An Economic Impact and Valuation Analysis of the St Andrew and St Joseph Bays Estuary Program (SASJBEP)

– Final Report

Prepared for:

Dr. Jessica Graham,
Executive Director

St Andrew and St Joseph Bays Estuary Program

By: The Florida State University Center For Economic Forecasting and Analysis (FSU CEFA)

Julie Harrington, Ph.D.
Morgan Holland, Ph.D.
Georgianna Strode, Ph.D.
Hannah Ransom
Cameron Valenti
Lydia Arrieta

July, 2023

Table of Contents

Executive Summary

Three estuary programs have recently been created in the Panhandle region of Florida – based on the EPA's National Estuary Program model: the Pensacola & Perdido Bay (PPBEP; hosted by Escambia County[1]), the Choctawhatchee Bay (hosted by Okaloosa County) and the St. Andrew & St. Joe Bay[2] (SASJBEP; hosted by FSU's Consensus Center at the Panama City Campus) Estuary Programs. In late 2022, the Florida State University Center for Economic Forecasting and Analysis (FSU CEFA) contracted with the SASJBEP to conduct an economic impact and valuation analysis of the SASJBEP. The following sections provide a summary of the study's economic impact and valuation analysis findings.

Direct Business Sales and Property Value Results

The sales and spending directly supported by the St Andrew and St Joseph Bay Estuaries are significant. Businesses within ½ mile of the watershed had nearly $4.4 billion in sales in 2020 and supported more than 51 thousand workers. A significant portion of Bay-related businesses are engaged in the service industry, with $1.8 billion in sales and about 25 thousand employees. Small businesses contribute the most to both employment and sales, with 43.3% of employees working at firms with less than ten employees, and 37.1% of sales occurring at firms with less than ten employees. Bay-related businesses in Bay County contribute the most to both sales and employment, with $3.9 billion in sales and 45,522 employees.

In addition to business spending, the estuaries are estimated to contribute $3.1 billion to property values in the area and nearly $94 million to consumer spending. The team estimates that properties right on the Gulf Front are the most impactful. Out of the $3.1 billion that the estuaries contribute to property values, over $2 billion comes from Gulf Front properties. This translates to $60.1 million of the $94 million increase in consumer spending. Properties in Bay County are again the most significant contributors to increased property values and consumer spending, with $2.1 billion in increased property values and $62.4 million in wealth induced spending.

[1] See: https://www.ppbep.org/
[2] See: https://pc.fsu.edu/estuaryprogram

Economic Impact Analysis Results

The SASJBEP area is not only valuable as an ecological and environmental treasure, but also as an engine of economic activity. This report demonstrates the economic value the St Andrew and St Joseph estuaries bring to the surrounding areas. Businesses that are directly impacted by the estuaries contribute significantly to their local economies, and generate a total of $4.4 billion in direct sales. In addition to business sales, local property values are also impacted by the SASJBEP area. The FSU CEFA team estimates that property values are increased by a total of $3.1 billion. The increase in property values attributed to proximity to the SASJBEP area leads to an additional $94 million in direct consumer, or wealth-induced, spending, for a total of $9.7 billion in output (sales/revenues). Direct employment supported by these businesses is 51,157 jobs. Businesses and consumer spending also contributed an additional 13,945 indirect and induced jobs. Total employment supported by businesses and consumer spending tied to the estuaries is 65,102.

Economic Valuation Analysis Results

This analysis includes a vulnerability study to show the need for considering risks of all types to the estuary system. Vulnerabilities produce different economic threats depending upon the type of land use affected by the threat. Weather and climate risks should be expanded to include storm surge, extreme heat, and other threats so that scientists and planners can be informed of the similarities and differences that each vulnerability poses. This study includes analysis of potential flooding, sea level rise, and water quality changes. It is hoped that the results can contribute to mitigation efforts and improvement to quality of life.

Flooding covers much more geographic area than sea level rise because flooding can occur anywhere and sea level rise occurs near the coast and inlet areas. Results from this analysis show land parcel values of all land use types in Bay and Gulf counties affected by flooding totaling over $23.2 billion with over $19.3 billion within the ½ mile buffer boundary. Sea level rise affects fewer land parcels, with $16.4 billion affected by SLR and $15.7 billion located within the ½ mile estuary buffer. Similarly, the number of land parcels affected by flood within the ½ mile buffer for Bay County is 14,039 and SLR affects only 781. In Gulf County within the ½ mile buffer, flooding affects 5,270 land parcels and SLR affects only 199.

In this geographic area, flooding presents a greater economic risk based upon market values of properties when compared to sea level rise. This scenario can be explained by the presence of more residential properties located in the flood zone as compared to the sea level risk area.

The SASJBEP watershed area will experience substantial population growth by the year 2040, especially with respect to Bay County. The increasing population, in addition to other factors such as sea level rise in the ensuing years, will continue to place substantial pressure on this area. The goal of this project is to provide local planners and other stakeholders with information on the value of the SASJBEP ecosystem, so that they may more accurately assess the costs and benefits related to future land-use decisions.

Finally, hedonic price modeling of the St Andrew and St Joseph Bays has revealed that water quality does affect the value of homes near the estuaries. This conclusion falls in line with studies with similar conclusions. Of the two measured water qualities, fecal coliform and enterococcus, the impact is most prominent for fecal coliform. For instance, if fecal coliform increases in the estuary by 1%, parcel values are expected to decrease by 0.469%. Applied to the mean price of a home at $187,174 in 2021, a 1% increase in the level of fecal coliform could have decreased the increase in the average parcel price by $878. Local government therefore has an incentive to increase higher water quality in the bay(s) area.

Literature Review

The following is a review of the literature concerning the economic modeling studies to date in the SASJBEP market area; including, the economic impact of estuaries on regional economies, the economic contribution of estuaries, and finally, use-values associated with estuaries and any potential changes in water quality. The following literature review is divided into global, national, state, and local sections.

Global

Globally, there are numerous studies that have examined the economic impact of estuaries on regional economies. A common methodology gleaned from the literature is travel cost analysis. The travel cost method defines the higher costs that visitors are willing to pay for trip and equipment expenditures to participate in more frequent recreational trips. A global literature search was performed on studies using the travel cost method to value e.g., beach day trips. The purpose of these studies is to estimate the satisfaction recreation users incur from a day at the beach. Che Leh, et. al., (2018) contributed to the literature by addressing several issues and limitations regarding economic value assessments using the travel cost method. According to the authors, future studies should consider variations in the calculation of travel duration as they differ based on individuals' influences, perceptions, and variations in transportation costs beyond general fuel and maintenance expenses.

A literature search also revealed studies on use value-issues associated with estuaries and any potential changes in water quality. Lankia, et. al., (2019) applied a combined travel cost and contingent behavior model to examine the effects of changes in water quality on recreational benefits by focusing on swimming trips in Finland. Recreation inventory data were used to provide information on welfare changes at the national level. The authors found that the recreation value of a swimming trip for the current state of beaches was approximately 16 euros. A hypothetical decrease in water quality to a level at which the water visibility would be less than one meter decreased the value per trip to 9 euros. In contrast, a hypothetical increase of water quality to a level at which the water visibility would be over two meters increased the value per trip to 22 euros. In many cases, increases in water quality will provide numerous economic and recreational benefits to regional economies. With that said, Ravenscroft and Church (2011) presented another view. The authors argued that the perceived recreational benefits associated with water quality improvements might be marginal, as people use complex heuristics to judge where and when they will pursue water-related recreation. Taking this into consideration, water quality may be one of the issues people consider when making the decision, but it is unlikely to be the major one.

National

An extensive search of national studies was conducted next. Chen (2013) applied a travel cost model to measure the monetary value of day trips to public Great Lakes beaches in Michigan. After collecting data through a two-stage survey of over 29,000 locals from 2011-2012, the author found that the value of access to a public beach for a day trip was estimated to be in the range of $32-$39 per person per trip, in 2011 dollars. Furthermore, Chen (2013) estimated that as beach trips increased to four days or more, the recreational value increased to approximately $53 per person per beach day, in 2011 dollars. Parsons, et. al. (2013) applied a travel cost model to combine revealed and stated preferences on beach use in Delaware and assess the effects of changes in beach width on recreation. The authors estimated the value of Delaware beach visits at $81 per trip for those that stay overnight and $33 per trip for those that stay for a single day, in 2010 dollars. In addition, findings revealed that narrowing the beach by one-quarter of its current width would contribute to a welfare loss of approximately $5 per person per day.

A search of the national literature revealed other modeling methodologies that capture the full extent of the economic impact of estuaries on regional economies. Landry, et. al. (2021) examined the relationship between residential property values and coastal beach width by applying a hedonic pricing model. Hedonic pricing is a model that identifies price factors based on the internal characteristics of the goods being sold, and external factors affecting them. The authors' findings suggest a positive correlation between improved beach width and quality and property values of homes and businesses, with proximity to the shore. Efimova (2019) applied a random utility model of beach use to measure per-trip values, focusing on the effect of hypothetical closures of beaches on the East Coast of the United States. Random utility models aim to model individuals' choices among discrete sets of alternatives. The survey area included 275 ocean beaches stretching along the shoreline from Massachusetts to South Carolina. The author considered three different trip types, day trips, short overnight trips up to four nights long, and long overnight trips from 4 to 30 nights long. Findings in 2015 dollars revealed that the loss-to-trip ratios for individual beach closures range from $17.7 to $32.5, $88.8 to $149.1, and $324 to $1,865.9 for a day, short and long overnight trips, respectively. Efimova (2019) highlighted the importance of considering longer trips in beach valuation, which has not been given enough attention in the existing literature.

There have been significant national studies that have examined the relationship between the health of bodies of water and economic impacts on regional economies. Wallace, et. al., (2017) estimated the economic contribution of Casco Bay in Maine, with an emphasis on the economic effects of changes to Bay health. The authors evaluated the likely effects of climate change on the Bay economy from a resource, tourism, and recreational perspective. The study concluded by emphasizing the need to establish frameworks for continued monitoring

and tracking of the health of the Bay due to its significant economic and environmental importance. Klemick, et. al., (2018) estimated the impact of a proposed water quality improvement policy on property values around the Chesapeake Bay using a hedonic pricing model. The authors collected 2015 property data from 14 counties bordering the Bay and estimated the effect of the proposed water clarity improvements on aggregate property values, in 2010 dollars. Kauffman (2018) assessed the broad economic benefits of improved water quality using the Delaware River as a case study. The author utilized the use values of recreational activities, the travel cost method, stated preferences, and benefits transfer to estimate the effect of increasing the dissolved oxygen criteria from 3.5 mg/L to 5.0 mg/L. Findings revealed that the 1.5 mg/L water quality improvement could result in estimated direct use benefits from $371 million to $1.1 billion per year, in 2010 dollars. Other economic sectors benefiting from the proposed improved water quality included recreational boating, recreational fishing, non-use values, and property values.

State

A literature search of estuary-related studies in the State of Florida revealed a significant focus on the economic significance of Bays on regional economies. Stainback (2017) examined the economic value and impact of some of the ecosystem services provided by Florida Bay, located between the Everglades and the Keys. Following an input-output analysis using IMPLAN Software and data collection from public sources, the author estimated that the total value of ecosystem services from Florida Bay was over $15 billion, in 2016 dollars. Ecosystem services studied included recreation and commercial fishing, residential real estate, and carbon sequestration. The author concluded that values are very likely to be underestimated, as only the four ecosystem services were included due to a lack of available data. Hindsley & Morgan (2014) applied recreational use values, surveys, and hedonic price models to assess the economic value of Sarasota Bay. The study, surveying 27,801 homes with proximity to the Bay, defined as homes between 0 to 4,000 feet, estimated that the total capitalized value associated with proximity was $3.1 billion, in 2014 dollars. Additionally, based on the total number of trips taken by residents and visitors, it is estimated that the total value of Sarasota Bay estuarine-related recreation is approximately $487.4 million per year. Adams (2014) presented a similar report of the economic contribution of Biscayne Bay to the Miami-Dade economy, considering visitation data and recreational uses. The author concluded by addressing changes in the Bay's water quality and the resulting potential future impacts on economic activities.

Seidel, et. al., (2015) developed a hedonic price model to study the effect of proximity to the St. Johns River on residential property values in Duval County. The authors collected data from single-family residential property sale prices in Duval County from 2003 to 2015. The

analysis revealed that being on the riverfront contributed to 46.2 percent of the sales price for the properties studied. Additionally, for every additional 33 feet of distance from the river, the study showed a reduction in property value of approximately $300 per acre.

Significant studies have been conducted in North Florida estimating estuaries' economic contribution and value. Harrington & Feng (2017) conducted an economic valuation and assessment analysis of the Pellicer watershed area, close to the Guana Tolomato Matanzas National Estuarine Research Reserve (GTM NERR), to provide relevant stakeholders with information on the value of the Pellicer estuarine ecosystem. The authors utilized four models from InVEST, a modeling software developed by Natural Capital Project, and statistics from the Florida Department of Revenue land-use parcels to conduct the economic and vulnerability analysis. The InVEST models were selected based on the GTM NERR researchers' priority, data availability, and the LU features. The analysis helped identify the ranking of priority conservation areas within the Pellicer watershed area. Stokes-Cawley, et. al., (2021) examined the economic contributions of four estuarine reserves, including the Guana Tolomato Matanzas (GTM) Reserve and the Apalachicola Reserve. Data was compiled between 2019 and 2020 from available public surveys and coordination with reserve officials, while an IMPLAN model was developed to calculate contributions. The authors estimated that the GTM Reserve hosts 222,361 visitors annually, with a per-person per-day visitor expenditure of $30.62 in 2020 dollars. Overall, the GTM reserve generates a total estimated annual revenue of $57,627,000 for Duval, Flagler, and St. Johns counties. Additionally, the authors' findings revealed that the Apalachicola Reserve hosts approximately 476,077 to 563,271 visitors annually. The reserve generates an estimated revenue of $46,408,000 for Franklin County and supports a fishery that generates $14 million to $16 million annually.

In the state of Florida, Baker, et al. (2015) valued the economic impact of shellfish farming on ecosystem services. Shellfish farming affects ecosystem service valuation through four service types: Regulating services that affect ecosystem structures by affecting the climate, water, and air quality; shellfish farming improves water quality and stores carbon. Shellfish farming is important in nutrient cycling which helps with decomposition, primary production, and even habitat formation to maintain ecosystem services. Through provisioning services which are the products such as food, water, minerals, shelter, and fuel required for basic human needs, shellfish farming provides a clear food resource to humans. Lastly, through cultural services, this includes any service which impacts human behavior and culture; in this regard shellfish farming indirectly supports recreation and ecotourism. Most importantly, shellfish farming heavily reduces nitrogen levels in the water preventing algal blooms which can be extremely destructive to an ecosystem and its services. In Florida, their study found that the hard clam farming industry supports 540 jobs and produces 125-

150 million clams annually, with an economic impact of $39 million from clam sales in 2012, in 2023 dollars this would be equivalent to $49.71 million. Every market-sized clam represents almost three grams of mineralized carbon, in the state of Florida 544 million gallons of seawater per day were filtered by the statewide production of 136 million clams; 25.4 thousand pounds of nitrogen were removed, and 760.6 thousand pounds of carbon were stored through their harvest. These changes in nitrogen and carbon due to shellfish farming represent $99,680 in environmental benefits, about 1% of the $11.9 million in the farm gate value of clam sales that year; converted in 2023 dollars this would be equivalent to $127,058 in environmental benefits. The study also finds that the average value of nitrogen removal in Florida is $4.09/lb and $51.26/ton for carbon storage. According to Kriner et al. (2021), which performed a risk assessment in the Gulf of Mexico; hurricanes cost the local communities $2.9 billion per year, these damages are expected to increase with greater storm frequency and severity.

Local

Following a global, national, and state-level search, a search of estuary-related studies in the market area of North Florida was conducted. Similar to those found in previous literature, various modeling methodologies are presented in the North Florida studies. Using the travel cost method, Nguyen (2017) examined the recreational benefits of four spring sites located in North Central Florida. The author estimated that the total economic value of outdoor recreation visiting the four springs, using 2016 attendance data, was $144,952,276, with an average trip valued at $177.49 per person per trip. Whitehead, et. al., (2018) took a different approach by applying the travel cost model to estimate the lost recreational value of visitors to Northwest Florida Beaches from canceled trips due to the Deepwater Horizon Oil Spill. Bi, et. al., (2019) used 2016-2017 interviews of recreational visitors at several sites along the Ocklawaha River to estimate visitors' willingness to pay for their recreational experiences, using 2019 dollars. The study found that the willingness to pay is $152.79 per person per year, above their actual trip expenditure, for those involved in fishing activities, and $69.98 per person per year, above their actual trip expenditure, for those engaged in other types of recreational activities.

Within the SASJBEP region, very little economic research has quantified the direct economic impact of estuary-related marine bodies. Fernald, et al. (1979) utilized economic base theory and a comprehensive market survey to estimate the economic importance of the marine recreation market in Bay County. The market survey took the form of questionnaires and interviews that were used to identify employment levels in the marine-related recreation market. An employment multiplier was then developed to fully gauge the impact on employment and income flow. At the time, 11% of total employment in Bay County was in the marine recreation business. This employment generated an estimated $7,329,994 of

income flow into Bay County, which is equivalent to $29,547,650 in 2023, suggesting that the regional marine bodies are valuable to the local economy when it comes to tourism and recreation. Bell et al. (1998) examined the economic benefits associated with artificial reefs adjacent to Escambia, Santa Rosa, Okaloosa, Walton, and Bay Counties. A model utilizing economic impact, user valuation, and benefit-to-cost ratio was constructed to achieve this. The study found that a total of $414 million in expenditures were associated with artificial reef use. This expenditure supported 8,136 jobs in the region and $84 million in income. Bay County received 36% of the total expenditure.

Ropicki, et al. (2006) examined the economic benefits associated with artificial reefs adjacent to Escambia, Santa Rosa, Okaloosa, Walton, and Bay Counties. A model utilizing economic impact, user valuation, and the benefit-to-cost ratio was constructed to achieve this. The study found that a total of $414 million in expenditures were associated with artificial reef use, representing $743.31 million in 2023. This expenditure supported 8,136 jobs in the region and $84 million in income, or $150.82 million in 2023. Bay County received 36% of the total expenditure the annual recreational use value was estimated to be $19.7 million, a total of $35.37 million in 2023 currency, with a discounted asset value of $656 million for the reef program, or $1,177.80 million in 2023. The benefit-to-cost ratio of the artificial reefs within the northwest Florida region was estimated to be 131, a value indicating an extremely high, positive return to the cost of developing and implementing the artificial reef programs within the five-county, northwest Florida region.

Stokes-Cawley, et al. (2021) performed an economic impact analysis of four estuary regions using input-output modeling through IMPLAN. One of the estuaries analyzed was the Apalachicola estuary. The study utilized reserve data from park officials and estimation range to break down visitation by activity. The reserve receives about 492,077 annual visitors. The 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (NSFHWAR) for the state of Florida and IMPLAN was used to calculate the economic contribution of visitors to the area. Overall, the reserve generates $46,408,000 for Franklin County annually and supports a fishery that generates about $16 million annually. A study on commercial fishing in the St. Andrew Bay system by Sutherland (1978) determined that the annual number of daytime anglers were estimated to range from 208,400 to 303,200 with associated expenditures ranging from $ 4.2 to $ 6.1 million, which represents $18.85 to $27.38 million in current dollars. They reached this estimate by surveying how many fishermen were active in St. Andrew Bay and estimating the average daily expenditures through statewide and national studies to find an appropriate average for St. Andrew Bay. Altsman & DeMay estimated that commercial fishing accounts for over $800 million in annual revenues in the Gulf of Mexico.

Harrington et al. (2022) conducted an economic impact and valuation analysis of the Pensacola and Perdido Bay (PPBEP) estuary. Three methodologies were utilized to measure this. The direct economic activity of businesses related to the PPBEP area was calculated. Property values that were influenced by proximity to the PPBEP area and the associated spending generated by the increase in wealth due to associated property valuation were calculated. These economic variables were then used to calculate indirect and induced economic impacts using REMI, a type of economic impact modeling software. Overall, the PPBEP estuary area is responsible for $22.6 billion in economic impacts.

Recent research has examined the value and future of ecosystem services within the SASJBEP region. One very important ecosystem within the region is seagrass. Seagrass provides the region with habitats for marine species, shoreline protection, sediment stabilization, and recreational activity. Altsman & DeMay (2007) estimated the economic importance of seagrass in Florida by considering commercial, recreational, and storm protection functions. The study found that the economic importance of one acre of seagrass is about $20,500. Considering the correlation between seagrass and economic importance, recent research has explored the condition of seagrass ecosystems in the region. A study conducted in St. Andrew & St. Joseph estuaries by Conmy et al. (2017) states that each acre of seagrass has an average value of $22,573, which statewide would have a value of $61 billion; "Seagrasses covered 7,676 acres in St. Joseph Bay in 2015" (Yarbro & Carlson., 2018), through mathematical extrapolation we can conclude that the value of the seagrass in the St. Joseph Bay estuary is approximately $22,573 per acre×7,676 acres=$173,270,348. According to Hatchell, et. al. (2020) St. Andrew Bay contains approximately 12,000 acres of seagrass, with the same method we can conclude that the value of seagrass in St. Andrew Bay approximately equals $22,573 per acre × 12,000 acres = $270,876,000. Lebrasse, et. al. (2022a) measured the temporal stability of seagrass extent, leaf area, and carbon storage in St. Joseph Bay. A deep learning algorithm was used with Landsat imagery to quantify the seagrass extent in St. Joseph Bay between 1990 – 2020. The study found that over the 30-year period, there were six seagrass extent declines in the area following tropical storms and hurricanes. These declines were followed by rapid recoveries, suggesting that St. Joseph Bay seagrass may be resilient to storms due to the stable marine ecosystem in the region. Over the state of Florida seagrass meadows provide more than $20 billion a year through recreational fishing, scalloping, and tourism, the study also claimed that around 2% of these seagrass meadows are in St. Joseph Bay. Lebrasse, et. al. (2022b) examined how seagrass meadows in St. Joseph Bay might be affected by future human development and climate change. The study utilized the bio-optical model GrassLight along with water quality and remotely sensed sea temperatures in the area. The study found that seagrass in St. Joseph Bay could be resilient to expected climate change in the future, as long as water quality is preserved. The area could also benefit from ocean acidification, which has been shown to increase seagrass productivity.

The future of the SASJBEP is uncertain, however, a study by Yarbro & Carlson (2011) pointed out that substantial development in the West Bay watershed in the St. Andrew Bay estuary will occur in the next several decades. Approximately 35,000 acres of forest and wetlands will be converted to residential, commercial, and industrial areas, and this change signifies a significant increase in the economic impact of the region, and likewise, a significant decrease in economic valuation of the associated environment, over the ensuing decades.

