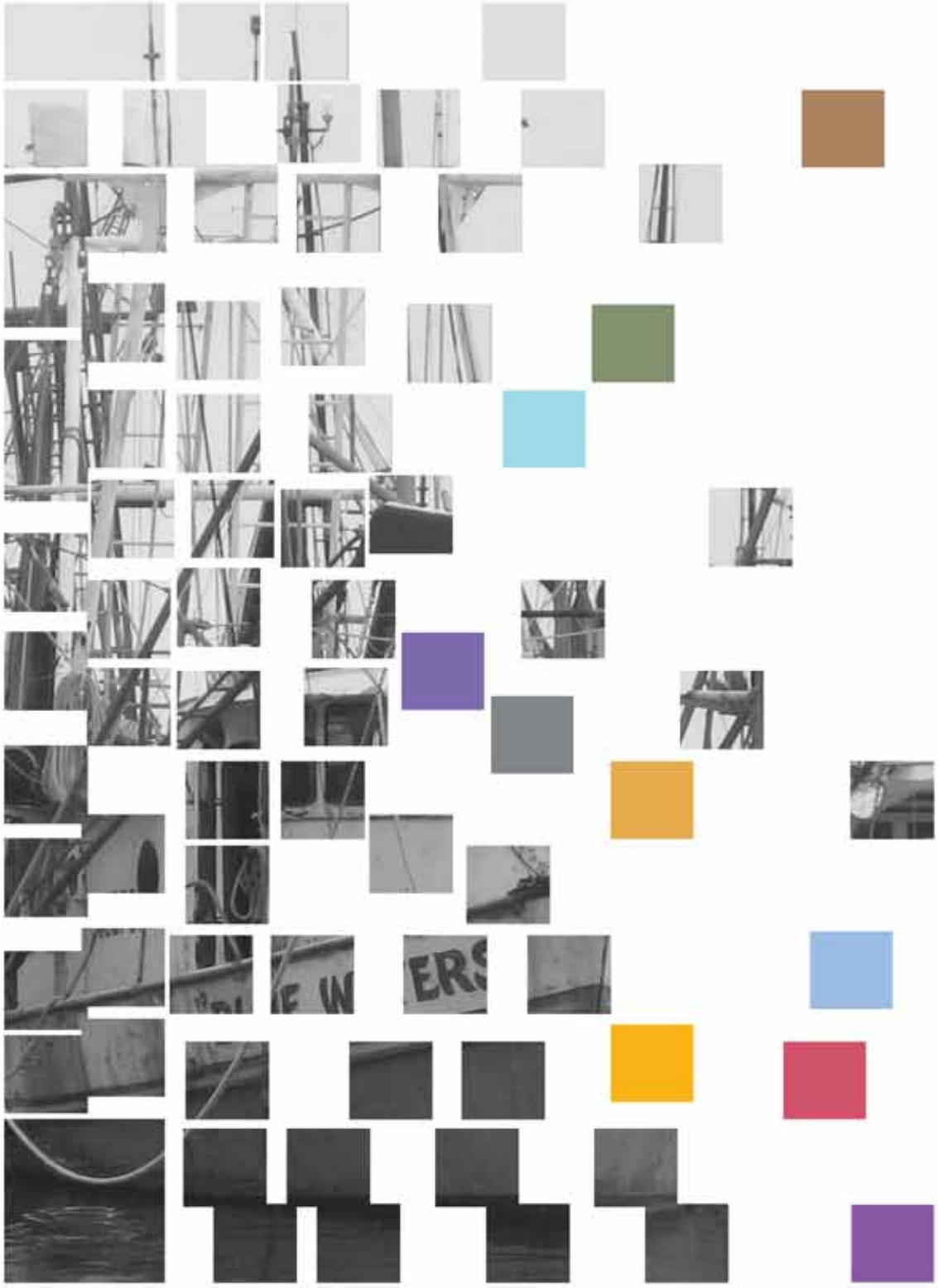

Mississippi Gulf Coast Food System Assessment

September, 2011

PLAN FOR OPPORTUNITY

This is a Working Document that has been approved by the Working Group and the Executive Committee. Working Documents provide information and recommendations that guide the on-going discussions and preparation of the final plan; these are not final plan documents. Once the draft final plan has been prepared, it will brought to the public through various outreach activities and reviewed by the various planning committees before the Executive Committee votes on adopting as the Final Plan for Opportunity.






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Introduction

The Plan for Opportunity is a collaborative planning project intended to guide the economic growth and development of the Mississippi Gulf Coast and to improve housing, employment and transportation opportunities throughout the region. The three year planning process will be guided by the Constituency for a Sustainable Coast (CSC), a group of stakeholder committees which will be organized and expanded over the course of the plan to include city and county leadership, key community and public partners, and residents of the region.

The Mississippi Gulf Coast was one of 45 regions nationwide to receive grant funding from the federal Partnership for Sustainable Communities to develop a regional sustainability plan. The Partnership for Sustainable Communities is an agreement between the U.S. Department of Housing and Urban Development, the U.S. Department of Transportation, and the U.S. Environmental Protection Agency to take a more holistic approach to better respond to the regional needs. Guided by six Livability Principles, the Partner agencies are coordinating investments, restructuring funding programs, and aligning policies to support local efforts to provide more housing choices, make transportation systems more efficient and reliable, reinforce existing investments, and support vibrant and healthy neighborhoods that attract businesses.

The Plan for Opportunity will bring the 3 coastal counties and 11 municipalities together in a comprehensive regional planning process that aims to:

- Lower transportation and housing costs by creating better connections between where people live and work.
- Develop in ways that value the natural environment, understanding that regional prosperity is dependent on our many environmental assets.
- Improve air quality by making buildings more energy efficient and reducing vehicle miles traveled.
- Create a broad range of employment and business opportunities by coordinating land-use, transportation and infrastructure planning.
- Improve regional health by ensuring that all communities have access to fresh food, safe recreation, open space, medical care, and clean air and water.

The planning process will be a broad-based effort, understanding that the success of the final Plan rests on the extent of stakeholder input and decision making. *The Plan for Opportunity* is key to strengthening the economy, improving quality of life for residents, and creating a more sustainable future for the region.

As part of the planning process the food systems subcommittee is actively preparing for a sustainable food system. This food system assessment is the first stage in the Consortium's efforts to envision a more sustainable food system for the Mississippi Gulf Coast. The Consortium has undertaken this study to better understand the complicated regional food system that feeds our coast. This food system study focuses on indicators, agricultural and aquaculture resources, distribution infrastructure, food security, the food economy, food waste and climate change.

This food system assessment includes the three coastal Mississippi counties, as well as a study of the 100-mile foodshed, including 33 counties and parishes across Alabama, Louisiana and Mississippi. The foodshed includes more than 2.4 million acres of agricultural land and over 16,000 farms.[1]

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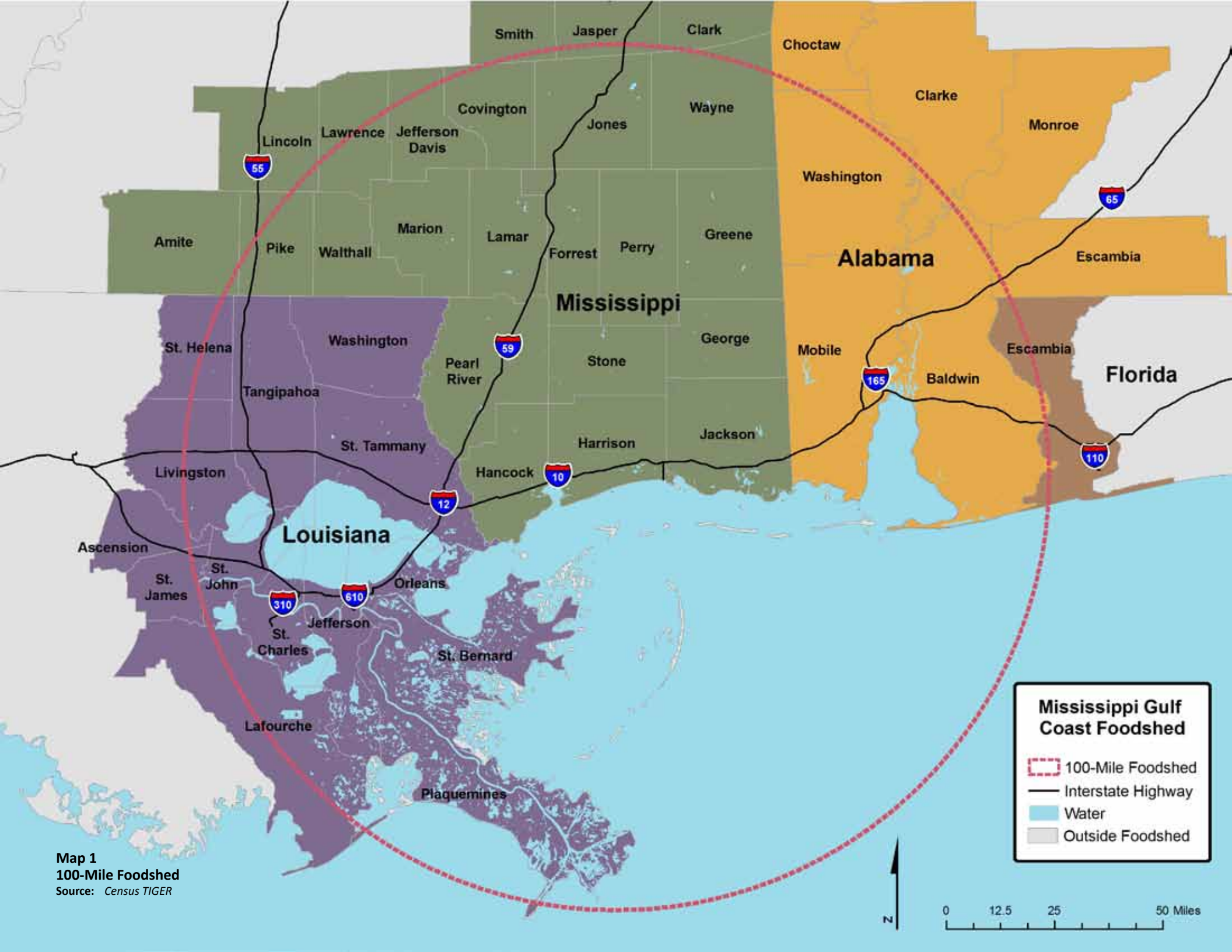


Map 1
100-Mile Foodshed
Source: *Census TIGER*

History of Food on the Mississippi Gulf Coast

The extensive waterway systems of the Mississippi Gulf Coast serve as the backbone of the area's history and cultural heritage. Native Americans fished and farmed the land thousands of years before the first Europeans set foot on the Mississippi Gulf Coast. Over time, agriculture, fishing, trading, logging, and shipbuilding have depended on the coastal waterway systems.

