern end of Sarasota Bay in Manatee County on Florida's central west coast. The community has a long history of commercial fishing that extends back to the early Spanish colonial era. Historically, the primary species landed were mostly inshore with mullet the most common until a statewide ban on entanglement nets in the mid-1990s. Since then, the primary species have become offshore species such as groupers and snappers along with a near shore bait fishery for Atlantic thread herring. Stone crab and mullet are important seasonal fisheries for the community with mullet roe still an important export (Impact Assessment, 2005a).

For those species landed in Cortez, sensitivity to stock status is substantially higher than the average for the Gulf of Mexico region between 2000 and 2018 (Figure 5). Sensitivity to temperature is also higher and sensitivity to ocean acidification lower than the Gulf average. Total climate sensitivity and vulnerability are above the regional average (Figure 6). The overall variation in these metrics indicates a rise in vulnerability to a high in 2005 with a decline until 2013 where vulnerability rises again.

Figure 7 provides a time series of the value of important species for Cortez from 2000 to 2018. Over that time, red grouper has been the predominant species with striped mullet becoming increasingly important after 2009. Stone crab value was more important in the early 2000s, but its contribution has decreased over time. In terms of diversity, Cortez initially has a relatively average score for both value and landing diversity. Notably diversity based on both values declines until 2016 when value diversity rises substantially while diversity in pounds declines. This signifies a decrease in landings for some high value species and a higher contribution toward value by species that constitute a higher percent of pounds landed.

The spikes that appear in the total climate vulnerability and value diversity index may be tied to the occurrence of red tides as each peak coincides with years of high incidences of red tide on Florida's west coast. This is relevant as red grouper is highly sensitive to the effects of red tide and it is a prominent high value species landed in Cortez. Overall, Cortez is much higher in terms of vulnerability and sensitivity to climate change than other Gulf communities. It also has a lower diversification score for pounds that has declined over recent years while value diversity has increased. How that contributes to or reduces vulnerability is unclear. However, despite revenue being distributed among a number of different species, market prices are subjected to varying external forces, and the community's increased dependence on landings of select species with relatively high climate change vulnerability may decrease its adaptive capacity in the face of environmental changes.

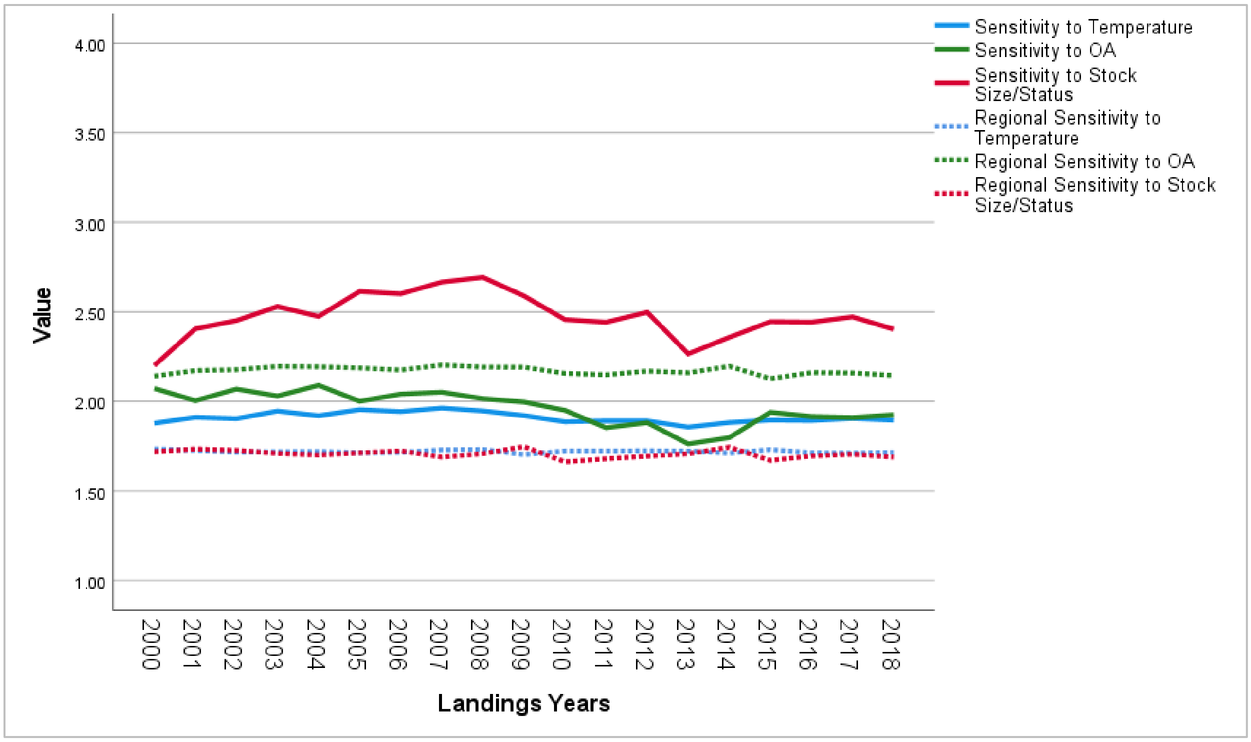

Figure 5. Yearly community climate sensitivity scores for Cortez FL with regional averages.

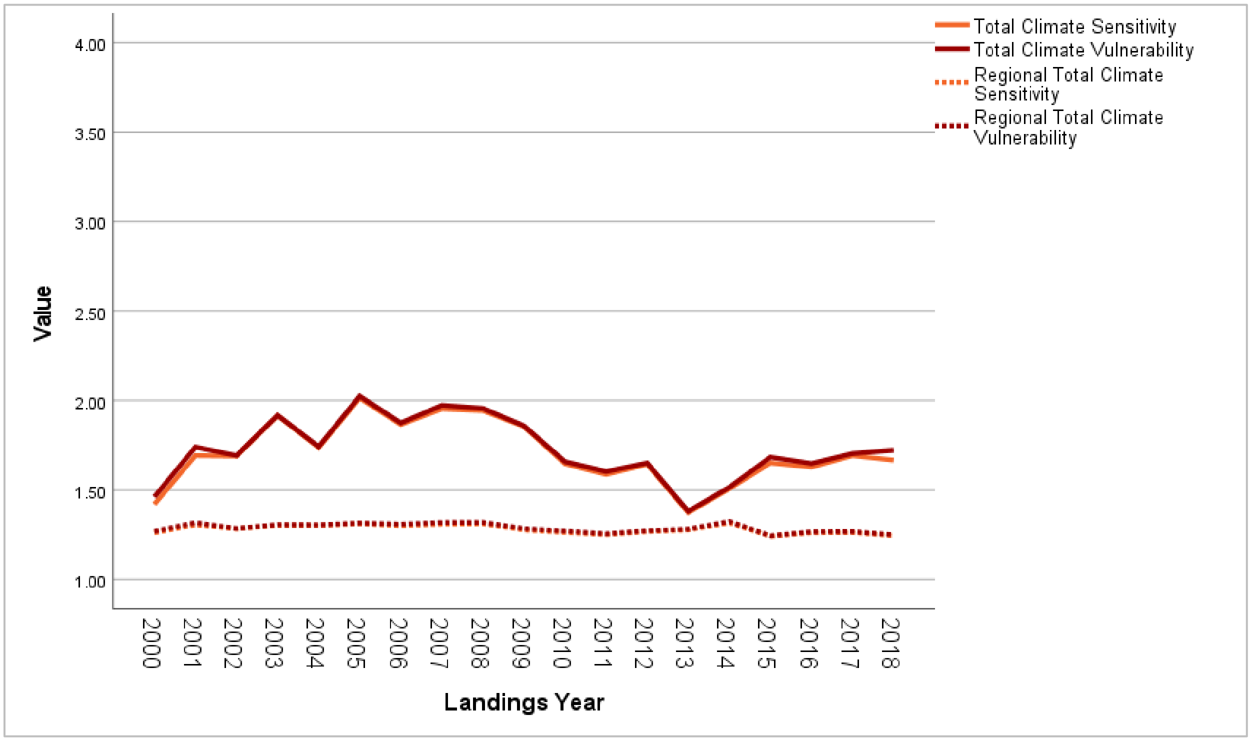

Figure 6. Yearly total community climate sensitivity and vulnerability scores for Cortez FL with regional averages.

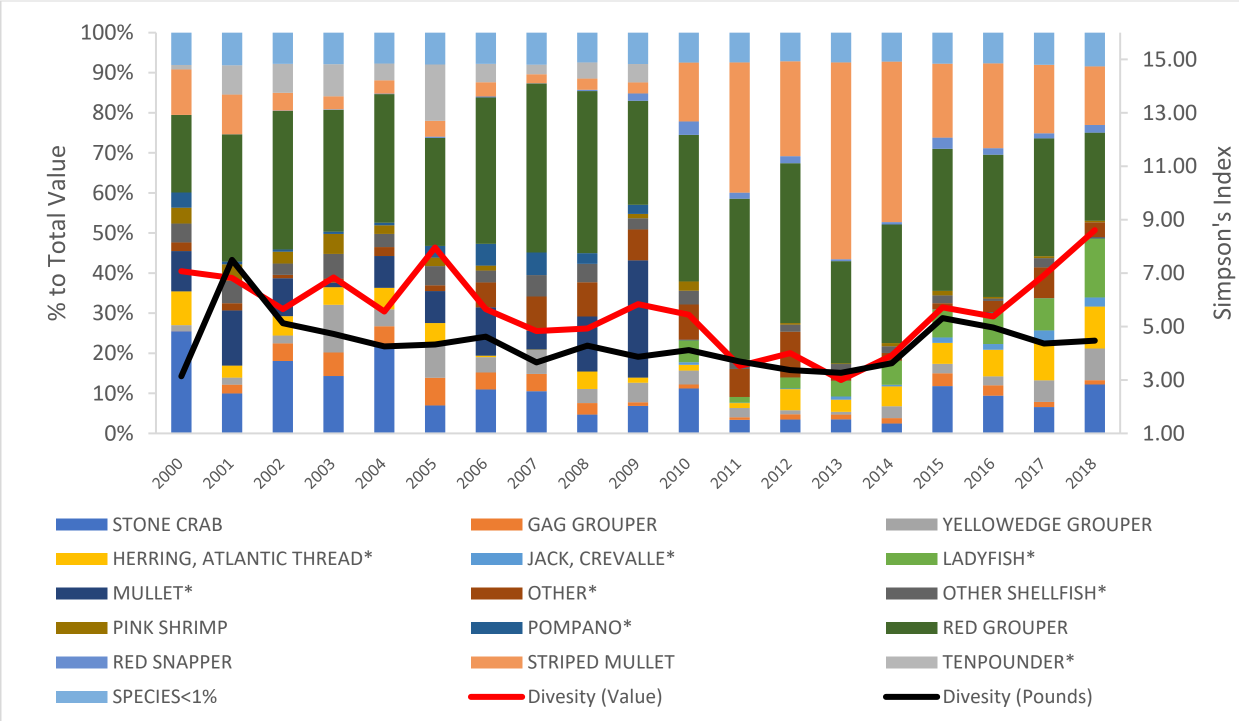

Figure 7. Composition of primary species landed and diversity index scores for pounds and value for Cortez. *Non-classified species

Bayou La Batre, Alabama

Bayou La Batre is a small fishing community in southern Mobile County, Alabama just west of Mobile Bay on the Mississippi Sound. Commercial fishing and seafood processing have been key components of the local economy since the early 1900s. Several varieties of shrimp are the primary seafood landed within the community with oysters, crabs and other finfish. Several large processors are located within the community and provide valued added services including cleaning, heading, picking, shucking, grading, breading, packaging, frozen storage, and transportation. Processors employed over 1500 workers in the early 2000s and continue to process large amounts of shrimp trucked in from other states. Boat building and other marine supply businesses provide support for the local and regional fishing fleet, which includes hundreds of fishing vessels docked in the bayou (Impact Assessment, 2004).

As shown in Figure 8, sensitivity scores for temperature are higher for Bayou La Batre than for other Gulf Region communities due to the mix of species landed in the community. Sensitivity scores for ocean acidification and stock size/status are both below the Gulf of Mexico average. Total climate sensitivity and vulnerability for Bayou La Batre are well below the Gulf Region average with little variation over the time-period between 2000 and 2018 (Figure 9).

Brown and white shrimp have been the predominant species in Bayou La Batre in terms of value, although in recent years pink shrimp have increased in importance. The consistency in landings has contributed to a low diversity score for the community overall across the entire

2000-2018 period (Figure 10). Relatively high scores for sensitivity to temperature related to the community's high dependence on shrimp creates potential vulnerabilities for Bayou La Batre under certain future climate change scenarios.

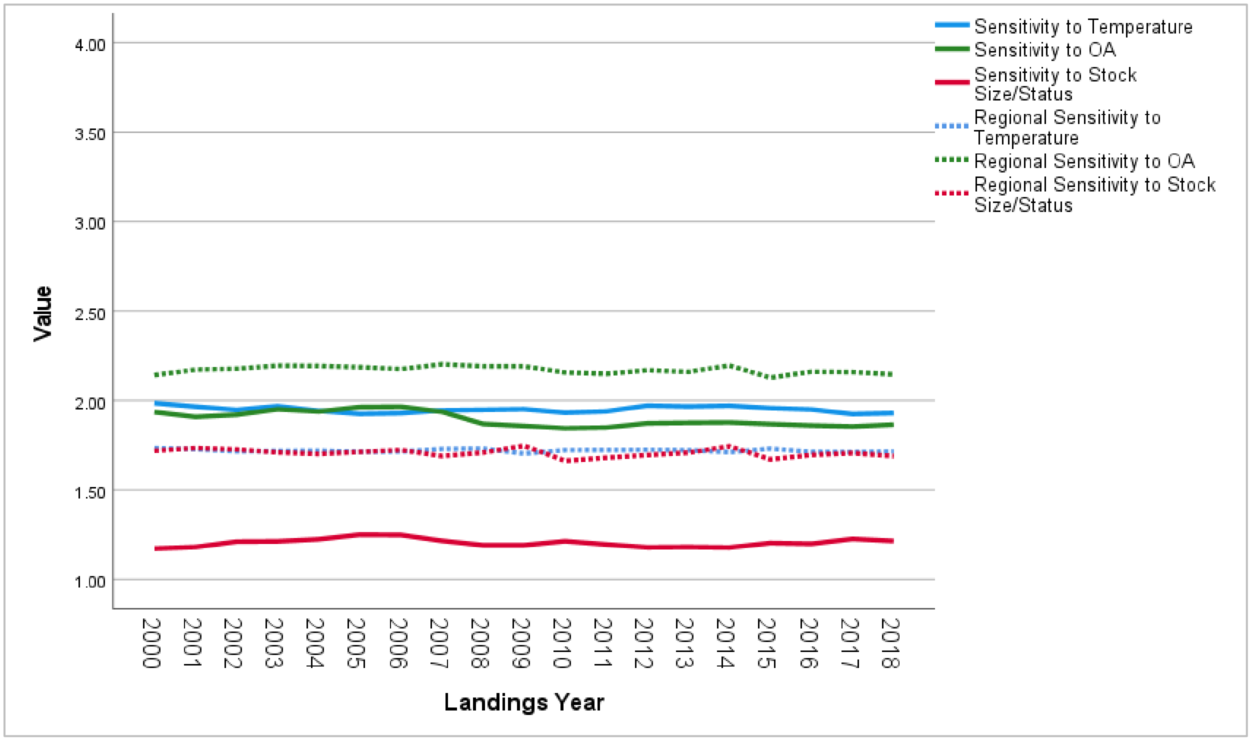

Figure 8. Yearly community climate sensitivity scores for Bayou la Batre LA with regional averages.