Research in the region has also focused on estuary-related ecotourism and its economic value. Worthy, et. al. (2013) examined how the 2010 Deepwater Horizon Oil Spill affected estuarine dolphin populations in the West Florida Panhandle. The study found that ecotourism services in the Panhandle depend heavily on the daily sighting of dolphins and would be further harmed, if a population decline occurred. McDonough (2008) has also identified dolphin-watching ecotourism as a major component of the tourism market along the Panhandle and Gulf Shores. The studies identified dolphin-watching ecotourism as an integral part of the region's $2.6 billion tourism market, representing $3.49 billion in 2023. A study in the Northern Gulf of Mexico, that included St. Andrew Bay, Mississippi Sound, Mobile Bay, Perdido Bay, Pensacola Bay, Choctawhatchee Bay, and Apalachicola Bay determined that “the Gulf coast attracts millions of residents, visitors, and businesses and contains ecologically and economically significant wetlands and habitats with an estimated commercial harvest value of $779 million in 2012” (Passeri, et. al., 2016) which represents around $992.96 in 2023.

Risk assessments in St. Andrew and St. Joseph Bays are important to determine the possible risk to economic infrastructure and human life. Adam (2021) constructed a map of St. Joseph Bay classifying high to low-risk areas through a weighted risk assessment. Areas with higher populations, more economic infrastructure, and at high risk of natural disasters like storms and flooding had higher weighted risk indices. Adam utilizes a numeric scale to classify the risk areas, this scale ranges from one to five, one being minimal risk and five being severe risk. Areas such as Port St. Joe have the highest risk (five in risk factor) of storm flooding since it meets all the criteria for a high-risk area, it is highly populous, at high risk of flooding, and has a lot of relevant economic infrastructure. The inland areas of Port St. Joe are still at high risk of flooding, but they are classified as level four; other areas with a classification of four are: Cape San Blas and a small southern section of Mexico Beach. The southern portions of the St. Joseph peninsula and Mexico Beach are classified as moderate or minor risk areas (3 & 2, respectively). It is important to note that a majority of these differences in risk factors are due to lower population and economic infrastructure in the area, not entirely due to lower risks of flooding.

The risks of flooding and natural disasters are especially significant in estuary systems since they are located near coastal areas. According to Kriner et al. (2021), St. Joseph Peninsula State Park hosts about 300,000 visitors annually and in 2018, Hurricane Michael became the first Category 5 storm to make landfall on the Florida panhandle, resulting in $18.4 billion in damages in the state of Florida and forcing the closure of over half the park. This region alone is impacted by an average of 3.7 named storms per year.

An Overview of the Economy near the SASJBEP Area

There are two main counties that directly border the estuaries – Bay and Gulf counties, with small portions of four other counties (Washington, Jackson, Calhoun and Walton) in Florida. This section characterizes the economy of this area using data from the American Community Survey (ACS) collected from IPUMS USA.[3] ACS data reveals that the economy of the SASJBEP Area is largely similar to the United States as a whole, with some notable exceptions. In addition to characterizing the current economy of the region, ACS data allows the team to examine how the economy in the region has changed between years 2005 and 2020.[4]

The American Community Survey (ACS) Data

The ACS is an annual survey administered throughout the U.S. that collects data from individuals and households on a wide range of topics including employment data. In particular, the survey asks respondents to report the industry of their employer or most recent employer, if a respondent has been unemployed for less than five weeks. IPUMS USA later categorizes the responses into North American Industrial Classification System (NAICS) -coded industries and industry categories. The team used responses about an individual's employment to construct estimates of total employment in each NAICS category.[5]

Industries in the SASJBEP Area

Figure 1 shows the NAICS industry categories in the SASJBEP Area by the percentage of the workforce in each industry in 2020. In addition, the Figure compares the percentage of the workforce in each industry in the SASJBEP Area to the percentage of the workforce in each industry in Florida, and the United States. Figure 1 reveals some differences between the SASJBEP Area and the broader economy. The SASJBEP region has greater employment in Retail Trade, Public Administration, Construction, Accommodation and Food Services, and

---

[3] Steven Ruggles, Sarah Flood, Ronald Goeken, Megan Schouweiler and Matthew Sobek. IPUMS USA: Version 12.0 [dataset]. Minneapolis, MN: IPUMS, 2022. https://doi.org/10.18128/D010.V12.0

[4] While ACS data has been collected since 2000, information about participants' counties of residence is not available before 2005. ACS data after 2020 had not yet been released during the time period of this study.

[5] Note that NAICS codes do not always directly correspond to SIC codes used later in the analysis. Therefore, there are some differences in industry categorization between this section and the rest of the report.

Real Estate, Rental and Leasing, and Utilities, than the U.S., or Florida, in line with the theory that proximity to water boosts tourism-related industries. Next, the region is less invested in Educational Services, and Agriculture, Forestry and Hunting than the US, though it does have greater employment in those sectors when compared with Florida. Finally, the region currently has fewer workers in Health Care, Administrative and Support, Professional, Scientific & Technical Services, Manufacturing, Finance & Insurance, Transportation, Information, Arts, and Other Services than the U.S., or Florida.

Figures 2 and 3 show how the makeup of the economy in the SASJBEP Area has changed since 2005. Figure 2 shows the growth in workers for industries for which growth has been positive. Figure 3 shows the change in workers for industries for which growth has been negative. There has been an increase in workers for most industries in the area, with the largest increase occurring in Retail Trade, Administration & Support, Health Care and Social Assistance, and Accommodation and Food Services. The most notable decrease in workers in the SASJBEP Area has been in the Public Administration, Manufacturing and Information industries.

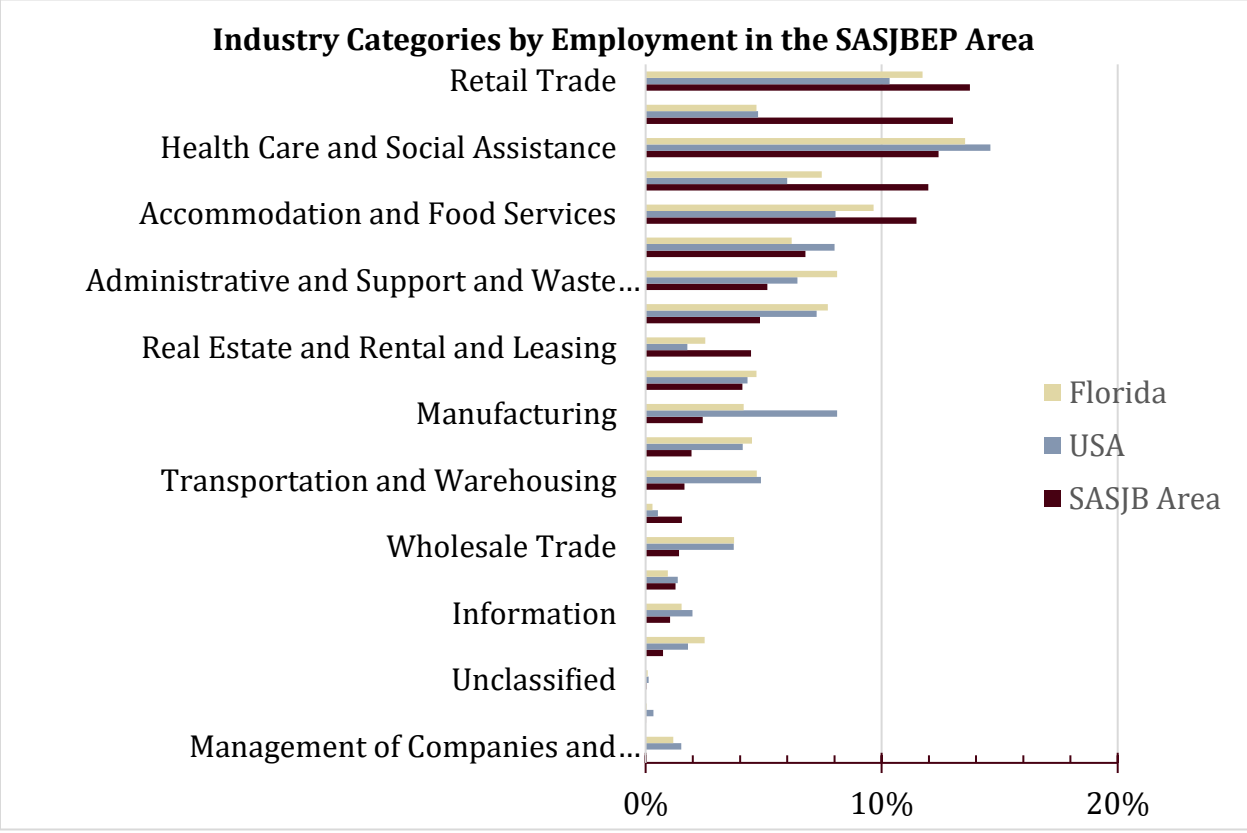


Figure 1. Industry Categories by Employment in the SASJBEP Area

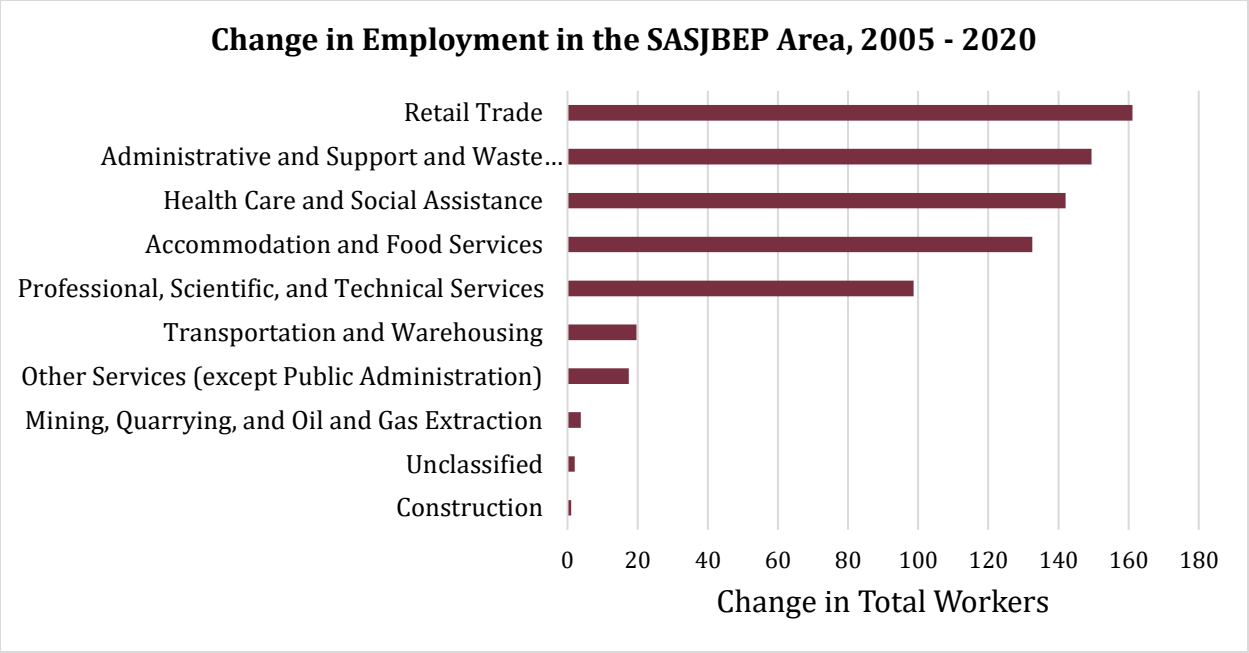


Figure 2. Industries with Positive Growth in Employment in the SASJBEP Area, Years 2005 – 2020

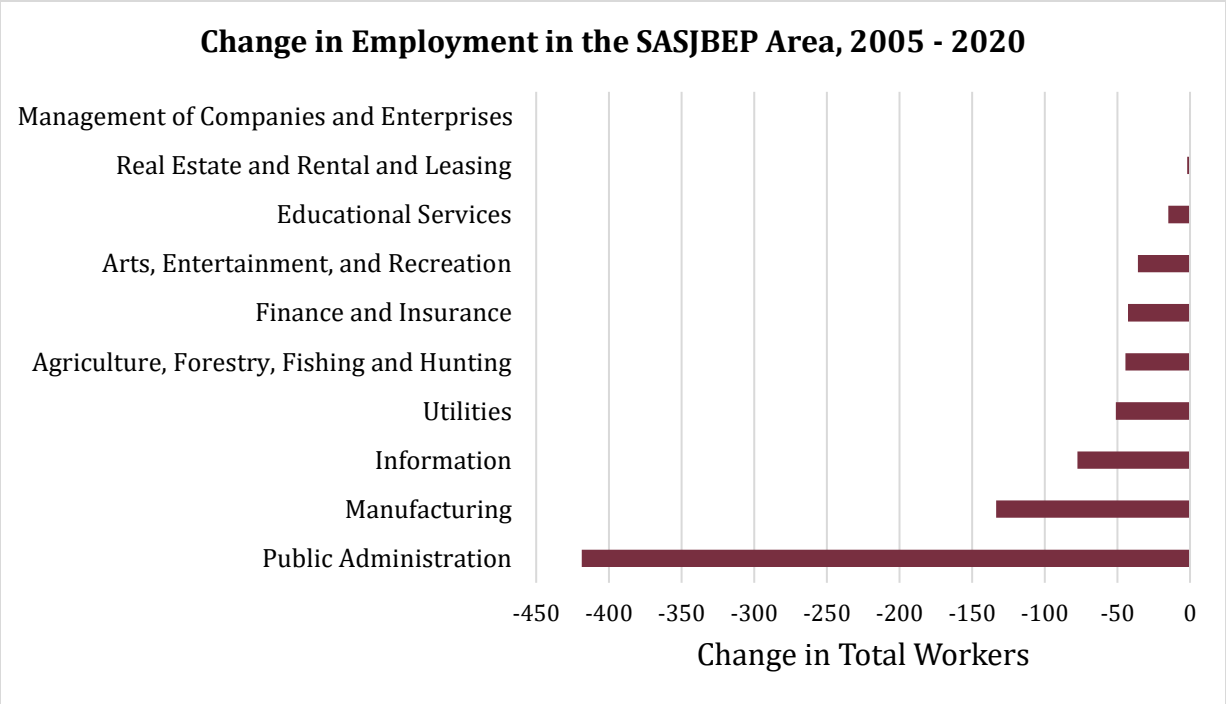


Figure 3. Negative Growth in Industries in the SASJBEP Area, Years 2005 – 2020

Detailed Examination of Employment Trends by Industry Type

To better characterize the ways in which the industrial makeup of the primarily two-county region has changed over time, this section provides a detailed breakdown of the employment

trends for the following industry categories: Goods producing industries, service industries, and government.

Goods Producing Industries

A goods producing industry is one with physical outputs that are either sold to final consumers and businesses or used as inputs in manufacturing and wholesale. Using NAICS codes, the four goods producing sectors are construction; manufacturing; agriculture, forestry, fishing, and hunting; and mining, quarrying, and oil and gas extraction. Figure 4 shows employment in goods producing sectors for each year since 2005.[6]

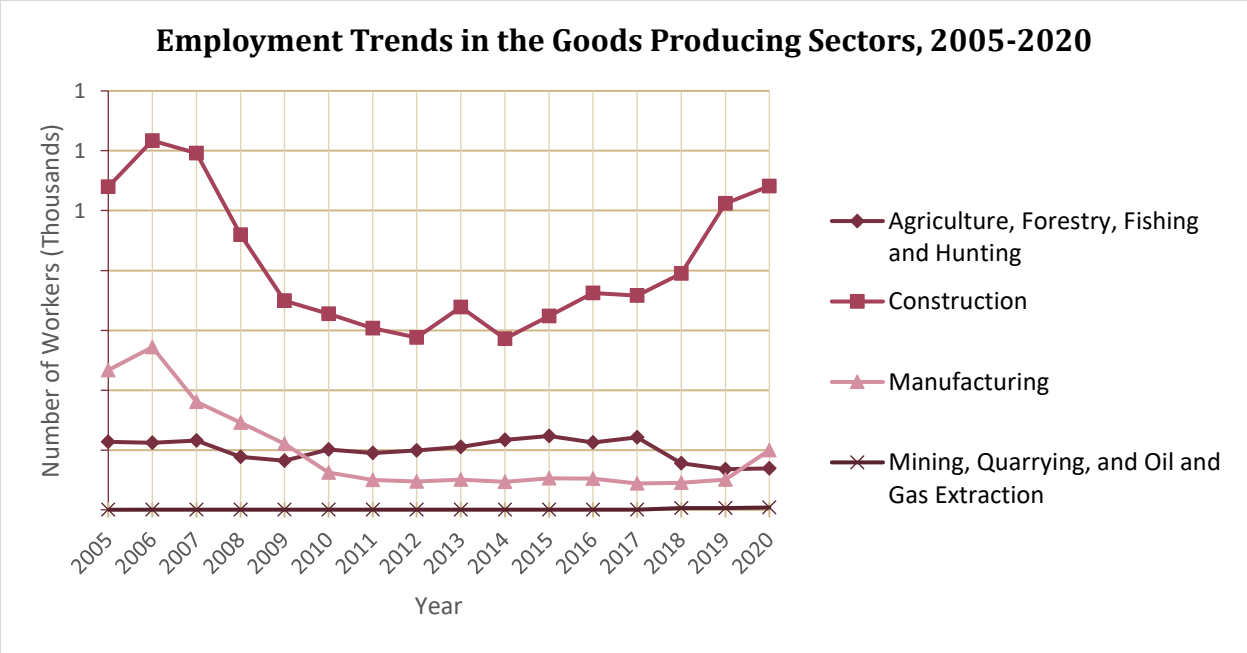


Figure 4: Employment Trends in the Goods Producing Sector, Years 2005-2020

Figure 4 shows that construction has been the primary goods producing sector since at least 2005, followed by Agriculture, Forestry, Fishing and Hunting.

Table 1 shows how the makeup of the goods producing employment has changed since 2005 by two measures. The first two columns list the percentage of the goods producing workforce engaged in each goods producing sector in 2005 and 2020. Agriculture, Forestry, Fishing, and Hunting, and Manufacturing both make up a lesser portion of the goods producing sector in 2020 than they did in 2005, while Construction, and Mining, Quarrying and Oil and Gas Extraction make up larger proportions of the goods producing workforce in 2020 than they

[6] Note, 2005 was selected as the starting year to show the oscillatory effect of the employment trends for the time period.

did in 2005. The Table reveals that construction grew considerably (75.8%) from 2005 to 2020.

Table 1: Growth in Goods Producing Employment, Years 2005 - 2020

Growth in Goods Producing Employment, 2005-2020		
Industry	**Percent of Goods Producing Workforce 2005**	**Percent of Goods Producing Workforce 2020**
Agriculture, Forestry, Fishing and Hunting	12.80%	9.67%
Construction	60.88%	75.78%
Manufacturing	26.30%	14.00%
Mining, Quarrying, and Oil and Gas Extraction	0.02%	0.55%

Table 2 shows manufacturing employment for each county in years 2005, 2010, and 2020. From this table, it is clear that the majority of manufacturing occurs in Bay County. Both Jackson and Gulf counties have experienced moderate growth in manufacturing since 2005, however, it should be noted that employment in manufacturing has decreased since 2005 in primarily all the counties in Florida.

Table 2: Manufacturing Employment by County, Years 2005-2020

Manufacturing Employment by County, Years 2005-2020							
Year	**Walton**	**Washington**	**Calhoun**	**Bay**	**Jackson**	**Gulf**	**Total**
2005	633	906	67	3,415	754	35	**5,775**
2010	444	336	65	3,165	629	35	**4,639**
2020	450	249	16	3,100	879	60	**4,694**

Service Industries

Unlike the goods producing industries, service industries do not provide tangible goods, instead performing tasks for other businesses or consumers. There are 15 NAICS industry categories considered service industries. For readability, service industry sectors are split into two categories in Figures 5 and 6. Figure 5 shows the total number of workers in service industry sectors for each year from years 2005 to 2020 in the SASJBEP region for the top seven industries as of 2020. Figure 6 shows the same Figure but for the bottom eight employers as of 2020.

Figure 5 shows that Retail Trade and Health Care and Social Assistance have jockeyed for top being the dominant service industry since at least 2005. Figure 6 shows that this area has very little activity in Management of Companies and Enterprises, with total employment being zero for a number of years from years 2005-2020. The next smallest category is Arts, Entertainment and Recreation. Figures 5 and 6 also show that there has been considerable growth in 8 out of the 15 service industry categories, which is analyzed further in Table 3.