In the sixteenth and seventeenth centuries the waters of the Mississippi Gulf Coast were explored by the Europeans looking for lands to colonize. The Coast's navigable waters and its potential for commercial exchange made it an ideal location for settlement. In 1700 Pierre le Moyne Sieur d'Iberville anchored in Mississippi waters; his landing on the mainland near Biloxi marked the birth of the French Louisiana colony.[2] The colony expanded rapidly to include Mobile and New Orleans. D'Iberville established Fort Maurepas near present-day Biloxi with help from colonists and provisions imported from France.

Biloxi became, for a short period, the colonial capital of a European empire and one of the oldest, continuously occupied communities in the United States. This colonial period also marked the first sustained contact between the French and the native inhabitants of Mississippi. The French settlement at Biloxi Bay and the harbor at Ship Island in the Mississippi Sound served as entry points for people moving through the area as free colonists, and also for ships trading in African slaves.[3]

Throughout the early 1800s the Gulf Coast was a battleground between British, French and American settlers. By the mid-1800s the shallow calm waters of the Mississippi Sound, protected from the open Gulf of Mexico by a series of barrier islands, facilitated the movement of goods, resources and people between New Orleans and Mobile. The establishment of steamboat services generated opportunities for New Orleans farmers and businessmen to travel on vacation to the Mississippi coastline. The steamboat enterprise eventually developed six stops along the Mississippi coastline which helped transform the area into a summer getaway for the wealthy. The wealthy who summered on the Mississippi Gulf Coast brought their African-American domestic staff with them who prepared Creole cuisine. By the 18th century trade was active with species from the Caribbean influencing the region's cuisine. The Spanish brought into the cuisine the use of cooked onions, green peppers, tomatoes, and garlic. Africans introduced okra. Local foods, such as crawfish, shrimp, oysters, crabs, and pecans found their way into Creole cuisine. From the Choctaw Indians came the use of filé, a powdered herb from sassafras leaves, to thicken gumbo. Creole cuisine was prepared by domestic staff, developing new dishes by mixing their own heritage into the dishes preferred by their employers. [4] [5]

Seafood Industry Development

The first part of the nineteenth century marked the beginning of the seafood industry in Biloxi. The surrounding landscape was favorable to the development of the seafood industry.[6] The area became one of the nation's premiere resort areas, attracting visitors primarily from Alabama and Louisiana to enjoy the readily available fresh seafood.

Source: *Mississippi Gulf Coast Community College Dixie Press Collection*

Alongside fishing, agriculture grew in the early 20th century. Harrison County developed a wool industry as the result of open-range sheep grazing, a common practice throughout the foodshed.

Shipbuilding industries emerged simultaneously to meet the growing demand for seafood by constructing larger boats. In the early nineteenth century, small boatyards existed along the entire Mississippi Gulf Coast. During this time, Biloxi's seafood industry supplied only local markets. Seafood distribution was limited to the coastal communities, and inland communities did not have regular access to seafood. Most of the catch was consumed and processed locally; the products could not be shipped to markets far from the area without spoilage.

The Gulf Coast's seafood industry commercialized with the invention of artificial ice in the mid-19th century and the extension of the Louisville and Nashville railroad system connecting New Orleans to Mobile.[7] The world's first commercial ice plant opened in New Orleans in 1868. Before long, two more commercial ice plants opened in Natchez (1870) and Jackson (1880), Mississippi.[8]

With the expanded coastal railroad service and the introduction of ice for refrigeration, Biloxi became the location of the first seafood cannery on the coast in 1881.[9] By 1890, Biloxi's canneries were processing two million pounds of oysters and 614,000 pounds of shrimp annually. By 1902, these numbers skyrocketed with twelve canneries reporting a combined catch of six million pounds of oysters and four and a half million pounds of shrimp. During down times the canneries would can fruits and vegetables.[10] The combination of boat modernization, rail access and the invention of seafood canning allowed the Biloxi seafood industry to expand and earn the designation "Seafood Capital of the World" by 1903. The city had grown to 8,000 people.

Ship Building

Fishermen required larger boats as the fishing industry grew. The catboat disappeared and gave way to the Biloxi Schooner, a boat that was best suited for the bayous, oyster reefs and the shallow bays and lakes of the Mississippi Gulf Coast.[11].The large numbers of fishermen that worked the shallow and plentiful waters of the Mississippi Sound quickly exhausted its marine fisheries. As a consequence, fishers moved into the open waters of the Gulf, which were until that point an untapped resource. The Biloxi Schooners were replaced by gasoline operated Luggers which allowed faster access to the Gulf of Mexico.

The shipbuilding industry received a further boost when local craftsmen were hired to build boats to support demand

from the U.S. Navy during the first and second world wars. During World War II, the Gulf Coast area saw large numbers of its male population mobilized to serve in the armed forces. The lack of hands in the shipbuilding industry was an opportunity for many women to join the shipyards. Women's contribution during this time did not pass under the radar; in 1942 Vera Anderson of Pascagoula was named "Champion Woman Welder of the World".[12]

Agriculture

Alongside fishing, agriculture grew in the early 20th century. Harrison County developed a wool industry as the result of open-range sheep grazing, a common practice throughout the northern forests of the region. The industry declined in the 1930s when open-range grazing was banned by the state.13 In Jackson County, the 1870s led to a boom in pecan production. Long Beach, after harvesting its yellow pine forests, began growing Long Red radishes and other vegetables. Long Beach served as a vegetable shipping point for the surrounding truck-farming region. Italian families from Hammond, Louisiana were purchasing land in Long Beach to expand their truck-farming operations. [14] Radishes were a beer hall staple in the 1910s and 1920s in the northern United States, leading to Long Beach becoming the radish capital of the world. However, as the Long Beach red radish became unpopular, cultivation declined and growers shifted to growing the common button radish.

Immigration

In order to meet the demands of the expanding seafood industry, significant immigration took place among several different ethnic groups. These included Polish from Baltimore, Slavonians, Louisiana Cajuns and Italians.[15] This wave of immigrants took place in the early 20th century and immediately after World War I. The Coast's economic boom attracted a large number of Slavonians that escaped their country to avoid political prosecution and conscription. A second group, the Louisiana Cajuns, also immigrated after the failure of the sugar cane crops in Louisiana. Italians also settled in Mississippi, where they operated grocery stores, fruit stands and restaurants.

The seafood processing factory owners provided their workforce with self-contained and self-sufficient camps. The camps offered the workers low rents and a store that carried basic supplies owned by the factory's owner. Residents of these communities benefited from the close proximity to friends and other family members. These housing arrangements provided and reinforced the workers' ethnic identities and enabled them to retain certain cultural traits and traditions that might otherwise have been lost.[16]

Women played an important role in the factories from the beginning. While the shrimping and oystering duties were male tasks, factory work was predominantly the female domain. However, some men were employed in the factories, including young boys that took their first steps into preparing the skill set necessary to survive the profession.

In addition to the previous ethnic groups, a latter group of immigrants were introduced in the Mississippi Gulf Coast. The Vietnamese arrived during the late 1970s and early 80s and revived the seafood industry by working in the packing plants.[17] The newly found jobs required little English proficiency and provided factory owners with inexpensive labor. Over time the Vietnamese immigrants became shrimp boat captains and deckhands based on their previous experience in Vietnam. Vietnamese fishers constitute half of the state's current commercial fishermen. The Vietnamese population has grown to almost 5,000 people, establishing communities in such cities as Pass Christian, Biloxi, Gulfport, D'Iberville, Ocean Springs, Gautier and Pascagoula.[18] The Vietnamese community has branched out from the seafood industry into other professions; however, at least 80 percent of the Vietnamese households still depend on the seafood industry. According to the Mississippi Coalition of Vietnamese American Fisherfolk and Families report, 2,000 Vietnamese individuals are directly employed by the seafood industry as commercial fishermen, seafood workers, and distributors.[19]

Indicators

Local governments, business owners, farmers, residents, schools, and many other entities are making significant changes in policy, products, and services in an effort to create a more wholesome, sustainable, healthy food system for their region. How does a region measure the success of these changes over time? Having tools by which to measure baseline conditions and the success of a region's food system plan is critical to its continued implementation and revision as a community works toward goals to improve the health and security of its residents and the environment. For example, the region should be interested in discovering if a fresh variety of food is reaching more residents, if farms in the region are contributing more foods to the system, and if residents are able to take advantage of a healthier, more equitable food system.

There are a series of efforts that have been undertaken to create indicators for the health of a community and its food system. The most comprehensive study of food system indicators was undertaken by the Wallace Center with funding from the W.K. Kellogg Foundation under the Food and Society Initiative, whose vision is a "future food system that provides all segments of society a safe and nutritious food supply grown in a manner that protects health and the environment and adds economic and social value to rural and urban communities."[20] The attributes of "good" food, as defined by FAS, are healthy, fair, green and affordable. This study combined with others [21] leads to clear guidelines for what should define an indicator.

- **Based on Goals:** the indicator measures progress toward the given goal or goals.
- **Opportunities-based**: the indicator measures progress toward the goals (positive) rather than regression away from the goals (negative).
- **Measurable at a regional level or smaller**: The indicator data must be available at the MSA or smaller level, rather than for the U.S. or Mississippi, and must be quantifiable.
- **Available**: The data must be available to the public
- **Relevant**: Addressing the most important trends and impacts related to these attributes
- **Stable, reliable, credible**: The data must be from a reliable and credible source, collected in a rigorous and consistent way and replicable from one time period to the next.
- **Cost-effective**: It must be possible to access the data with little monetary input.
- **Understandable and usable**: The indicator must be easily grasped by potential interpreters of the data so that they can apply it in their own communities.
- **Sensitive to change**: The indicator must respond to change over a reasonable length of time—not take hundreds of years to show progress.
- **Support Decision Making**: Promote learning and effective feedback to decision making.

Source: *Jennifer Silcott*

Additionally, the most desirable indicators are those that "are transparent, based on publicly accessible data, and open to interpretation by the stakeholders."[22] The data used by the Wallace Center for this study was collected from established sources at the national level, but an effort was made to select indicators that can be adapted to state, regional and local levels.

While there are a multitude of indicators that could be considered, those selected should most directly measure the health and food production of the region and be sensitive to changes in how the region makes decisions about land use, policy, zoning, and transportation. Indicator data should be within reach of the public and easily understandable. As goals are set by residents and stakeholders, the indicators can be selected to measure progress toward each goal depending on the availability and scale of accurate data.

Regional Indicators

The following is a summary of key potential indicators and the data available. The remainder of this report provides further detail about the existing conditions within the food system.

Human Health

A review of a number of studies identified possible indicators that could be used to measure health and food security. [23]

- Death Rates of diet-related diseases: The Mississippi Department of Health reports that 40 percent of all deaths are due to Cardiovascular Disease (CVD). This rate is 29 percent higher than the national rate, and Mississippi has the highest CVD mortality rate in the nation. This state level data is provided by the Mississippi Department of Health and was collected in 2000.[24] County level data on obesity and diabetes is provided by the Centers for Disease Control and Prevention (CDC) for 2007 and is available online.
- Obesity and overweight prevalence: According to County Health Rankings (2009), the obesity rate in Hancock and Harrison Counties is 31 percent, and Jackson County is 32 percent. This puts all three counties in the highest category for obesity both within Mississippi and within the United States. This data is provided by the University of Wisconsin in collaboration with the

Source: *Amanda Meddles*

16.2 percent of Hancock County residents consume five or more servings of fruits and vegetables a day.