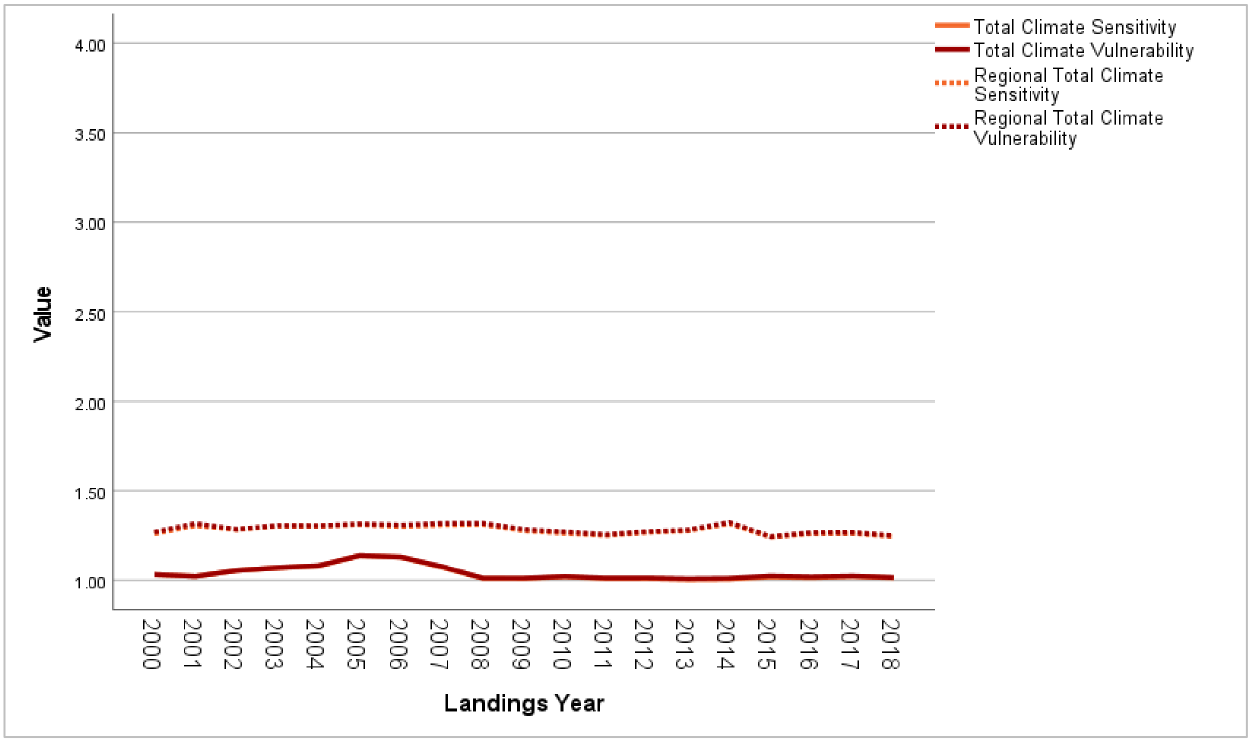

Figure 9. Yearly total community climate sensitivity and vulnerability scores for Bayou la Batre LA with regional averages[6].

[6] The lines for total sensitivity and total vulnerability are almost identical for some communities in the Gulf with low diversity of landings in which the climate indicator scores are being driven by one or two dominant species (or a species group like shrimp) that have been classified identically for overall sensitivity and total vulnerability (see Appendix I). Therefore, any differences in the two measures resulting from the relatively minor contributions of other classified species are too small to be easily visualized in the graph.

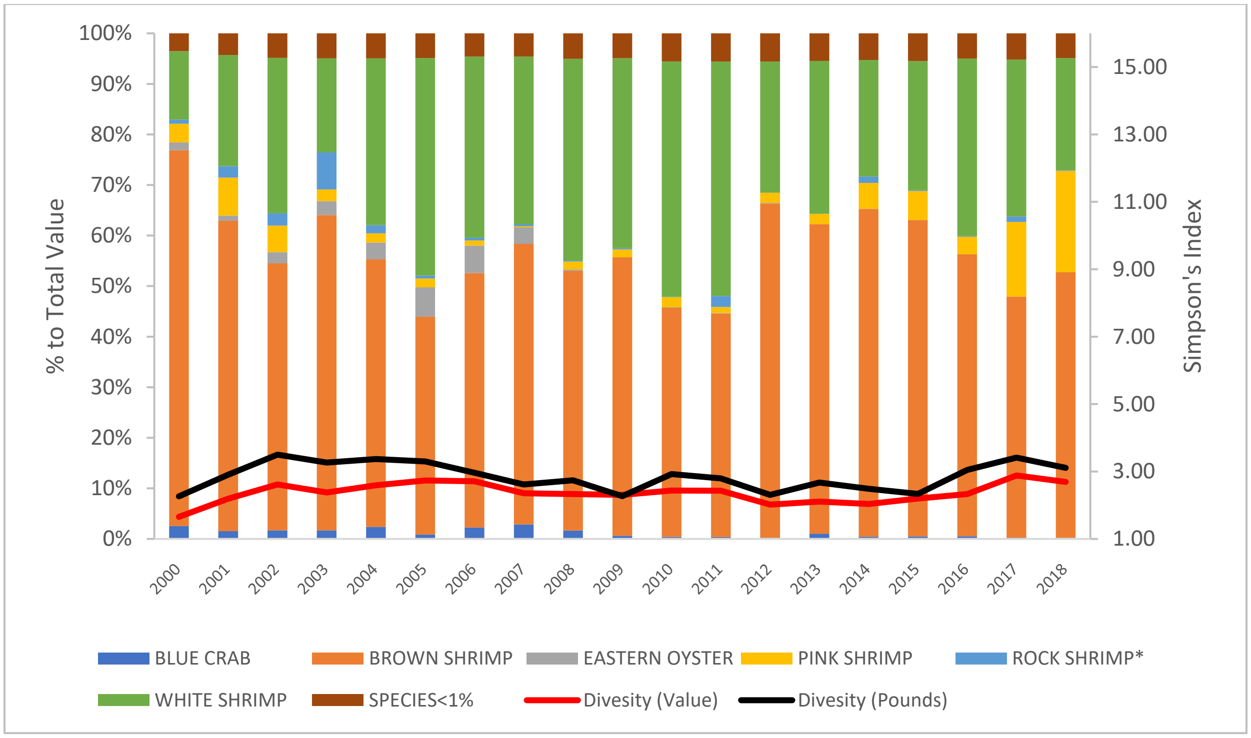

Figure 10. Composition of primary species landed and diversity index score for pounds and value for Bayou La Batre. *Non-classified species

Biloxi, Mississippi

Biloxi is on the Mississippi Gulf Coast in the Southeastern corner of Harrison County bordered by the Mississippi Sound to the south and Biloxi Bay on the east. The community saw growth in the seafood industry with its first cannery opening in 1881, growing throughout the 1920s and 30s. Many processors and dealers were still operating into the 1950s and 1960s with a significant increase in landings. The number of processors and dealers has dwindled in recent years as tourism and recreation have become more important in the local economy, especially with casinos and the gaming industry established on the waterfront in the 1990s. The commercial fleet has decreased since then, although there continues to be a steady supply of seafood coming into the port of Biloxi (Impact Assessment, 2004).

As shown in Figure 11, sensitivity scores are higher than the average for temperature for Biloxi than for other Gulf Region communities due to the mix of species landed in the community. Sensitivity scores for ocean acidification and stock size/status are both below the Gulf of Mexico average. Total climate sensitivity and vulnerability for Biloxi is well below the Gulf Region average with little variation over the time-period between 2000 and 2018 (Figure. 12).

Brown and white shrimp have been the predominant species in terms of value in Biloxi with brown shrimp being the more prominent, except in 2010 and 2016. The consistency in landings of those two species and few others has contributed to a low diversity score for the community across the entire 2000-2018 period for both value and pounds (Figure 13). Similar to Bayou La Batre, Biloxi's high dependence on shrimp species that are vulnerable to increases in water temperature contribute to the community's vulnerability under certain climate change conditions.

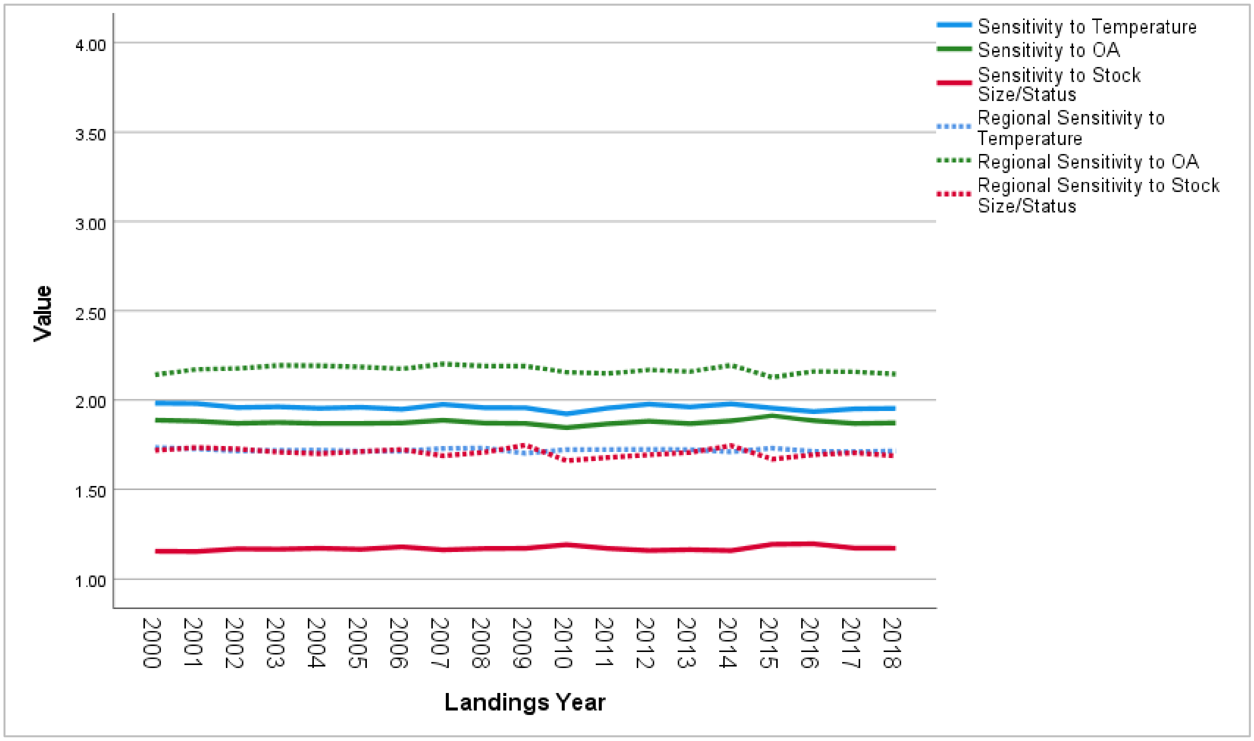

Figure 11. Yearly community climate sensitivity scores for Biloxi MS with regional averages.

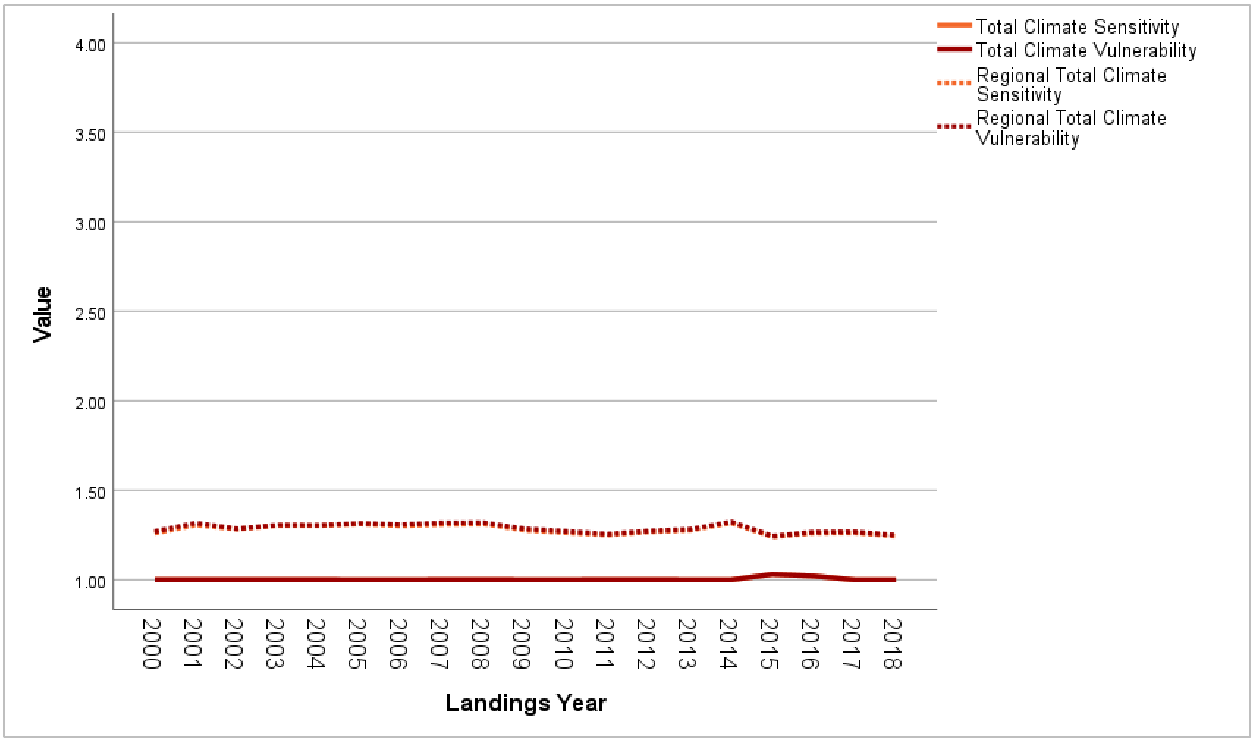

Figure 12. Yearly total community climate sensitivity and vulnerability scores for Biloxi MS with regional averages.

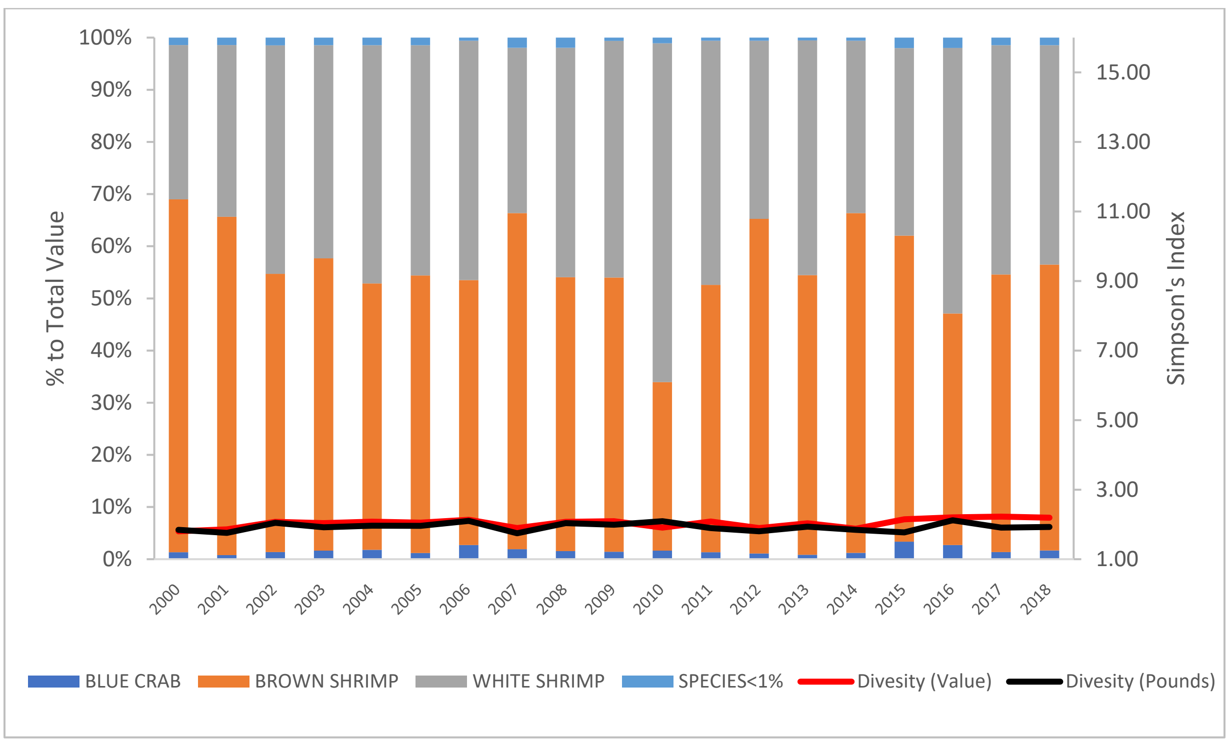

Figure 13. Composition of primary species landed and diversity index score for pounds and value for Biloxi. *Non-classified species

Houma, Louisiana

Houma is the center of government for Terrebonne Parish located on the Gulf Intracoastal Waterway at the intersection of Highways 90 and 24. Historically, the community became the hub for commercial fishing activity when the railroad was established but shifted in the 1970s when its infrastructure began to support the oil industry. Today, Houma is home to many commercial fishing support industries but only a few dealers and processors with many fishermen living along the bayous to the south of the community (Impact Assessment, 2005b).