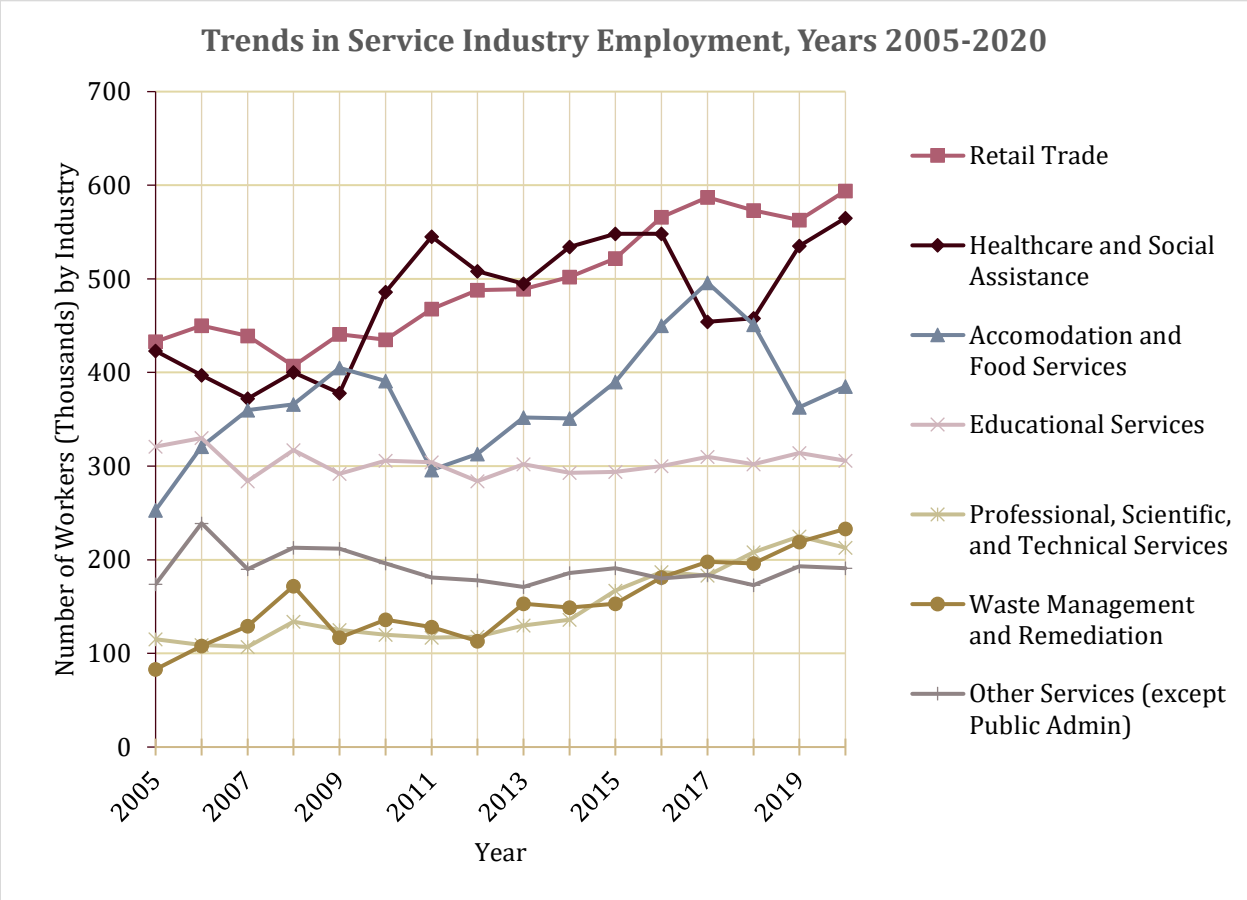


Figure 5: Trends in Service Industry Employment, Years 2005-2020

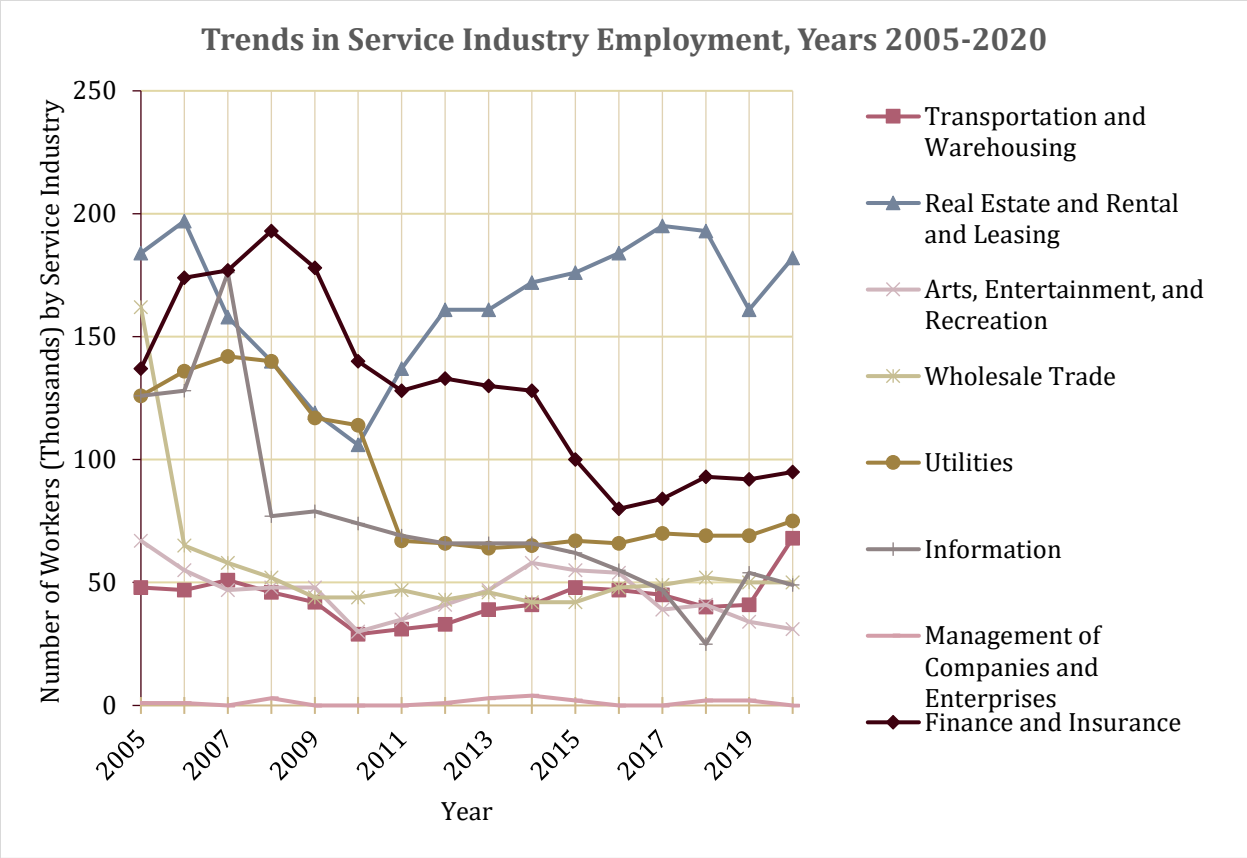


Figure 6: Trends in Service Industry Employment, Years 2005-2020 (Cont.)

Table 3 analyzes changes in the makeup of the service industries. The first two columns show the percentage of the service industry workforce in each category. Columns 3-5 show annualized growth in each sector for five-year periods between 2005 and 2020. There have been some significant changes in the makeup of the workforce engaged in service industries since 2005. Retail Trade, and Health Care and Social Assistance have both gained shares in the service sector, while other industries have lost shares. This indicates that there has been some diversification in service industries since 2005.

Table 3: Growth in Service Industry Employment, Years 2005-2020

Growth in Service Industries Employment, 2005-2020					
Industry	**Percent of Service Industry Workforce 2005**	**Percent of Service Industry Workforce 2020**	**Growth 2005 - 2010**	**Growth 2010 - 2015**	**Growth 2015 - 2020**
Retail Trade	16.32%	19.56%	0.46%	20.00%	13.79%
Health Care and Social Assistance	15.94%	18.60%	14.89%	12.76%	3.10%
Accommodation and Food Services	9.54%	12.68%	54.55%	-0.26%	-1.28%
Educational Services	12.10%	10.08%	-4.67%	-3.92%	4.08%
Professional, Scientific, and Technical Services	4.33%	7.01%	4.35%	39.17%	27.54%
Admin & Support and Waste Mgt & Remediation Services	3.13%	7.67%	63.86%	12.50%	27.45%
Other Services (Except Public Administration)	6.56%	6.29%	12.64%	-2.55%	0.00%
Finance and Insurance	5.16%	3.13%	2.19%	-28.57%	-5.00%
Transportation and Warehousing	1.81%	2.24%	-39.58%	65.52%	41.67%
Real Estate and Rental and Leasing	6.94%	5.99%	-42.39%	66.04%	3.41%
Arts, Entertainment, and Recreation	2.53%	1.02%	-55.22%	83.33%	-43.64%
Wholesale Trade	6.11%	1.65%	-72.84%	-4.55%	19.05%
Utilities	4.75%	2.47%	-9.52%	-41.23%	11.94%
Information	4.75%	1.61%	-41.27%	-16.22%	-20.97%
Management of Companies and Enterprises	0.04%	0.00%	-100.00%	N/A	-100.00%

Government

The final sector that the team analyzed is the government sector, comprised of the industry categories Public Administration and Active Duty Military. Figure 7 shows the number of people employed in these two categories for each year from 2005 to 2020. This Figure shows that both categories represent a significant part of the economy in the two county (Bay and Gulf) area. For most of this period, Public Administration had more workers than Active Duty Military throughout the time period, to 2020.

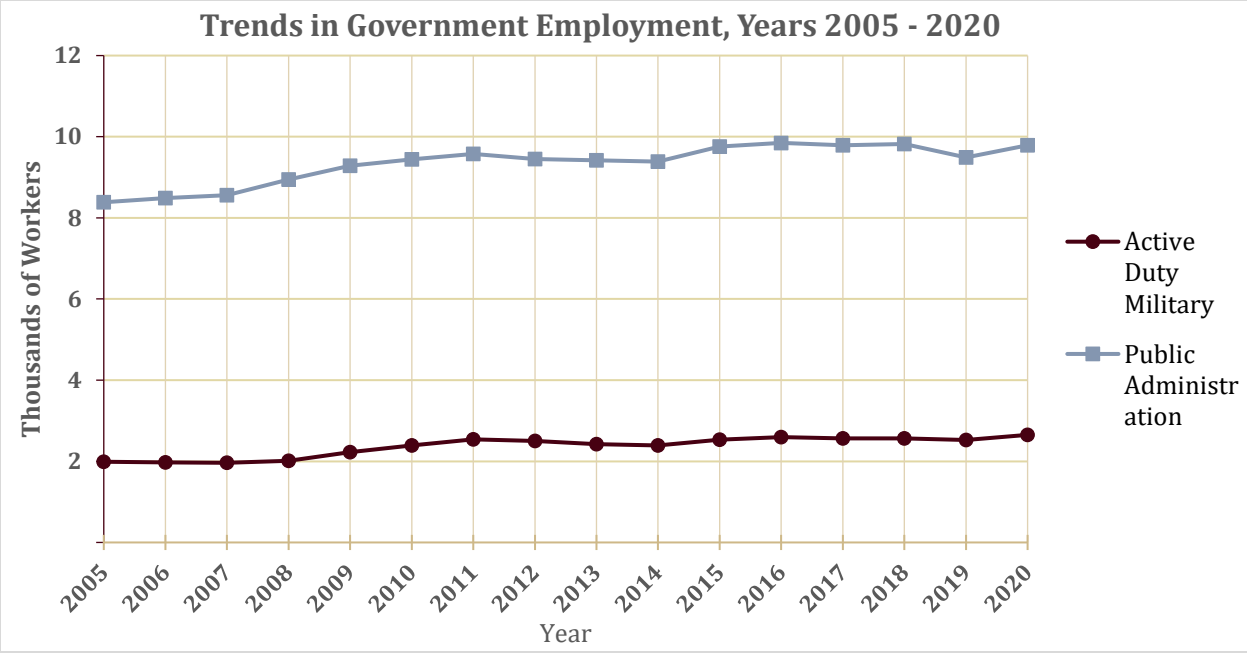


Figure 7: Trends in Government Employment, Years 2005-2020

Similar to the other industry sectors, Table 4 shows trends in the government sector in two ways. Columns 1 and 2 report the share of the government sector workforce employed in each industry. Columns 3 – 5 report the annualized growth in each industry for five year periods from 2005-2020. Similar to Figure 7, Table 4 shows that there has been considerable growth in Active Duty military from 2005-2010 (20.42%). In addition, there has been a slight decline in employment in Public Administration from 2015-2020.

Table 4: Growth in Government Employment, Years 2005-2020

Growth in Government Employment, 2005-2020					
Industry	**Percent of Government Workforce 2005**	**Percent of Government Workforce 2020**	**Growth 2005 – 2010**	**Growth 2010 – 2015**	**Growth 2015 – 2020**
Public Administration	76.28%	72.91%	10.23%	2.46%	-1.17%
Active Duty Military	23.72%	27.09%	20.42%	5.82%	4.63%

Tourism

Estuaries provide an area with increased tourism opportunities through recreational fishing, boating, swimming, and other activities. This section provides historical background for tourism using several sources of data. First is employment data from the ACS. Second is estimated bed tax data from the Florida Department of Revenue (FDOR). Using NAICS codes, Figure 8 depicts the employment in tourism-related industries for Years 2005, 2010, 2015, and 2020.

Figure 8 shows that tourism-related industries in the area are dominated by "Eating and Drinking Establishments" which includes all restaurants and bars. Table 5 breaks down changes in the makeup of the tourism industry similar to previous sections, where columns 1 and 2 report the share of the tourism workforce for each tourism-related industry in 2005 and 2010. Columns 3 – 5 report annualized growth for five-year periods between 2005 and 2015 for each industry.

Table 5 shows that employment in Eating and Drinking Establishments has experienced a greater share of the tourism workforce since 2005 but has nevertheless declined slightly in its share of tourism growth in 2015-2020. In terms of employment numbers, Travel Accommodations has risen to become the second largest employer in the tourism industry, with Other Amusement, Gambling, and Recreation Industries placing third. Gas stations have also experienced growth in their share of tourism employment though 2020.

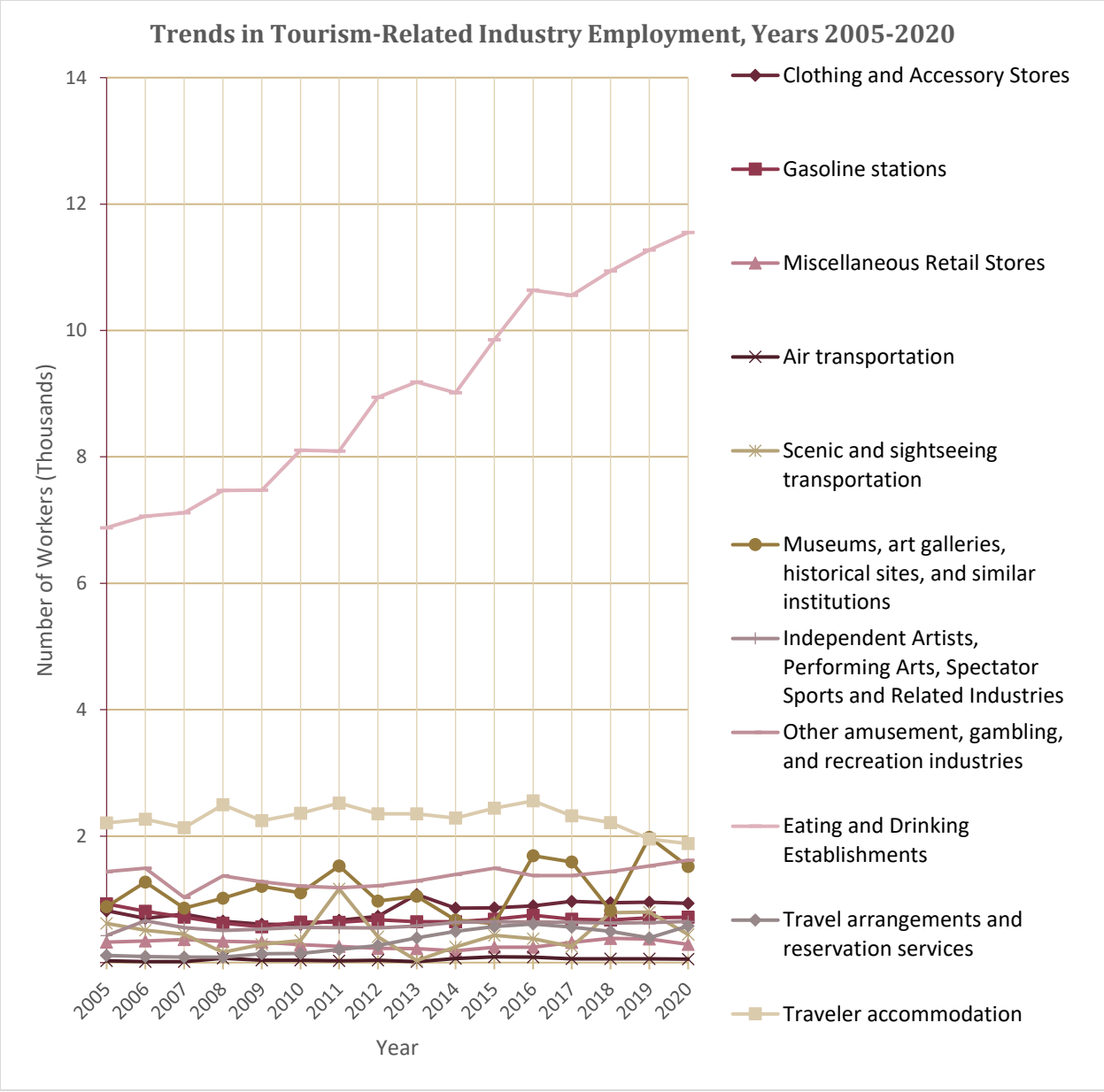


Figure 8: Trends in Tourism-Related Employment, Years 2005-2020

Table 5: Growth in Tourism-Related Employment, Years 2005-2020

Growth in Tourism Employment, Years 2005 - 2020					
Industry	**Percent of Tourism Workforce 2005**	**Percent of Tourism Workforce 2020**	**Growth 2005 - 2010**	**Growth 2010 - 2015**	**Growth 2015 - 2020**
Clothing and Accessory Stores	4.49%	4.14%	42.76%	10.65%	-31.70%
Gasoline stations	4.22%	5.62%	13.47%	10.25%	24.57%
Miscellaneous Retail Stores	2.40%	1.86%	-42.39%	99.84%	-21.20%
Air transportation	0.29%	0.17%	69.58%	-7.37%	-55.24%
Scenic and sightseeing transportation	0.80%	0.60%	-25.07%	30.87%	-16.64%
Museums, art galleries, historical sites, and similar institutions	1.18%	1.14%	15.15%	-5.25%	4.08%
Independent Artists, Performing Arts, Spectator Sports and Related Industries	3.93%	3.87%	20.31%	-0.62%	-3.83%
Other amusement, gambling, and recreation industries	9.49%	7.97%	9.00%	9.63%	-17.86%
Eating and Drinking Establishments	55.48%	62.86%	20.60%	25.09%	-12.22%
Travel arrangements and reservation services	1.04%	1.99%	250.54%	-20.60%	-20.01%
Travel accommodation	16.69%	9.78%	1.70%	-16.88%	-21.26%

A second measure of an area's tourism come from estimated bed taxes from the FDOR.[7] In addition to a 2% base tax collected by the State of Florida, counties in Florida are authorized to apply an additional sales tax on short-term rentals like hotels and condominiums, commonly known as bed taxes. The maximum rate a county can charge depends on the facilities in the county the tax is intended to support, but under normal circumstances the maximum a county can charge is 5% (2% minimum plus up to an additional 3%). The current

[7] Data on bed taxes were included for Bay and Gulf counties.

rates for the two counties in Florida are 5% for Bay and 5% for the Gulf[8].[9] Figure 9 shows the total bed taxes collected in Bay and Gulf counties, in 2020 dollars.

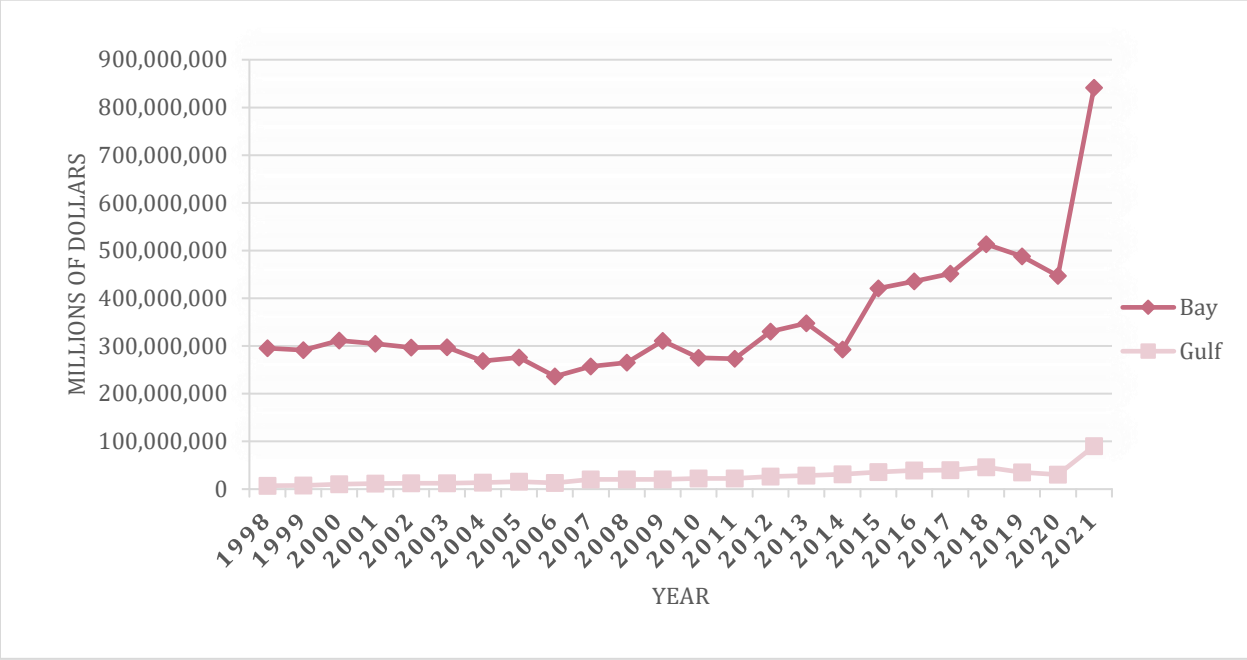


Figure 9: Bed Tax Collections in Bay and Gulf Counties, Years 1998-2021

As Figure 9 shows, Bay County leads the two counties in bed tax collections. The chart also shows a large spike in collections in 2021 following the dip in collections in 2020 caused by the COVID-19 pandemic. The spike is consistent across Florida and is also consistent with pent-up demand for travel that built up during the pandemic.[10] Ignoring the anomalous years of 2020 and 2021, both counties have seen growth in bed taxes since 1998. Table 6 shows growth rates in bed taxes for five-year increments from years 1999-2019, in 2020 dollars. Note that Table 6 excludes 2020 and 2021 to avoid obscuring the underlying trends in bed taxes. The Table shows that bed taxes have grown significantly for both Florida counties, as well as for the region as a whole.

[8] Except for facilities in a special "Expansion District," which are 4%.
[9] Local Option Transient Rental Tax Rates (Tourist Development Tax Rates). Florida Department of Revenue. https://floridarevenue.com/Forms_library/current/dr15tdt.pdf
[10] See, for example https://www.newsherald.com/story/news/local/2021/09/20/panama-city-beach-florida-sees-spike-tourism-tax-revenue-2021/8368421002/

Table 6: Average Growth in Bed Tax Collections in Bay and Gulf Counties

Average Growth in Bed Tax Collections in Two Florida Counties				
	Time Period (Years)			
County	**1999-2004**	**2005-2009**	**2010-2014**	**2015-2019**
Bay	-7.75%	12.70%	6.25%	15.88%
Gulf	75.05%	32.42%	39.65%	-2.15%

Methodology and Data

Methodology

The economic methodology used in this report follows that of Harper, Morgan, and Morgan (2006), hereafter referred to as the "Haas Report". To calculate the economic impact of the SASJBEP Area, the FSU CEFA team uses two sources of economic value: business activity associated with the SASJBEP Area and properties that benefit from the proximity to the SASJBEP Area. Businesses directly benefit from the estuaries through access to transportation, tourism service opportunities and natural resources. In addition, businesses benefit indirectly from individuals coming to the area because of the estuary. The estuaries attract individuals, both as tourists and permanent residents, who then generate economic activity by patronizing the businesses near the estuaries.

In addition to economic activity generated directly through businesses, economic activity is also stimulated by the desirability of, or demand for, the estuaries themselves. The recreational and economic activities provided by the estuaries increase the desirability of nearby residential properties, increasing their value. Since residential property is a large portion of many families' wealth, when property values increase, average wealth levels increase as well. When families' wealth increases, they are more inclined to spend money; this is known as a wealth effect on consumer spending. Economic literature indicates that 3% of an increase in household wealth will be used on consumer spending (Guerrieri, Lorenzoni, and Vavra; 2018) This increase in consumer spending based on higher property values has a multiplicative impact on the local economy in the same way that business sales do.

Finally, this report considers multipliers on economic activity. When a consumer spends money at a particular business, that business uses this income to pay vendors, employees, and owners, who, in turn, use this income to pay their own vendors, patronize other businesses, and make investments. Thus, a single dollar spent at a business propagates

through the economy, generating much more than a single dollar's worth of economic activity. When calculating overall economic impacts, the team uses three categories:

1) Direct effects are direct expenditures at businesses.
2) Indirect effects are expenditures by businesses generated by indirect effects. Specifically, paying vendors and employee salaries out of income from sales.
3) Induced effects are expenditures at businesses that employees make after being paid.