Robert Wood Johnson Foundation on the County Health Rankings website. Sources for the website include CDC, Community Health Status Indicators, and the Food Environment Atlas.[25]

- Prevalence of childhood overweight: In the United States, childhood obesity affects 12.5 million, or 17 percent, of the childhood population. Childhood obesity leads to cardiovascular risk factors including high cholesterol, hypertension, and diabetes, along with psychosocial disorders. It also tends to affect Hispanic male and non-Hispanic black female populations disproportionately. According to the National Center for Health Statistics Survey, 44.4 percent of Mississippi children are considered overweight or obese.[26] Sources for state level childhood obesity rates include CDC and National Health & Nutrition Survey. County level data may be available through CDC or the Mississippi State Department of Health.
- Fruit and vegetable consumption: In 2009, only 22.4 percent of Mississippians were consuming two or more fruit servings per day, and 21.6 percent were consuming three or more vegetables per day according to a survey conducted by the Behavioral Risk Factor Surveillance System, compared to 32.5 percent and 26.1 percent at the national level. Five servings are recommended per day. This data is available annually at the state level and averaged over a multi-year period at the county level. Between 2004 and 2009, 16.4 percent of Hancock County residents consumed the recommended amount of fruits and vegetables, while this was 18.6 percent in Jackson County.[27]

Other indicators for health might include measuring amounts of healthy food in supermarkets, additives and pesticide residue in food, and the number of people growing their own produce. These indicators are currently limited by their specificity, and by the lack of reliable data available, but may become important to consider in the future.

Food Security

Household food security can be defined by access to

enough nutritional foods for an active lifestyle, available at all times, and acquired in socially acceptable ways. Food insecurity indicates limited or uncertain access to adequate supplies of safe, nutritional food; or limited ability to acquire such food in socially acceptable ways. Food insecurity statistics are identified by consumer response to questions regarding access to and availability of adequate and nutritional food supplies for their household. The USDA statistics are based on a national food security survey conducted annually as a supplement to the Current Population Survey, reaching about 50,000 households.[28]

The Wallace Center study considers food security as a factor of the "affordable" attribute of a good food system. "Affordable food comes from food systems in which all people and households can obtain healthy diets, either by buying the food with household income, using subsidies to offset the cost, or other socially acceptable ways."[29] This definition is extended to cover accessibility issues in the food system as well, and considers conditions such as food deserts. Indicators selected include: The prevalence of household food security: This measures the percentage of the population that is food secure, as reported by the USDA Economic Research Service and is available on the Food Environment Atlas website. The data is available at the state and county level.[30]

The prevalence of childhood food security: This considers the percentage of children ages 0-17 that are food secure, also reported by the ERS; the figure tends to be higher because adults will feed their children before feeding themselves. Data may not be publicly available at the county level.

Number of SNAP authorized stores per capita: The Supplemental Nutrition Assistance Program is designed to assist low-income households in obtaining adequate nutritious food supplies. For food security, it is important that SNAP recipients have access to stores that accept SNAP benefits. Data on the number of stores per capita and other related statistics is provided by the Food Environment Atlas for 2009 at the county level.

Other issues of affordability/accessibility worth considering as indicators include the percentage of children served by free or reduced breakfast or lunch programs, the number of people affected by food deserts, the number of initiatives to develop full-service retail markets in low-income neighborhoods, and the number of transportation initiatives to increase accessibility of supermarkets to low-income citizens.

Local Food Supply and Consumption

Food produced close to home is ideal for consumption because it has fewer miles to travel to reach the consumer. This typically means food is fresh and nutritionally dense, and eaters have a better idea where it's coming from. The proximity of food production from food processing and distribution centers is often difficult to measure because of the complex nature of value chains and related transportation networks. Measuring direct sales is one method of tracking whether or not food is being consumed from within local or regional markets.[31] Measurements of local agricultural production also indicates viability of local markets. Indicators may include:

- Number of farmers' markets and direct farm sales, and/or number of CSAs: County level data is available from

the Food Environment Atlas.[32]

- Number of institutions purchasing food from region: This indicator can be broken down to measure the number of farm-to-school programs, hospitals purchasing local foods, and any other institutions that purchase food from farms within the food shed. According to the Food Environment Atlas, no farm-to-school programs currently exist.
- Farmland remaining in production: The Census of Agriculture provides county level data on the amount of farmland in production.[33]
- Value of sales from fruits and vegetables, or number of acres dedicated to growing vegetables: The Economic Research Service collects data at the county level regarding the number of acres dedicated to growing vegetables.[34]

Marine Fisheries Health

For the Mississippi Gulf Coast Region, healthy marine fisheries are an important component to a healthy food system. Because of the recent drastic impact of the oil spill, it may be reasonable to select mariculture recovery indicators that will measure the progress toward pre-oil spill rates of harvesting, fishing, and seafood processing. Data sources for types and amounts of seafood harvested in each county have not been identified, but some measurements may be used to indicate the accessibility and competitiveness of fishing. Possible indicators might include:

- Number of fishing licenses and permits: Data should be available from the Mississippi Department of Wildlife, Fisheries, and Parks.
- Income from commercial fishing and processing: Data is provided by the Bureau of Labor Statistics on the number of employees and annual pay at the state level.

Matching Indicators to Goals

Recent indicator studies including the Vivid Picture Project for the State of California, the San Diego Food System Assessment for San Diego County, and the Greater Philadelphia Food System Study use an indicator selection process that begins with clarifying the goals and visions of a sustainable food system appropriate to the scale of study. Stakeholders are intimately engaged in the indicator selection process to support the belief that "indicators are useless if they are not used- as such, it is essential that stakeholders understand and support the set of indicators selected."[35] Stakeholders include farmers, processors and manufacturers, distributors, food retailers, restaurateurs, interested consumers, nonprofit organizations (including institutions), elected officials, support businesses (such as suppliers or insurance providers), and professional organizations.[36] Participants and experts provide feedback on data content and data sources, and rate their acceptability. Identifying existing data gaps was also necessary, as "interpreting data across fields and institutions has proved challenging."

The goal-oriented indicator studies lay out goals appropriate to the respective food systems (state, regional, or county level), and then identify indicators that can be used to measure progress toward reaching those goals. Indicators were proposed and presented complete with trend data, source information, data particulars, and analysis of strengths and limitations.

For example, one of the goals identified by the Vivid Picture Project for California's food system is that it "Encourages eaters to know where, how, and by whom their food is produced."[37] When consumers understand and are connected to agriculture, they tend to seek out healthy, local food.[38] Seven different indicators were selected for this goal, including the number of certified farmers' markets, sales from certified farmers' markets, number of Community Supported Agriculture programs, number of farms that offer agricultural tourism, number of school gardens, and the number of farm-to-school programs, and the total direct sales per capita, as a percent of agricultural sales. Each of the above indicators represents some aspect of consumer knowledge about where food is coming from and how it is grown. Data for the indicators was gathered for the state of California from national sources including the USDA Census of Agriculture, state level sources such as the California Department of Food and Agriculture, and organizational websites dedicated to tracking local agriculture in California.

For the San Diego Food System Assessment, the indicator data was collected at the county level whenever possible and at a regional level otherwise; local data was then compared to state level or national level data to contextualize trends.[39] The visions chosen for San Diego are derived from a threefold definition of a sustainable food system that is meant to improve human, environmental, and economic health. Each vision has three to six sub goals, and each sub goal has indicators that have been proposed to measure progress toward each goal. The assessment emphasizes health and well-being of residents, agricultural and environmental stewardship, and sustainable economic growth.

Indicators for the San Diego study include tracking the number of farmers' markets and direct sales, number of school and community gardens, fruit and vegetable consumption, obesity rates and rates of diabetes, units of emergency food available and transportation linkage to healthy food. Environmental indicators selected measure working land for food production, improving waterways, supporting animal welfare, recycling and composting, and reducing food system related greenhouse gas emissions. Indicators include number and size of farms, crop acreage, farm revenue by crop variety, commercial fish landings,

Source: *Jim Melka*

Household food security can be defined by access to enough nutritional foods for an active lifestyle, available at all times, and acquired in socially acceptable ways.

Source: *Amanda Meddles*

The number of farmers' markets and community gardens are examples of indicators supporting healthy food access.

organic farms and animal producers, amount of recycled waste and water, and fossil fuel expenditures. Indicators for economic growth, with emphasis on local and regional procurement and sale of food, include the number of farm to school programs and CSAs, number of farms and fisheries, minority owned farms, number and wages of food system jobs.

Stakeholder recommendations were developed alongside the San Diego food system assessment, addressing needs and maximizing current assets as revealed by the data included in the report. Strategies for improvement were also suggested in areas where goals were not being adequately met.

In a similar process of reaching out to stakeholders for identification of primary goals and values, the Delaware Valley Regional Planning Commission has begun the process of setting goals and identifying indicators to measure progress toward a more sustainable food system that meets the needs of the region. The Greater Philadelphia Food System Study and indicator selection process illustrates how a region, with the help of stakeholders, can tailor the selection of goals and indicators to meet its primary needs and values.

Agricultural Resources

The foodshed has more than 13 million acres, of which 2.4 million is used for farmland, see Table 1. This is an increase from 2.1 million in farmland in 1997.[40] Between 2001 and 2006, urban development increased 5.25 percent from 617,864 acres to 650,277 acres in the foodshed, accounting for a portion of the loss of farmland. Map 2 illustrates the land cover within the foodshed, showing that forestry is the most common land use accounting for 34 percent of the land cover with significant acreage in the De Soto National Forest or as part of the Conservation Reserve program.[41] [42]

Agricultural Land Base

Figure 1 illustrates the overall trend of farms in the foodshed. It is important to note, however, that while the number of farms and acreage of farms went up in the foodshed from 2002 to 2007, in the coastal counties there was a loss of 700 acres of farmland and a loss of two farms.[43]

The land base within the foodshed is characterized by a variety of farmland types including cropland, pasture, woodland (pastured and non-pastured), and land in farmsteads with buildings and other infrastructure. In addition to overall farmland, specific farmland types in the foodshed have shown a great deal of change overtime. Between 2002 and 2007, total acreage of harvested cropland, pastured cropland, and pastured woodland has shown a significant decrease while non-pasture woodland and permanent pasture increased significantly, as shown in Figure 2.