Sensitivity scores for ocean acidification and stock size/status are higher than the average for Houma than for other Gulf Region communities due to the mix of species landed in the community as shown in Figure 14. Sensitivity to temperature is closer to the Region's average throughout the time period analyzed. Sensitivity scores for ocean acidification is much higher than the Gulf of Mexico average. Total climate sensitivity and vulnerability for Houma is well above the Gulf Region average with some variation over the time-period between 2000 and 2018 (Figure 15).

Oysters have been the predominant species in terms of value in Houma with yellowfin tuna becoming important in the early 2000s. Red snapper became more prominent in value in the later 2000s, but oysters remain the primary species in terms of value for the community. The community's high dependence on oysters is what drives its observed sensitivity to ocean acidification throughout the period analyzed. Diversity scores for both value and pounds are low across the entire 2000-2018 period, but they have risen in recent years with an increase in other species contributing to the value of landings, particularly red snapper (Figure 16), which resulted in a slight overall decrease in the community's sensitivity to ocean acidification between 2013 and 2018. The impact of the relative importance of yellow fin tuna to the community's overall climate change vulnerability is difficult to interpret given that this species has not been assessed for climate vulnerability by SEFSC biologists.

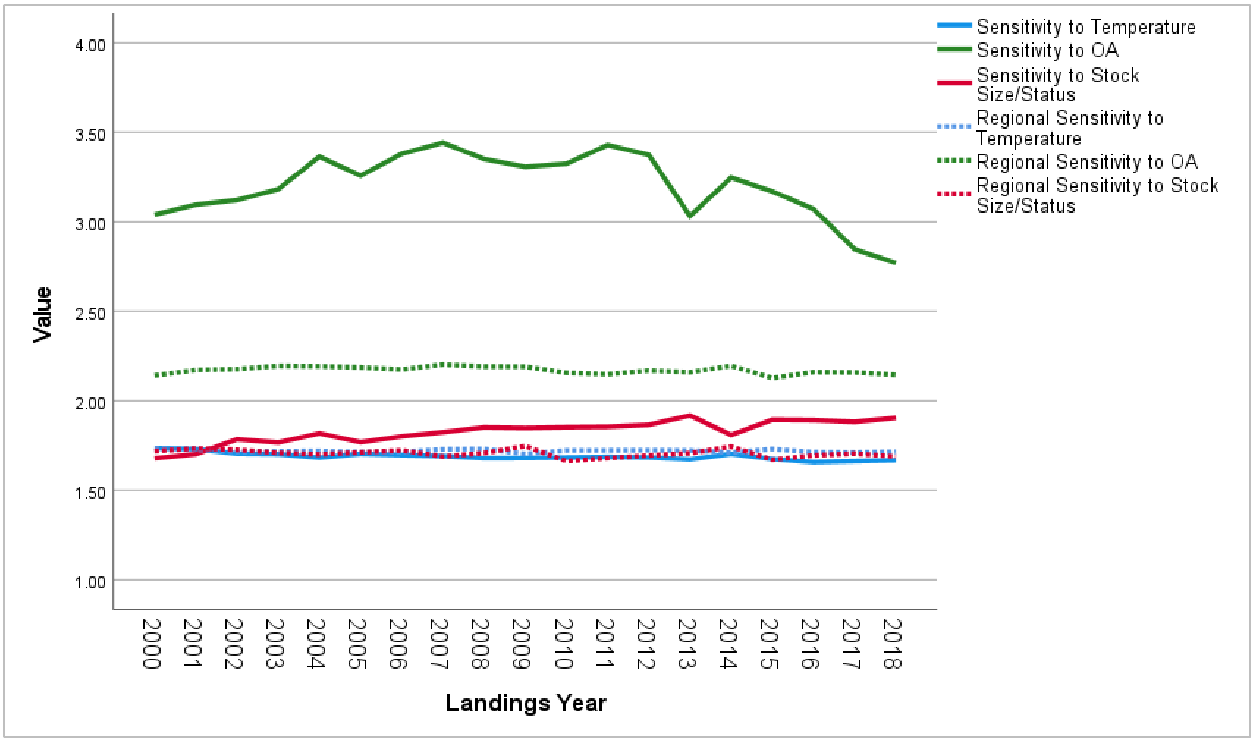

Figure 14. Yearly community climate sensitivity scores for Houma LA with regional averages.

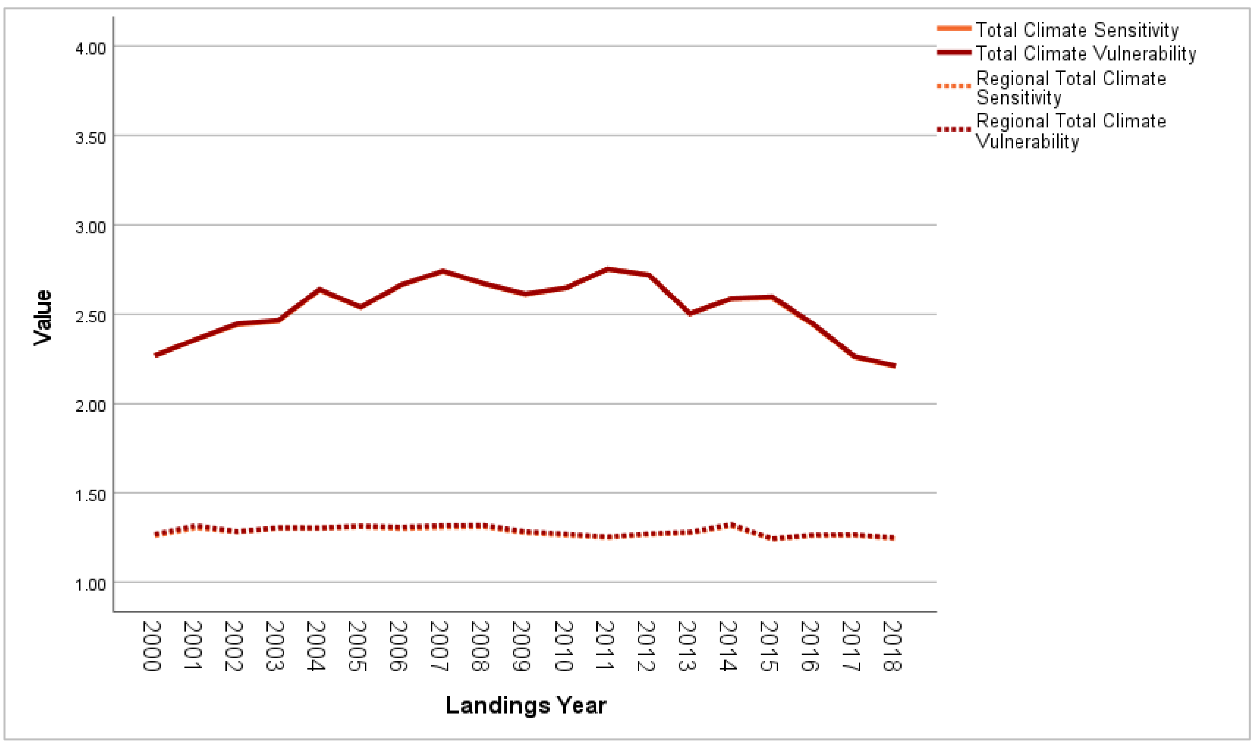

Figure 15. Yearly total community climate sensitivity and vulnerability scores for Houma LA with regional averages.

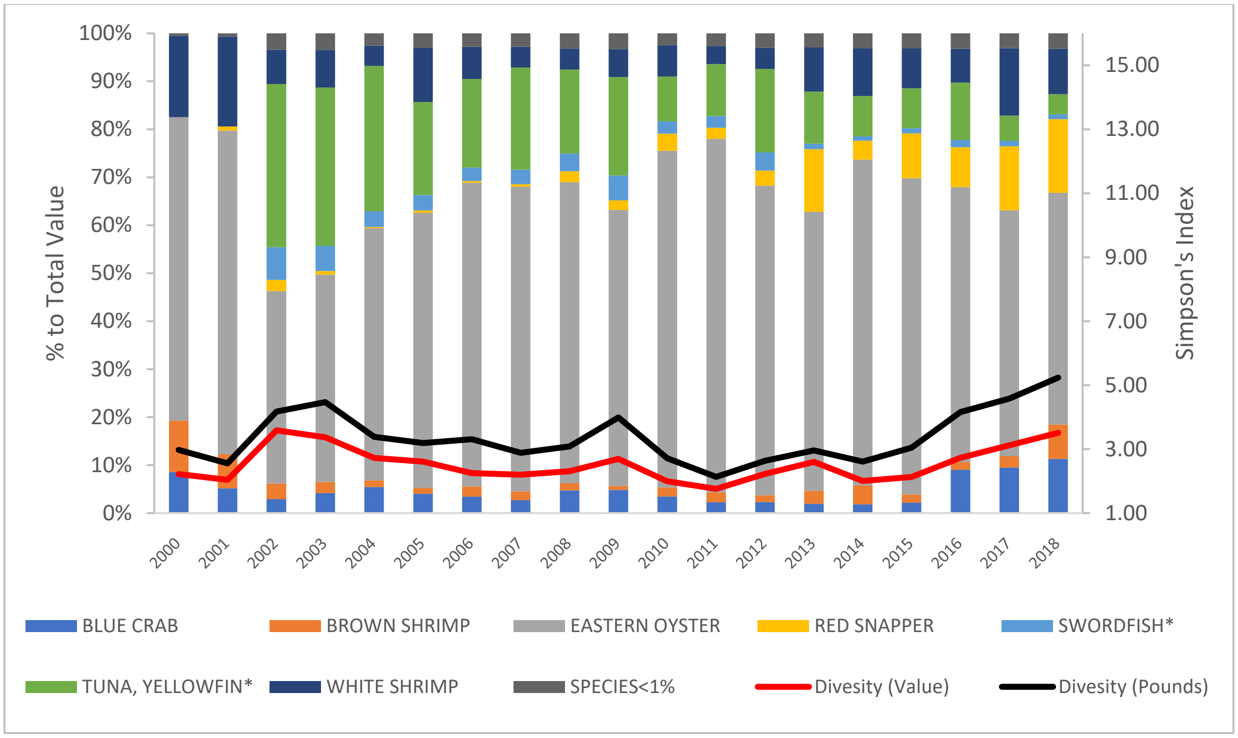

Figure 16. Composition of primary species landed and diversity index score for pounds and value for Houma. *Non-classified species.

Galveston, Texas

The community of Galveston sits on the northeastern end of Galveston Island, just 50 miles south of Houston. Historically, the community's economic engine has revolved around port activities, which included commercial fishing, but predominantly was based on the cotton industry. Today the port handles a wide variety of products including containers but has also become a major port for the cruise industry. Several commercial fishing dealers who handle shrimp and finfish are also presently located in the port (Impact Assessment, 2005c).

Sensitivity scores for all Galveston indices are generally lower than the average for other Gulf Region communities. However, sensitivity to stock size/status has risen above the average in recent years as shown in Figure 17. The sensitivity score for temperature is above but close to the Gulf of Mexico average throughout most of the time series. While sensitivity to ocean acidification is well below the Gulf average, total climate sensitivity and vulnerability for Galveston is close to the Gulf Region average with some variation over the time-period between 2000 and 2018 (Figure 18).

White and brown shrimp have been the predominant species in terms of value in Galveston with brown shrimp becoming less so over time. The community's high dependence on these two shrimp species is reflected in the overall higher sensitivity to ocean acidification observed in Figure 17. Red snapper became more prominent in value in the later 2000s, which drove the community's increase in sensitivity to stock size/status. While diversity scores for both value and pounds are low across the entire 2000-2018 period, they are consistently close to being equal throughout (Figure 19).

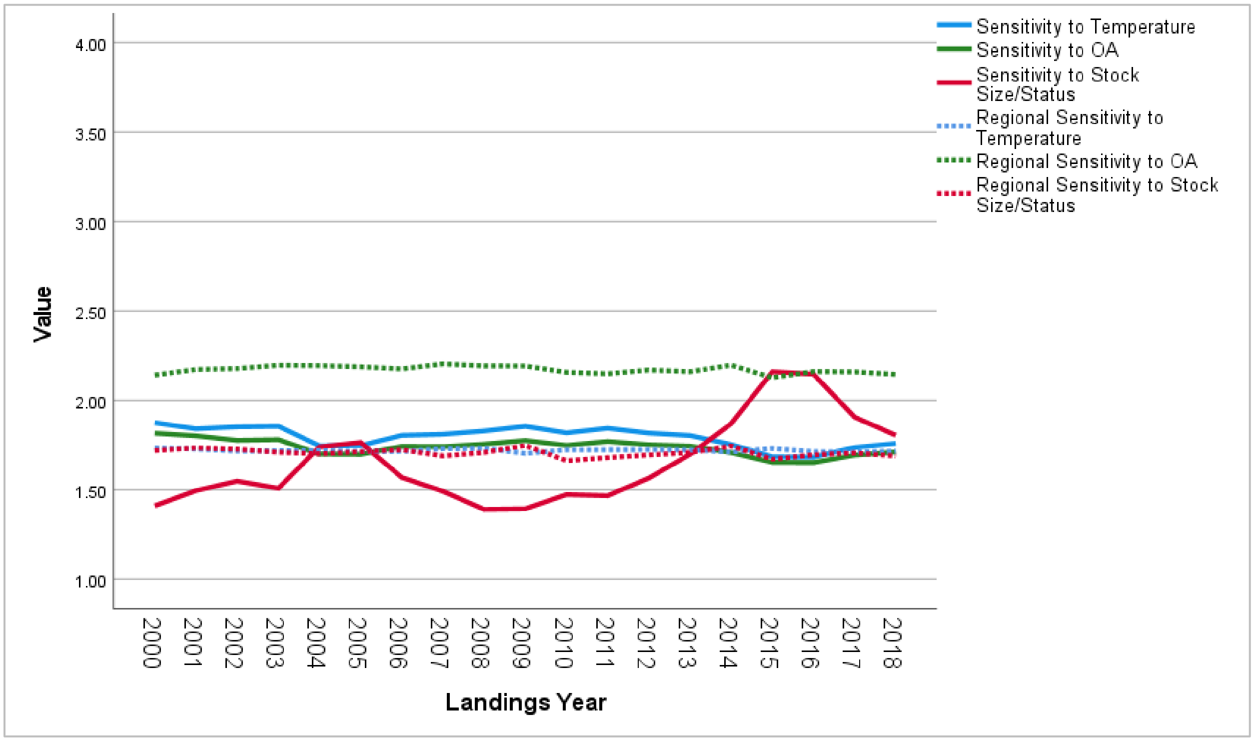

Figure 17. Yearly community climate sensitivity scores for Galveston TX with regional averages.