Keeping these three components in mind, the methodology of this report can be summarized as:

1) Identify businesses related to the SASJBEP area and calculate the direct economic activity by industrial sector (SIC).
2) Identify properties whose values are likely influenced by proximity to the SASJBEP Area. Calculate the additional wealth contributed by the SASJBEP Area and the additional consumer spending generated by this wealth.
3) Use the results of (1) and (2) to calculate indirect and induced economic impacts using economic impact modeling software (REMI).

This project improves on the methodology of the Haas Report by using more detailed GIS data on watershed boundaries. This allows the team to better identify businesses and properties that rely on the estuaries based on their proximity. In addition, this study uses more recent literature on the property value premium from proximity to water and the wealth effect on consumer spending. This literature confirms that the Haas Report's original estimates for these numbers are sound.

Data

The data used in this report come from several sources. The team used GIS data from the SASJBEP to identify the boundaries of the estuary.[11] The team placed a one-half mile buffer around the estuaries to define a boundary for analysis. SASJBEP asked for the analysis buffer to include the Tyndall Air Force Base because of its economic and historical importance to the area. To find businesses related to the SASJBEP area, the team used NETS 2020[12], a database of businesses identified by Dun & Bradstreet and which are surveyed annually. Using the addresses of businesses in NETS 2020, the team identified businesses that are within one-half mile of the estuaries and considers these businesses to be directly related to

[11] The GIS data was provided as Shapefiles (SHP) by Ryann Rossi, of SASJBEP, on 11-17-22 .
[12] NETS 2020 Florida is a business database of over 7.5 million businesses, from years 1990 to 2020. The NETS database is owned and managed by Dr. Don Walls. The SIC codes also provide up to 8 digits resolution (level of detailed business description) for business types.

the SASJBEP area. The team then aggregated sales data from NETS 2020 (year 2020) for these businesses by county and by SIC industrial sector. To find properties that are likely impacted by the SASJBEP area, the team used parcel and just value data from the Florida Department of Revenue (FDOR). Keeping consistent with the previous Haas reports' methodology, the team split properties into four tiers depending on distance from the estuaries. The team added a fifth category to accommodate views of the Gulf of Mexico.

1) Zero – 250 feet (Bayfront)
2) 250 – 600 feet (Bayview)
3) 600 feet – ¼ miles (Partial Bayview)
4) ¼ miles – ½ miles (No Bayview)
5) Zero – 250 feet or Gulf to the closest roadway (Gulf-front)[13]

The FSU CEFA team then identified average and total just values of properties for different distances to the estuaries. This study does not attempt to estimate how proximity to the SASJBEP area affects property values. Doing so would require statistical modeling that can separate the effects of various other determinants of price such as lot size, house size, proximity to amenities other than the estuaries, etc. Instead, the team applied estimates from the economics literature to the just values calculated in this report to determine how much property values are affected by proximity to the estuaries, as shown in Table 7.

Table 7. Estimates of Property Price Premiums from Proximity to SASJBEP Area

Empirical Estimates of Property Price Premiums from Proximity to SASJBEP area		
Study	**Proximity**	**Price Premium**
Major et al. (2003)	Ocean Front	156%
	Bay Front	15%
	Beach Block	46%
	2nd Block	10.50%
Bensen et al. (1997)	Ocean Front	147%
	Ocean View	32%
	Partial Ocean View	10%
Michael et al. (2003)	Bay Front	from 40% to 63%
	100m	3% to 18% less per 100 m distance
Miller et al. (2019)	Ocean Front	45%
Cohen et al. (2015)	Various	2.7% decline for each 1% increase in distance

[13] FSU CEFA and FREAC found a number of properties with both Gulf front and Bayview or Partial Bayview, and decided to also include a new category that includes Gulf front only.

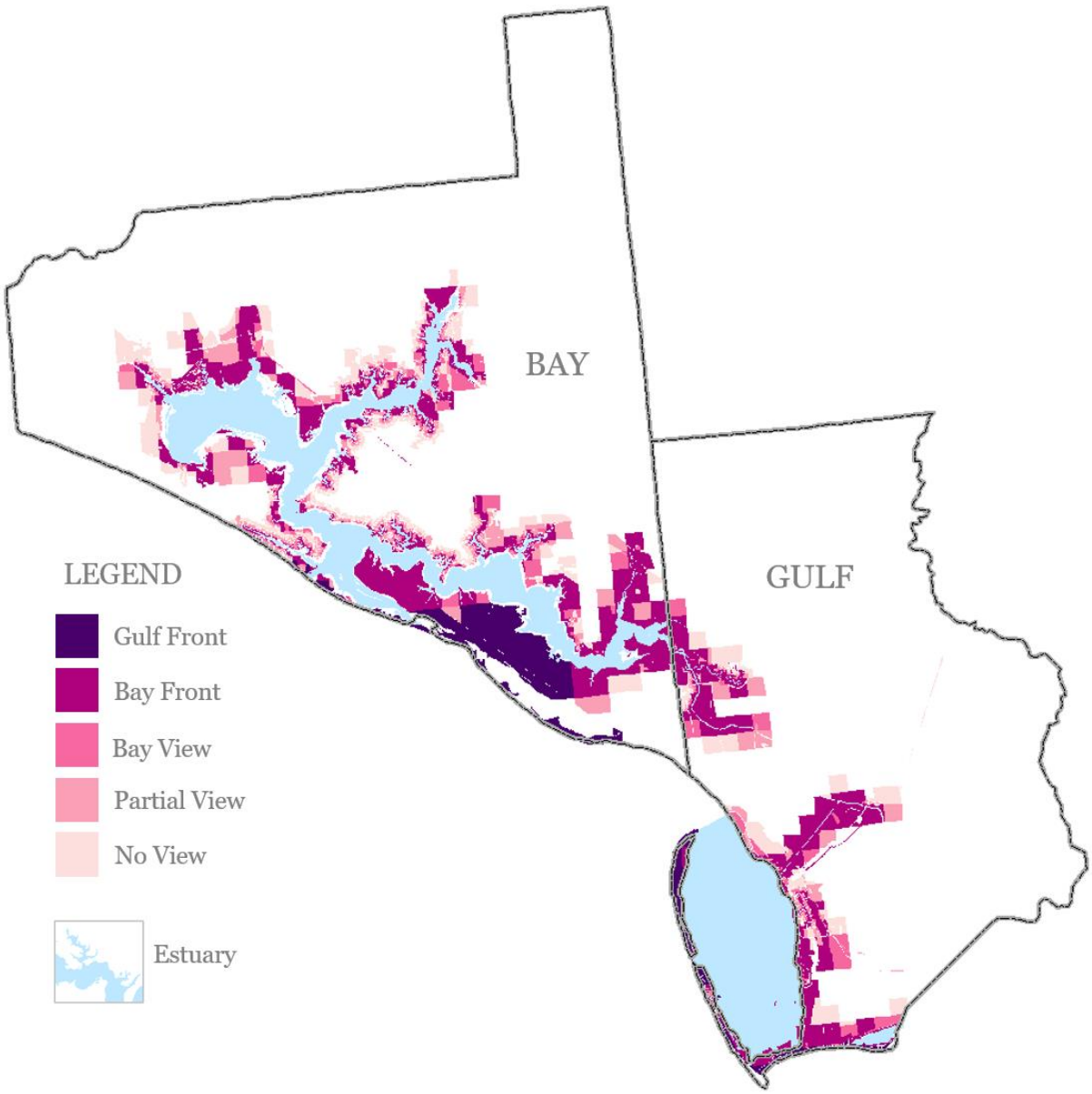
Following the methodology outlined in the Haas report, the team determined that the results during Hurricane Michael et. al., are a conservative benchmark and set the proportion of the price of a home determined by proximity to the estuaries to 45% for bay front, 10% for bay view, 3% for partial bay view, and 0% for all other properties. Finally, the team uses the economics literature again to determine an appropriate estimate of the wealth effect on consumer spending of 3% (Guerrieri, Lorenzoni, and Vavra; 2018).

Data Cleaning and Preparation

To prepare the NETS 2020 data for analysis, the team extracted businesses for each county in the SASJBEP area (Bay and Gulf counties, FL). Each business has an associated address, and latitude. Each business also has an associated longitude that must be multiplied by -1 to conform to GIS mapping standards. The businesses were then converted to a GIS shape file using the provided latitudes and longitudes. Next, the shape file delineating the estuary boundaries was used to select businesses within ½ mile of the watershed. Next, the team deleted all businesses that were not in operation in 2020 to limit the sample to a single year.[14] Finally, total sales and total employees for the identified businesses are aggregated to produce totals by SIC code and by county. See Appendix A (Tables A-1 and A-2) to view the data sources, and GIS data pre-processes used in the economic analyses.

To prepare data to analyze the effect of proximity to the SASJBEP area, the team joined parcel GIS data with just value data provided by FDOR. Next, the team created a new variable "bayview" with values "gulffront", "front," "view," "partial," "none," and "x." The categories were determined according to the distances from the bay as previously mentioned. The Gulf-front category was added because distance from an estuary may result in a Partial or No View for the estuary when properties were located on the Gulf coast. The spatial delineation was the closest roadway. The team used Google Street View and personal knowledge of the area to verify that the Gulf-front properties had a Gulf view. In Bay County, the Gulf-front properties tended to be high-rise condominiums offering desirable views. The Gulf-front properties in Gulf County tended to be single-story with ample land area resulting in attractive views. Each property was assigned only one view category. The team then aggregated each category to produce total parcel numbers, total values, and average just values for each category and each county. Figure 10 shows a map of the properties categorized by distance from the SASJBEP area.

[14] The team also joined the file with parcel data from FDOR so that business property values could be analyzed. In addition, the team kept a separate file that contains all businesses in operation from years 1990 – 2020 for historical analysis. However, no analysis of these additional files was conducted for this report.



* The darkest color indicates a waterfront view and the lightest color represents no view. Properties farther than 1/2 mile are not shown.

Figure 10. Properties Categorized by Distance in the SASJBEP Area Within the ½ Mile Buffer

Results of Businesses and Property Values in the SASJBEP Area

Businesses

Table 8 show the total number of businesses, number of employees, and aggregated sales for each SIC code for all businesses within ½ mile of the estuaries. The Table shows that businesses within ½ mile of the estuary contribute significantly to the local economy, employing 51,157 people and generating greater than $4.4 billion in sales.

Table 8: Businesses by SIC Code within ½ Mile of the SASJBEP Area

Small, Medium and Large Businesses within 1/2 Mile of the SASJBEP Area				
	Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**
Small, Medium, and Large Employees	Agriculture, Forestry, and Fishing	220	500	$20,176,187
	Mining	1	6	$1,050,012
	Construction	1,206	3,411	$396,804,571
	Manufacturing	178	3,348	$554,957,264
	Transportation, Comm., Electric, Gas, and Sanitary Services	316	2,343	$455,875,885
	Wholesale Trade	213	900	$208,779,596
	Retail Trade	939	6,662	$600,261,736
	Finance, Insurance, and Real Estate	815	3,210	$339,814,294
	Services	5,128	24,562	$1,831,616,724
	Public Administration	132	6,215	$9,955,397
	Totals	**9,148**	**51,157**	**$4,419,291,666**

By far the largest industry sector in the SASJBEP area is the service(s) sector with 5,128 businesses, 24,562 employees, and more than $1.83 billion in sales[15]. The smallest sector in the estuary area is mining with only 1 business, 6 employees, and $1.1 million in sales. In addition to examining businesses as a whole, the team broke down businesses into large (50 or more employees), medium (between 10 and 49 employees) and small (less than 10 employees) to show the distribution of businesses and their total sales compared over these categories. The results of this breakdown are in Tables 9, 10 and Figure 11.

[15] All total sales are in NETS data year dollars ($2020).

Figure 11 shows that most businesses have less than 10 employees and that only 1.6% of businesses have more than 50 employees. Even though large businesses are the minority numerically, they produce 44.2% of sales and account for 39.2% of employees. Another notable feature is that small businesses account for 43.3% of employees but only 37.1% of sales, indicating that small businesses in the area support larger numbers of employees on fewer dollars of revenue. This can be explained by small businesses either paying their employees less than larger businesses, or by small businesses dividing the revenues more equally between owners and employees. Determining which is the case is beyond the scope of this analysis. Please see Appendix B for breakouts by respective counties.

Table 9: Large, Medium and Small Businesses within 1/2 Mile of the SASJBEP Area

Large, Medium, and Small Businesses within 1/2 Mile of the SASJBEP Area				
	Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**
Less than 10 Employees (Small)	Agriculture, Forestry, and Fishing	220	500	$20,176,187
	Mining	1	6	$1,050,012
	Construction	1,184	2,769	$288,390,534
	Manufacturing	144	475	$47,611,964
	Transportation, Communications, Electric, Gas, and Sanitary Services	286	890	$65,771,966
	Wholesale Trade	207	630	$100,492,869
	Retail Trade	688	2,305	$212,396,838
	Finance, Insurance, and Real Estate	789	2,253	$215,139,533
	Services	4,867	12,103	$686,575,754
	Public Administration	49	192	$479,397
	Totals	**8,435**	**22,123**	**$1,638,085,054**
10 - 49 Employees (Medium)	Agriculture, Forestry, and Fishing	0	0	$0
	Mining	0	0	$0
	Construction	17	277	$39,013,675
	Manufacturing	20	322	$61,171,196
	Transportation, Communications, Electric, Gas, and Sanitary Services	18	384	$118,189,383
	Wholesale Trade	3	81	$33,350,436
	Retail Trade	238	3,287	$259,823,252
	Finance, Insurance, and Real Estate	20	322	$91,910,238
	Services	204	3,277	$212,979,970
	Public Administration	51	1,048	$9,476,000
	Totals	**571**	**8,998**	**$825,914,150**

Table 10. Large, Medium and Small Businesses within 1/2 Mile of the SASJBEP Area, Cont.

Large, Medium, and Small Businesses within 1/2 Mile of the SASJBEP Area (Cont.)				
	Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**
50 or more Employees (Large)	Agriculture, Forestry, and Fishing	0	0	$0
	Mining	0	0	$0
	Construction	5	365	$69,400,362
	Manufacturing	14	2,551	$446,174,104
	Transportation, Communications, Electric, Gas, and Sanitary Services	12	1,069	$271,914,536
	Wholesale Trade	3	189	$74,936,291
	Retail Trade	13	1,070	$128,041,646
	Finance, Insurance, and Real Estate	6	635	$32,764,523
	Services	57	9,182	$932,061,000
	Public Administration	32	4,975	$0
	Totals	**142**	**20,036**	**$1,955,292,462**

Table 11 shows how businesses, employees, and sales are distributed by industry group. Table 11 shows that Bay County generates the most economic activity, with nearly $4 billion in sales and 8,124 workers. This should not be surprising since the largest city in the area, Panama City, is located in Bay County. In contrast, Gulf County is the least productive county with only about $0.5 million in sales and 1,024 employees.

Figure 12 breaks down the total sales in each county by SIC category. Figure 12 shows that industries are not equally distributed between each county. Services make up the majority of sales in each county but range from 43% of sales in Bay County to nearly 30% of sales in Gulf County. Proportionate with the large share of services in Bay County; Transportation, Communications, Electric, Gas and Sanitary Services, and Finance, Insurance, and Real Estate are lower in Bay County than in Gulf County. This may indicate that Bay County has a greater portion of the tourist economy than other parts of the estuary area. This is consistent with the tourist destinations of Panama City Beach being located in Bay County.

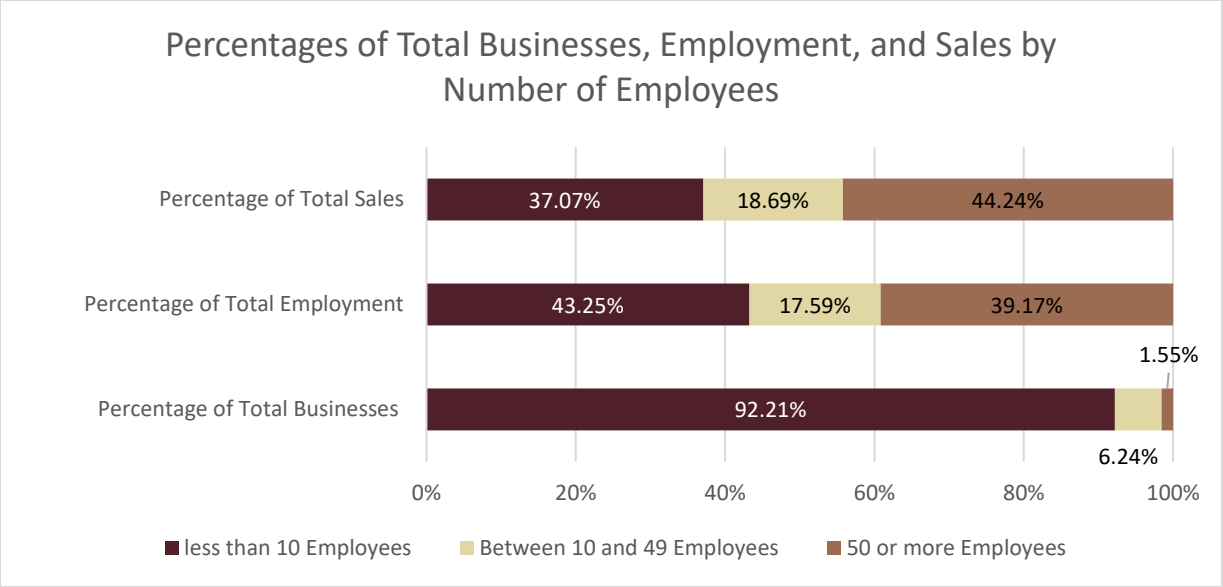


Figure 11. Percentages of Total Businesses, Employment, and Sales by Number of Employees

Table 11. Total Businesses, Employees, and Sales by County for Businesses within 1/2 Mile of the SASJBEP Area

Total Businesses, Employees, and Sales by County for Businesses within 1/2 Mile of the SASJBEP Area			
County	**Total Businesses**	**Total Employees**	**Total Sales**
Bay	8,124	45,522	$3,937,453,259
Gulf	1,024	5,635	$481,838,407
Totals	**9,148**	**51,157**	**$4,419,291,666**

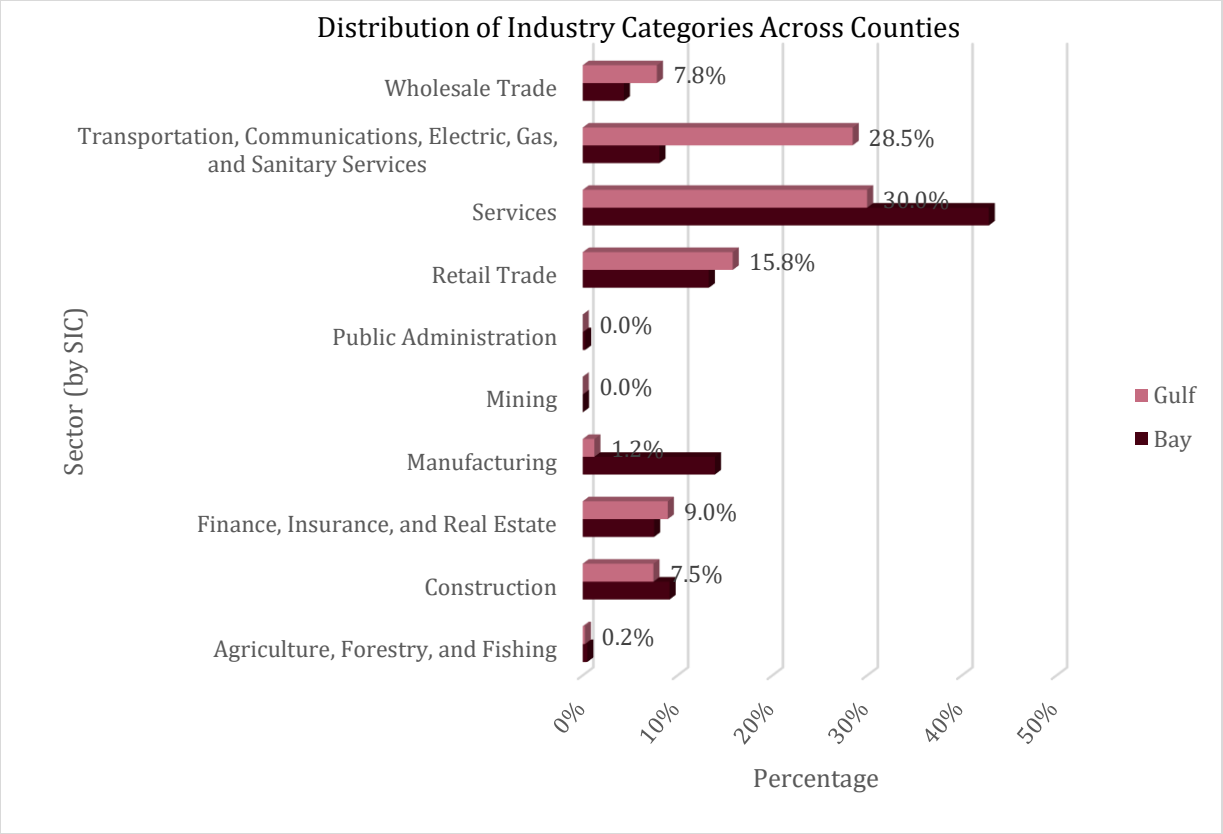


Figure 12. Distribution of Industry Categories Across Counties

Property Values

Table 12 reports the market values of residential properties within ½ mile of the SASJBEP area. This table shows that the properties are not distributed evenly between the two counties. Bay County has the largest number of properties within ½ mile of the estuaries at 41,930 units, while Gulf County has only 8,209 units. These units in Bay and Gulf counties are worth a substantial amount, ranging from a total of $2.4 billion in Gulf County to $8.7 billion in Bay County. In addition, the decline in average values between bay front and bay view properties is largely consistent with the theory that properties receive a premium from proximity to the estuaries. Properties more distant from the estuaries may increase in average acreage or average square footage. In addition, properties far from the estuaries in Bay County may be closer to downtown in Panama City. Determining the influence of the estuaries independent of these factors is beyond the scope of this analysis. Instead, as discussed in the methodology section, the team assumes that a percentage of housing values are determined by proximity to the estuaries depending on which distance category a property is in. Please see Appendix C for breakouts of property market values by respective property types.