The foodshed is home to a variety of other production systems including poultry, cattle, and hogs/pigs. There are 143 acres of meat-type poultry farming, 568 acres of cattle farming, and 37 acres of hog/pig farming in the coastal counties. In the foodshed there are 500 acres of meat-type poultry farming, 8,786 acres of cattle farming and 447 acres of hog/pig farming.[44] In addition, in Harrison County there are two dairy processing plants that purchase Grade A raw milk.[45]

Soils

The soils within the foodshed are some of the most fertile in the nation, as a result of centuries of glacial deposits and sedimentation. The USDA Natural Resources Conservation Service designates soil classes depending on production suitability, such as Prime Farmland, Prime Farmland if protected from flooding/ erosion, and not Prime Farmland.[46] Prime Farmland is defined as land containing the best composition for producing food, feed, forage, fiber, and oil seed crops.[47] Thirty-four percent of the total land area in the foodshed contains prime farmland soils, as shown in Table 2.

Growing Season

The foodshed's climate is characterized by long, hot and humid summers, and short, mild winters. The mean annual precipitation is between 47 and 62 inches that fall mostly during late autumn, winter, and early spring. The mean annual air temperature is between 60 and 67 degrees Fahrenheit. The number of freeze-free days range from 235 to 305, which provides a long and productive growing season.[48] The foodshed

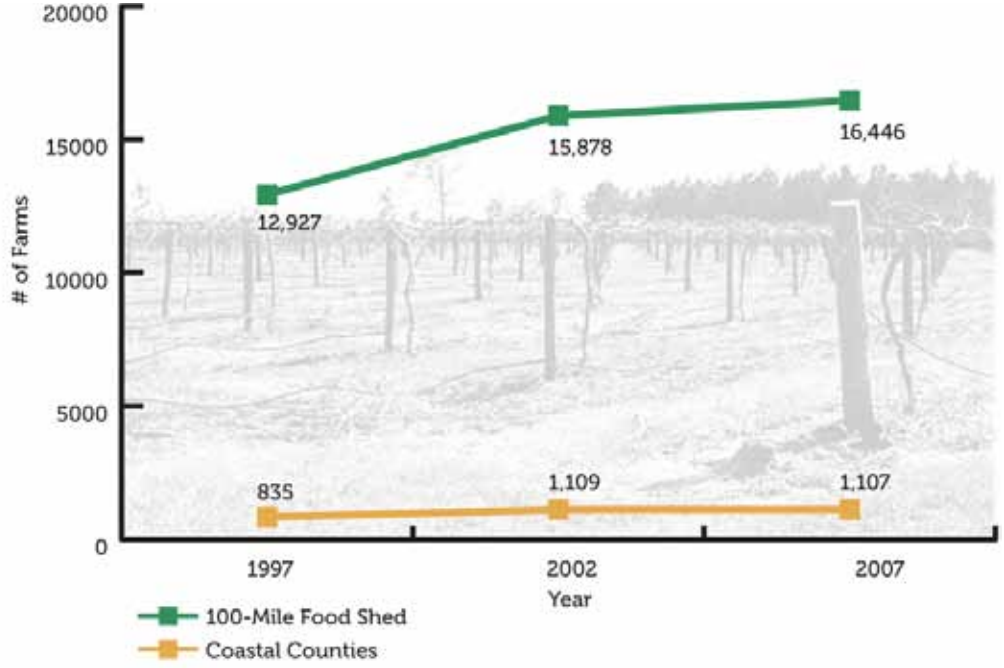


Figure 1
Number of Farms
Source: *US Census of Agriculture Reports 1997-2007.*

Figure 1 illustrates the overall trend of farms in the foodshed. It is important to note, however, that while the number of farms and acreage of farms went up in the foodshed from 2002 to 2007, in the coastal counties there was a loss of 700 acres of farmland and a loss of two farms.

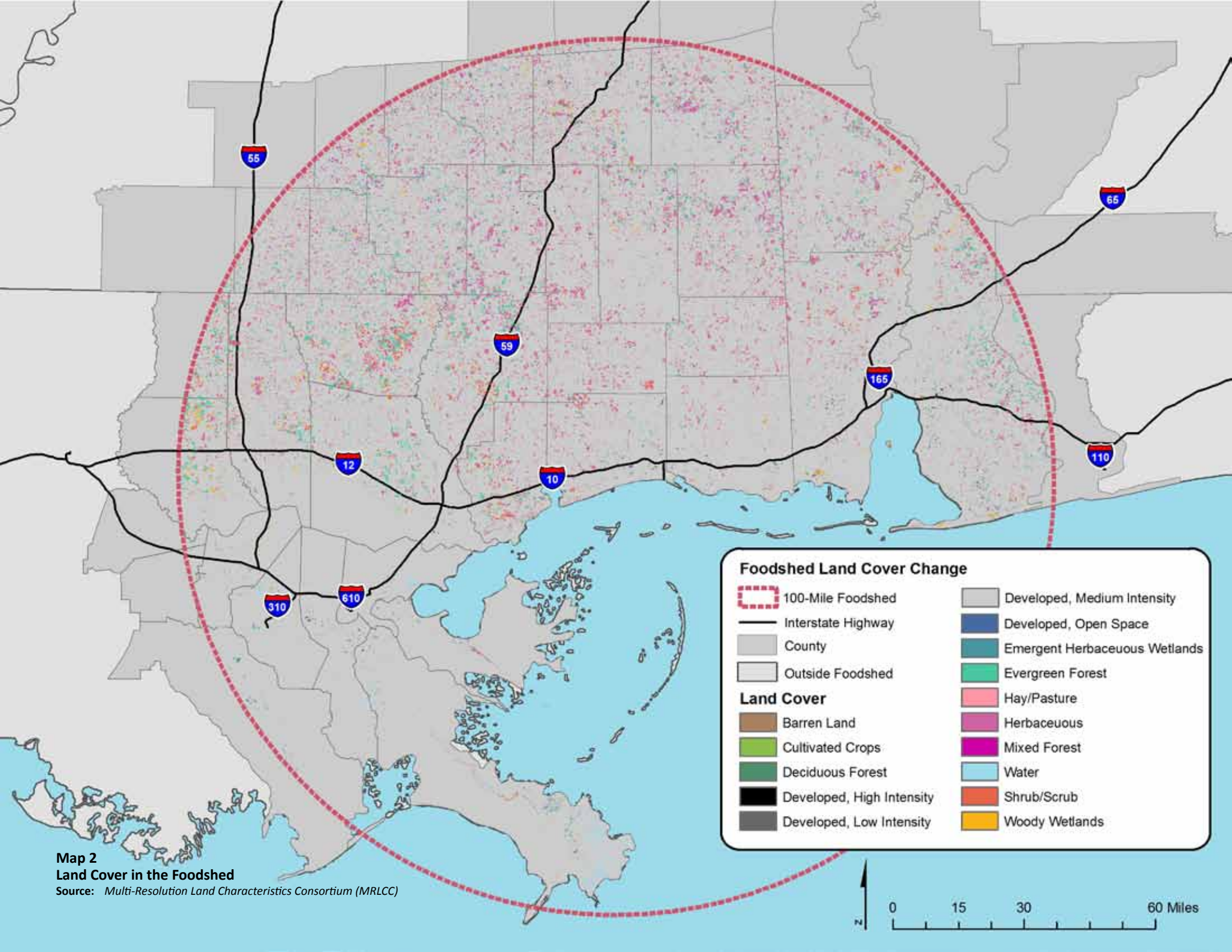
region falls within USDA Hardiness Zones eight and nine, which designate an average minimum annual temperature range of 15 to 25 degrees Fahrenheit.[49]

Market Enterprises

Farmers' markets[50] and Community Supported Agriculture (CSA)[51] are a means of farm-to-consumer direct distribution. Local farmers sell produce at farmers' markets throughout the three coastal counties. Certified Farmers' Markets are accredited by the Mississippi Department of Agriculture and participate in the USDA Market Nutrition Program. The Mississippi Department of Agriculture Certified Farmers' Market Program certifies markets that have two vendors growing and selling Mississippi produce at the market during the time of spring certification, certified markets are shown on Map 3. In addition, markets participating in the USDA Market Nutrition Program provide produce vouchers for income-eligible residents. It gives consumers access to fresh, local produce throughout the year and benefits local farmers with a market for their products and year-round marketing. Real Food Gulf Coast, a nonprofit collaborative between two Farmers'

Table 1
Farms and Farm Acreage
Source: *US Census 2009 (population), USDA Census of Agriculture 2007, US Census 2000 (land area)*

2007	Mississippi Coastal Counties	100-mile Foodshed
Total Land Area in Acres	1,142,400	13,196,160
Total Farm Acreage	105,159	2,446,800
Total Number of Farms	1,107	16,446



Map 2
Land Cover in the Foodshed
Source: *Multi-Resolution Land Characteristics Consortium (MRLCC)*

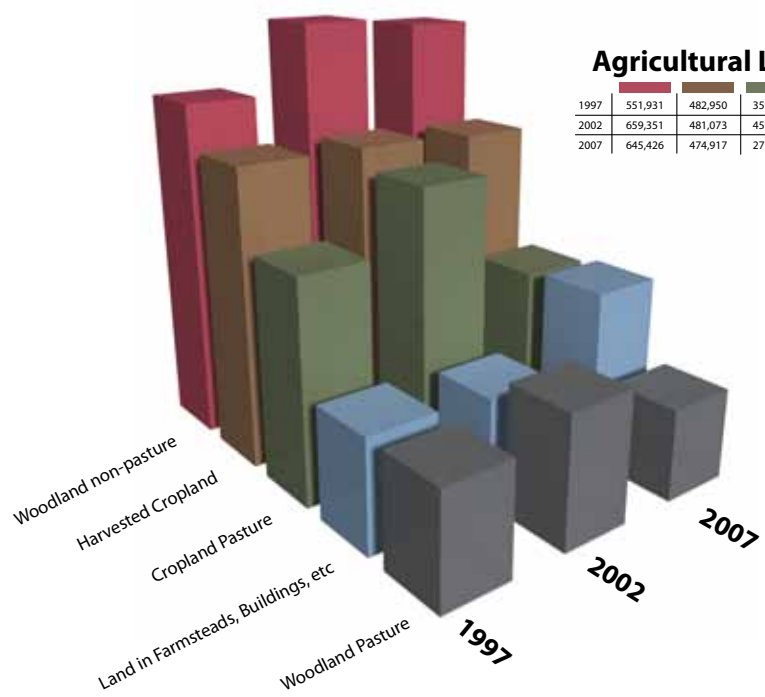


Figure 2
Acres of Agricultural Land Cover
Source: *US Census of Agriculture 2007*

**Data from Orleans, Saint Bernard, Saint Charles, and Saint John the Baptist, LA parishes unavailable*

The land base within the foodshed is characterized by a variety of farmland types including cropland, pasture, woodland (pastured and non-pastured), and land in farmsteads with buildings and other infrastructure. In addition to overall farmland, specific farmland types in the foodshed have shown a great deal of change overtime. Between 2002 and 2007, total acreage of harvested cropland, pastured cropland, and pastured woodland has shown a significant decrease while non-pasture woodland and permanent pasture increased significantly,

Markets in Ocean Springs and Long Beach, formed in 2009 to promote and support a local and sustainable food economy along the Mississippi and Alabama Gulf Coast. It seeks to increase knowledge about the links between food, agriculture, nutrition, health, and community strength. In addition to farmers' markets and CSA's, the gulf coast benefits from agritourism[52] enterprises, such as u-pick farms, brewery tours, airboat rides, and shrimping excursions.