Line graph showing yearly trends for total community climate sensitivity and vulnerability with regional averages.

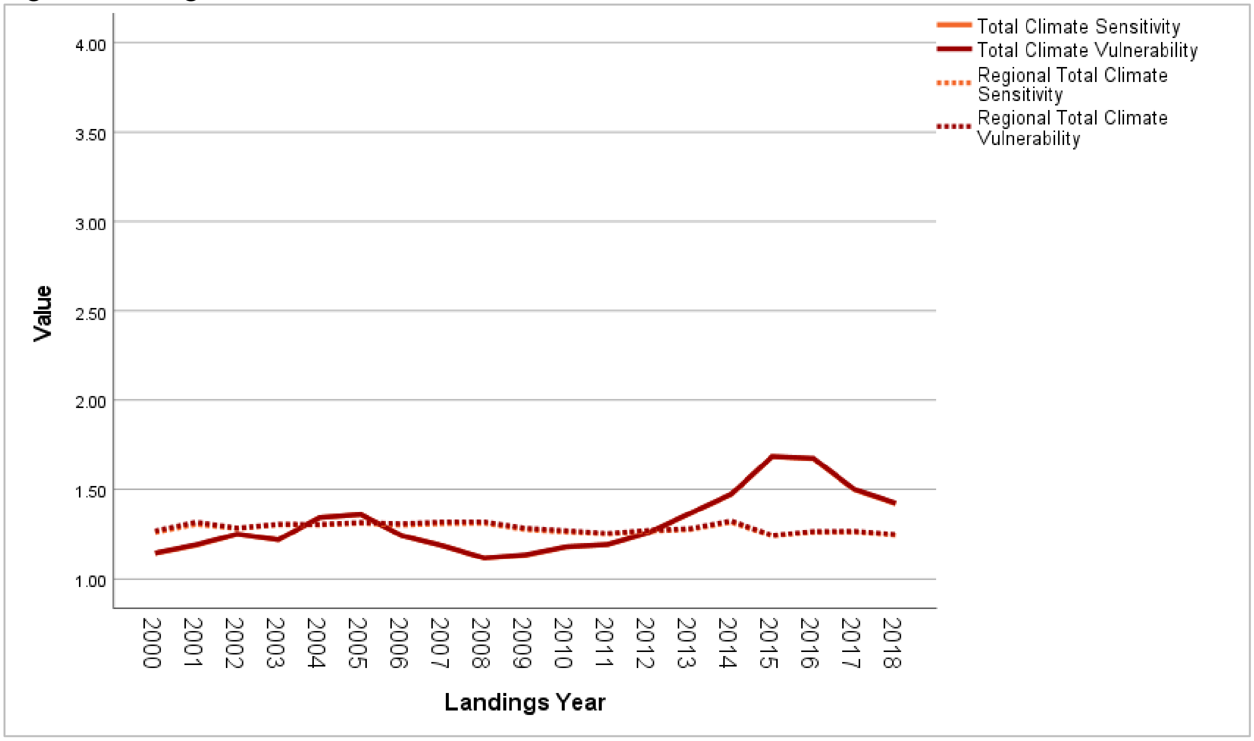

Figure 18. Yearly total community climate sensitivity and vulnerability scores for Galveston TX with regional averages.

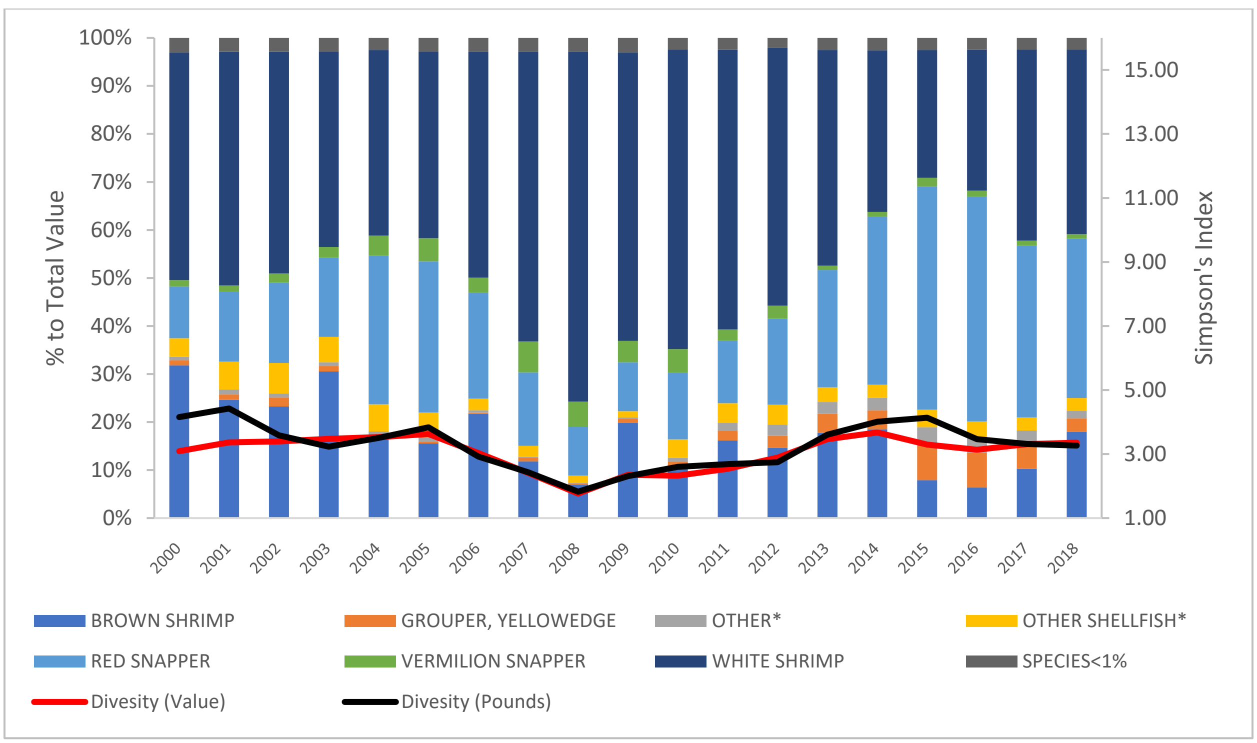

Figure 19. Composition of primary species landed and diversity index score for pounds and value for Galveston. *Non-classified species.

Profiled Communities in the South Atlantic

Wanchese, North Carolina

Wanchese is one of two villages located on Roanoke Island in Dare County, North Carolina. Located at the southernmost end of the island, Wanchese is a small, unincorporated community with a current population of approximately 1,500 people. Fishing has long been a central activity of this area, with archeological evidence indicating the presence of Native American fishing settlements as far back as 900AD (OuterBanks.com and Outer Banks Visitors Guide. https://www.outerbanks.com/wanchese.html. Accessed December 8, 2021). Commercial fishing in Wanchese has been traced back to the nineteenth century and Wanchese's first fish house was established in 1936 (Jepson et. al. 2005).

Wanchese commercial fishing activity currently is focused around the Wanchese Seafood Industrial Park, which opened in 1981. Packinghouses in the park purchase locally landed seafood for distribution all along the Eastern Seaboard and the marinas bordering the Park serve as the base for large shrimp trawlers and other fishing vessels that fish in the Pamlico and Albemarle Sounds and in more distant areas offshore (The Outer Banks of North Carolina. Wanchese Seafood Industrial Park. https://www.outerbanks.org/listing/wanchese-seafood-industrial-park/302/ Accessed December 8, 2021.)

Charter boat fishing has also become increasingly popular in Wanchese in recent years, with the number of charter boats increasing and facilities being created to handle the increased presence of the for hire industry (Jepson et. al. 2005).

For those species landed in Wanchese, sensitivity to ocean acidification and stock status are currently trending below the regional average for the South Atlantic, while sensitivity to temperature is similar to the regional average (Figure 20). Total climate sensitivity and vulnerability are also below the regional average (Figure 21). There has been some variation in these metrics over time, however, which indicates that the mix of species landed within the community and their respective climate vulnerability rates may vary on a periodic basis.

Figure 22 shows that commercial fish landings in Wanchese include a relatively large diversity of species with some of the more prominent including Atlantic croaker, blue crab, yellowfin tuna and white shrimp. In recent years, the diversity of species landed by value has increased while, at the same time, the diversity of species by pounds has decreased sharply. Although these trends can be explained by overall changes in the relative mix of species landed in terms of volume and value, further research is required to interpret more precisely the reason for these fluctuations, and how these trends may affect overall community climate vulnerability. However, decreases in diversity in terms of volume may indicate a potential vulnerability for Wanchese if stocks of these important species are affected by environmental changes and the community becomes more dependent on species of relatively low landings volume historically to generate revenue.

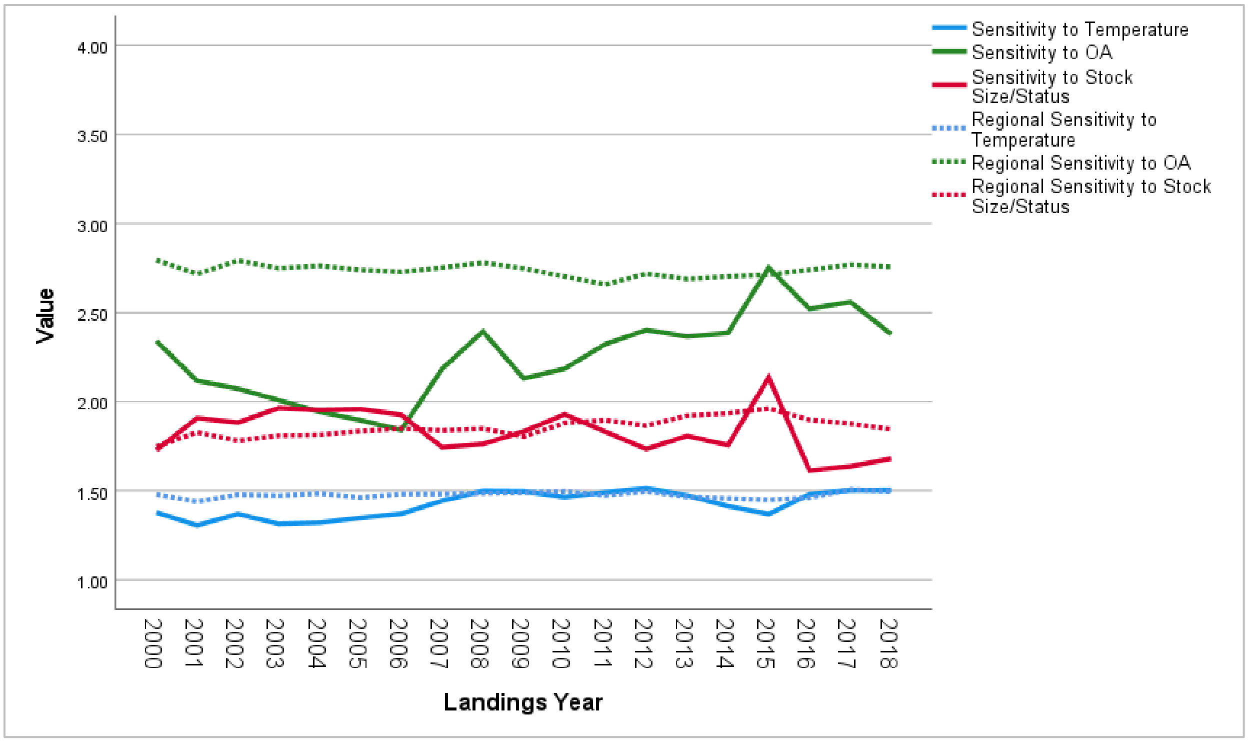

Figure 20. Yearly community climate sensitivity scores for Wanchese NC with regional averages.

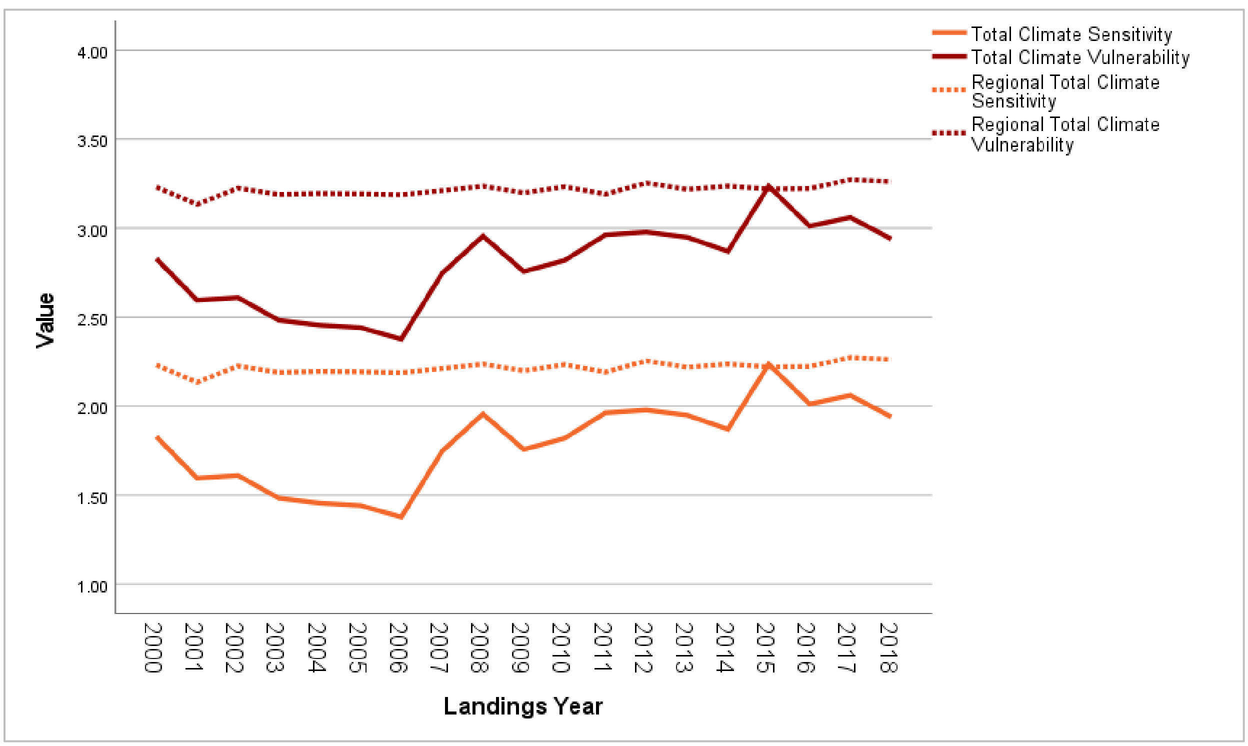

Figure 21. Yearly total community climate sensitivity and vulnerability scores for Wanchese NC with regional averages.