Table 12: Market Value of Properties by Proximity to the SASJBEP Area

Market Value of Properties by Proximity in the SASJBEP Area				
County	**Proximity to Bay**	**Number of Units**	**Average Market Value**	**Total Market Value**
	Gulf Front	4,839	$374,775	$1,813,538,204
Bay	Bay Front	5,748	$286,566	$1,647,181,827
	Bay View	6,450	$184,482	$1,189,909,741
	Partial Bay View	11,260	$176,757	$1,990,286,302
	No Bay View	13,633	$150,397	$2,050,374,290
	Total	**41,930**	**$1,172,977**	**$8,691,290,364**
	Gulf Front	2,505	$527,241	$1,320,739,212
Gulf	Bay Front	1,510	$269,705	$407,254,967
	Bay View	1,240	$186,497	$231,255,814
	Partial Bay View	1,680	$175,080	$294,135,180
	No Bay View	1,274	$110,507	$140,785,938
	Total	**8,209**	**$291,652**	**$2,394,171,111**
Grand Total		**50,139**	**$1,464,629**	**$11,085,461,475**

Table 13 reports the total increase in property values attributed to the estuaries according to the percentages discussed in the methodology section. In addition, this table reports the increase in consumer spending attributed to increased property values. Table 13 shows that the total increases in property values are estimated to be over $3.1 billion, and the total consumer spending attributed to increases in property values is more than $94 million. In contrast, Bay County had the largest increase in property value associated with the estuaries at about $2.1 billion, which translates to an increase in consumer spending of more than $62.4 million.

Table 13. Increase in Property Values and Consumer Spending from Proximity to the SASJBEP Area

Total Increase in Property Values and Consumer Spending From Proximity to Estuaries				
County	**Proximity**	**Number of Units**	**Increase in Property Values**	**Wealth Induced Spending**
Bay	Gulf Front	4,839	$1,160,664,451	$34,819,934
	Bay Front	5,748	$741,231,822	$22,236,955
	Bay View	6,450	$118,990,974	$3,569,729
	Partial Bay View	11,260	$59,708,589	$1,791,258
	No Bay View	13,633	$0	$0
	Total	**41,930**	**$2,080,595,836**	**$62,417,876**
Gulf	Gulf Front	2,505	$845,273,096	$25,358,193
	Bay Front	1,510	$183,264,735	$5,497,942
	Bay View	1,240	$23,125,581	$693,767
	Partial Bay View	1,680	$8,824,055	$264,722
	No Bay View	1,274	$0	$0
	Total	**8,209**	**$1,060,487,467**	**$31,814,624**
Total	Gulf Front	7,344	$2,005,937,547	$60,178,127
	Bay Front	7,258	$924,496,557	$27,734,897
	Bay View	7,690	$142,116,555	$4,263,496
	Partial Bay View	12,940	$68,532,644	$2,055,980
	No Bay View	14,907	$0	$0
	Total	**50,139**	**$3,141,083,303**	**$94,232,500**

Table 13 also shows that Gulf front properties contribute the most to increases in property values. This is due in part to a higher proportion of property values being explained by proximity to the estuaries (91.4% as opposed to 8.6% for Bay and Partial Bay View), but it is also due to higher average property values for Gulf and Bay Front properties as reported in Table 12.

Economic Impact Analysis

REMI (2020 data) is a widely used dynamic integrated input output (I/O) and econometric model. The REMI model is based on neoclassical theory and was founded in 1980. The

model's structure incorporates inter-industry transactions and endogenous final demand feedbacks. The basic assumption of REMI is that the model is based on theoretical structural restrictions rather than individual econometric estimates based on single time-series observations for each region. It has much in common with the computable general equilibrium (CGE) models. REMI is used extensively to measure proposed legislative and other program and policy economic impacts across the private and public sectors of the state by the Florida Joint Legislative Management Committee, Division of Economic and Demographic Research, the Florida Department of Employment Opportunity and other state and local government agencies. In addition, it is the chosen tool to measure these impacts by a number of universities and private research groups that evaluate economic impacts across the state and nation. REMI shares two underlying assumptions with mainstream economic theory: households maximize their utility and producers maximize their profits. It includes hundreds of equations that describe cause-and-effect relationships in the economy, extending beyond an I/O model. The REMI used for this analysis (version 3.0) was developed specifically for the state of Florida and includes 160 sectors.[16] REMI's principal advantage is that it is a dynamic I/O econometric model and can be used to forecast both direct and indirect economic effects over multiple-year timeframes. REMI uses three sources of employment, wage and salary data: the Bureau of Economic Analysis (BEA) employment, wage and personal income series, ES 202 establishment employment and wage and salary data, and county business patterns (CBPs) data published by the Bureau of the Census. The industries are based on the North American Industrial Classification System (NAICS).

The SASJBEP's economic impact forecast time horizon is to the year 2040.[17] The following expected annual economic impact results for the SASJBEP area are presented in Figure 13, and include: output, income (in current dollars), and numbers of expected jobs.

[16] It should be noted that two counties in Florida (Bay and Gulf Counties) were analyzed using REMI (for state of Florida).
[17] Based on personal communication with the SASJBEP.

The economic impacts presented below are based on the data by county shown in Tables 8 and 13.[18]

- Employment increases to 67,698 jobs in year 2024. After the first four years where the market demonstrates a slight over-employment strategy, it begins to decrease the number of jobs annually, until year 2030, where it begins to climb incrementally annually, reaching 73,173 in year 2040.
- Annual Output increases to $9.7 billion in year 2022, and continues to rise to $13.9 billion in year 2040.
- Personal Income increases by $4.3 billion in year 2022 and gradually increases to $12.1 billion in year 2040.

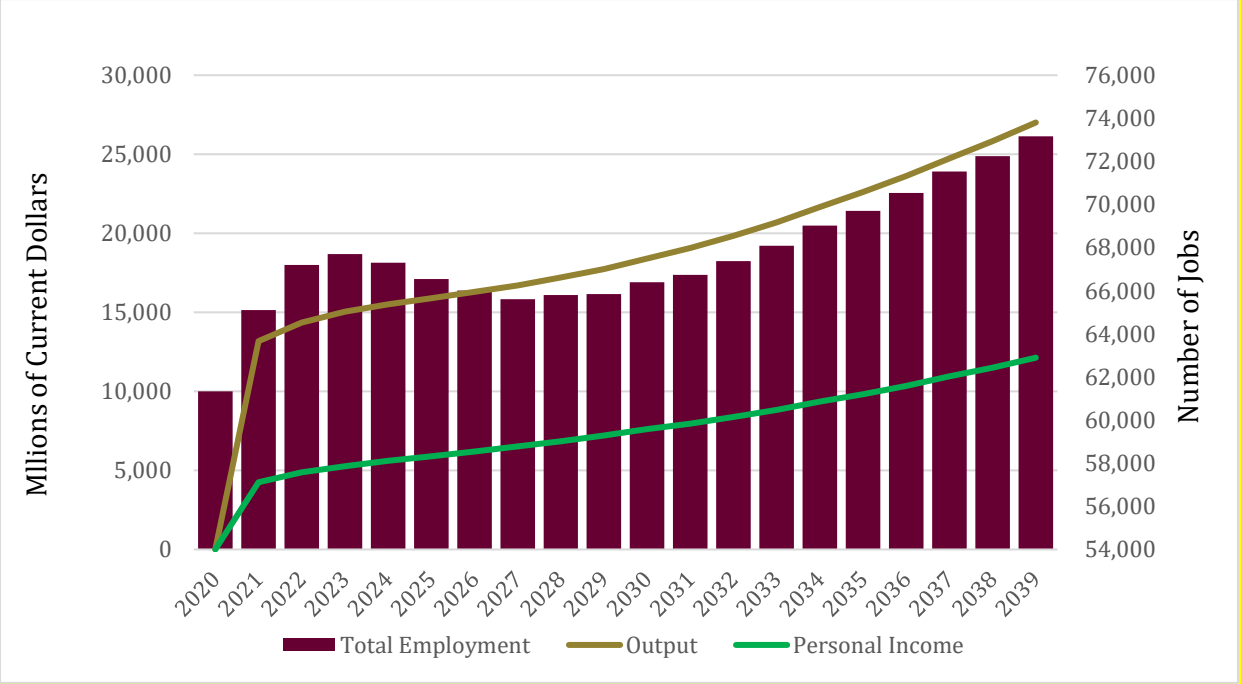


Figure 13. Projected SASJBEP Area Economic Impacts Including Output, Income and Jobs to Year 2040

[18] The data includes all business type sales and wealth induced spending in current dollars in the SASJBEP area. An assumption of two percent annually was made relating to the expected growth rate over time. The growth rate of two percent was based on economic assumptions related to growth rates based on the current credit underwriting standards.

Economic Valuation

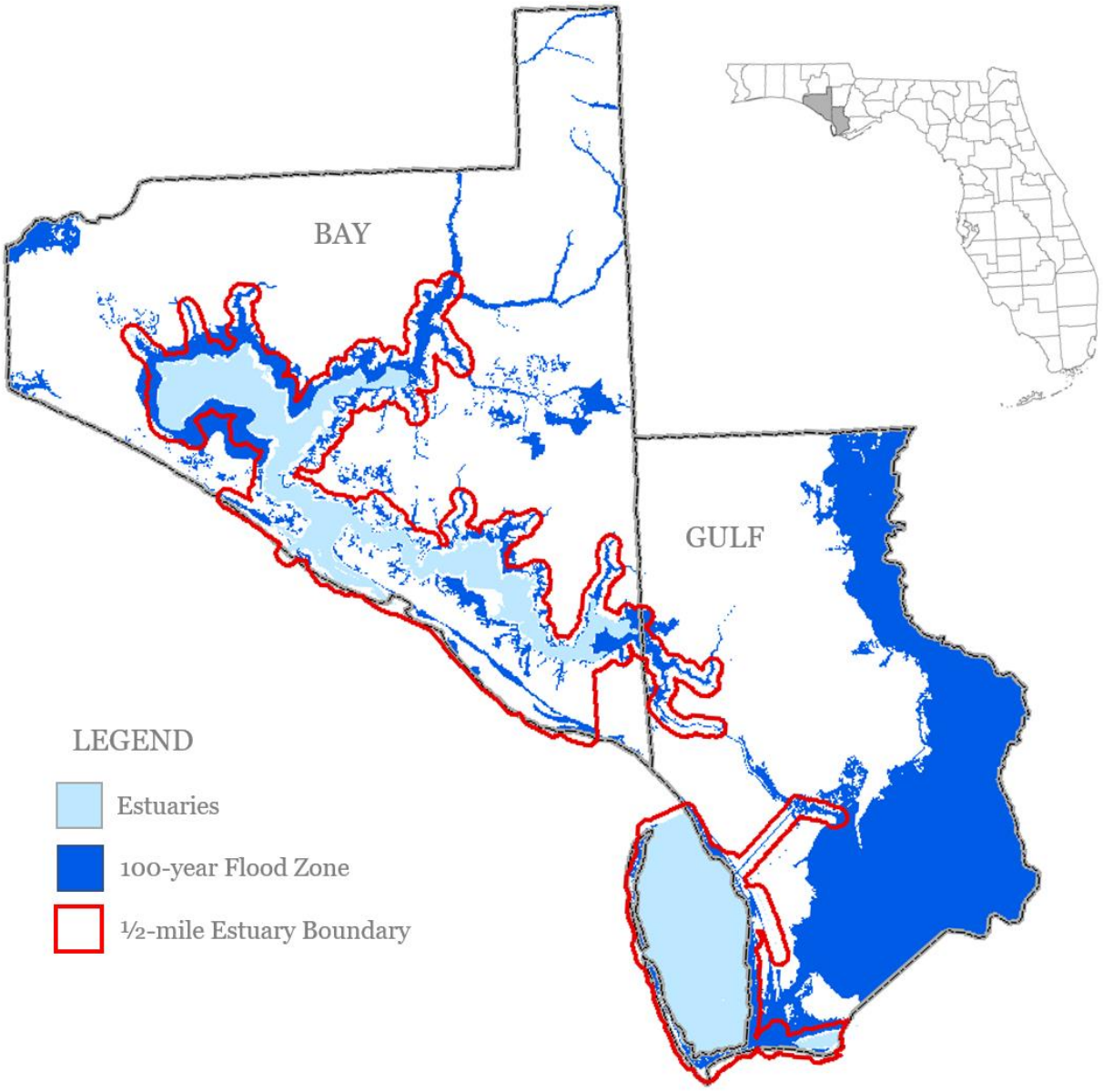
Vulnerability Analyses – Flooding and Sea Level Rise

Flooding and Sea Level Rise can impact the estuaries environmentally and economically. Runoff, which can include fertilizer and sewage, threatens water quality, increases risk of algae overgrowth, and poses risks to fish and the livelihoods of fishermen. Flooding and sea level rise can contribute to lower property values. Sea level rise exacerbates nuisance flooding, saltwater intrusion, increased storm surge, and threats to critical infrastructure. Sea level rise that results in complete inundation can result in properties becoming unusable.

Study Area

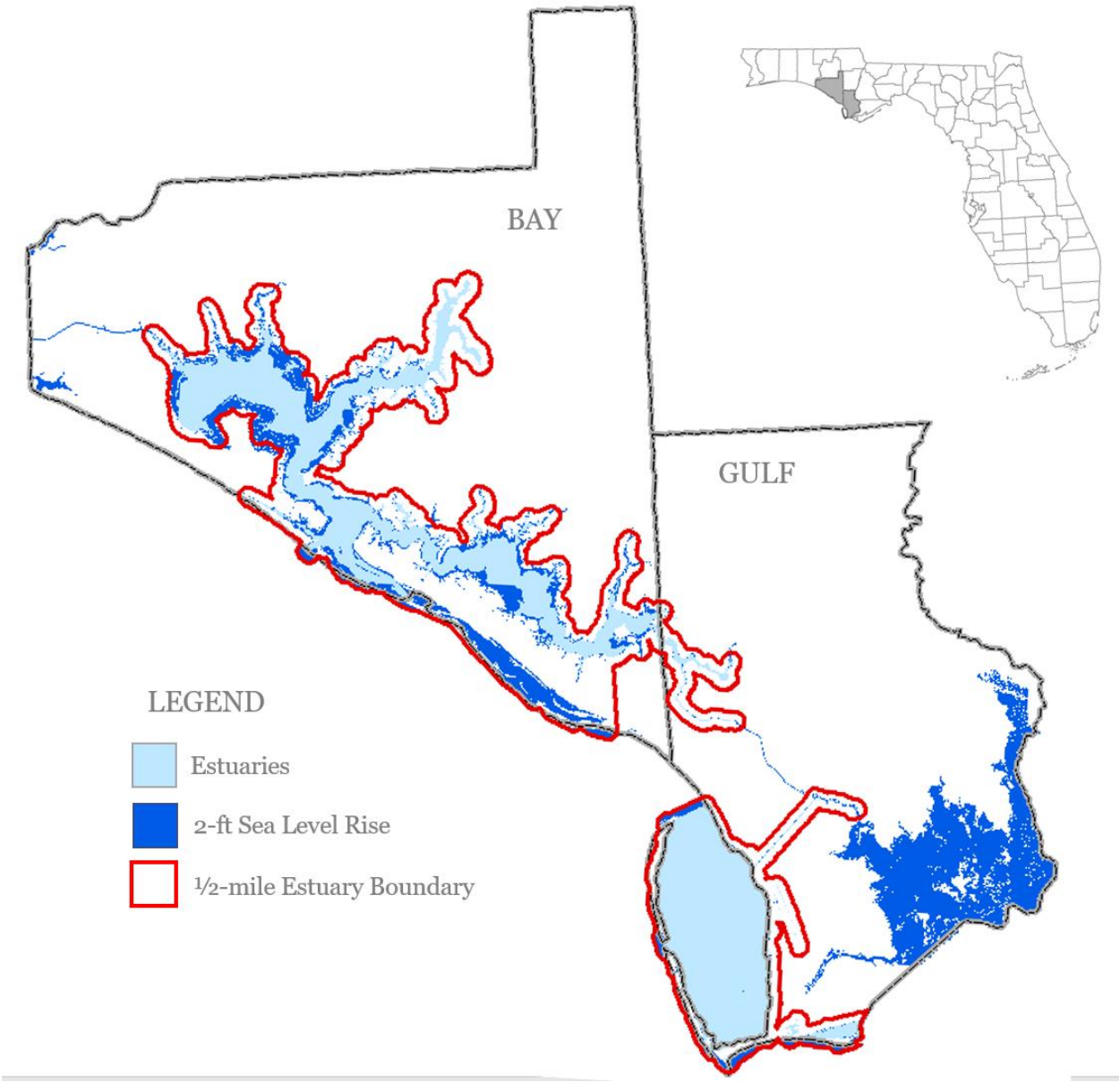
This report focuses on limited economic impacts of flooding and sea level rise for Bay and Gulf Counties. Flood data was provided by the Federal Emergency Management Agency (FEMA) and sea level rise data is from the National Oceanic and Atmospheric Administration (NOAA). The vulnerability analysis in this report provides side-by-side comparisons of the two water-related threats to facilitate understanding of the geographic scope of the risks.

Figures 14 and 15 show Flood and Sea Level Rise for these three counties and the differences in geographic areas that each occupies. Flooding occurs more inland in low-lying areas and has a larger geographic footprint. Sea Level Rise is located near the coast over a smaller geographic area. The analyses to follow will show different impacts based upon the land use types affected by each type of threat.



*SASJBEP with ½ mile buffer zone; the light blue polygons represent the estuary, and the medium blue polygons are the 100-Year Flood boundary.

Figure 14. Map of the 100-Year Flood for SASJBEP Area



*SASJBEP with ½ mile buffer zone; the light blue polygons represent the estuary, and the medium blue polygons are the 2-foot sea level rise boundary.

Figure 15. Map of 2-foot Sea Level Rise for the SASJBEP Area

Data and Methods

Flooding is a common hazard and can occur almost anywhere. Areas near rivers and coasts are common targets, but flooding can occur in places without bodies of water. Flooding can be caused by heavy rains, storm surge, construction, failure of a water control structure, or inadequate drainage. The adverse effects of flooding can include property/infrastructure damage, crop and livestock loss, water contamination, negative economic impacts, mortgage complications, housing displacement, and even loss of human life. The risks of flood can change over time due to new construction and changing weather patterns, requiring regular reassessment efforts. The Federal Emergency Management Agency (FEMA) works with federal and local partners to identify areas of risk to benefit planning practices.

Sea level rise can negatively impact drinking water, agriculture, coastal plant life, wildlife, and increase storm surge and flood risk. Economically, rising seas can cause beach erosion, and negatively impact tourism and real estate markets. The National Oceanic and Atmospheric Administration (NOAA) is dedicated to understanding and predicting changes in climate and weather. Sea level rise predictions offer support to communities to assess potential changes in tides for the benefit of planning and preparation.

The FSU Research Team is using the latest data from the FEMA and NOAA agencies for flooding and sea level rise. As these two datasets are considered authoritative, the team is incorporating them directly into this project. We use GIS methods to visualize and analyze market value and land use types in relation to these two datasets.

Flooding

Flooding is defined as the flow of water onto land that is normally dry. Floods are dangerous and kill more people in the United States each year than tornadoes, hurricanes, or lightning. This report uses the “100-year flood” measurement for estuary analysis. The term “100-year flood” as described by a television or radio spokesperson can mistakenly convey that a storm of this nature would happen every 100 years. However, hydrologists describe the term using a combination of magnitude and duration, and it is possible for a “100-year flood” to occur more frequently than every 100 years. The flood level is computed using past data and changes to topology, whether man-made or natural. It is important to regularly obtain new flood data for disaster preparedness and planning purposes.

This project shows a sample of the three counties for the 100-year flood as an example of how the flood zone data can be used. Readers are encouraged to make use of this body of work for flood analysis in their communities.

Figures 16a-c show the 100-year Flood Zone overlaying the various land use types. In eastern Bay County, much of the underlying land use is agricultural, followed by institutional lands, and less land area categorized as residential, commercial, industrial, and miscellaneous.

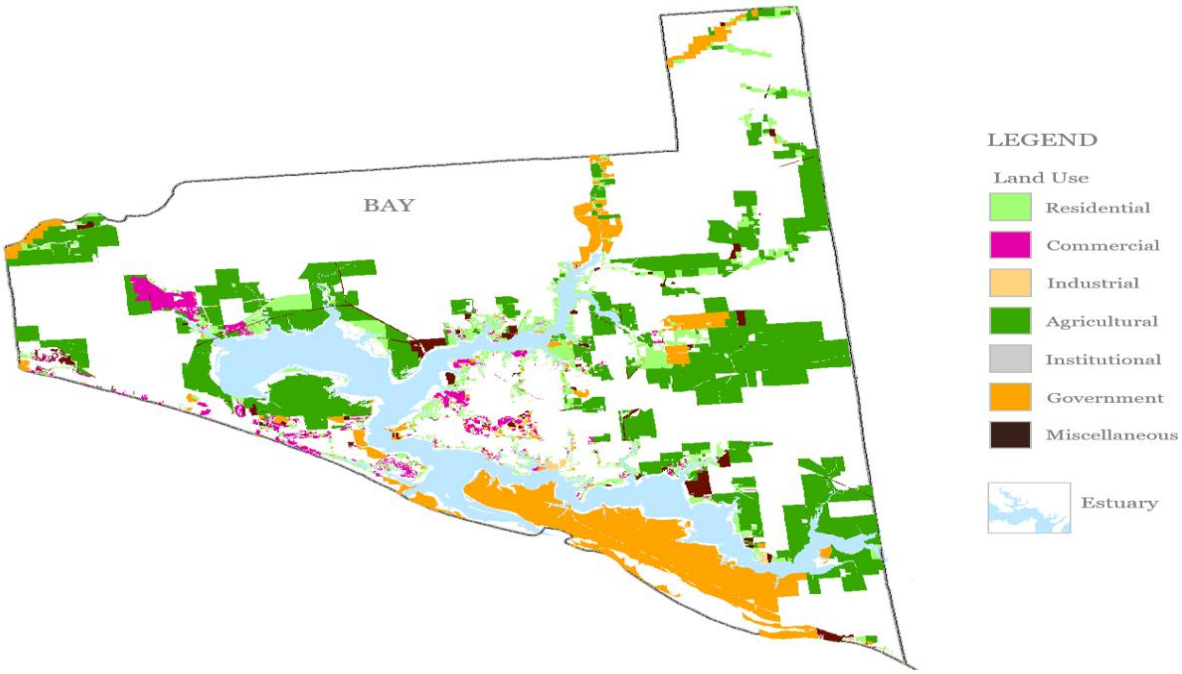


Figure 16a. The SASJBEP Area (Bay County) 100-Year Flood Zone and Property Parcels by Land Use Type

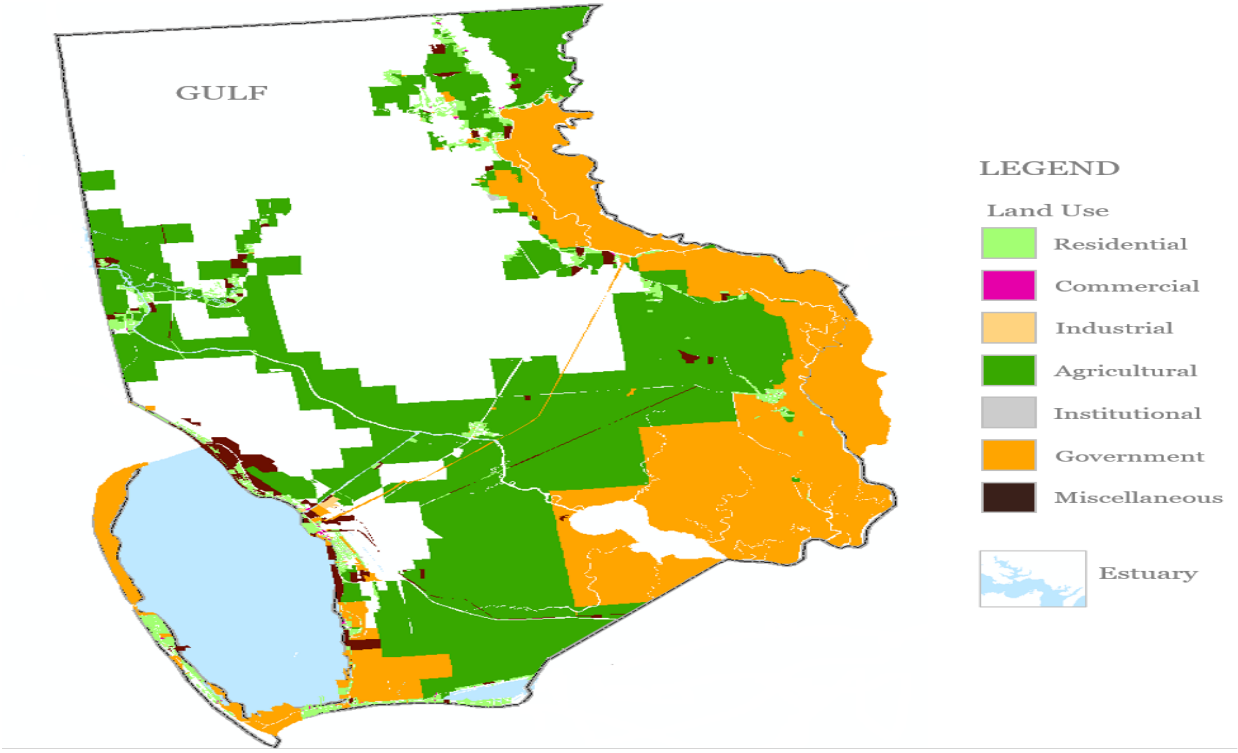


Figure 16b. The SASJBEP Area (Gulf County) 100-Year Flood Zone and Property Parcels by Land Use Type

The tables to follow outline the market values of the land parcels within the Flood zone. Table 14 shows an overview of all land parcels within the three counties by land use category. Table 15 provides a close-up of the land parcels that lie within the Flood zone and the SASJBEP ½ mile buffer. In both cases, the governmental land use category has the highest market value, and the institutional and industrial categories trend towards a lower market value. Table 16 breaks down the residential land use type into various housing type (i.e. single family, condo, etc.) by waterfront view, based upon our earlier analysis as shown in Appendix C.