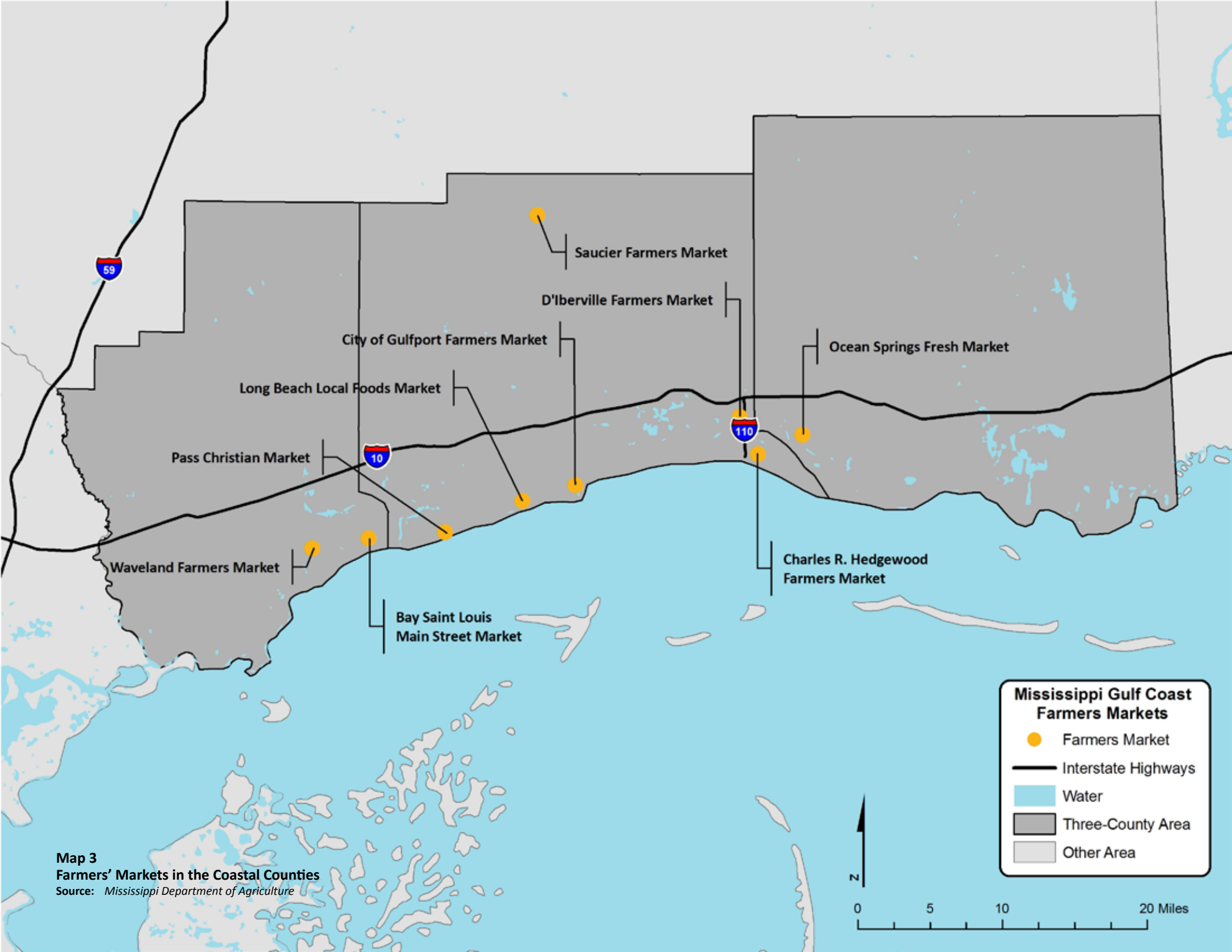
Farm Structure

Of the 16,446 farms in the foodshed, the majority of farms (6,019 farms) are in the 10 to 49 acre range, closely followed by farms in the 50 to 179 acre range (5,647 farms); about half (8,049) of the farms value their annual sales at less than $2,500. In the Mississippi coastal counties, 513 out of the 1,107 farms encompass 10 to 49 acres, with over half (635) of the farms valuing their annual sales at less than $2,500. Typically, a farm in Hancock, Harrison, and Jackson Counties has a yearly expense of about $19,000, as opposed to the foodshed, where farms spend roughly $68,000. Meanwhile, the average total income before taxes and expenses is $1,436 per farm for the three counties and almost $2,000 a year for the foodshed.

In the three coastal counties, 37 percent of the principal operators list their primary occupation as farming; in the foodshed, 41 percent are full-time operators. The median age for the primary operator is 57 years of age in the foodshed. The primary operators of the farms in the foodshed are primarily white males (1,631 out of 1,723), with 92 American Indian, Hispanic, and African American operators.

Top Products and Market Values

The market value of all agricultural products sold in Hancock, Harrison, and Jackson Counties was $14 million in 2007, with total operations cost amounting to around $5 million. By comparison, the foodshed observed a total market value of all agricultural products near $1.4 billion, with farms netting around $290 million. The leading livestock commodity for the foodshed by both number of farms participating and value is cattle/calves/cows with over 8,700 farms raising calves and cattle, 7,499 farms raising cows for beef, and 323 farms using their cattle for milk.



Map 3
Farmers' Markets in the Coastal Counties
Source: *Mississippi Department of Agriculture*

Soil Designation	Acres	Agricultural Soils as Percent of Total Land Area
Total Land Area (acres)	13,196,160	--
Prime Farmland Soils*	4,494,317	34.1%
Prime Farmland if protected from flooding/erosion**	3,941,550	29.9%
Not Prime Farmland***	3,612,773	27.4%

**Prime Farmland soils have low erosion potential and do not rely on subsurface drainage for continued production; data from Washington County, AL, Jefferson, Orleans, and Plaquemines Parishes, LA, and Greene County, MS are not included*

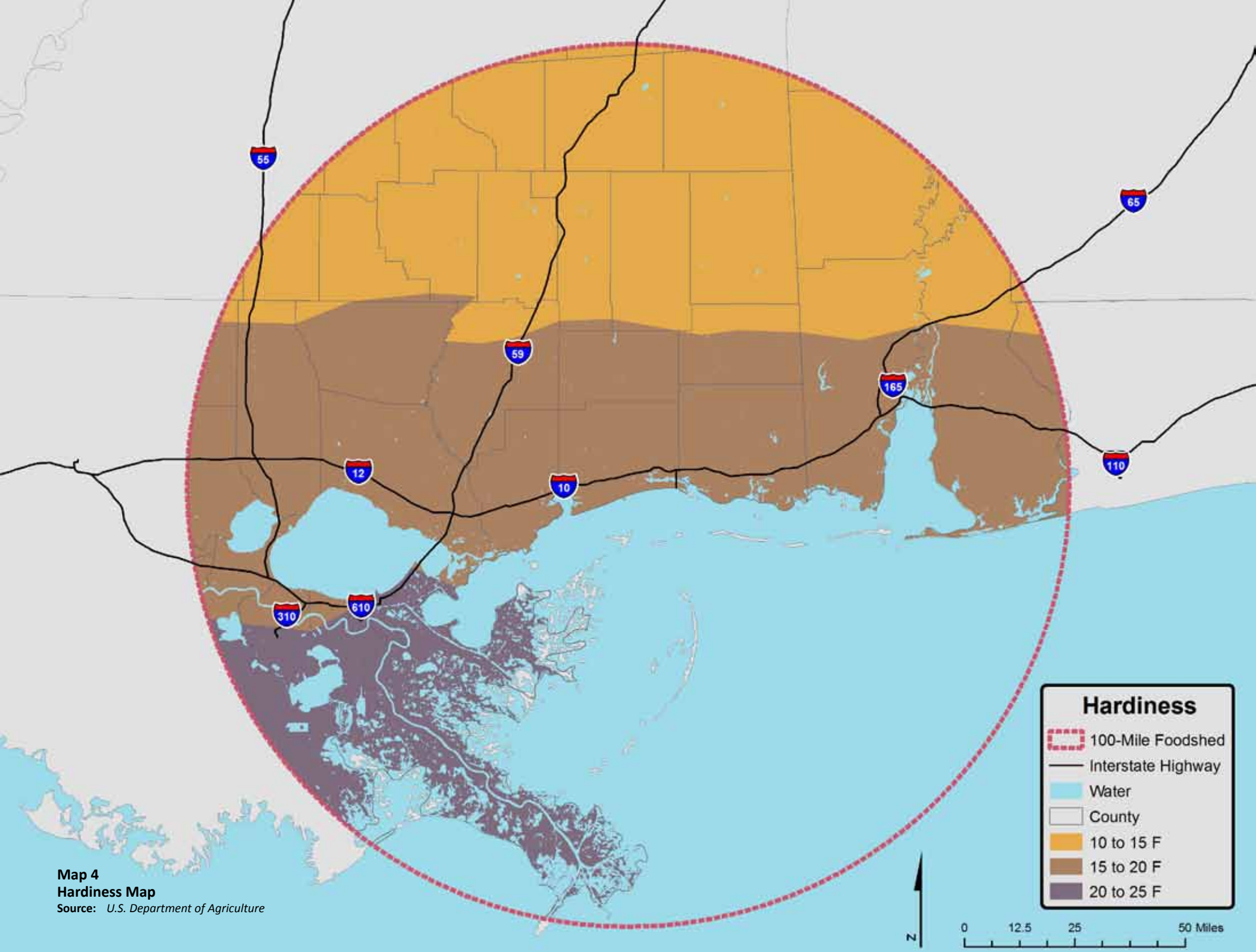
***Prime Farmland if protected from flooding/erosion has high potential for flooding and erosion, but can be agriculturally productive when specific management strategies are in place; data from Washington County, AL, Livingston, St. Charles Parishes, LA, and Greene County, MS are not included*

****Not Prime Farmland is due to currently forested land cover, urban land cover, frequency of flooding, presence of coastal plains, or unsuitable soil composition for agriculture; data Washington County, AL and Greene County, MS are not included*

Table 2
Farmland Soils
Source: *US Census of Agriculture 2007, USDA Natural Resources Conservation Service Soil Survey, US Census 2000*

Other livestock often raised in the area include horses/ponies/mules/burros/donkeys, hogs/pigs, and chickens. The top crop items (based on acres covered and value) for the foodshed include vegetables, nuts, berries, and greenhouse items. [53]

From 1995 to 2009, the State of Mississippi received $7.28 billion in subsidies. The coastal counties received $14.5 million in subsidies during this time period. The type of subsidies varies by county with disaster payments being the second most common subsidy, with $1.95 million dispersed across the coastal counties. In Hancock County, the Conservation Reserve program was the leading subsidy with $1.05 million dispersed. By number of recipients, livestock subsidies came in second behind the disaster payments with 122 recipients. In Harrison County, fish subsidies were the leader in number of recipients and subsidy amount awarded from 1995 to 2009. In Jackson County, $3.33 million in cotton were dispersed, while livestock subsidies had the most recipients (80) from 1995 to 2009.[54]



Map 4
Hardiness Map
Source: *U.S. Department of Agriculture*

Aquaculture

Mississippi has $250 million in food fish sales from aquaculture farms, the highest value of aquaculture production in the country representing 37 percent of the national total. Mississippi has 9.3 percent of all aquaculture farms in the United States. Louisiana has the largest number of aquaculture farms, with 873, while Alabama has 215 aquaculture farms. [55] Within the foodshed there is significant contribution to aquaculture through catfish, trout, tilapia, and crawfish production among others. Mississippi did not have any saltwater mariculture operations at the time of the census and still lacks mariculture ventures to date, although there are some experimental mariculture activities occuring. For example, the Gulf Coast Research Lab is raising shrimp in closed recirculation systems.[56]

The foodshed includes farms and fish hatcheries. Aquaculture farms serve as a source of fish for restaurants and individual consumption. The U.S 2007 Census of Aquaculture reports the number of aquaculture farms disaggregated by county within the foodshed and complied by state, see Table 3. The largest catfish operations in both Mississippi and Alabama are located beyond the foodshed. Aquaculture farms located within the foodshed include AquaGreen, LLC in Perkinston and Slade's Fish Hatchery in Lumberton.