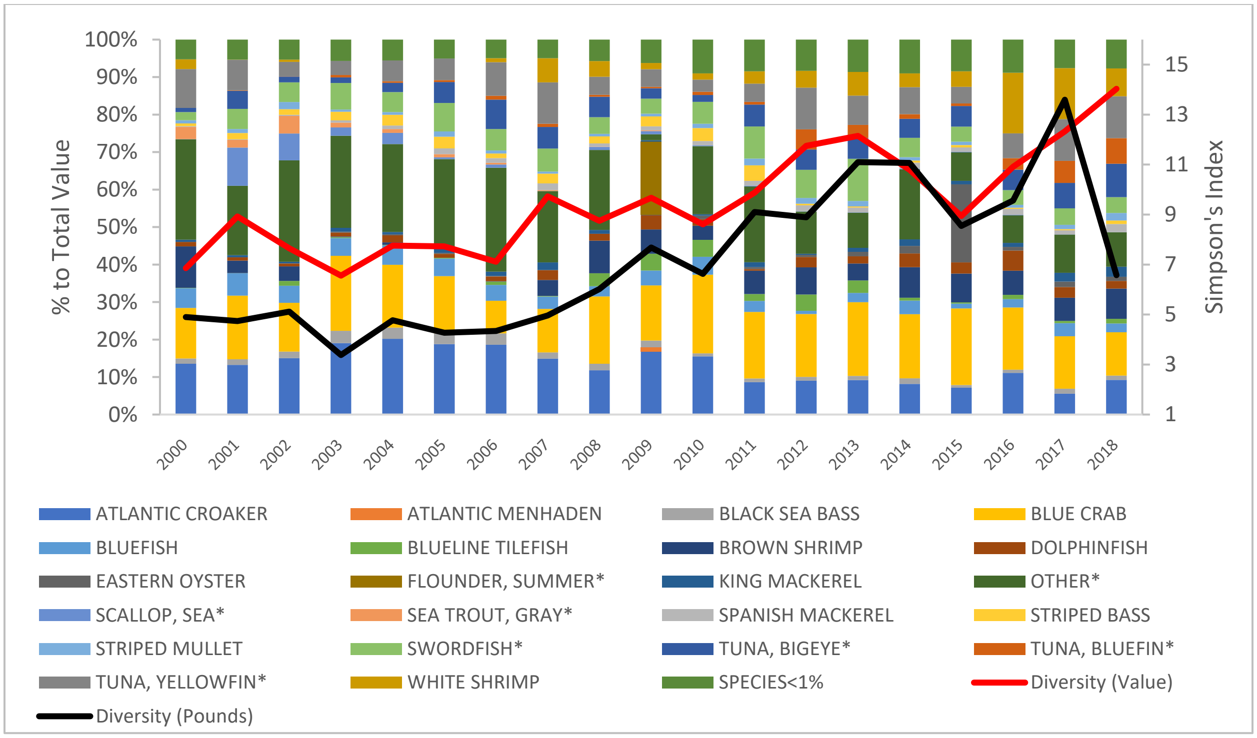

Figure 22. Composition of primary species landed and diversity index score for pounds and value for Wanchese. *Non-classified species.

Little River SC

Little River is one of the oldest settlements along the South Carolina coast. Fishermen and farmers began settling the area in the late 1600s and 1700s, when the small, protected harbor also served as a refuge for shipwreck survivors and pirates. The area became a thriving port town in the 1850s but the development of the community was impacted with the onset of the Civil War (Jepson et. al., 2005). Today, the town of Little River has a rapidly growing population of approximately 11,000 people. Located just 20 miles from Myrtle Beach, South Carolina, water-based tourism activities are important for the local economy, and the town is well known for charter and deep-sea fishing and as well as casino boats. The town has also long been a hub for a small commercial fishing fleet, and the community is well known for its annual ShrimpFest and Blue Crab Festivals (Little River South Carolina http://www.littleriversc.com/. Accessed December 8, 2021).

For the species landed in Little River, sensitivity to stock size/status and temperature are significantly higher than the regional average and sensitivity to ocean acidification is significantly lower than the regional average (Figure 23). However, overall total climate vulnerability and sensitivity are lower than the regional average. Total sensitivity and vulnerability declined significantly in comparison to the regional average approximately 10 years ago, indicating that there was a change in the overall composition of landings in Little River community during that period (Figure 24).

Figure 25 shows that there is a relatively high diversity of species landed in Little River with some of the most important being vermillion snapper, golden tilefish and gag grouper. The relative importance of snappers and groupers likely drives the overall high sensitivity to stock size/status and temperature scores for the community. The diversity of the composition of species landed in Little River, both in terms of pounds and value, peaked and then has decreased in comparison to the period between 2006 and 2009. However, the trends related to changes in diversity of pounds and value have generally followed the same pattern over the entire 2000 – 2018 time series.

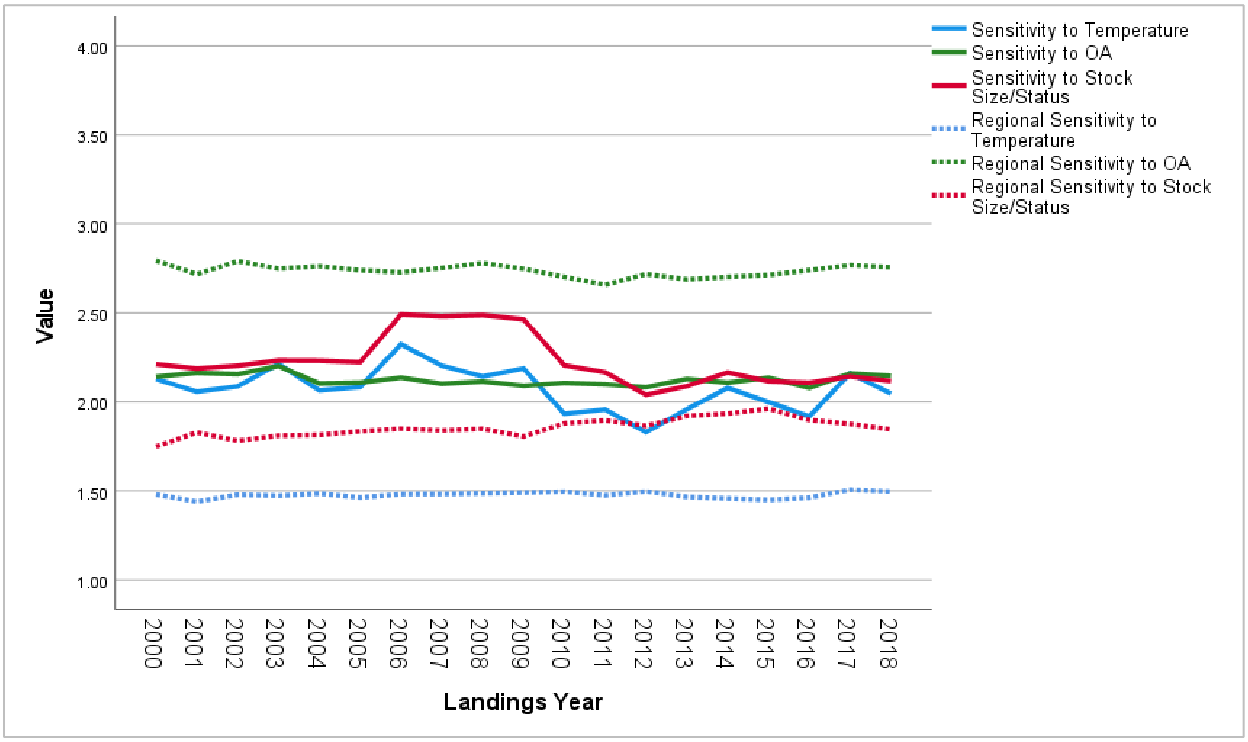

Figure 23. Yearly community climate sensitivity scores for Little River SC with regional averages.

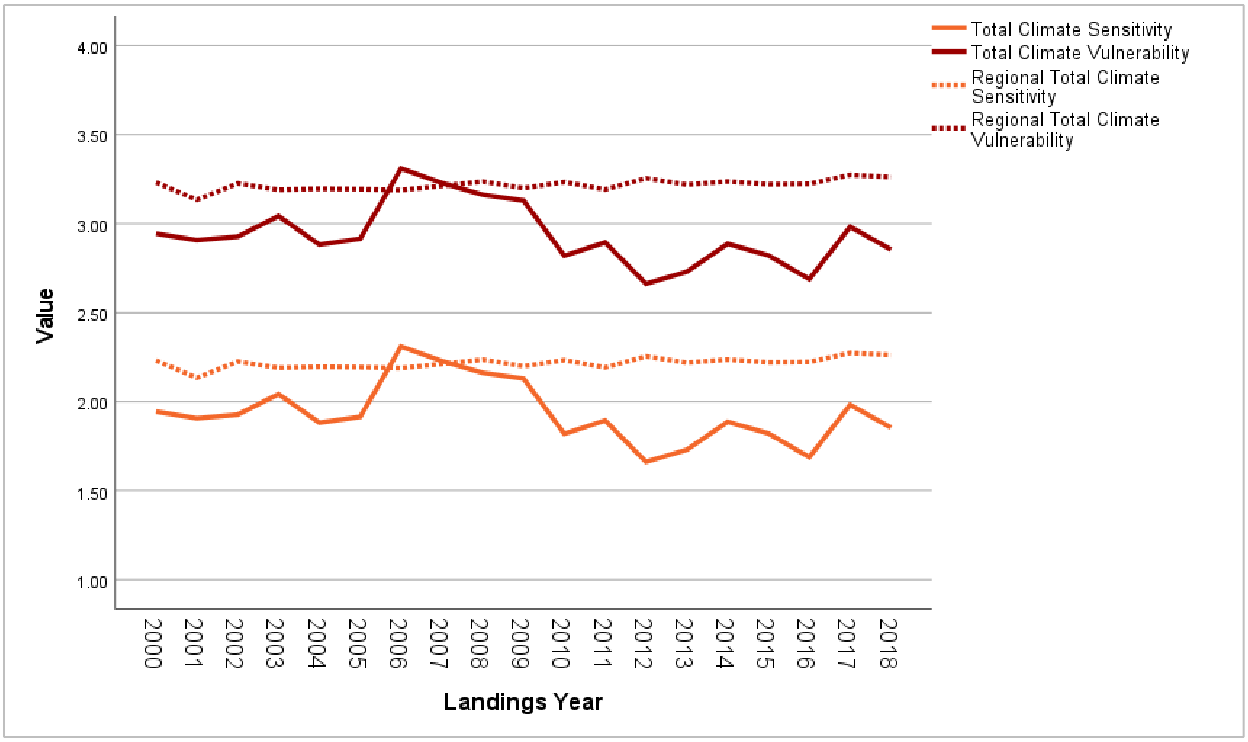

Figure 24. Yearly total community climate sensitivity and vulnerability scores for Little River SC with regional averages.

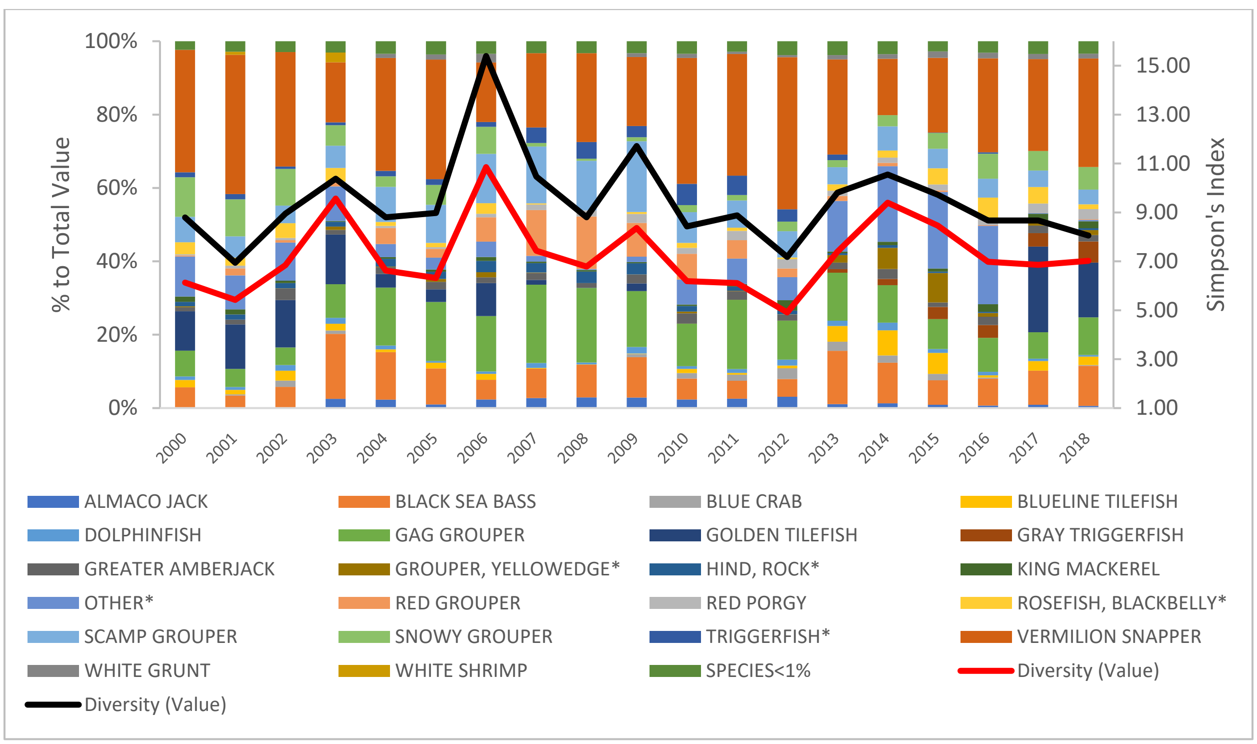

Figure 25. Composition of primary species landed and diversity index score for pounds and value for Little River. *Non-classified species

Savannah GA

Savannah, Georgia is a city best known for its historic district and picturesque parks and architecture. The city, established in 1733 on the Savannah River, was the first state capital of Georgia and has long been an important Atlantic seaport and industrial center. Currently, Savannah is one of Georgia's largest cities with a population of approximately 150,000 people. The city has active charter and commercial fishing fleets but due to the overall size and diversity of the city, these represent a relatively small contribution to the city's overall economy.

Savannah's commercial seafood industry focuses almost exclusively on blue crab, white shrimp and other shellfish species. Sensitivity to ocean acidification is much higher than the regional average, probably due to the dominance of shrimp and shellfish in local landings. However, sensitivity to stock size/status is much lower than the regional average, and sensitivity to temperature is similar to the regional average (Figure 26). Overall, climate sensitivity and vulnerability scores for Savannah remain higher than the regional averages, although the trends indicate a decline in overall climate sensitivity and vulnerability over the past 20 years (Figure 27), which is probably explained by the overall increase in blue crab and decrease in brown shrimp's contribution to value landed. As a result, the diversity of landings in both pounds and value is low in comparison to other profiled communities (Figure 28).