Table 14. Market Values for the SASJBEP Area Land Parcels Located Within the 100-Year Flood Zone

Market Values for SASJBEP Area within 100-year Flood Zone		
Land Use Category	**Number of Parcels**	**Total Market Value**
Residential	26,539	$7,115,856,177
Commercial	1,103	$1,060,880,807
Industrial	174	$147,705,870
Agricultural	953	$379,798,746
Institutional	105	$155,299,630
Government	954	$14,089,486,590
Miscellaneous	354	$202,477,252
Totals	**30,182**	**$23,151,505,072**

*Includes Bay and Gulf counties.

Table 15. Market Values for the SASJBEP Area Land Parcels Located Within the 100-Year Flood Zone and the SASJBEP ½ Mile Buffer

Market Values for SASJBEP Area within 100-year Flood Zone and SASJBEP 1/2 Mile Buffer		
Land Use Category	**Number of Parcels**	**Total Market Value**
Residential	17,903	4,821,164,096
Commercial	549	394,767,135
Industrial	60	93,959,744
Agricultural	383	131,924,050
Institutional	52	33,470,790
Government	475	13,677,022,802
Miscellaneous	165	134,196,221
Totals	**19,587**	**$19,286,504,838**

*Includes Bay and Gulf counties.

Table 16. Market Values Within SASJBEP and the 100-year Flood Zone Categorized by Type of Waterfront View

Market Values within the SASJBEP Area Buffer and 100-year Flood Zone				
Proximity to Bay	**Housing Category**	**Number of Units**	**Average Market Value**	**Total Market Value**
Gulf Front	Vacant	1,159	235,898	273,405,643
	Family Home	1,772	725,707	1,285,952,973
	Mobile Home	2	165,932	331,863
	Townhouse	33	403,059	13,300,944
	Condo	4,212	370,305	1,559,726,277
	Totals	**7,178**	**436,433**	**3,132,717,700**
Bay Front	Vacant	2,247	129,740	291,526,086
	Family Home	3,809	390,927	1,489,042,318
	Mobile Home	131	122,868	16,095,738
	Townhouse	66	296,080	19,541,307
	Condo	825	273,362	225,523,535
	Totals	**7,078**	**288,461**	**2,041,728,984**
Bay View	Vacant	1,668	64,114	106,942,059
	Family Home	4,664	229,270	1,069,316,023
	Mobile Home	300	93,630	28,089,036
	Townhouse	133	218,822	29,103,332
	Condo	812	229,291	186,183,918
	Totals	**7,577**	**187,361**	**1,419,634,368**
Partial View	Vacant	2,707	52,959	143,358,839
	Family Home	8,431	211,534	1,783,445,353
	Mobile Home	759	101,297	76,884,321
	Townhouse	287	205,802	59,065,266
	Condo	611	361,602	220,938,726
	Totals	**12,795**	**178,483**	**2,283,692,505**
No View	Vacant	3,484	40,412	140,793,938
	Family Home	9,421	192,292	1,811,584,690
	Mobile Home	1,275	79,789	101,730,797
	Townhouse	326	149,357	48,690,305
	Condo	242	361,745	87,542,369
	Totals	**14,748**	**148,518**	**2,190,342,099**
Totals		**49,376**	**224,160**	**11,068,115,656**

Sea Level Rise

Sea level rise is a global concern as almost 30 percent of the world's population lives in coastal areas. Sea level rise contributes to nuisance flooding, erosion, and storm hazards. Infrastructure such as roads, bridges, sewage treatment plants, landfills, and more are threatened. This report uses 2-foot sea level rise estimates as the probability is increasingly likely to occur between years 2020 and 2100.

Figures 17 a-c show the 2-foot Sea Level Rise Zone overlaying the various land use types. In the more northern part of Bay County, much of the underlying land use is institutional, agricultural and governmental, and less land area categorized as miscellaneous, residential and commercial. The lower portion of the county has considerable land in the governmental category; due to the location of Tyndell Air Force Base.

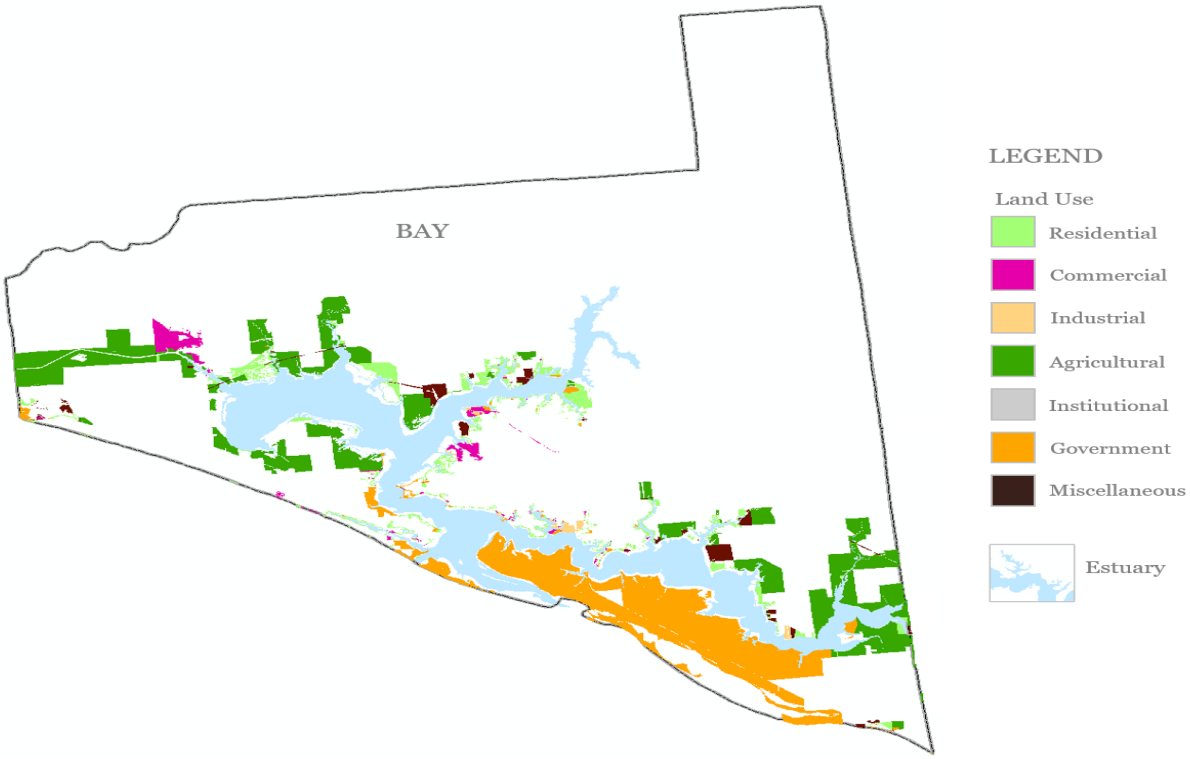


Figure 17a. The SASJBEP Area (Bay County) Sea Level Rise Zone and Property Parcels by Land Use Type

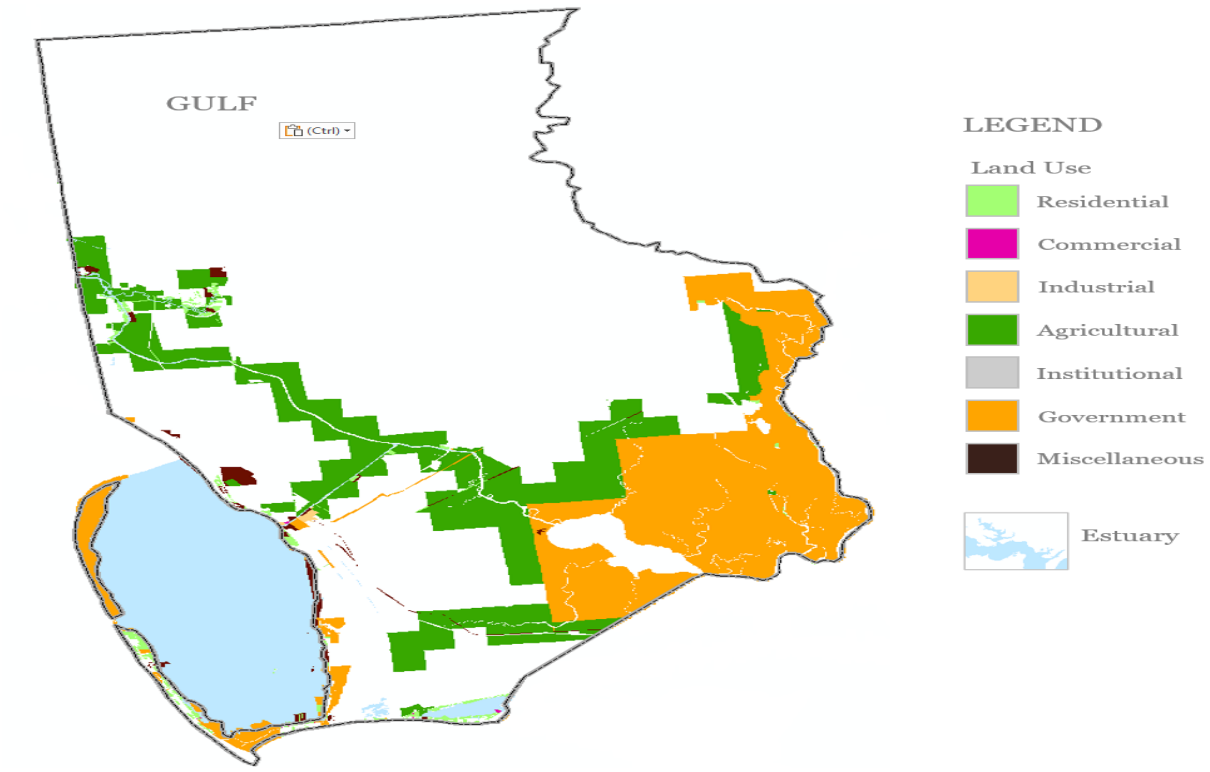


Figure 17b. The SASJBEP Area (Gulf County) Sea Level Rise Zone and Property Parcels by Land Use Type

The tables to follow outline the market values of the land parcels within the Sea Level Rise zone. Table 17 outlines land parcels for the county by land use category. Table 18 provides a close-up of the land parcels that lie within the Sea Level Rise zone and the SASJBEP ½ mile buffer. In both cases, the governmental and residential land use categories have the highest market value, and the miscellaneous category trends toward a lower market value in spite of having a larger portion of land area. Table 19 breaks down the residential land use type into various housing type (i.e. single family, condo, etc.) by waterfront view, based upon analysis similar to Appendix C.

Table 17. Market Values for the SASJBEP Area Land Parcels Located Within the 2-foot Sea Level Rise Zone

Market Values for SASJBEP Area within the 2-foot Sea Level Rise Zone		
Land Use Category	**Number of Parcels**	**Total Market Value**
Residential	6,321	$2,524,336,921
Commercial	185	$233,298,321
Industrial	37	$76,810,009
Agricultural	296	$135,201,668
Institutional	9	$9,166,020
Government	383	$13,345,176,841
Miscellaneous	105	$89,696,489
Totals	**7,336**	**$16,413,686,269**

*Includes Bay and Gulf counties.

Table 18. Market Values for Land Parcels Located Within the 2-foot Sea Level Rise Zone and the SASJBEP ½ Mile Buffer

Market Values for SASJBEP Area within the 2-foot Sea Level Rise Zone		
Land Use Category	**Number of Parcels**	**Total Market Value**
Residential	4,393	$1,570,006,904
Commercial	158	$192,942,863
Industrial	30	$70,958,102
Agricultural	231	$82,487,401
Institutional	7	$8,755,390
Government	230	$13,124,479,883
Miscellaneous	64	$59,505,051
Totals	**5,113**	**$15,109,135,594**

*Includes Bay and Gulf counties.

Table 19. Market Values Within the SASJBEP Area and the 2-Foot Sea Level Rise Zone Categorized by Type of Waterfront View

Market Values within the SASJBEP Area Buffer and SLR Zone				
Proximity to Bay	**Housing Category**	**Number of Units**	**Average Market Value**	**Total Market Value**
Gulf Front	Vacant	1,075	241,515	259,628,124
	Family Home	1,310	785,487	1,028,988,187
	Mobile Home	2	165,932	331,863
	Townhouse	1	689,965	689,965
	Condo	105	320,273	33,628,698
	Totals	**2,493**	**530,793**	**1,323,266,837**
Bay Front	Vacant	1,989	137,145	272,781,484
	Family Home	3,196	421,541	1,347,245,767
	Mobile Home	100	137,779	13,777,915
	Townhouse	56	305,317	17,097,735
	Condo	825	273,362	225,523,535
	Totals	**6,166**	**304,318**	**1,876,426,436**
Bay View	Vacant	978	83,621	81,781,014
	Family Home	2,147	284,427	610,664,362
	Mobile Home	110	84,757	9,323,244
	Townhouse	35	351,774	12,312,096
	Condo	812	229,291	186,183,918
	Totals	**4,082**	**220,545**	**900,264,634**
Partial View	Vacant	1,249	65,250	81,497,226
	Family Home	2,543	280,894	714,314,148
	Mobile Home	127	76,854	9,760,520
	Townhouse	52	265,271	13,794,077
	Condo	611	361,602	220,938,726
	Totals	**4,582**	**227,042**	**1,040,304,697**
No View	Vacant	1,112	59,432	66,087,926

	Family Home	1,706	253,036	431,679,644
	Mobile Home	176	77,004	13,552,672
	Townhouse	20	196,341	3,926,823
	Condo	242	361,745	87,542,369
	Totals	**3,256**	**185,132**	**602,789,434**
Totals		**20,579**	**279,073**	**5,743,052,038**

Economic Valuation Analysis of Changes in Water Quality

This section examines changes in water quality and how they relate to the economic valuation of the estuaries. The quality of the water in estuaries is linked to its desirability as a tourist destination. Given tourism is one of the primary industries in the St. Andrew and St. Joseph Bays, changes in the water quality may have an impact on the economic value of the estuaries. This section examines that link through the valuation of real estate properties that are near the estuaries.

Estimating the Link Between Water Quality and Economic Value

To test the theoretical link between water quality and economic value, this section uses data from the National Water Quality Monitoring Council (NWQM)[19] and FDOR. The NWQM keeps a database of water characteristic measurements taken by various local, state, and federal authorities, as well as volunteer organizations. The FDOR data used in this analysis is parcel-level data on just value and geographic location. Using these two data sources, the team can use statistical analysis to evaluate the impact of water quality on home prices.

Parcel Value Data

The research team uses percent change in parcel just values as the dependent variable for the analysis in this section. To have the best picture of how just values change over time, the team needed data at the highest frequency available for the longest period possible. FDOR has annual just value data for the two Florida counties in the St. Andrew and St. Joseph Bays, for which the team uses data from 2010-2022,[20] though it is only available through a public information request. After acquiring this data, each year was filtered to only include the parcels within ½ mile of the St. Andrew and St. Joseph Bays. Additionally, the parcels were filtered to include only residential properties. Finally, each year/county is distributed as a

[19] https://www.waterqualitydata.us/
[20] 2023 data is not currently available.

separate table, which were merged for analysis. Figure 18 displays a map of the parcels used in the hedonic modeling.

*Parcels are in garnet. Florida borders and shorelines are in gold.

Figure 18. Parcels Included in the Hedonic Model

Water Quality Data

The NWQM stores water quality data in several tables that can be queried for characteristics, geolocation, sample date and time, and other measures. The research team first narrowed the sampling locations to a box defined by latitude and longitude surrounding the St Andrew and St Joseph Bays area. Next, the research team selected several of water quality measures, including toxins, organic matter, and microbiological contaminants. Using GIS data to define the boundaries of the St Andrew and St Joseph Bays, the research team then narrowed the sampling locations down to only those within the estuaries' boundaries. Figure 19 shows the location of the monitoring sites. Note that not all monitoring sites were used in each year due to data limitations.

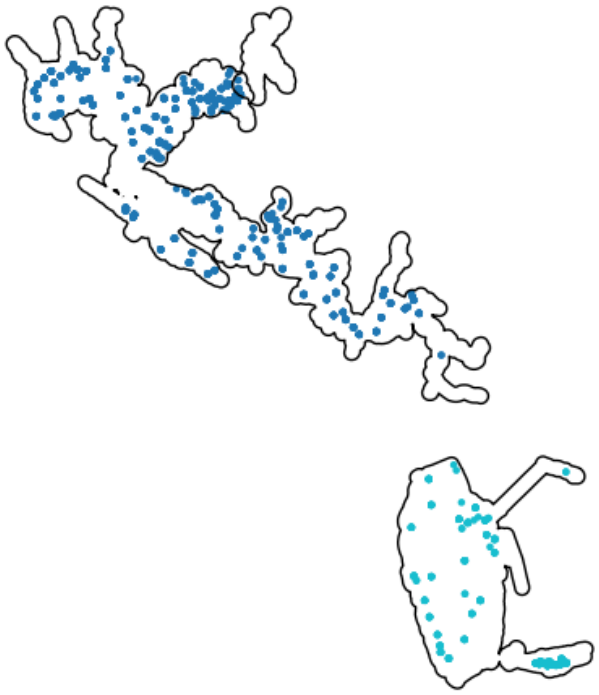


Figure 19. Monitoring Sites Data Used in the Hedonic Model

Next, the research team averaged each measure of water quality by year and by the SASJBEP area. After examining the averaged data, the team determined that very few water quality measures were taken frequently enough to be useful in the analysis. Therefore, the team narrowed the measures down to only two criteria: enterococcus (measured in colony forming units per 100ml) and fecal coliform (measured in most probable number per 100ml).

Enterococcus and fecal coliforms are types of bacteria that commonly come from the fecal matter of terrestrial animals. Enterococcus is of particular concern because it can directly cause several diseases, including urinary tract infections, meningitis, and wound infections. Fecal coliforms may also cause diseases, for example, some strains of *Escherichia coli*, but it is less common. Some enterococcus and fecal coliforms are present in nearly all bodies of water, but excessive amounts may indicate excess agricultural runoff from livestock or poor water sanitation practices (Krishinhi, Tchounwou, & Farah, 2013). Therefore, an increase in enterococcus and fecal coliforms should be associated with a decline in house prices.

Methodology for the Economic Valuation Analysis Using Hedonic Modeling

The research team uses a percent first-difference, linear regression design in this analysis. The primary reason for choosing this methodology is that each parcel in this data contains individual characteristics that do not change over time that determine its price (individual-

level fixed effects).[21] One way to ensure that these characteristics do not affect the analysis is to take the first difference. For example, a parcel being located in an urban area is correlated with property values and may also be correlated with water quality, assuming water quality is worse in urban areas. Since location does not change over time for parcels, taking the first difference removes the influence of this variable on the regression equation.

First differences are converted into percent differences because the different indicators of water quality are measured in different units (colony forming units for fecal coliforms and enterococcus). Converting each measure into percent differences allows comparison between the three measures without complications arising from differing units. Finally, differences in just values are converted to percent differences because prices tend to change in steady growth rates expressed in percentages, as opposed to linearly. A general formula for the regression estimation is:

$$\Delta\widehat{JustValue}_{\iota,t} = \beta_0 + \beta_1 \Delta F_t + \beta_2 \Delta E_t + \Delta X_t \delta$$

where $\Delta\widehat{JustValue}_{\iota,t}$ is the estimated percent change in just value for property *i* in year *t*, ΔF_t is the percent change in average fecal coliforms, ΔE_t is the percent change in enterococcus, and ΔX_t is a vector of time-varying factors thought to influence property values. The factors include the percent change in the median selling price of homes in the United States and the percent change in the population of the Panama City metropolitan statistical area.[22] One disadvantage of using a percent first difference design is that it complicates the interpretation of the results. The coefficients β_j for j = 1,2,3 can be interpreted as differences in the percent changes in just values associated with a 1% difference in the change in each measure of water quality, holding the change in all other factors constant. For example, if the percent difference in Enterococcus increases by 1%, the percent difference in parcel values is expected to change by β_1.

Given each estuary is fed by a separate watershed, the team chose to perform regression analyses separately for properties near each estuary, using the average water quality measures from the nearest estuary in each regression. In addition, the team performed a primary regression, which combines the two estuaries, using average water quality measures from the nearest estuary to each parcel. The formulas for the two separate regressions are the same as the formula above, while the formula for the combined regression is:

$$\Delta\widehat{JustValue}_{\iota,t} = \beta_0 + \beta_1 \Delta F_{i,t} + \beta_2 \Delta E_{i,t} + \Delta X_t \delta$$

---

[21] For more information on the first-difference regression design, see Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT press.
[22] Retrieved from FRED: https://fred.stlouisfed.org/

The inclusion of additional *i* subscripts indicates that the water quality measures are different for different parcels, depending on which estuary is closer.