The Mississippi Department of Agriculture and Commerce maintains a list of registered aquaculture operations, Table 4 lists the registered aquaculture processors located within the Mississippi portion of the foodshed.

Catfish Production

The United States' leading aquaculture industry is commercial catfish, generating over 46 percent of the total value of aquaculture production in the nation.[57] Channel catfish were originally found only within the Gulf States, with the Mississippi River Delta particularly well suited for catfish pond environments.[58] Many of the ponds use rainfall and storm runoff to fill ponds and maintain water levels.[59] Before pond production, catfish were caught in nearby rivers with cane poles or bought from commercial fishers.[60] Most catfish operations sell their fish directly to processing plants with the assistance of the Department of Agriculture and Commerce and Catfish Farmers of America (CFA).[61] Since the 1960s, catfish pond size has seen a reduction from 40-60 acres to 10-15 acres, to ease management. While the two major catfish-producing areas are in the Delta and East-Central Mississippi, there is some catfish production in south Mississippi. Slade's Fish Hatchery in Lumberton is a family owned business that operates full-time and is one of the few catfish hatcheries located within the foodshed. They sell fish for stocking and provide pond assistance to individual and private pond-owners. They do not distribute to distributors such as grocery stores and restaurants.

Tilapia Production

Tilapia are a tropical non-native species that can be grown in cages, tanks, raceways and ponds and can spawn every 45 to 70 days.[62] Tilapia must be raised indoors to prevent accidental introduction into natural waters and are raised in recirculation tanks above 70 degrees Fahrenheit.[63] Much of the tilapia produced in the United States is transported to ethnic markets

in major metropolitan areas. It is difficult for Mississippi tilapia farmers to compete in the fillet market; it is therefore essential for producers to seek out local or niche markets for live whole fish.[64] Tilapia farming is concentrated in the southern part of the state and most operations are at a small scale;[65] Some examples are the Living Waters tilapia farm in Poplarville and the Aqua Green, LLC tilapia farm in Perkinston.[66] Aqua Green, LLC in Perkinston is currently in the process of expanding its markets to better serve local consumers. Primarily a tilapia operation that distributes to New York City, Aqua Green is now looking at ways it can harvest saltwater fish to market more locally and has begun placing test markets for live fish in various locations throughout southern Mississippi.

Alligator Production

The alligator is native to the foodshed, concentrated in Louisiana's marshes. Commercial farms and the management of wild alligator hunting supply market demands without affecting natural alligator populations, see Table 5. While alligator meat is processed, alligators are primarily harvested for their leather. The Louisiana Department of Wildlife and Fisheries (LDFW) works with alligator farms to ensure that proper harvesting is maintained.

The wild alligator harvest program of the LDWF was founded in 1972. Since then, it is estimated that approximately 800,000 wild alligators have been harvested, with over $230 million dollars generated in revenue for the state of Louisiana. [67] Approximately 81 percent of Louisiana's coastal alligator habitats are privately owned. Since these coastal habitats have been under management by LDWF, approximately 6.5 million eggs and 3.5 million farm-raised alligators have been harvested, generating $704 million in value. The Insta-Gator Ranch in Covington, Louisiana is an example of an alligator operation that works with the LDWF to produce and maintain the local alligator population. LDFW also manages alligator hunting season.[68]

Alligator hunting for the state of Mississippi was formally initiated in 2005 and requires that each hunter have a permit.[69] There are currently 17 counties that are open to limited hunting. The State allows hunting on public waters within two zones. The designated Pascagoula River Zone, in Jackson County north of

Table 3
Number of Aquaculture Farms and Hatcheries in the Foodshed
Source: *2002 Census of Aquaculture*

	Alabama	Mississippi	Louisiana
Catfish	12	26	0
Trout	2	5	0
Game Fish	3	3	2
Baitfish	0	2	0
Crustacean	0	1	9
Mollusk	0	0	62

The foodshed includes farms and fish hatcheries. Aquaculture farms serve as a source of fish for restaurants and individual consumption. The U.S 2007 Census of Aquaculture reports the number of aquaculture farms disaggregated by county within the foodshed and complied by state.

Table 5
Alligator Farms and Ranches in the Foodshed
Source: *Louisiana Department of Wildlife and Fisheries*

City	Farm
Springfield	Coats Alligator Farm
	Wall's Gator Farm
Ponchatoula	Alonzo McCrory
Covington	Insta-Gator Ranch
Hammond	Circle M. Ranch
	Klierbert's Alligator and Turtle Farm
Madisonville	V.I.S. USA Company
Bush	Elizabeth A. Smallwood
Slidell	Captain Gator

Table 4
Registered Aquaculture Operations in the Foodshed
Source: *Mississippi Department of Agriculture and Commerce*

The Mississippi Department of Agriculture and Commerce maintains a list of registered aquaculture operations, Table 4 lists the registered aquaculture processors located within the Mississippi portion of the foodshed.

County	City	Company
Harrison	Pass Christian	Bradford Oyster & Seafood, Inc.
	Biloxi	C.F. Gollott & Son Seafood
	Pass Christian	Crystal Seas Seafood
	Biloxi	Gollott & Sons Transfer/Strg.
	Ocean Springs	Ocean Springs Seafood
Jackson	Moss Point	Black Creek Aquaculture, Inc
	Pascagoula	Pascagoula Ice & Freezer Co.
	Escatawpa	SeaChick, (Miss.) Inc.
Washington	Hollandale	Farm Fresh Catfish
	Leland	Lauren Farms, Inc.

Hwy 90, is the public hunting zone located within the foodshed. In 2010, there were 260 total available permits with 2,086 total applicants for hunting access on public waters.[70] The 2010 alligator hunting season recorded a harvest of 224 alligators for Mississippi.

Alligator hunting season in Alabama within Mobile and Baldwin counties is permitted by the State and has restrictions on the number of people allowed to hunt during any given period of time.

Crawfish Production

Crawfish began being harvested commercially in the late 19th century in southern Louisiana, with early crawfish harvests gathered from natural waters.[71] Crawfish can either be farmed in rice field rotations or in permanent crawfish farms. The practice of re-flooding rice fields after harvest and small pond farming began in the 1950s with funding from the Louisiana Wildlife and Fisheries Commission, effectively beginning the practice of "crawfish farming." Eighty percent of Louisiana's statewide crawfish harvests are from crawfish farms. While crawfish farming has increased over time, wild harvests have declined in large part due to long term trends in water management.[72]

Peak crawfish harvests occur from March through June. Over 90 percent of crawfish are marketed and sold live, while the remainders are processed as tail meat. The short shelf life of fresh crawfish limits national distribution, keeping crawfish primarily as a regional product except for tail meat. US producers experience competition with tail meat produced in China.[73]

Fish Hatcheries

Fish hatcheries support the aquaculture industry. The Lyman Fish Hatchery located in Gulfport is privately owned and works with the Mississippi Department of Wildlife and Fisheries to assist in managing sport fish populations in public waters. The Lyman Fish Hatchery is currently under construction to harvest salt-water fish. Hatcheries located within the foodshed are indicated in Map 5.

Potential Aquaculture Markets

The Gulf Coast Research Lab in Ocean Springs researches the

Source: *Megan O'Connor*

Alligators seen here at the Insta-Gator Ranch are captured as eggs and raised for processing. Approximately 12 percent of the alligators at the Insta-Gator ranch are released back into the wild.