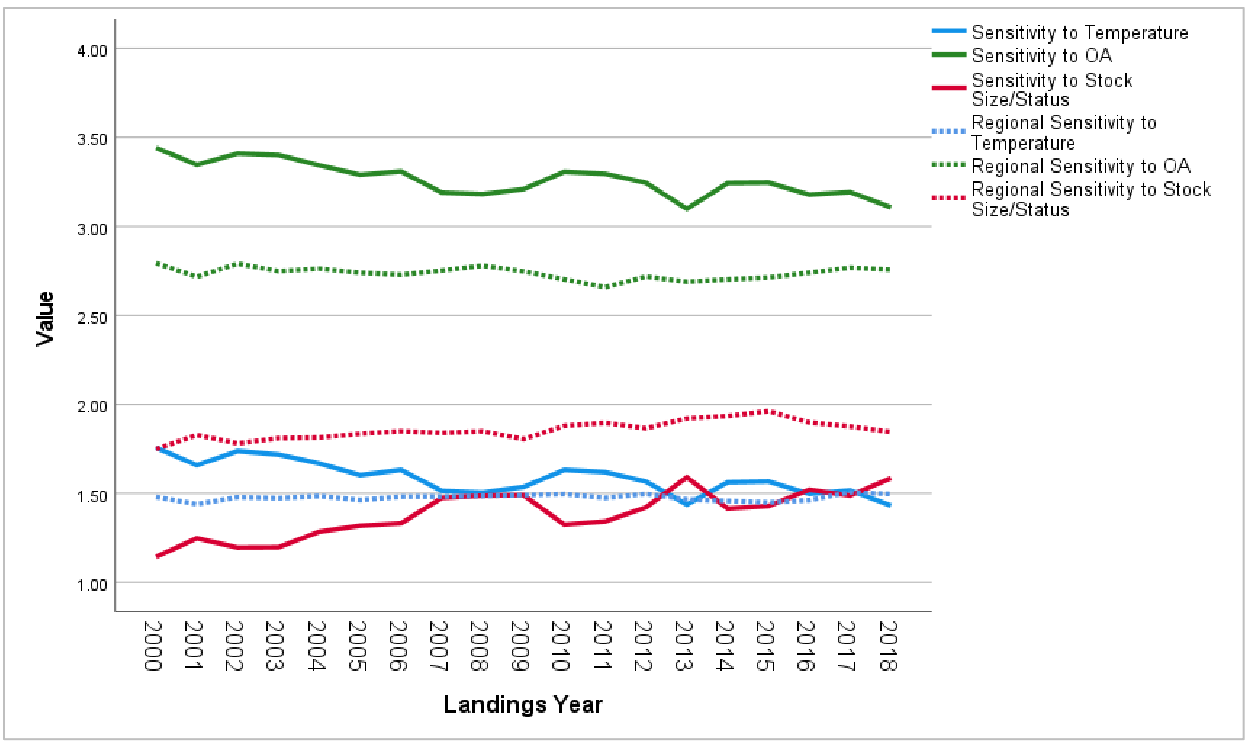

Figure 26. Yearly community climate sensitivity scores for Savannah GA with regional averages.

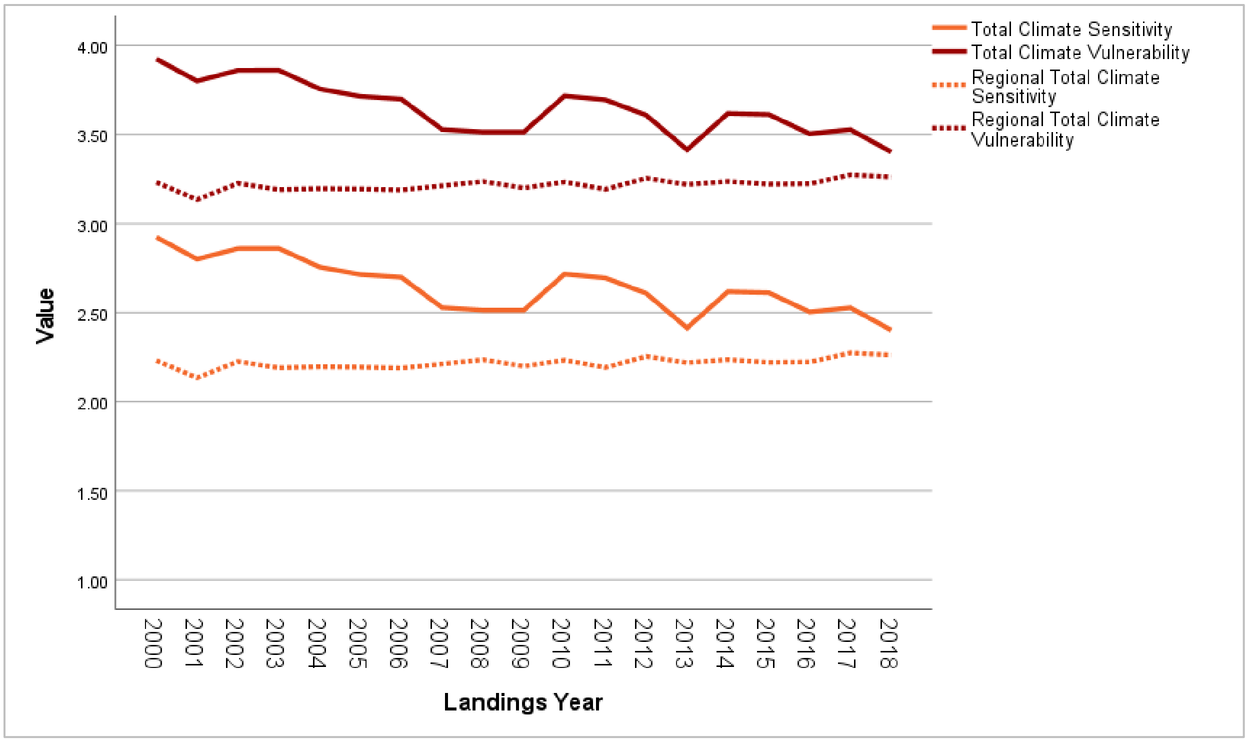

Figure 27. Yearly total community climate sensitivity and vulnerability scores for Savannah GA with regional averages.

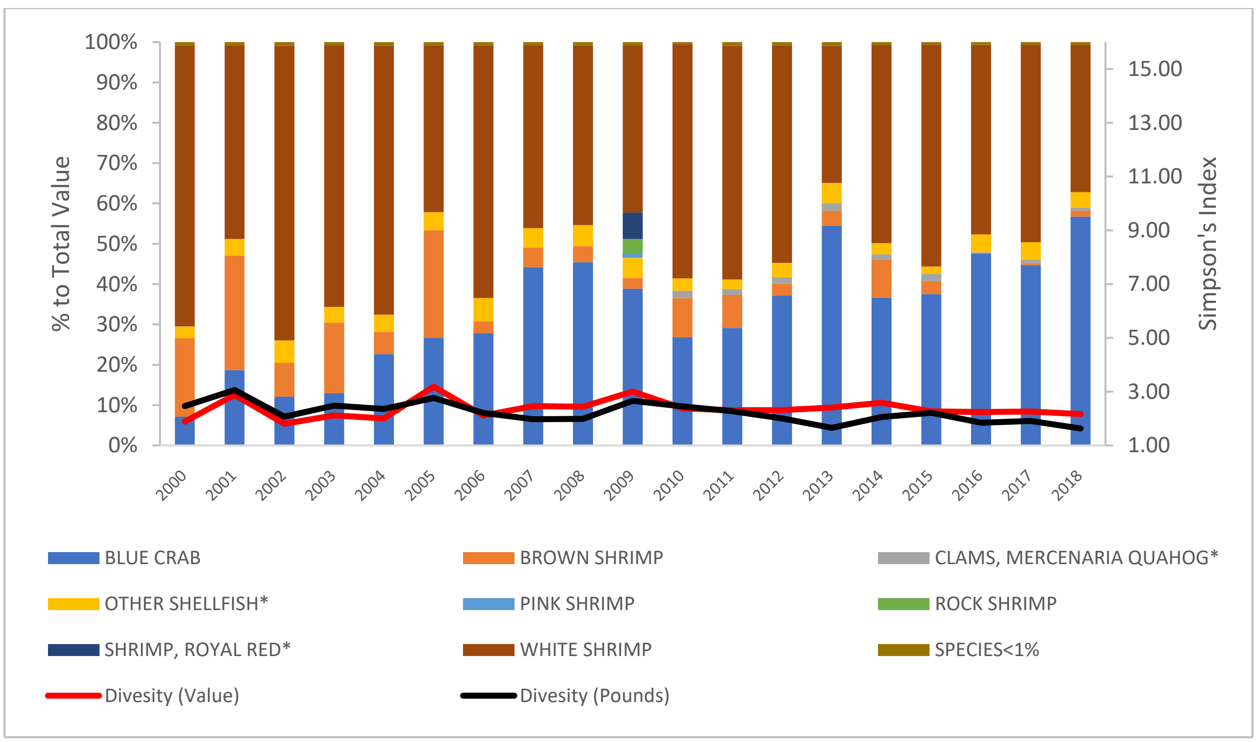

Figure 28. Composition of primary species landed and diversity index score for pounds and value for Savannah. *Non-classified species

Miami, Florida

Miami was a rough frontier-style hamlet of some 300 residents when Henry Flagler's Florida East Coast Railroad reached the area in 1896, connecting it with the rest of the East Coast of the United States. Since that time, the city of Miami has grown into a city of some ½ million people; a global center of tourism, culture and international finance and trade; and the hub of one of the largest metropolitan areas in the United States with a population of over 6 million people as of 2020.

Located along the shore of Biscayne Bay, from its earliest days the economy of Miami has been dependent on marine activities, including commercial and recreational fishing. Flagler's railroad brought anglers to south Florida in the early 20th century in pursuit of tarpon, sailfish, barracuda, and king mackerel and, later in the century, Pier 5 and Baker's Haulover became famous as local charter boat docks (Florida Department of State, MFH Museum of Florida History, Lure of Florida Fishing. https://museumoffloridahistory.com/exhibits/previous-exhibits/lure-of-florida-fishing. Accessed December 9, 2021). Charter and private recreational fishing continue to be very important activities that support the local tourist industry.

Commercial fishing originally focused on mackerel and became a major industry soon after the city's incorporation. The arrival of the railroad allowed the shipping of fish out of Miami. By 1909, some two million pounds of fish were caught and shipped from Miami. As the city grew, commercial fishing increased, with vessels, fish houses, and boat building and repair facilities locating primarily along the Miami River. By 1938, commercial fishermen in Miami reportedly landed 125 million pounds of fish. East Coast Fisheries, established along the Miami River in the 1930s, became one of the largest fish processors and dealers on the United States East Coast (City of Miami, N.d.). Besides mackerel, other commercially important species emerged including spiny lobster, stone crabs, mahi mahi, snapper, grouper, and oysters.

By the early 2000s, although pink shrimp caught for bait and food represented the most important fishery product caught in Biscayne Bay overall, spiny lobster was by far the most important species landed in Miami in terms of value, a trend that continues to this day (Johnson et. al. 2012). Although a small commercial fishing fleet focused largely on fishing for lobster continues to dock and operate along the Miami River, the commercial fishing industry in Miami appears to be in decline in recent years. East Coast Fisheries closed its doors for the last time in 2000. Gentrification has severely reduced the area available for working waterfronts, particularly along the Miami River. Many Miami-based fishermen have retired or relocated to the Florida Keys.

For the species landed in Miami, sensitivity to ocean acidification and temperature has been much higher than the regional average since 2000 and sensitivity to stock size/status is lower than the regional average (Figure 29). Total climate sensitivity and total climate vulnerability have also been much higher than the regional averages (Figure 30). Composition of landings since 2000 demonstrates a slight declining trend in diversity in value and pounds as the Miami fishery has become increasingly dominated by spiny lobster. The years when diversity in value and pounds increased were 2005, 2009 and 2012 when the relative contribution of spiny lobster to total value decreased (Figure 31). In those years, species such as yellowtail snapper and stone crab provided a higher relative contribution to total value. The high dependence of the Miami fishery on spiny lobster appears to contribute significantly to relatively high levels of climate vulnerability and sensitivity, as exemplified by the fact that the value of both of these metrics decreased considerably in the higher diversity years.

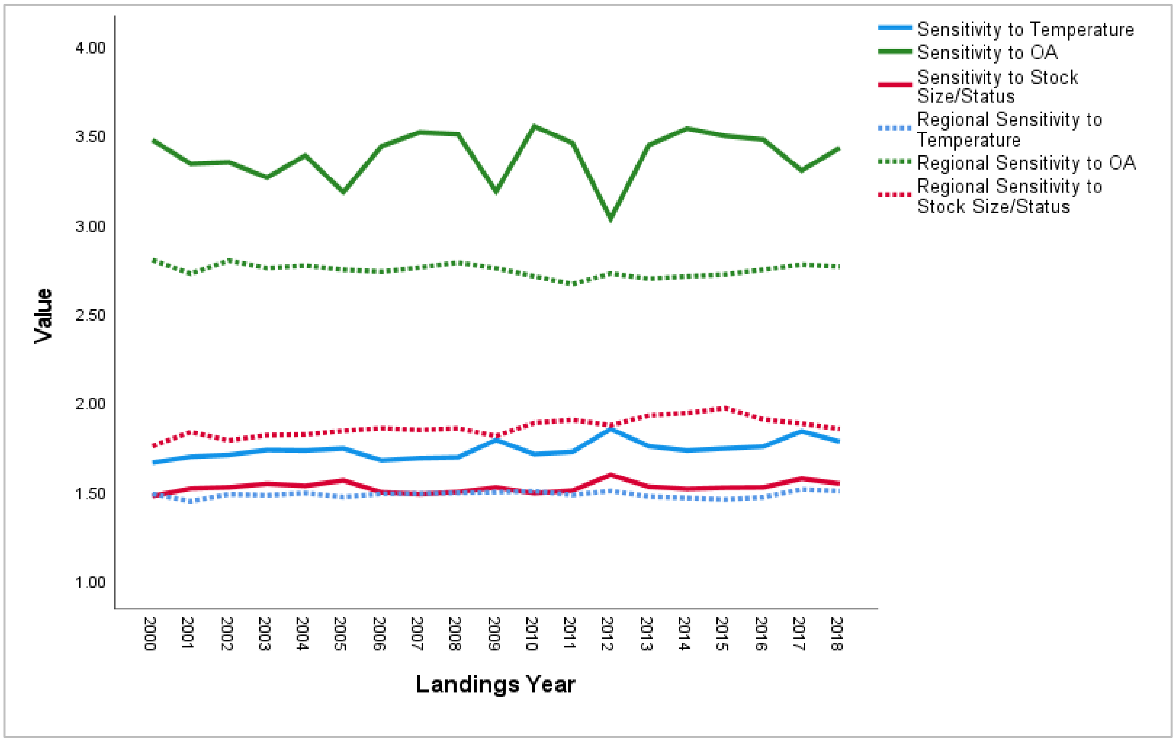

Figure 29. Yearly community climate sensitivity scores for Miami FL with regional averages.

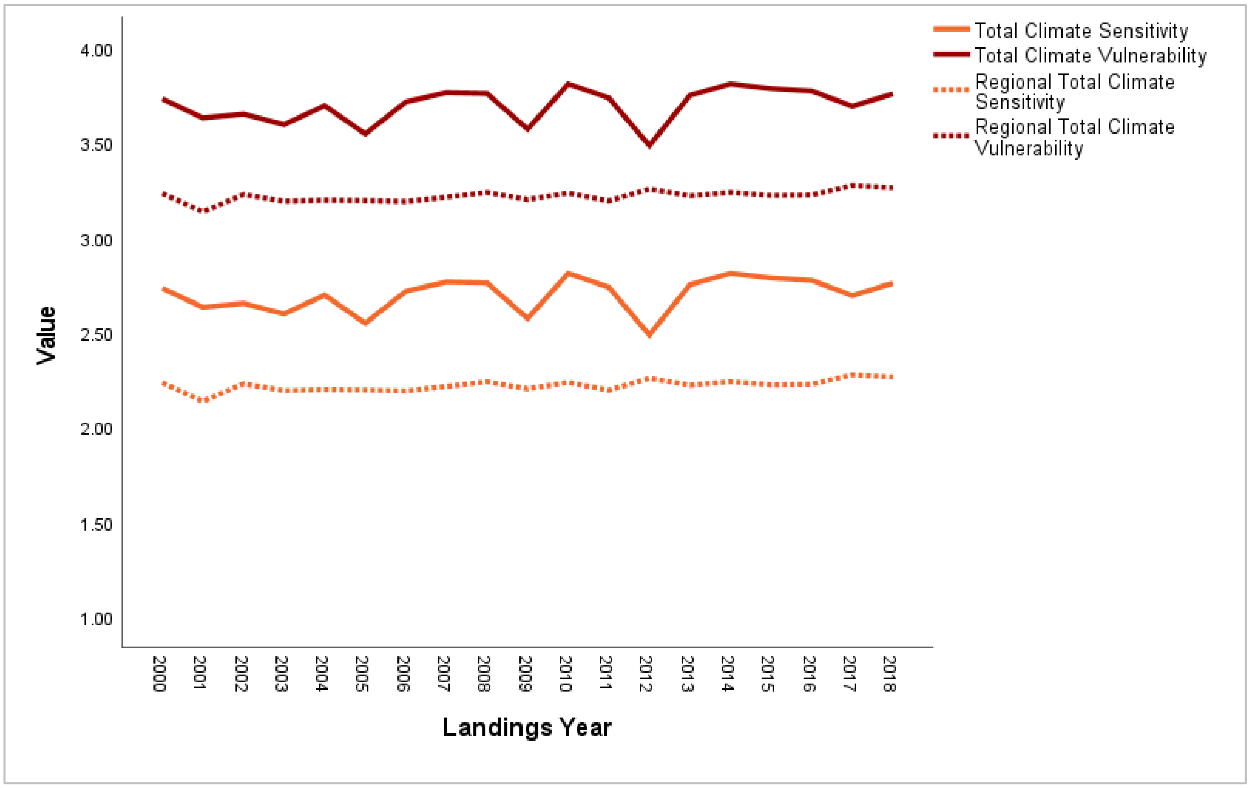

Figure 30. Yearly total community climate sensitivity and vulnerability scores for Miami FL with regional averages.