Results of the Economic Valuation Analysis Using Hedonic Modeling

Table 20 presents the results of these three hedonic models. All three models are statistically significant for their measure of water quality, while they seem to have differing effects of water quality measure. The combined model predicts that a 1% change in fecal coliform leads to a 0.469% decrease in just values. For example, from the parcel price of $187,174 in 2021, increasing fecal coliform levels by 1% is expected to decrease each parcel price by around $878. While this difference may seem small, there were 47,680 parcels in the 2021 data, so that the cumulative impact of the water quality would be estimated to be around $42 million. Therefore, the local governments in the areas of the St Andrew and St Joseph Bays estuaries as well as the Bay and Gulf counties are motivated to improve the water quality of their estuaries. In the combined model, enterococcus has a smaller impact on parcel prices than fecal coliform, where a 1% increase in enterococcus is associated with a 0.084% increase in parcel prices.

Limitations and Considerations

Examining the results in Table 20 reveals some noteworthy inconsistencies. For instance, the St Joseph Bay results do not include any measure of water quality besides that of fecal coliform due to the lack of measurements taken for the St Joseph Bay estuary. Additionally, the sign on its coefficient is positive, contrary to intuition regarding the impact of fecal coliform presence in the water and is likely a result of omitted variable bias. Furthermore, the combined results returned the same coefficients as that of the St Andrew Bay estuary. This is most likely due to the limited available data returned from the St Joseph Bay estuary so that much of the combined results encompass that of the St Andrew estuary.

Furthermore, past studies have found that a water quality measure closely correlated with changes in housing values is that of Chlorophyll A. Chlorophyll A is a measure of algae in a body of water, the presence of which is normal as a base in the food chain (Boyer et al 2009). However, excess levels can represent high runoff of nutrients from surrounding farming and agricultural land, causing plant life in the water to decay. Therefore, one would expect an increase in Chlorophyll A to be associated with a decrease in parcel values. Chlorophyll A was not included in this hedonic model, however, due to a lack of measure qualities taken for the St Andrew and St Joseph Bays estuaries. Considering the watershed caused by the St Andrew estuary, the research team suggests increasing the measure qualities of Chlorophyll A so that it might be included in further studies to avoid any future omitted variable bias.

Table 20. Results of the Economic Valuation Using Hedonic Modeling

Coefficient	St. Andrew Bay Only	St. Joseph Bay Only	Combined Results
Intercept	0.0326%*** (0.001)	0.0482%*** (0.005)	0.0326%*** (0.001)
Enterococcus	0.084%*** (0.002)	-	0.084%*** (0.002)
Fecal Coliform	-0.469%*** (0.013)	0.186*** (0.009)	-0.469%*** (0.013)
Mean Selling Price	-8.529%*** (0.221)	-1.41%*** (0.069)	-8.529%*** (0.221)
PCB Population	11.18%*** (0.367)	6.229%*** (0.495)	11.18%*** (0.367)
Number of Obs.	197,619	46,135	197,619
R-squared	0.012	0.016	0.012

Standard errors in parentheses. Statistical significance level: ***1%, **5%, *10%

Economic Valuation Using Hedonic Modeling Conclusions

As we can see from the results of the hedonic modeling analysis, water quality is important to the economic impact of the estuaries, which falls in line with studies with similar conclusions. Additionally, the impact is most prominent for fecal coliform. If fecal coliform increases in the estuary by 1%, parcel values are expected to decrease by 0.469%. Applied to the mean price of a home at $187,174 in 2021, a 1% increase in the level of fecal coliform could have decreased the increase in the average parcel price by $878. Local government therefore has an incentive to increase water quality in the bay area.

Conclusions

Direct Business Sales and Property Value Results

The sales and spending directly supported by the St Andrew and St Joseph Bay Estuaries are significant. Businesses within ½ mile of the watershed had nearly $4.4 billion in sales in 2020 and supported more than 51 thousand workers. A significant portion of Bay-related businesses are engaged in the service industry, with $1.8 billion in sales and about 25 thousand employees. Small businesses contribute the most to both employment and sales, with 43.3% of employees working at firms with less than ten employees, and 37.1% of sales

occurring at firms with less than ten employees. Bay-related businesses in Bay County contribute the most to both sales and employment, with $3.9 billion in sales and 45,522 employees.

In addition to business spending, the estuaries are estimated to contribute $3.1 billion to property values in the area and nearly $94 million to consumer spending. The team estimates that properties right on the Gulf Front are the most impactful. Out of the $3.1 billion that the estuaries contribute to property values, over $2 billion comes from Gulf Front properties. This translates to $60.1 million of the $94 million increase in consumer spending. Properties in Bay County are again the most significant contributors to increased property values and consumer spending, with $2.1 billion in increased property values and $62.4 million in wealth induced spending.

Economic Impact Analysis Results

The SASJBEP area is not only valuable as an ecological and environmental treasure, but also as an engine of economic activity. This report demonstrates the economic value the St Andrew and St Joseph estuaries bring to the surrounding areas. Businesses that are directly impacted by the estuaries contribute significantly to their local economies, and generate a total of $4.4 billion in direct sales. In addition to business sales, local property values are also impacted by the SASJBEP area. The FSU CEFA team estimates that property values are increased by a total of $3.1 billion. The increase in property values attributed to proximity to the SASJBEP area leads to an additional $94 million in direct consumer, or wealth-induced, spending, for a total of $9.7 billion in output (sales/revenues). Direct employment supported by these businesses is 51,157 jobs. Businesses and consumer spending also contributed an additional 13,945 indirect and induced jobs. Total employment supported by businesses and consumer spending tied to the estuaries is 65,102.

Economic Valuation Analysis Results

This analysis includes a vulnerability study to show the need for considering risks of all types to the estuary system. Vulnerabilities produce different economic threats depending upon the type of land use affected by the threat. Weather and climate risks should be expanded to include storm surge, extreme heat, and other threats so that scientists and planners can be informed of the similarities and differences that each vulnerability poses. This study includes analysis of potential flooding, sea level rise, and water quality changes. It is hoped that the results can contribute to mitigation efforts and improvement to quality of life.

Flooding covers much more geographic area than sea level rise because flooding can occur anywhere and sea level rise occurs near the coast and inlet areas. Results from this analysis show land parcel values of all land use types in Bay and Gulf counties affected by flooding totaling over $23.2 billion with over $19.3 billion within the ½ mile buffer boundary. Sea level rise affects fewer land parcels, with $16.4 billion affected by SLR and $15.7 billion located within the ½ mile estuary buffer. Similarly, the number of land parcels affected by flood within the ½ mile buffer for Bay County is 14,039 and SLR affects only 781. In Gulf County within the ½ mile buffer, flooding affects 5,270 land parcels and SLR affects only 199.

In this geographic area, flooding presents a greater economic risk based upon market values of properties when compared to sea level rise. This scenario can be explained by the presence of more residential properties located in the flood zone as compared to the sea level risk area.

The SASJBEP watershed area will experience substantial population growth by the year 2040, especially with respect to Bay County. The increasing population, in addition to other factors such as sea level rise in the ensuing years, will continue to place substantial pressure on this area. The goal of this project is to provide local planners and other stakeholders with information on the value of the SASJBEP ecosystem, so that they may more accurately assess the costs and benefits related to future land-use decisions.

Finally, hedonic price modeling of the St Andrew and St. Joseph Bays has revealed that water quality does affect the value of homes near the estuaries. This conclusion falls in line with studies with similar conclusions. Of the two measured water qualities, fecal coliform and enterococcus, the impact is most prominent for fecal coliform. For instance, if fecal coliform increases in the estuary by 1%, parcel values are expected to decrease by 0.469%. Applied to the mean price of a home at $187,174 in 2021, a 1% increase in the level of fecal coliform could have decreased the increase in the average parcel price by $878. Local government therefore has an incentive to increase higher water quality in the bay(s) area.

References

Adam, J. (2021). *Assessing Morphological Response and Vulnerability of Barrier Islands to Extreme Storms in Northwest Florida* [Doctoral dissertation, University of South Florida].

Adams, C. (2014). Imperiled water quality of Biscayne Bay.. *Florida Sea Grant*. https://sfyl.ifas.ufl.edu/media/sfylifasufledu/miami-dade/documents/sea-grant/Imperiled-Water-Quality-in-Biscayne-Bay.pdf

Afzal, & Akhtar, A. M. (Punjab F. R. I. (2013). Factors Affecting Carbon Sequestration In Trees. *Journal Of Agricultural Research (Lahore)*, *51*(1), 61–69.

Altsman, D., & DeMay, R. (2007). Seagrass status and trends in the northern Gulf of Mexico: 1940–2002 (Report NO. 2006–5287). U.S. Geological Survey Scientific Investigations.. https://doi.org/10.3133/sir20065287

Baker, S., Grogan, K., Larkin, S., & Sturmer, L. (2015). "Green" clams: estimating the value of environmental benefits (ecosystems services) generated by the hard clam aquaculture industry in Florida. https://shellfish.ifas.ufl.edu/environmental-benefits/#:~:text=The%20economic%20value%20of%20these%20benefits%20was%20estimated,of%20clam%20sales%20%28%2411.9%20million%29%20in%20that%20year

Bell, F.W., M.A. Bonn, and V.R. Leeworthy. (1998). Economic Impact and Importance of Artificial Reefs in Northwest Florida. Office of Fisheries Management and Assistance Service, Florida Department of Environmental Administration, Tallahassee, FL.

Bi, X., Borisova, T., & Hodges, A. W. (2019). Economic value of visitation to free-flowing and impounded portions of the Ocklawaha River in Florida: Implications for management of river flow. *Review of Regional Studies*, *49*(2), 244–68.https://doi.org/10.52324/001c.9754

Boyer, J. N., Kelble, C. R., Ortner, P. B., & Rudnick, D. T. (2009). Phytoplankton bloom status: Chlorophyll a biomass as an indicator of water quality condition in the southern estuaries of Florida, USA. *Ecological indicators, 9(6), S56-S67.*

Chen, M. (2013). Valuation of public Great Lakes beaches in Michigan. https://www.semanticscholar.org/paper/Valuation-of-public-Great-Lakes-beaches-in-Michigan-Chen/27dd583d38f97a431aa9d6cd7690e85d6199a72b

Conmy, R. N., Schaeffer, B. A., Schubauer-Berigan, J., Aukamp, J., Duffy, A., Lehrter, J. C., & Greene, R. M. (2017). Characterizing light attenuation within northwest Florida estuaries: Implications for Restore Act water quality monitoring. *Marine Pollution Bulletin, 114*(2), 995–1006. https://doi.org/10.1016/j.marpolbul.2016.11.030

Efimova, E. (2019). *A RANDOM UTILITY MODEL OF BEACH USE ON THE EAST COAST OF THE UNITED STATES: PER-TRIP VALUES AND HYPOTHETICAL BEACH CLOSURES*.

https://udspace.udel.edu/bitstream/handle/19716/24995/Efimova_udel_0060D_13843.pdf?isAllowed=y&sequence=1

Fernald, E. A., Walby, K., Miller, S. J., & Jones III, J.P. (1979). Marine-related recreation business and public facilities in Bay County, Florida. https://repository.library.noaa.gov/view/noaa/46707

Harper, Rick; Morgan, A., Morgan, C. *Economic Analysis of the Contribution of Choctawhatchee Bay to Okaloosa and Walton Counties*. (2006). Haas Center for Business Research and Economic Development.

Harrington, J., Holland, M., Strode, G., & Kabbani, J. (2022). An economic impact and valuation analysis of the Pensacola and Perdido Bays estuary program (PPBEP). *Final Report.*

Harrington, J., & Feng, S. (2017, May). *An Economic Valuation and Assessment Analysis of the Pellicer Watershed*. Center for Economic Forecasting and Analysis Florida State University. https://cefa.fsu.edu/sites/g/files/upcbnu1851/files/Final%20Report_5_30_2017.pdf

Hatchell, B., Konchar, K., Shea, C., & Furman, B. (2020). Pilot study for seagrass habitat restoration at West Bay, St. Andrew Bay, Florida. https://www.myflorida.com/apps/vbs/vbs_pdf.download_file?p_file=F1191679250_PilotStudyForSeagrassHabitatRestorationatWestBayFinalReport.pdf

Hindsley, P., & Morgan, A. (2014). The Sarasota Bay economic valuation project: Phase II. https://sarasotabay.org/wp-content/uploads/SBEP_SarasotaBay_EconomicValuation_PhaseII.pdf

i-Tree. (2022). *I-Tree canopy* (Version 4.4). i-Tree. https://canopy.itreetools.org/

Kauffman, G. J. (2019). Economic benefits of improved water quality in the Delaware River (USA). *River Research and Applications*, *35*(10), 1652–1665. https://doi.org/10.1002/rra.3484

Kishinhi, S. S., Tchounwou, P. B., & Farah, I. O. (2013). Molecular approach to microbiological examination of water quality in the Grand Bay National Estuarine Research Reserve (NERR) in Mississippi, USA. *Environmental health insights, 7, EHI-S11455.*

Klemick, H., Griffiths, C., Guignet, D., & Walsh, P. (2018). Improving water quality in an iconic estuary: An internal meta-analysis of property value impacts around the Chesapeake Bay. *Environmental and Resource Economics*, *69*(2), 265–292. https://doi.org/10.1007/s10640-016-0078-3

Kriner, E., Aldenberg, P., Byrne, J., Kendall, B., & Nicholas, R. (2021). St. Joseph Peninsula disasters: Using NASA earth observations to investigate land cover, shoreline change, and

sediment transport in St. Joseph Peninsula after hurricane Michael.. https://ntrs.nasa.gov/citations/20210025922

Landry, C. E., Turner, D., & Allen, T. (2022). Hedonic property prices and coastal beach width. *Applied Economic Perspectives and Policy*, *44*(3): 1373– 1392. https://doi.org/10.1002/aepp.13197

Lankia, T., Neuvonen, M., & Pouta, E. (2019). Effects of water quality changes on the recreation benefits of swimming in Finland: Combined travel cost and contingent behavior model. *Water Resources and Economics*, *25*, 2–12. https://doi.org/10.1016/j.wre.2017.10.002

Lebrasse, M. C., Schaeffer, B. A., Coffer, M. M., Whitman, P. J., Zimmerman, R. C., Hill, V. J., Islam, K. A., Li, J., & Osburn, C. L. (2022a). Temporal stability of seagrass extent, leaf area, and carbon storage in St. Joseph Bay, Florida: A semi-automated remote sensing analysis. *Estuaries and Coasts*, *45*(7), 2082-2101. https://doi.org/10.1007/s12237-022-01050-4

Lebrasse, M. C., Schaeffer, B. A., Zimmerman, R. C., Hill, V. J., Coffer, M. M., Whitman, P. J., Salls, W. B., Graybill, D. D., & Osburn, C. L. (2022b). Simulated response of St. Joseph Bay, Florida, seagrass meadows and their belowground carbon to anthropogenic and climate impacts. *Marine Environmental Research*, *179*, 105694. https://doi.org/10.1016/j.marenvres.2022.105694

Leh, F. C., Mokhtar, F. Z., Rameli, N., & Ismail, K. (2018). Measuring recreational value using travel cost method (TCM): A number of issues and limitations. *International Journal of Academic Research in Business and Social Sciences*, *8* (10). https://doi.org/10.6007/ijarbss/v8-i10/5306

McDonough, J. (2008) The business of nature. Miss.-Ala. Bays and Bayou Symposium, Biloxi MS, Oct 28-29, 2008.

Nguyen, B.H., & Bi, X. (2017). Using the travel cost method to estimate fresh-water based recreation in north central Florida. https://doi.org/10.22004/ag.econ.258277

Nowak, D. J. (2021). Understanding i-Tree: 2021 Summary of Programs and Methods. *General Technical Report Forest Service.* https://doi.org/10.2737/NRS-GTR-200-2021

Nowak, D. J., Greenfield, E. J., Hoehn, R. E., & Lapoint, E. (2013). Carbon storage and sequestration by trees in urban and community areas of the United States. *Environmental Pollution,* 178, 229-236. https://doi.org/10.1016/j.envpol.2013.03.019

Passeri, D.L., Hagen, S.C., Plant, N.G., Bilskie, M.V., Medeiros, S.C. and Alizad, K. (2016). Tidal hydrodynamics under future sea level rise and coastal morphology in the Northern Gulf of Mexico. *Earth's Future*, *4*(5),159-176. https://doi.org/10.1002/2015EF000332

Ravenscroft, N., & Church, A. (2011). The attitudes of recreational user representatives to pollution reduction and the implementation of the European water framework directive. *Land Use Policy*, *28*(1), 167–174. https://doi.org/10.1016/j.landusepol.2010.05.009

Ropicki, A., Adams, C., Lindberg, B., & John, S. (2006). The economic benefits associated with Florida's artificial reefs. *EDIS*, *2021*(4), 8. https://doi.org/10.32473/edis-fe649-2021

Seidel, V., Milon, W., Barker, A., & Diamond, C. (2015, January). Economic impact of the St. Johns water quality on property values. St. Johns river water management district. *Water e-Journal*, 1-12. https://doi.org/10.21139/wej.2016.028

Stainback, A. (2017). The economic significance of Florida Bay. https://conference.ifas.ufl.edu/geer/past/geer2017/presentations/5_Sandpiper/4_Thursday/1130_Stainback_Session35.pdf

Stokes-Cawley, O., Stroud, H., Lyons, D., Wiley, P., & Goodhue, C. (2021). Economic contribution analysis of national estuarine research reserves. *Water*, *13*(11), 1596. https://doi.org/10.3390/w13111596

Sutherland, D. F. (1978). Estimated average daily instantaneous numbers of recreational and commercial fishermen and boaters in the St. Andrew Bay system, Florida, and adjacent coastal waters, 1973 (Vol. 724). Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Wallace, R., Bouvier, R., Yeitz, L., & Colgan, C. (2017). The economic contribution of Casco Bay. https://digitalcommons.usm.maine.edu/cbep-publications/187

Whitehead, J. C., Haab, T., Larkin, S. L., Loomis, J. B., Alvarez, S., & Ropicki, A. (2018). Estimating lost recreational use values of visitors to northwest florida due to the deepwater horizon oil spill using cancelled trip data. *Marine Resource Economics*, *33*(2), 119–132. https://doi.org/10.1086/697560

Worthy, G., Wells, R., Martin, S., & Shippee, S. (2013). *Impacts of the 2010 Deepwater Horizon Oil Spill on estuarine bottlenose dolphin populations in the west Florida panhandle* (No. 10-1101). Final Tech Report, Florida Institute of Technology, Contract.

Yarbro, L.A., & Carlson, P.R. (2011). Seagrass integrated mapping and monitoring for the state of Florida mapping and monitoring report No. 1. https://hillsborough.wateratlas.usf.edu/upload/documents/Seagrass-Integrated-Mapping-Monitoring-Fla-FWC-2011.pdf

Yarbro, L.A., & Carlson, P.R. (2018). Summary report for St. Joseph Bay. https://myfwc.com/media/18667/simm3-st-joseph-bay.pdf

Appendix A. Data Sources and GIS Data Pre-Processes Steps for Analysis

Table A-1. Data Sources Used for this Project

Data Sources Used for this Project			
Source	**Type of Data**	**Purpose for this Project**	**Format**
SASJBEP	SASJBEP boundaries	Define estuary boundary	GIS shapefile
NETS 2020	Business data	Analyze business sales and employment over time and by SIC classification	CSV file
Florida Department of Revenue (FDOR)	Property appraiser data for Bay and Gulf Counties	Analyze just values for property parcels and land use categories	GIS shapefile
National Oceanic and Atmospheric Administration (NOAA)	2-foot Sea Level Rise predictions	Define areas affected by sea level rise modeling	GIS shapefile
Federal Emergency Management Agency (FEMA)	100-year Flood Zone predictions	Define areas affected by flood modeling	GIS shapefile

Table A-2. GIS Data Pre-Processes Used to Prepare Data for Analysis

GIS Data Pre-Processing Steps		
Data	**Processing Step**	**Result**
SASJBEP boundary	Used GIS to create a 1/2 mile buffer around estuary boundaries. Edited boundary to include Tyndall Air Force base at the request of SASJBEP Team	GIS shapefile (polygon format)
NETS 2020	Used GIS to convert CSV data into a GIS shapefile	GIS shapefile of businesses (point format). Used GIS to spatial join the NETS point data to the FDOR property appraiser data.
NOAA Sea Level Rise data	n/a	Original GIS shapefile format (polygon format)
FEMA Flood data	n/a	Original GIS shapefile format (polygon format)

Appendix B. Detailed Results of Businesses in the SASJBEP Area

Summary of Businesses within 1/2 mile of the SASJBEP Area, Bay County				
Small Businesses (less than 10 employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	206	469	$19,062,955	$110,838,918
Mining	1	6	$1,050,012	$374,000
Construction	1,050	2,445	$253,945,223	$313,895,396
Manufacturing	135	440	$44,323,552	$66,164,351
Transportation, Comm., Electric, Gas, and Sanitary Services	259	786	$58,654,840	$239,387,308
Wholesale Trade	187	570	$89,916,683	$111,971,157
Retail Trade	575	1,929	$175,293,999	$337,391,946
Finance, Insurance, and Real Estate	695	1994	$192,387,854	$423,429,213
Services	4,360	10,862	$609,583,183	$8,531,064,074
Public Administration	41	158	$479,397	$80,268,318
Totals	**7,509**	**19,659**	**$1,444,697,698**	**$10,214,784,681**
Medium Businesses (between 10 and 49 employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	0	0	$0	$0
Mining	0	0	$0	$0
Construction	16	265	$37,513,675	$2,503,380
Manufacturing	19	297	$58,554,735	$11,149,525
Transportation, Comm., Electric, Gas, and Sanitary Services	14	321	$107,368,555	$24,109,097
Wholesale Trade	2	67	$29,748,572	$397,536
Retail Trade	200	2765	$232,035,619	$161,883,871
Finance, Insurance, and Real Estate	16	270	$85,815,923	$5,650,384
Services	180	2929	$197,878,065	$210,458,930
Public Administration	43	918	$9,476,000	$181,401,090
Totals	**490**	**7,832**	**$758,391,144**	**$597,553,813**