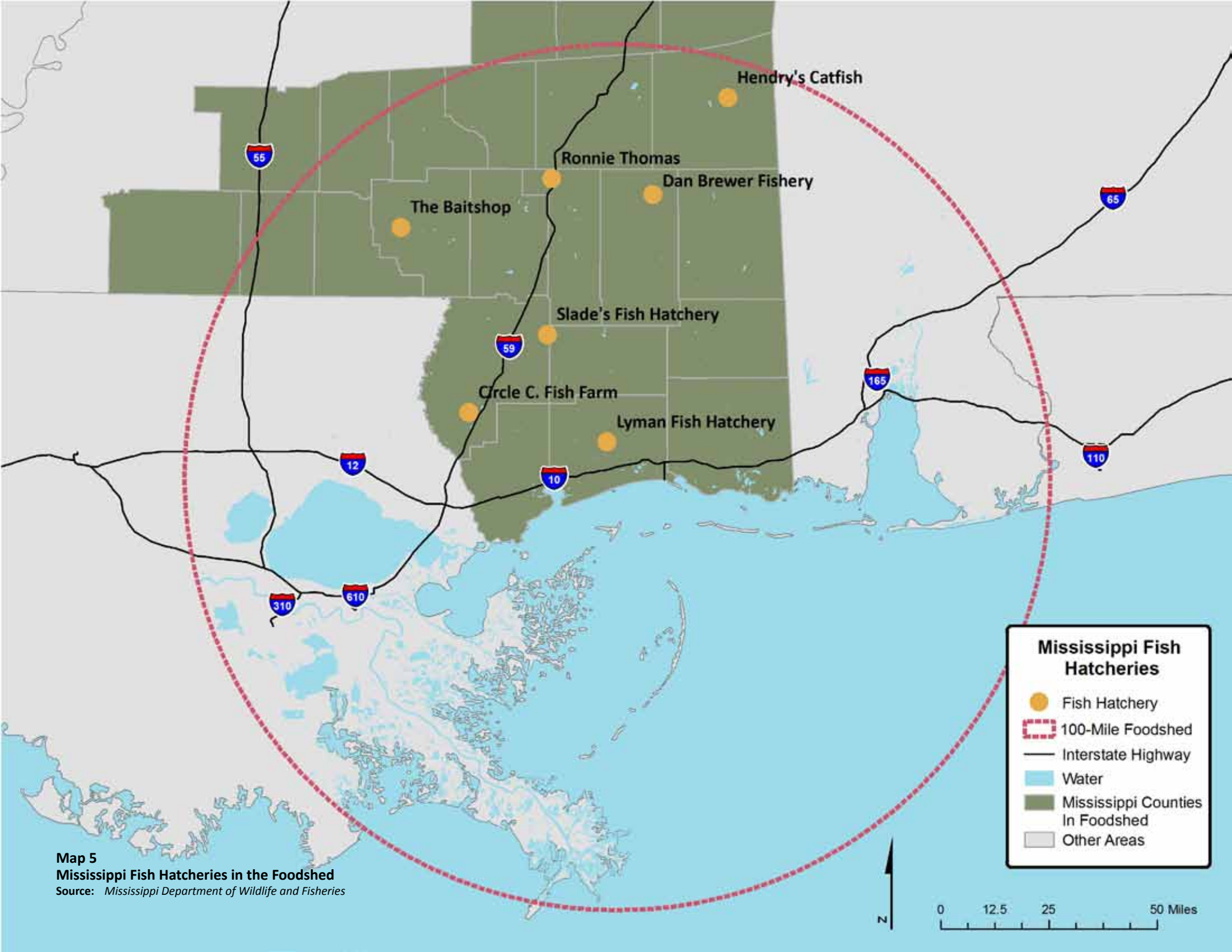
potential for aquaculture to play a significant role in the economic development of Southern Mississippi.[74] The Mississippi State University Agricultural and Forestry Experiment Station began extensive research in the mid 1980s to evaluate establishing a freshwater prawn industry in the state.[75] Prawns are intolerant of cold temperatures, forcing farmers to leave prawns in ponds for as long as possible to maximize harvest. This often creates market problems for the farmer who must sell variable amounts of prawns year-to-year.[76] The average stocking rates for prawns are 12,000 to 16,000 prawns per acre and they grow for a period of 120 to 150 days, yielding from 500 to 1,000 pounds per acre.[77] Alabama has no special permits for prawns and allows the harvesting of prawns, while Mississippi and Louisiana require fishers to obtain licenses for harvest.[78] To harvest prawns in Louisiana, a fish farming license is required.[79]

Commercial Freshwater Fishing

Commercial freshwater fishing allows individuals to fish for resale. Each state has laws and regulations regarding commercial freshwater fishing to protect and monitor the number of fish species in state waters. Commercial freshwater fishing licenses are required within the State of Mississippi when the fishers intend to sell nongame gross fish for retail, wholesale, or shipping to markets or dealers.[80] [81] Types of species caught commercially include catfish, alligator gar, carp, eel, and freshwater drum.

Sports Fishing

The Mississippi Department of Wildlife, Fisheries and Parks (MDWFP) defines game fish to include all bream, black bass, shadow bass, walleye, sauger, yellow perch, hybrid striped bass, striped bass, yellow bass, and all pickerel.[82] The MDWFP produces fishing reports for the rivers and lakes within the foodshed, including Pascagoula River, Lake Bogue Homa, Lake Columbia, Geiger Lake, Lake Perry, Lake Walthall, and Lake Bill Waller.[83] [84] The Coastal Region division of the MDWFP maintains these public waters with pond checks, fish restoration, and the distribution of information regarding aquatic habitat and ecology.[85] The MDWFP uses a type of "scoring system" as a method of ranking



Map 5
Mississippi Fish Hatcheries in the Foodshed
Source: *Mississippi Department of Wildlife and Fisheries*

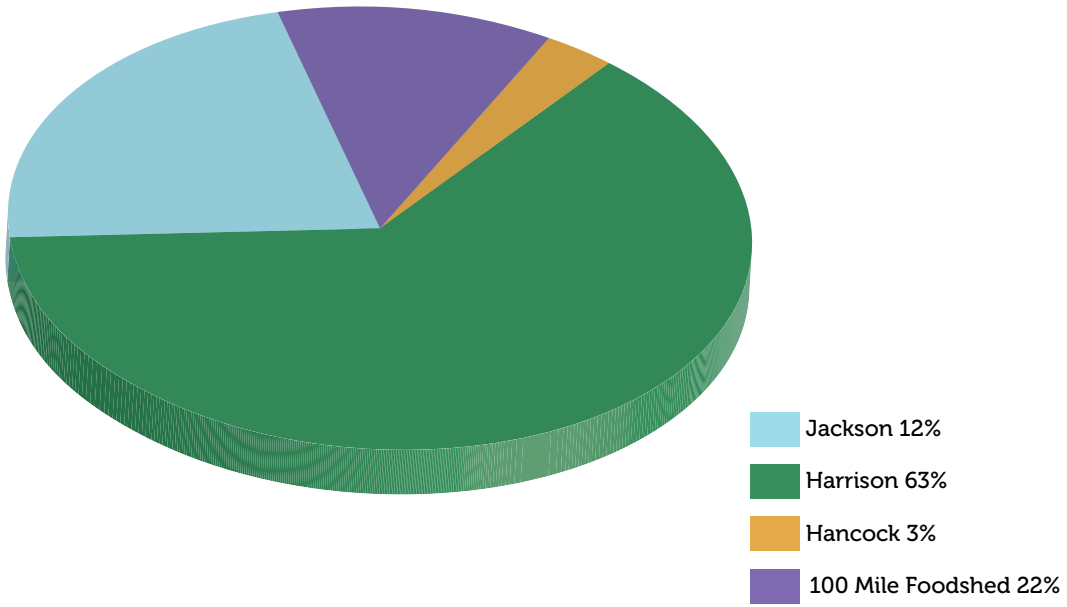


Figure 3
Location of Commercial Seafood Businesses
Source: *Mississippi Department of Marine Resources*

The DMR identifies 45 commercial seafood businesses. These businesses are secondary seafood handlers and include processors, retailers and wholesalers. Eighty-eight percent of these businesses are located in the coastal counties.

fish populations in Mississippi recreational waters.[86] This allows for the fish population data collected by fishery biologists to be represented in a clear and accessible format for public users.

The Mississippi coastal counties and surrounding foodshed have numerous public boat and ramp access points along its rivers and lakes. The MDWFP Ramp and Pier Program builds and renovates public boat ramps and courtesy piers with funds from license sales, state and federal money from the Federal Aid in Sport Fish Restoration Program.[87]

Aquatourism

Aquatourism invites visitors to discover "pond to plate" stories. This includes visiting catfish ponds and riding boats into the Gulf to catch shrimp.[88] Some of these trips include the Biloxi Shrimping Trip where visitors may go on a seventy-minute shrimping expedition. The Insta-Gator Ranch in Covington, Louisiana invites tourists to learn and see how alligators are harvested from the marshes and raised on the ranch. The Gulf Coast Gator Ranch and Airboat Swamp, in Pascagoula, allows tourists to take boat rides throughout the Grand Bay Estuary while viewing alligators and other animal life. This farm does not harvest alligators and is only operated for tourism purposes.

Marine Fisheries

Saltwater seafood is harvested from the Mississippi Sound and the open sea beyond the barrier islands. These waters serve as an important source of food for the coastal counties and beyond. The Mississippi Department of Marine Resources manages the state's saltwater fisheries.

Mississippi Sound

Nearly 400,000 acres fall within Mississippi's state borders. Its width varies from seven to 15 miles, and its maximum depth exceeds 30 feet.[89] The sound is an important economic thoroughfare for the region; as part of the greater Gulf Intracoastal Waterway traversing between Mobile, Alabama and New Orleans, Louisiana. State maritime boundaries demarcate

its "Exclusive Economic Zones" (EEZ) from federal waters. The boundary line is three nautical miles from the shoreline.[90]

The Mississippi EEZ is measured from the southern coast of its barrier islands rather than the coastal counties, extending beyond the sound.[91] The barrier islands include five sand islands, Cat Island, Ship Island, Horn Island, Petit Bois Island in Mississippi and Dauphin Island in Alabama. These islands separate the Mississippi coastline from the deeper water channels of the sound. With the exception of Dauphin Island, the barrier islands are a part of the Gulf Islands National Seashore Park. They are not available for development and commercial fishing is prohibited, but recreational fishing with a valid license is permitted. [92]

The Sound is an important economic engine and seafood resource for the foodshed. Its suitability as a habitat for consumable seafood depends on the overall health of the Gulf of Mexico and inputs from the mainland watershed. The sound is vital to stocks of fish and invertebrates and provides foraging and nursery areas for several bird species, marine turtles and the occasional manatee or porpoise.[93] Key habitats for economically relevant seafood stock are generally located within estuarine systems associated with the barrier islands or the open sea habitats beyond.[94]

Estuaries are important nesting and feeding areas for a wide array of marine life and are the bedrock of Mississippi's seafood economy, filtering freshwater pollutants from seawater and hosting several commercially important species for at least part of their life cycle. [95] [96] All three coastal counties have at least one important freshwater body that empties into a sound estuary.

Mariculture

Seafood is important to Mississippi's economy and the foodshed. Commercial landings bring revenue to the state through processing, direct sales and licensing feed. The 2008 combined commercial fishery landings in Alabama and Mississippi were worth $88 million.[97] The Pascagoula-Moss Point port is one of the most active in the nation and it ranked sixth nationwide for commercial seafood landings (in pounds) in 2006.[98]

Despite success, the US demand for seafood is greater than its renewable supply. Local commercial landings are not enough to keep local seafood processors open year round. The solution to both of these issues has been to import foreign seafood. Approximately 84 percent of seafood consumed by Americans is imported.[99] Mariculture is one potential opportunity to compete with imports. Mariculture is the branch of aquaculture concerned with the cultivation of saltwater organisms including edible fish, shrimp and oysters. Half of the seafood imported to the United States is sourced from international mariculture ventures,[100] but mariculture development in the United States has been slow relative to its freshwater counterpart. The slow development of mariculture ventures is partially due to the lack of policy framework.

Commercial Seafood Processors, Sellers and Distributors

The DMR identifies 45 commercial seafood businesses. These businesses are secondary seafood handlers and include processors, retailers and wholesalers. Eighty-eight percent of these businesses are located in the coastal counties, see Figure 3. Of these 45 seafood businesses, 34 percent are seafood processors and 42 percent are retail. Wholesale distributors round out the list with the smallest percentage. The primary seafood handled by these businesses is shrimp and oysters, Mississippi's major seafood exports. Combined, shrimp and oyster processing make up 63 percent of the seafood processed in coastal Mississippi. In order to stay open year round, the commercial processors handle seafood imports in the off seasons.