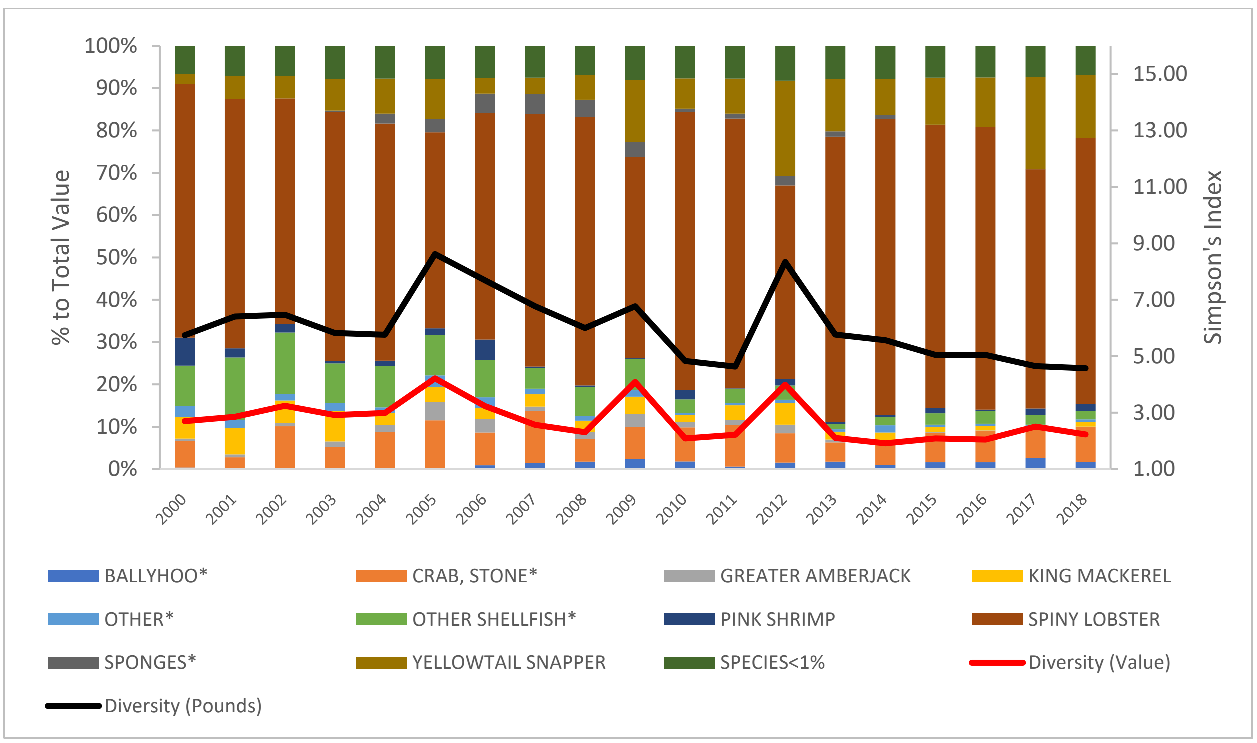

Figure 31. Composition of primary species landed and diversity index score for pounds and value for Miami. *Non-classified species.

Fernandina Beach. Florida

Fernandina Beach is located in Nassau County, Florida on Amelia Island, which is the northernmost barrier island of Florida's east coast. The town of Fernandina was originally established by Spain in 1811. The town currently has a population of some 13,000 individuals and is part of the Greater Jacksonville metropolitan area.

The community of Fernandina Beach has a long fishing history. Immigrants in the 1700s were net fishermen seeking species such as mullet, sheepshead, crabs, trout, turtles, drum, oysters, and menhaden. By the early 1900s, the most prominent industries in Fernandina Beach area were agriculture, forestry, fishing, and tourism. Shrimp fishing began in 1902 and, soon after, shrimp processing and shipment facilities were established in the community. Currently, the vast majority of landings in Fernandina Beach are made up of white, pink and brown shrimp (Jepson et. al. 2005).

Old Town Fernandina Beach, which has been designated a National Historic District, preserves the fishing heritage of the community. Today, the town's harbor is filled with commercial and charter fishing boats, shrimp boats and private fishing vessels. Seafood restaurants also contribute to the fishing village ambiance. Although tourism has become the primary source of economic revenue, commercial and charter fishing continue to play an important economic role in the community (Ibid.)

Fernandina Beach fisheries sensitivity to temperature and ocean acidification are considerably higher than the regional average; on the other hand, sensitivity to stock size/status is much lower than the regional average (Figure 32). Total climate vulnerability and sensitivity have consistently been much higher than the regional average, although climate sensitivity and vulnerability dropped briefly in 2003 and 2004, likely due to an increase in rock shrimp landings during those two years (Figure 33).

Figure 34 shows the low diversity of landings in Fernandina Beach, which are dominated by different species of shrimp. A few other species including king whiting and other shellfish are also landed commercially but these represent a very small fraction of overall landings. The diversity of species landed both in terms of pounds and value have fluctuated slightly on a year by year basis but the overall trend for both of these have remained relatively flat over the entire 2000 – 2018 time series. This reflects the high dependence of this community on shrimp throughout the whole period, which likely drives the relative high sensitivity to ocean acidification and temperature scores.

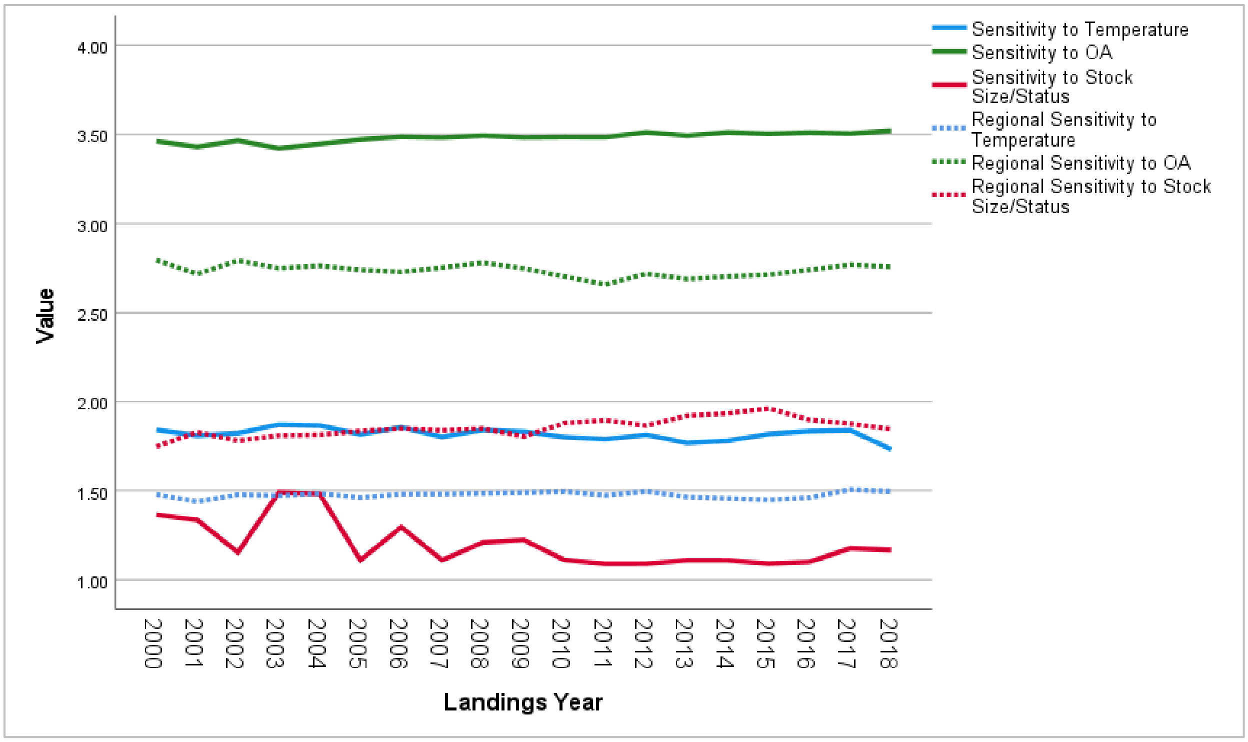

Figure 32. Yearly community climate sensitivity scores for Fernandina Beach FL with regional averages.

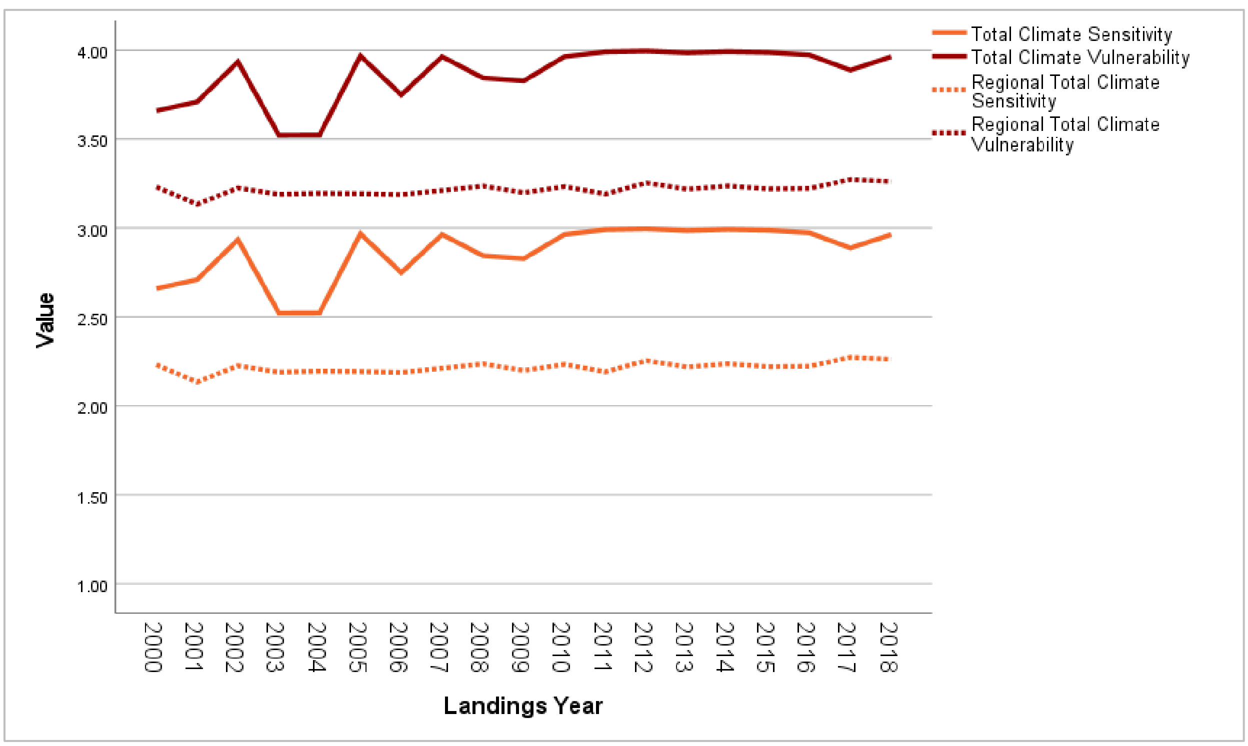

Figure 33. Yearly total community climate sensitivity and vulnerability scores for Fernandina Beach FL with regional averages.

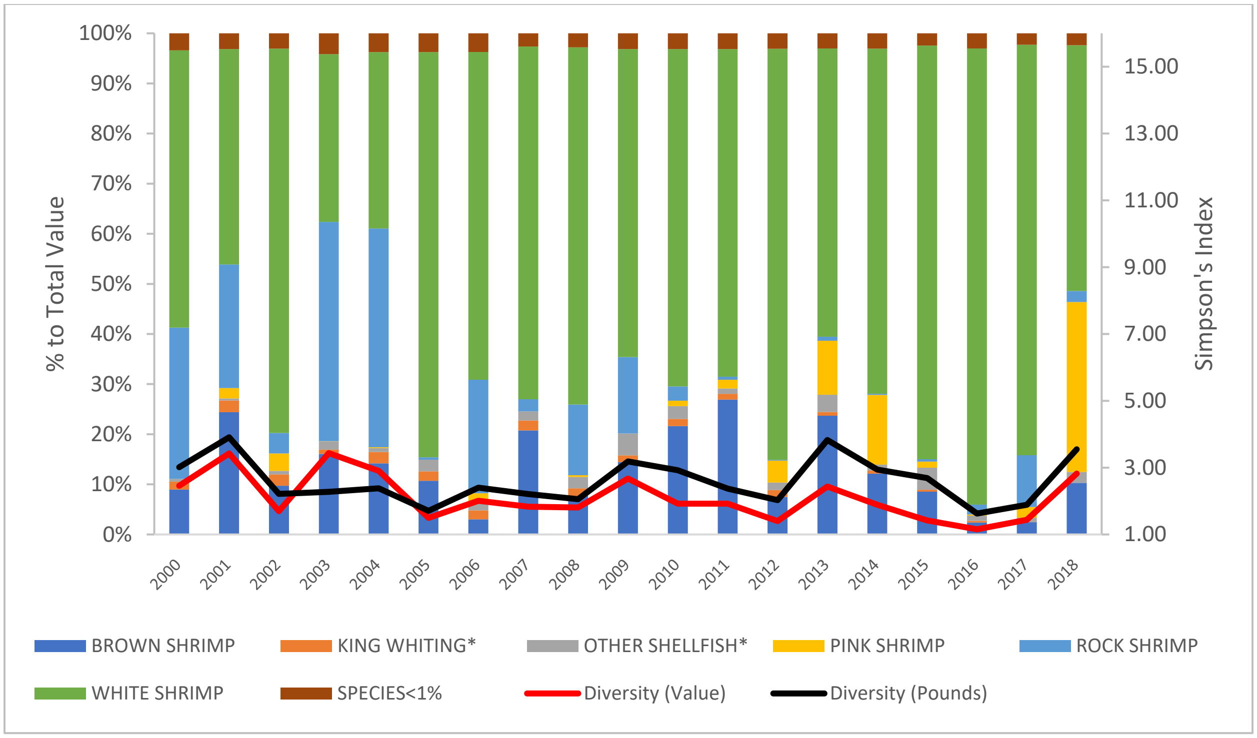

Figure 34. Composition of primary species landed and diversity index score for pounds and value for Fernandina Beach. *Non-classified species.