Summary of Businesses within 1/2 mile of the SASJBEP Area, Bay County (Cont.)				
Large Businesses (50 or more employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	0	0	$0	$0
Mining	0	0	$0	$0
Construction	5	365	$69,400,362	$1,378,571
Manufacturing	14	2551	$446,174,104	$70,205,931
Transportation, Communications, Electric, Gas, and Sanitary Services	10	734	$152,654,536	$2,612,602
Wholesale Trade	2	139	$51,433,000	$167,265
Retail Trade	12	995	$116,669,471	$15,378,020
Finance, Insurance, and Real Estate	4	285	$18,385,755	$3,713,876
Services	50	8,351	$879,647,189	$1,361,036,660
Public Administration	28	4,611	$0	$127,704,479
Totals	**125**	**18,031**	**$1,734,364,417**	**$1,582,197,404**
All Businesses				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	206	469	$19,062,955	$110,838,918
Mining	1	6	$1,050,012	$374,000
Construction	1071	3,075	$360,859,260	$317,777,347
Manufacturing	168	3,288	$549,052,391	$147,519,807
Transportation, Communications, Electric, Gas, and Sanitary Services	283	1,841	$318,677,931	$266,109,007
Wholesale Trade	191	776	$171,098,255	$112,535,958
Retail Trade	787	5,689	$523,999,089	$514,653,837
Finance, Insurance, and Real Estate	715	2,549	$296,589,532	$432,793,473
Services	4,590	22,142	$1,687,108,437	$10,102,559,664
Public Administration	112	5,687	$9,955,397	$389,373,887
Totals	**8,124**	**45,522**	**$3,937,453,259**	**$12,394,535,898**

Summary of Businesses within 1/2 mile of the SASJBEP Area, Gulf County				
Small Businesses (less than 10 employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	14	31	$1,113,232	$17,099,520
Mining	0	0	$0	$0
Construction	134	324	$34,445,311	$147,987,383
Manufacturing	9	35	$3,288,412	$11,380,315
Transportation, Comm., Electric, Gas, and Sanitary Services	27	104	$7,117,126	$28,094,690
Wholesale Trade	20	60	$10,576,186	$23,847,720
Retail Trade	113	376	$37,102,839	$130,491,688
Finance, Insurance, and Real Estate	94	259	$22,751,679	$112,081,712
Services	507	1241	$76,992,571	$597,772,393
Public Administration	8	34	$0	$7,335,350
Totals	**926**	**2,464**	**$193,387,356**	**$1,076,090,771**
Medium Businesses (between 10 and 49 employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	0	0	$0	$0
Mining	0	0	$0	$0
Construction	1	12	$1,500,000	$1,184,360
Manufacturing	1	25	$2,616,461	$1,184,360
Transportation, Comm., Electric, Gas, and Sanitary Services	4	63	$10,820,828	$4,737,440
Wholesale Trade	1	14	$3,601,864	$1,184,360
Retail Trade	38	522	$27,787,633	$46,320,340
Finance, Insurance, and Real Estate	4	52	$6,094,315	$4,817,700
Services	24	348	$15,101,905	$29,424,680
Public Administration	8	130	$0	$9,837,995
Totals	**81**	**1,166**	**$67,523,006**	**$98,691,235**

Summary of Businesses within 1/2 mile of the SASJBEP Area, Gulf County (Cont.)				
Large Businesses (50 or more employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	0	0	$0	$0
Mining	0	0	$0	$0
Construction	0	0	$0	$0
Manufacturing	0	0	$0	$0
Transportation, Communications, Electric, Gas, and Sanitary Services	2	335	$119,260,000	$2,368,720
Wholesale Trade	1	50	$23,503,291	$1,184,360
Retail Trade	1	75	$11,372,175	$1,184,360
Finance, Insurance, and Real Estate	2	350	$14,378,768	$2,368,720
Services	7	831	$52,413,811	$7,133,904
Public Administration	4	364	$0	$5,175,660
Totals	**17**	**2,005**	**$220,928,045**	**$19,415,724**
All Businesses				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	14	31	$1,113,232	$17,099,520
Mining	0	0	$0	$0
Construction	135	336	$35,945,311	$149,171,743
Manufacturing	10	60	$5,904,873	$12,564,675
Transportation, Communications, Electric, Gas, and Sanitary Services	33	502	$137,197,954	$35,200,850
Wholesale Trade	22	124	$37,681,341	$26,216,440
Retail Trade	152	973	$76,262,647	$177,996,388
Finance, Insurance, and Real Estate	100	661	$43,224,762	$119,268,132
Services	538	2,420	$144,508,287	$634,330,977
Public Administration	20	528	$0	$22,349,005
Totals	**1,024**	**5,635**	**$481,838,407**	**$1,194,197,730**

Summary of Businesses within 1/2 mile of the SASJBEP Area, All Counties				
Small Businesses (less than 10 employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	220	500	$20,176,187	$127,938,438
Mining	1	6	$1,050,012	$374,000
Construction	1,184	2,769	$288,390,534	$461,882,779
Manufacturing	144	475	$47,611,964	$77,544,666
Transportation, Comm., Electric, Gas, and Sanitary Services	286	890	$65,771,966	$267,481,998
Wholesale Trade	207	630	$100,492,869	$135,818,877
Retail Trade	688	2,305	$212,396,838	$467,883,634
Finance, Insurance, and Real Estate	789	2,253	$215,139,533	$535,510,925
Services	4,867	12,103	$686,575,754	$9,128,836,467
Public Administration	49	192	$479,397	$87,603,668
Totals	**8,435**	**22,123**	**$1,638,085,054**	**$11,290,875,452**
Medium Businesses (between 10 and 49 employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	0	0	$0	$0
Mining	0	0	$0	$0
Construction	17	277	$39,013,675	$3,687,740
Manufacturing	20	322	$61,171,196	$12,333,885
Transportation, Comm., Electric, Gas, and Sanitary Services	18	384	$118,189,383	$28,846,537
Wholesale Trade	3	81	$33,350,436	$1,581,896
Retail Trade	238	3,287	$259,823,252	$208,204,211
Finance, Insurance, and Real Estate	20	322	$91,910,238	$10,468,084
Services	204	3,277	$212,979,970	$239,883,610
Public Administration	51	1,048	$9,476,000	$191,239,085
Totals	**571**	**8,998**	**$825,914,150**	**$696,245,048**

Summary of Businesses within 1/2 mile of the SASJBEP Area, All Counties (Cont.)				
Large Businesses (50 or more employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	0	0	$0	$0
Mining	0	0	$0	$0
Construction	5	365	$69,400,362	$1,378,571
Manufacturing	14	2,551	$446,174,104	$70,205,931
Transportation, Comm., Electric, Gas, and Sanitary Services	12	1,069	$271,914,536	$4,981,322
Wholesale Trade	3	189	$74,936,291	$1,351,625
Retail Trade	13	1,070	$128,041,646	$16,562,380
Finance, Insurance, and Real Estate	6	635	$32,764,523	$6,082,596
Services	57	9,182	$932,061,000	$1,368,170,564
Public Administration	32	4,975	$0	$132,880,139
Totals	**142**	**20,036**	**$1,955,292,462**	**$1,601,613,128**
All Businesses				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	220	500	$20,176,187	$127,938,438
Mining	1	6	$1,050,012	$374,000
Construction	1,206	3,411	$396,804,571	$466,949,090
Manufacturing	178	3,348	$554,957,264	$160,084,482
Transportation, Comm., Electric, Gas, and Sanitary Services	316	2,343	$455,875,885	$301,309,857
Wholesale Trade	213	900	$208,779,596	$138,752,398
Retail Trade	939	6,662	$600,261,736	$692,650,225
Finance, Insurance, and Real Estate	815	3,210	$339,814,294	$552,061,605
Services	5,128	24,562	$1,831,616,724	$10,736,890,641
Public Administration	132	6,215	$9,955,397	$411,722,892
Totals	**9,148**	**51,157**	**$4,419,291,666**	**$13,588,733,628**

Appendix C. Results of Market Values of Properties by Residence Type in SASJBEP Area

Market Values within the SASJBEP Area Buffer and 100-year Flood Zone				
Proximity to Bay	**Housing Category**	**Number of Units**	**Average Market Value**	**Total Market Value**
Gulf Front	Vacant	1,092	$267,119,540	$267,119,540
	Family Home	1,972	$1,286,194,973	$1,286,194,973
	Mobile Home	2	$331,863	$331,863
	Townhouse	33	$14,300,944	$14,300,944
	Condo	4,245	$1,566,330,096	$1,566,330,096
	Totals	**7,344**	**$426,781**	**$3,134,277,416**
Bay Front	Vacant	2,252	$291,526,086	$291,526,086
	Family Home	3,984	$1,501,747,416	$1,501,747,416
	Mobile Home	131	$16,098,450	$16,098,450
	Townhouse	66	$19,541,307	$19,541,307
	Condo	825	$225,523,535	$225,523,535
	Totals	**7,258**	**$283,058**	**$2,054,436,794**
Bay View	Vacant	1,668	$106,985,564	$106,985,564
	Family Home	4,770	$1,070,803,706	$1,070,803,706
	Mobile Home	300	$28,089,036	$28,089,036
	Townhouse	140	$29,103,332	$29,103,332
	Condo	812	$186,183,917	$186,183,917
	Totals	**7,690**	**$184,807**	**$1,421,165,555**
Partial View	Vacant	2,846	$143,358,839	$143,358,839
	Family Home	8,437	$1,784,174,330	$1,784,174,330
	Mobile Home	759	$76,884,321	$76,884,321
	Townhouse	287	$59,065,266	$59,065,266
	Condo	611	$220,938,726	$220,938,726
	Totals	**12,940**	**$176,540**	**$2,284,421,482**
No View	Vacant	3,484	$140,793,938	$140,793,938
	Family Home	9,580	$1,812,022,903	$1,812,022,903
	Mobile Home	1,275	$101,730,797	$101,730,797
	Townhouse	326	$49,070,221	$49,070,221
	Condo	242	$87,542,369	$87,542,369
	Totals	**14,907**	**$146,989**	$2,191,160,228
Totals		**50,139**	**$221,095**	**$11,085,461,475**

Appendix D. Mexico Beach Analysis

The City of Mexico Beach is an important tourist destination and economic draw to the general SASJBEP area. Mexico Beach is located between the St. Andrews and St. Joe estuaries but is outside of the ½ mile analysis buffer and thus outside the scope of this project. However, because of the importance of the area, we include a stand-alone analysis of the city in this Appendix. The analysis area is the city limits boundary as defined by the Florida Geographic Data Library (fgdl.org). This section analyzes land use, residential prices by Gulf views, and business employment and sales.

Land Use

Figure D-1 shows a map of the land use by property parcel and Table D-1 enumerates the number of parcels and market value for each land use category. The agriculture and miscellaneous categories account for the fewest but largest land parcels. The residential category accounts for over 57,000 properties and over $12.5 billion in market value. There are over 4,000 commercial properties scattered along the main highway US 98 with over $2 billion in the land market value.

Figure D-1. Land use types in Mexico Beach Florida

Table D-1. Market Values for the Mexico Beach Land Parcels

Land Use Category	Number of Parcels	Total Market Value
Residential	57,828	$12,596,882,251
Commercial	4,269	$2,830,687,077
Industrial	477	$366,769,222
Agricultural	163	$117,851,214
Institutional	332	$350,223,757
Government	1,331	$1,216,448,446
Miscellaneous	240	$146,253,061
Total	**64,640**	**$17,625,115,028**

Gulf Views

The analysis of the Gulf views was conducted using property parcel and just valuation data from the Florida Department of Revenue (FDOR). Keeping consistent with the previous Haas reports' methodology, the team split properties into four tiers depending on distance from the Gulf (as Mexico Beach is not proximate to estuaries). It should be noted that the definition for Gulf Front differs from previous definitions in this study because the distance from the Gulf to the nearest roadway is much greater in Mexico Beach than for the estuarial areas. The team used Google Street View and personal knowledge of the area to verify reasonable Gulf views. Figure D-2 shows a map of property parcels and the resulting views.

1) Zero – 250 feet (Gulf front)
2) 250 – 600 feet (Gulf view)
3) 600 feet – ¼ miles (Partial Gulf view)
4) ¼ miles – ½ miles (No Gulf view)

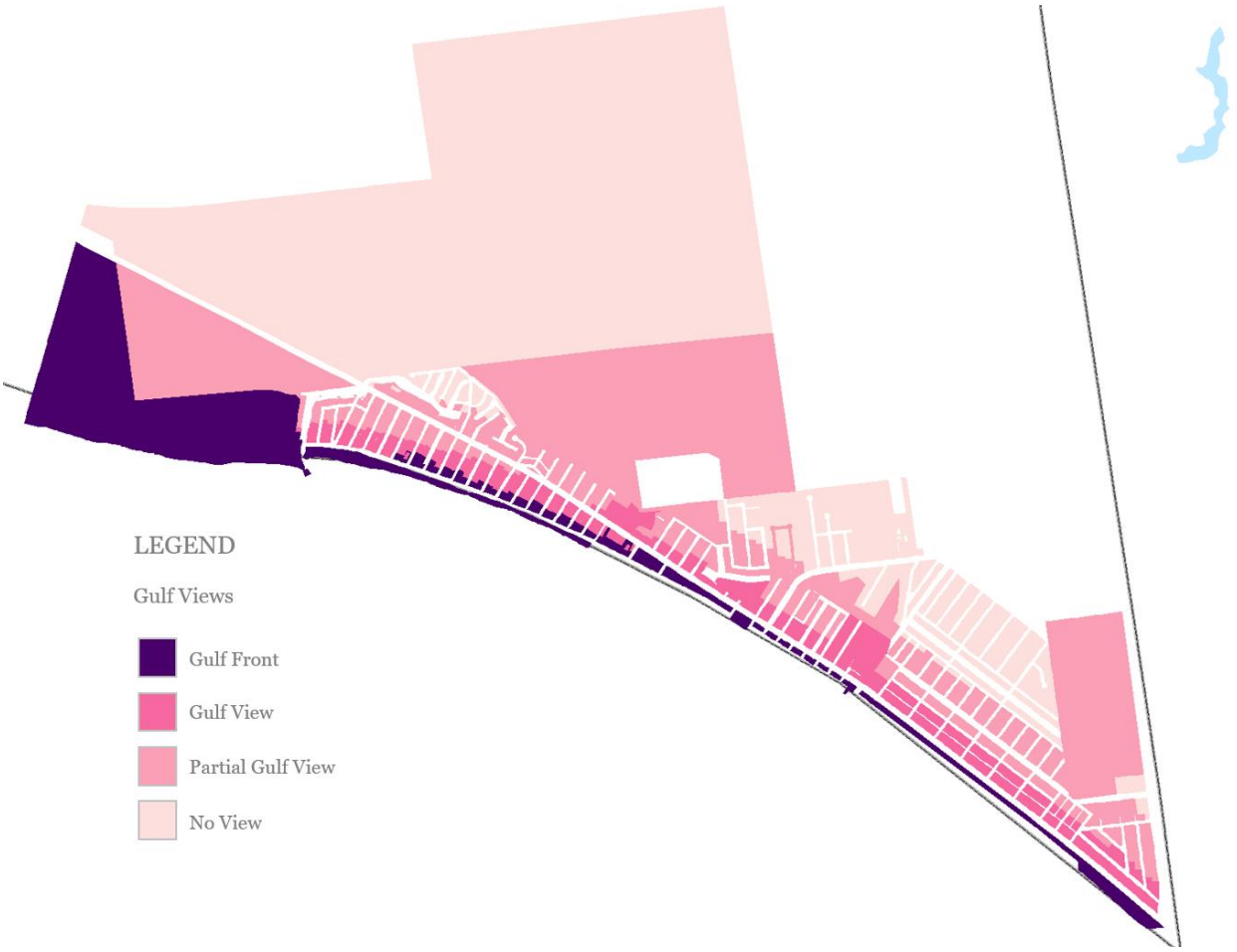


Figure D-2. Gulf Views of Mexico Beach for All Land Use Types

Table D-2 shows that residences with a Gulf Front view have the highest market value, averaging over $500 thousand per property. Parcels with a Gulf view have the second highest value, at over $300 thousand, followed by the Partial Gulf view and No View categories. Of the types of residences, Family Homes have the highest values in the Gulf Front and Gulf View categories, but Townhomes or Condos have higher values in the less desirable view categories. The category with the highest market value is Family Home with a Gulf Front view, with the average property exceeding $1 million.

Table D-2. Market Values of Residence Type and Gulf View

Market Values within the SASJBEP Area Buffer in Mexico Beach				
Proximity to Bay	**Housing Category**	**Number of Units**	**Average Market Value**	**Total Market Value**
Gulf Front	Vacant	98	$156,052	$35,701,704
	Family Home	30	$586,105	$31,435,258
	Mobile Home	0	$127,079	$0
	Townhouse	0	$823,727	$0
	Condo	0	$266,238	$0
	Totals	**128**	**$345,993**	**$67,136,962**
Gulf View	Vacant	280	$105,825	$65,270,163
	Family Home	191	$452,871	$87,268,235
	Mobile Home	4	$76,598	$859,270
	Townhouse	5	$503,079	$1,986,641
	Condo	179	$276,831	$59,494,312
	Totals	**659**	**$323,539**	**$214,878,621**
Partial Gulf View	Vacant	336	$110,306	$57,453,313
	Family Home	400	$490,882	$124,302,352
	Mobile Home	37	$61,998	$6,166,092
	Townhouse	4	$525,776	$1,215,084
	Condo	118	$230,980	$43,756,758
	Totals	**895**	**$276,645**	**$232,893,599**
No View	Vacant	213	$65,698	$19,349,886
	Family Home	236	$230,789	$61,408,914
	Mobile Home	38	n/a	$4,701,691
	Townhouse	3	$188,735	$663,845
	Condo	40	n/a	$11,058,537
	Totals	**530**	**$194,059**	**$97,182,873**
Totals		**2,212**	**$276,714**	**$612,092,055**

Businesses

Table D-3 show the total number of business, number of employees, and aggregated sales for each SIC code within the city limits. The service(s) sector is the largest industry in the area. There are 107 businesses with 273 employees, and over $14 million in sales. Tables D-4 and D-5 show that most businesses are considered small (less than 10 employees) and medium (between 10 and 49 employees). There are no large businesses (50 or more employees) in the area. Small businesses comprise 95% of all businesses, 76% of employment, and 90% of sales. Figure D-3 shows a spatial distribution of the businesses by type within the city.

Table D-3. Businesses by SIC Code Within Mexico Beach City Limits

All Businesses				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	4	10	$221,500	$0
Mining	0	0	$0	$0
Construction	22	65	$9,212,217	$187,003
Manufacturing	1	8	$1,600,000	$0
Transportation, Comm., Electric, Gas, and Sanitary Services	9	27	$2,441,201	$1,470,236
Wholesale Trade	6	13	$1,276,469	$138,684
Retail Trade	22	132	$7,827,102	$4,918,672
Finance, Insurance, and Real Estate	22	89	$8,827,581	$960,577
Services	107	273	$14,562,882	$9,656,275
Public Administration	4	66	$0	$528,344
Totals	**197**	**683**	**$45,968,952**	**$17,859,791**

Table D-4. Small Businesses Within Mexico Beach

Small Businesses (less than 10 employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	4	10	$221,500	$0
Mining	0	0	$0	$0
Construction	22	65	$9,212,217	$187,003
Manufacturing	1	8	$1,600,000	$0
Transportation, Communications, Electric, Gas, and Sanitary Services	9	27	$2,441,201	$1,470,236
Wholesale Trade	6	13	$1,276,469	$138,684
Retail Trade	16	60	$5,195,318	$4,918,672
Finance, Insurance, and Real Estate	21	79	$7,928,135	$960,577
Services	105	252	$13,629,422	$9,656,275
Public Administration	2	10	$0	$330,286
Totals	**186**	**524**	**$41,504,262**	**$17,661,733**

Table D-5. Medium Businesses Within Mexico Beach

Medium Businesses (between 10 and 49 employees)				
Sector (by SIC)	**Number of Businesses**	**Number of Employees**	**Total Sales**	**Total Just Value of Properties**
Agriculture, Forestry, and Fishing	0	0	$0	$0
Mining	0	0	$0	$0
Construction	0	0	$0	$0
Manufacturing	0	0	$0	$0
Transportation, Comm., Electric, Gas, and Sanitary Services	0	0	$0	$0
Wholesale Trade	0	0	$0	$0
Retail Trade	6	6	$2,631,784	$0
Finance, Insurance, and Real Estate	1	1	$899,446	$0
Services	2	2	$933,460	$0
Public Administration	2	2	$0	$198,058
Totals	**11**	**11**	**$4,464,690**	**$198,058**

Figure D-3. Map of Businesses in Mexico Beach by SIC Code

Appendix E. Carbon Sequestration

Carbon sequestration is the process of capturing and storing carbon dioxide from the atmosphere. In the St. Andrews Bay Estuary, 69.21 kilotons (kT) (±4.91) of elemental carbon, or 253.76 kT (±18.02) of CO_2, is sequestered annually in the trees. This values at $11.8 million. 6,372.91 kT (±452.53) of CO_2 is stored in trees in the area (not an annual rate), valued at $296.4 million. In the St. Joseph Bay Estuary, 53.48 kT (±5.78) of CO_2 is sequestered annually in the trees, valued at $2.5 million. 1,343.06 kT (±145.24) of CO_2 is stored in trees in the area, valued at $62.5 million (i-Tree, 2022).

Carbon dioxide (CO_2) is a potent greenhouse gas, capable of making temperatures rise while in the atmosphere (Afzal, 2013). The gas is emitted into the atmosphere via human lead processes, such as manufacturing and production (Afzal, 2013). Trees are significant natural sinks for CO_2 due to their biomass, wherein carbon is stored. Trees undergo photosynthesis, in which the plant takes in CO_2, fixes it, and releases oxygen into the atmosphere (Afzal, 2013; Nowak, 2021). The process of removing carbon from the atmosphere and storing it is carbon sequestration, and trees sequester carbon during photosynthesis (Nowak, 2021). Such ecosystem processes provide an economic benefit to the environment; carbon emissions are a "negative externality" – companies that produce carbon emissions do not bear the cost of the damage it causes (Afzal, 2013). Trees sequester carbon naturally, and to sequester carbon through other methods is costly.

To determine the annual carbon sequestration and the corresponding monetary values in the St. Andrews and St. Joseph Bay areas, respectively, the "i-Tree canopy" tool was used. The "i-Tree" software estimates carbon storage, annual carbon sequestration, and emissions of carbon from tree decomposition using a point-overlay system managed by the user to determine ground cover classes (i-Tree, 2022).[23] Based on the areas classified as tree cover, the tool provides annual estimations. The biomass of a tree multiplied by 0.5 produces a carbon storage estimate (Nowak, 2021).

Carbon storage and sequestration by urban trees play an important role in environmental and human health. Trees in the urban areas of the United States are estimated to store 643 million tons at a value of $50.5 billion. The annual sequestration is estimated to be 25.6 million tons at a value of $2.0 billion (Nowak et al., 2013). Urban trees, as a result of carbon storage and sequestration, influence air temperatures and building energy use, therefore altering carbon emissions from urban sources. The implications of this include influences on local climate, carbon cycles, energy use, and climate change. Trees in urban areas have a grand potential to store and sequester tremendous amounts of carbon. An understanding

[23] See: https://canopy.itreetools.org/

and consideration of urban eco-systems, and the inherent eco-system services provided by such, have the potential to be used to develop better management plans at the city, county, and state level, as well as national policies. Both of which have the possibility to significantly improve environmental quality and human health (Nowak et al., 2013). As carbon sequestration and storage increases, negative impacts on the climate decrease, and less money is spent on mitigating climate change, and sequestering carbon from the atmosphere using expensive technologies. Trees mitigate the social cost of carbon emissions.