Conclusion

The species climate vulnerability indices used in our analyses are part of a national program whereby NOAA Fisheries is attempting to identify species that are highly susceptible to various aspects of climate change. Taking that biological information and applying it at the community level is a next logical step in an ecosystem approach to fisheries management. The need for these indices has been outlined in both the Climate Change Regional Implementation Plans (https://www.fisheries.noaa.gov/national/climate/climate-science-strategy-regional-action-plans) and Ecosystem Based Fishery Management Roadmaps (https://www.fisheries.noaa.gov/national/ecosystems/ecosystem-based-fishery-management-implementation-plans) for the Southeast Region that call for the development of a community-based climate change vulnerability index. The creation of these community level indices is the first step in understanding the complex nature of a changing environment and how the impacts of those changes may affect marine resource users and their communities.

In this initial development of these indices, we chose to focus on the diversity of value of landings at the community level rather than diversity of pounds landed. However, we included a measure of change regarding diversity of pounds landed to enrich the interpretation of community climate vulnerability trends. While the amount of a species landed is important and has an influence in the infrastructure needed to accommodate those landings, value of landings, considered here an indicator of community revenue reliance on a species, have a far-reaching impact on the overall community as it will extend to households of crew and other support industries through pay structure and other monetary facets throughout the community. However, both trends in diversity are important to understand, and further analyses of changes in landings composition and community reliance over time is certainly warranted.

The community climate change vulnerability indices developed here are part of a continuing effort to create viable tools to help understand how fishing businesses and fishing communities are affected by the ongoing changes in climate. While the information provided here is primarily descriptive, the intent is to provide data that can be used to analyze trends and highlight other information that might provide insight into where adaptation and mitigation efforts can be focused to help those who depend on marine resources navigate an ever-changing ecosystem. These community indices can be used to analyze and compare regional and national trends and, in combination with other biological and socio-economic indicators, to model community trends under different scenarios of environmental and managerial change and, thus, provide important spatial and temporal information for decision-making. It is the joining of the biological and social science research that offers a more holistic perspective on climate change, which will help to guide decision making for both managers and constituents.

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APPENDIX I

Table A1.1. List of South Atlantic species classified based on climate vulnerability

Species Name	Functional Group	Total Sensitivity Classification	Total Vulnerability Classification
Almaco jack	Coastal Pelagic	Moderate	High
American eel	Diadromous	Moderate	High
American shad	Diadromous	High	Very High
Anchovies	Forage	Low	Moderate
Atlantic and Gulf sturgeon*	Diadromous	Very High	Very High
Atlantic croaker	Coastal	Low	Moderate
Atlantic menhaden	Forage	Low	Moderate
Atlantic sharpnose shark	Shark	Moderate	High
Belted sandfish	Reef Fish	Low	Moderate
Black drum	Coastal	Moderate	High
Black sea bass	Reef Fish	Low	Moderate
Blue crab	Invertebrate	Moderate	High
Blue runner	Coastal Pelagic	Low	Moderate
Blueback herring*	Diadromous	High	Very High
Bluefish	Coastal Pelagic	Low	Moderate
Blueline tilefish	Deep Water Reef	High	Very High
Bonnethead shark	Shark	Moderate	High
Brown shimp	Invertebrate	High	Very High
Cobia	Coastal Pelagic	Moderate	High
Cubbyu*	Reef Fish	Low	Moderate
Dolphin	Pelagics	Low	Moderate
Dusky shark*	Shark	High	Very High
Eastern oyster	Invertebrate	High	Very High
Emerald parrotfish*	Reef Fish	Moderate	High
Gag grouper	Reef Fish	High	Very High
Golden crab	Invertebrate	Moderate	High
Golden tilefish	Deep Water Reef	High	Very High
Goliath grouper*	Reef Fish	High	Very High
Gray snapper	Reef Fish	Moderate	High
Gray triggerfish	Reef Fish	Low	Moderate
Greater amberjack	Reef Fish	Low	Moderate
Hogfish	Reef Fish	High	Very High
Horseshoe crab	Invertebrate	High	Very High
King mackerel	Coastal Pelagic	Low	Moderate
Lane snapper	Reef Fish	Low	Moderate
Little tunny	Pelagics	Low	Moderate
Mutton snapper	Reef Fish	Low	Moderate
Nassau grouper	Reef Fish	Moderate	High
Pinfish	Forage	High	Very High
Pink shrimp	Invertebrate	Low	Moderate
Red drum	Coastal	High	Very High
Red grouper	Reef Fish	Moderate	High
Red porgy	Reef Fish	High	Very High
Red snapper	Reef Fish	Moderate	High
Redband parrotfish	Reef Fish	Moderate	High
Rock shrimp	Invertebrate	Moderate	High

Sand tiger shark	Shark	Moderate	High
Sandbar shark	Shark	Moderate	High
Scamp grouper	Reef Fish	Moderate	High
Sheepshead	Coastal	High	Very High
Slippery dick	Reef Fish	Moderate	High
Snook*	Coastal	Low	Moderate
Snowy grouper	Deep Water Reef	Moderate	High
Sockeye salmon	Reef Fish	High	Very High
Southern flounder	Coastal	Moderate	High
Spanish mackerel	Coastal Pelagic	Low	Moderate
Speckled hind	Deep Water Reef	High	Very High
Spiny dogfish	Shark	Low	Moderate
Spiny lobster	Invertebrate	High	Very High
Spot	Coastal	Low	Moderate
Spotted seatrout	Coastal	Moderate	High
Striped bass	Diadromous	High	Very High
Striped mullet	Coastal	Low	Moderate
Tomtate	Reef Fish	Low	Moderate
Vermilion snapper	Reef Fish	Low	Moderate
Wahoo	Pelagics	Low	Moderate
Warsaw grouper	Deep Water Reef	High	Very High
Weakfish	Coastal	Moderate	High
White grunt	Reef Fish	Low	Moderate
White shrimp	Invertebrate	High	Very High
Yellowtail snapper	Reef Fish	Moderate	High

species did not have landings recorded for the South Atlantic between 2000 and 2018

Table A1.2. List of FL Keys and Gulf of Mexico species classified based on climate vulnerability

Species	**Functional Group**	**Total Sensitivity Classification**	**Total Vulnerability Classification**
Almaco jack	Coastal Pelagic	Low	Moderate
Anchovies	Coastal Pelagic	Low	Low
Atlantic croaker	Coastal	Low	Low
Atlantic sharpnose shark	Elasmobranch	Low	Low
Atlantic stingray*	Elasmobranch	Low	Low
Ballyhoo	Coastal	Low	Moderate
Banded rudderfish	Coastal	Low	Low
Black drum	Coastal	Low	Low
Black grouper	Groupers	High	Very High
Black sea bass	Offshore Bottomfish	Low	Low
Blacknose shark	Elasmobranch	Low	Low
Blacktip shark	Elasmobranch	Low	Low
Blue crab	Invertebrate	Low	Low
Bluefish	Pelagics	Low	Low
Blueline tilefish	Offshore Bottomfish	Moderate	Moderate
Bonnethead shark	Elasmobranch	Low	Low
Brown shrimp	Invertebrate	Low	Low
Butterfish	Coastal	Low	Low
Cero mackerel	Coastal Pelagic	Low	Moderate
Cobia	Coastal Pelagic	Low	Low
Dolphin	Pelagics	Low	Moderate
Dusky shark*	Elasmobranch	High	High
Eastern oyster	Invertebrate	High	High

Finetooth shark	Elasmobranch	Moderate	Moderate
Florida pompano	Coastal Pelagic	Low	Low
Flyingfishes	Pelagics	Low	Moderate
Gag grouper	Groupers	High	High
Golden tilefish	Offshore Bottomfish	Moderate	Moderate
Goliath grouper*	Groupers	High	High
Gray snapper	Snappers	Low	Low
Gray triggerfish	Other Reef Fish	Low	Low
Great hammerhead shark	Elasmobranch	High	High
Greater amberjack	Coastal Pelagic	Low	Low
Gulf menhaden*	Coastal	Low	Low
Gulf sturgeon*	Diadromous	Very High	Very High
Hogfish	Snappers	Moderate	Moderate
King mackerel	Coastal Pelagic	Low	Moderate
Lane snapper	Snappers	Low	Low
Lemon shark	Elasmobranch	Moderate	Moderate
Lesser amberjack	Coastal Pelagic	Low	Low
Mutton snapper	Snappers	Low	Moderate
Nassau grouper	Groupers	High	Very High
Nurse shark	Elasmobranch	Low	Low
Pinfish	Coastal	Low	Low
Pink shrimp	Invertebrate	Low	Low
Red drum	Coastal	Low	Low
Red grouper	Groupers	Moderate	Moderate
Red snapper	Snappers	Moderate	Moderate
Royal red shrimp	Invertebrate	Low	Low
Sandbar shark	Elasmobranch	Moderate	Moderate
Scalloped hammerhead shark	Elasmobranch	High	High
Scamp grouper	Groupers	Moderate	Moderate
Sheepshead	Coastal	Low	Low
Smalltooth sawfish*	Elasmobranch	High	High
Snook*	Coastal	Moderate	High
Snowy grouper	Groupers	Moderate	Moderate
Southern flounder	Coastal	Low	Low
Southern stingray	Elasmobranch	Moderate	Moderate
Spanish mackerel	Coastal Pelagic	Low	Low
Speckled hind	Groupers	High	High
Spiny lobster	Invertebrate	Moderate	Moderate
Spotted seatrout	Coastal	Low	Low
Stone crab	Invertebrate	Low	Low
Striped mullet	Coastal	Low	Low
Tarpon*	Coastal	Moderate	Moderate
Tiger shark	Elasmobranch	Moderate	Moderate
Tomtate	Other Reef Fish	Low	Low
Vermilion snapper	Snappers	Low	Low
Warsaw grouper	Groupers	High	High
Wenchman	Snappers	Low	Low
White shrimp	Invertebrate	Low	Low
Yellow stingray	Elasmobranch	Low	Low
Yellowedge grouper	Groupers	High	High
Yellowmouth grouper	Groupers	High	Very High
Yellowtail snapper	Snappers	Low	Low

APPENDIX II

Table A2.1. South Atlantic communities displaying 50% or more average contribution of classified species to landed value and with a 5-year Regional Quotient mean greater than 0.009 ranked by overall sensitivity. Profiled communities are highlighted in grey.

Community	St	Region	Sensitivity to Temperature	Sensitivity to OA	Sensitivity to Stock Size/Status	Overall Sensitivity	Total Vulnerability
Fernandina Beach	FL	South Atlantic	1.80	3.51	1.13	2.96	3.96
Alliance	NC	South Atlantic	1.78	3.47	1.12	2.95	3.95
Brunswick	GA	South Atlantic	1.75	3.44	1.18	2.88	3.88
Oriental	NC	South Atlantic	1.65	3.24	1.29	2.77	3.77
Miami	FL	South Atlantic	1.76	3.44	1.53	2.76	3.76
Townsend	GA	South Atlantic	1.69	3.34	1.37	2.76	3.76
Hobucken	NC	South Atlantic	1.73	3.21	1.30	2.75	3.75
Darien	GA	South Atlantic	1.65	3.33	1.30	2.74	3.74
Engelhard	NC	South Atlantic	1.66	3.24	1.30	2.72	3.72
Mcclellanville	SC	South Atlantic	1.69	3.00	2.14	2.66	3.66
Hollywood	FL	South Atlantic	1.78	3.25	1.58	2.62	3.62
Atlantic Beach	FL	South Atlantic	1.79	3.18	1.34	2.59	3.59
Sneads Ferry	NC	South Atlantic	1.64	3.11	1.58	2.58	3.58
Titusville	FL	South Atlantic	1.86	3.27	1.49	2.57	3.57
Jacksonville	FL	South Atlantic	1.63	3.22	1.45	2.54	3.54
Savannah	GA	South Atlantic	1.52	3.19	1.49	2.53	3.53
Beaufort	SC	South Atlantic	1.34	3.13	2.09	2.47	3.47
Saint Augustine	FL	South Atlantic	1.55	2.89	1.71	2.33	3.33
Charleston	SC	South Atlantic	1.38	2.86	2.25	2.28	3.28
Swan Quarter	NC	South Atlantic	1.34	2.92	1.91	2.26	3.26
Wilmington	NC	South Atlantic	1.44	2.74	2.28	2.22	3.22
Wanchese	NC	South Atlantic	1.45	2.52	1.76	2.02	3.02
Elizabeth City	NC	South Atlantic	1.19	2.78	1.94	2.02	3.02
Kill Devil Hills	NC	South Atlantic	1.17	2.84	1.92	2.01	3.01
Columbia	NC	South Atlantic	1.17	2.83	1.93	2.01	3.01
Shiloh	NC	South Atlantic	1.17	2.82	1.93	2.00	3.00
Little River	SC	South Atlantic	2.04	2.13	2.13	1.85	2.85
Port Orange	FL	South Atlantic	1.78	2.05	1.64	1.81	2.81
Cocoa	FL	South Atlantic	1.70	1.55	1.52	1.20	2.20
Fort Pierce	FL	South Atlantic	1.70	1.54	1.45	1.17	2.17

Table A2.2. Gulf of Mexico and FL Keys communities displaying 50% or more average contribution of classified species to landed value and with a 5-year Regional Quotient mean greater than 0.009 ranked by overall sensitivity. Profiled communities are highlighted in grey.

Community	St	Region	Sensitivity to Temperature	Sensitivity to OA	Sensitivity to Stock Size/Status	Overall Sensitivity	Total Vulnerability
Port Sulphur	LA	Gulf	1.71	3.49	1.81	2.79	2.79
San Leon	TX	Gulf	1.70	3.46	1.81	2.75	2.75
Houma	LA	Gulf	1.67	3.02	1.88	2.42	2.42
New Orleans	LA	Gulf	1.63	3.16	1.88	2.29	2.29
Madeira Beach	FL	Gulf	1.94	1.96	2.81	2.14	2.16
Belle Chasse	LA	Gulf	1.81	2.71	1.51	1.95	1.95
Saint Bernard	LA	Gulf	1.66	2.81	1.72	1.92	1.92
Panama City	FL	Gulf	1.67	1.68	2.41	1.88	1.89
Tavernier	FL	Keys	1.49	2.42	1.96	1.82	1.89
Marathon	FL	Keys	1.59	2.47	1.94	1.63	1.64
Key Largo	FL	Keys	1.56	2.30	1.94	1.63	1.77
Cortez	FL	Gulf	1.89	1.90	2.42	1.63	1.65
Islamorada	FL	Keys	1.63	2.42	1.95	1.62	1.67
Key West	FL	Keys	1.60	2.31	1.77	1.60	1.64
Galveston	TX	Gulf	1.72	1.68	1.98	1.55	1.55
Destin	FL	Gulf	1.50	1.52	2.09	1.45	1.82
Summerland Key	FL	Keys	1.68	2.30	1.82	1.36	1.46
Golden Meadow	LA	Gulf	1.86	1.91	1.34	1.14	1.16
Fort Myers Beach	FL	Gulf	1.77	1.84	1.43	1.07	1.08
Port Bolivar	TX	Gulf	1.92	1.83	1.25	1.05	1.05
Dulac	LA	Gulf	1.81	1.98	1.36	1.05	1.05
Chauvin	LA	Gulf	1.87	1.88	1.26	1.03	1.03
Venice	LA	Gulf	1.87	1.81	1.29	1.02	1.02
Bayou La Batre	AL	Gulf	1.95	1.87	1.20	1.01	1.02
Biloxi	MS	Gulf	1.96	1.88	1.18	1.01	1.01
Grand Isle	LA	Gulf	1.92	1.85	1.20	1.01	1.02
Tampa	FL	Gulf	1.76	1.84	1.37	1.00	1.00
Palacios	TX	Gulf	2.00	1.89	1.14	1.00	1.00
Abbeville	LA	Gulf	1.86	1.83	1.24	1.00	1.00
Brownsville	TX	Gulf	2.03	1.92	1.13	1.00	1.00
Port Arthur	TX	Gulf	1.91	1.84	1.19	1.00	1.00
Port Isabel	TX	Gulf	2.03	1.92	1.13	1.00	1.00
Duck Key	FL	Keys	1.84	2.36	1.92	1.00	1.00