The majority of seafood handled by the commercial processors is either shrimp or oysters. Combined, shrimp and oyster processing make up 63 percent of the seafood processed in coastal Mississippi. In order to stay open year round, the commercial processors handle seafood imports in the off seasons.[101]

Shrimp and oyster farms comprise the biggest share of mariculture in the United States. Only fourteen states operated eastern oyster mariculture farms in 2002 with combined gross revenue of $39.8 million. Of these operations, only Louisiana falls within the foodshed. Fishers with mariculture-raised saltwater

shrimp and oyster enjoyed $20.7 million and $102.9 million in nationwide sales. Louisiana is the top producer of mariculture-raised oysters selling 22.4 million pounds in 2002.[102]

Legal Framework

The legal framework controlling the development and management of maritime resources is a complex matter. Territorial Sea is the official designation for oceanic resources under sovereignty of a nation-state. The National Oceanic and Atmospheric Administration (NOAA) define Territorial Sea boundaries as 12 nautical miles from the shore.[103] However, as determined by the 1953 Submerged Lands Act (SLA), the United States shares this boundary with coastal states. The SLA grants coastal states the right to all lands, waters and resources located within three nautical miles of the coastline.[104]

Fisheries in both state and federal waters are managed under the guidance of the Magnuson Stevens Fishery Conservation and Management Act of 1976. The Act protects US fisheries "from the irreversible effects from over fishing" through the establishment of eight regional councils to manage fisheries according to geographic location and need.[105] The regional council for the Gulf is the Gulf of Mexico Fisheries Council. The Fisheries Council guides regulations and policies for the waters extending from state waters up to the end of the EEZ.[106]

The Mississippi Aquaculture Act of 1988 authorized the Mississippi Department of Agriculture and Commerce to develop an Aquatic Ventures Center (AVC) pending available funding. The AVC would encourage open water mariculture ventures in state territory through the establishment of commercial aquaculture parks. The coastal counties would develop these parks through a port authority or development commission and the aquaculture parks themselves would be treated as a floating industrial park. However, the Statute has never been funded.[107]

Locations for mariculture ventures in Mississippi territorial waters will be limited in the event the AVC eventually receives funding. The MDMR Ordinance 13.001 (Aquaculture Ordinance) forbids aquaculture operations within one mile of public oyster reefs, bird nesting area, sea turtle nesting grounds or habitats of endangered or threatened species. Net-pen farms are forbidden to locate within one mile of sea grass beds and molluscan shellfish farms must locate over 1,500 feet from the same. To be compliant with code, mariculture entrepreneurs will need to demonstrate that it will occupy areas meeting all of these restrictions and within Mississippi state waters.

Fisheries in state waters are governed individually. Although states must adhere to federal regulations and catch limits, states have the right to "expand state regulations into federal waters" for species not regulated by the federal government.[108] Three departments manage the marine fisheries of the states within the foodshed: The Department of Wildlife and Fisheries in Louisiana, the Department of Conservation and Natural Resources in Alabama and the Mississippi Department of Marine Resources (MDMR). The MDMR was established in 1994 and acts with the guidance of the Commission on Marine Resources.[109] The commission is a five-member panel appointed by the governor for four-year terms. The Commission represents commercial seafood processors, NPO environmental organizations, charter boat operators, recreational fishermen and commercial fishermen.[110] The MDMR regulates seafood seasons, catch limits and other regulations.

Locating mariculture operations in the open sea beyond the three-mile state nautical boundary would place the mariculture farm in federal territorial waters. As it stands, this would be a violation of the Submerged Land Act. Although state and federal boundary issues have largely been put to rest in recent years, new uses for offshore and coastal areas such as mariculture have the potential to reignite some of these disputes as states attempt to move mariculture operations further from sensitive coastal areas.[111] The NOAA draft Aquaculture Policy is the first step in managing this confusing state/federal issue.

Protecting the Gulf

The MDMR promotes several habitat rehabilitation projects to protect and manage seafood resources in the Sound. Several of these programs focus on preserving or rehabilitating artificial reefs to protect sensitive habitats of sport and seafood stock. The 1999 *Artificial Reef Plan* was designed to enhance "the marine habitat for associate important sport fishes and other

organisms."[112] Artificial reefs are found both offshore and inshore. MDMR works with oil companies in a "Rig-to-Reefs" program to convert decommissioned oil rigs for artificial reef development. Eight abandoned rigs have been rehabilitated into reefs to date.

Sports Fish Recreation Act

The *Artificial Reef* programs benefit greatly from federal statutes that set aside money for aquatic management programs, particularly the Sports Fish Recreation Act (also known as the Dingell-Johnson/Wallop Breaux Act). The 1950 Sports Fish act was modeled after the Wildlife Restoration Act to "restore and better manage America's declining fishery resources."[113] The law distributes grants to state-sponsored projects that support this mission statement from funds garnered from excise taxes on electric boat motors (3 percent) and fishing equipment (10 percent). Taxed equipment includes fishing reels, sonar devices for locating fish, outboard boat motors, motorboat fuel, sporting arms, and import duties on pleasure boats.[114]

Mississippi received four grants from the Aquatic Resources Trust Fund in 2009 worth a combined $478,794. Two grants deal specifically with mariculture resources: The Mississippi Gulf Coast Striped Bass Restoration Program received $52,250 for phase one of its restoration efforts (catch and tag bass) and the Mississippi Artificial Reef program received $142,500 to manage existing artificial reefs.[115]

Barriers to Mariculture Development in Mississippi

Open water mariculture ventures received a big push from President Obama's administration in February 2011 with the unveiling of the NOAA draft Aquaculture Policy for mariculture development. The policy will attempt to "integrate environmental, social, and economic considerations in management decisions."[116] It is open for public commentary until April 11, 2011.[117] However, there are significant barriers to be overcome before large-scale mariculture ventures can be undertaken in the study area.

The Mississippi State University (MSU) Costal Research and Extension Center is working on several projects to identify needed links in the sea to market supply chain and to test for the viability of mariculture systems that meet the three criteria of sustainability: Long-term productivity and market stabilization, profitability, and environmental friendliness. The Coastal Research and Extension Center believes that viable off-shore mariculture operations for edible finfish may start within the next ten years with live bait mariculture, the most promising and least intensive short-term investment.[118]

Mariculture is a promising venture for meeting nutritional needs and spurring economic development in the foodshed, but it is not without risks or detractors. A report produced by the PEW Oceans Trust summarizes potential environmental impacts of mariculture development into five categories: biological pollution, fish stock, organic pollution, chemical pollution and habitat modification.[119]

Food Systems Recovery

The Mississippi Gulf Coast Region has gone through series of devastating disasters in recent years, including Hurricane Katrina, the national recession, and the most recent and catastrophic disaster – the Deepwater Horizon oil spill. The oil spill is substantially affecting tourism, seafood production and industry employment, in addition to the environmental and ecological impacts. The combination of this nation's recorded largest crude oil spill, huge amount of chemical dispersants, and many environmental and ecological factors, brings a serious combination of threats to biodiversity, the economy in the Mississippi Gulf Coast Region, and also presents numerous problems relating to the regional food system.

The Impact of Oil on Seafood

On April 20, 2010, the Deepwater Horizon explosion created one of the largest environmental disasters in US history. In the weeks and months that followed, hundreds of millions of liters of crude oil spilled into the Gulf of Mexico, threatening the waters and surrounding lands, marshes, and beaches; damaging fish and wildlife; and disrupting the lives of many residents and communities in the Gulf region.[120]

The biological impacts after an oil spill vary throughout a marine organisms' life cycle. These effects are caused by the oil itself, the chemical components in oil, or even dispersants for post-oil treatment. Oil contamination can alter natural habitats, resulting in oil incorporating into sediments and clogging habitats such as coral reefs. Oil can also interfere with species mobility and feeding, and cause physical smothering effects on flora and fauna, leading to suffocation, and heat stress.[121]

Chemically, the impacts of the hazardous substances can be divided into four categories by the mode of action: acute toxicity, leading to lethal, sub-lethal, immediate effects; chronic toxicity, leading to delayed or long-term effects; bioaccumulation, especially in mollusks like oysters, mussels; tainting of seafood.[122] Toxic effects are often caused by polycyclic aromatic hydrocarbons (PAHs) in dispersants and dissolved oil. PAHs have a wide range of molecular weights; they are readily absorbed into sedimentary particles and can become concentrated in coastal sediments.[123] They can kill fish, mammals, and aquatic invertebrates directly through smothering and other physical and chemical mechanisms. Even if not fatal, PAHs can cause diseases and damage tissues; induce reproductive and developmental problems; and impair immune systems in fish and other organisms. PAHs can enter the food web through marine organisms through bioaccumulation. Bioaccumulation begins in invertebrates and is magnified in the process up the food chain to fish and marine mammals when they consume prey.[124]

Oil causes negative effects on key organisms leading to changes in biological communities. For example, oil indirectly increases the abundance of intertidal algae by directly killing the mollusk species which graze on the algae.[125]

Concerns are often expressed about the effects of oil on fish and shellfish eggs and larvae, especially as their sensitivity to oil pollution has been demonstrated in laboratory toxicity tests. However, there is no definitive evidence that oil-induced mortalities of fish and shellfish eggs and larvae in the open sea have resulted in significant effects on future adult populations.[126]

Short-term Impact on Seafood

Since the Deepwater Horizon incident, great efforts have been put into the post-spill clean-up and restoration. The incident triggered concerns about the impacts of the oil spill; liability for damages; and the administrative process of leasing and regulatory requirements concerning health, safety, and environmental protection in drilling.[127]

Oil reached the Mississippi coast, after traveling more than 100 miles.[128] Oil reached the barrier island Petit Bois on June 1, 2010. [129] The MDMR acted quickly to minimize the immediate impact on the seafood harvest by opening shrimp season ten days earlier than normal on June 3, 2010.[130] The MDMR has since worked in coordination with the EPA and US Food and Drug Administration (FDA) to develop testing, closure and re-opening protocols to protect the public from oil-tainted seafood. Fishing areas with visible surface oil were closed as a precautionary measure. Seafood sampling following the oil breach was carried out in four steps: baseline sampling, response sampling, reopening sampling, and ongoing federal sampling.[131]

All samples were tested for chemicals associated with oil contamination. It is not officially believed that the chemical compounds found in dispersants accumulate in seafood.[132] Most Mississippi territorial waters were closed to commercial and recreational fishing by July 1, 2010 pending testing results and contamination fears. However, all Mississippi territorial waters were reopened to finfish and shrimp on August 6, 2010. Blue crab fishing in all territorial waters followed on August 26th and the FDA gave Mississippi approval to proceed with their oyster season on August 15th. The MDMR eventually allowed a limited season beginning on November 8, 2010.[133] For the first time in twenty years, only tonging — a laborious, by-hand harvesting process — was permitted.[134]

All the measurements of oil impact are effective to some extent. Only taking seafood yields into consideration, the oil impact on seafood in the near future is not significant since both manual restoration and natural remediation are underway, leading to biological recovery. Especially in the open sea, there is no evidence that any oil spill has significantly affected adult fish populations. Even where larvae may have suffered extensive mortalities this has seldom been detected in subsequent adult populations. Many seafood species produce vast numbers of eggs and larvae widely distributed by currents, which is a strategy to overcome the high rate of natural mortality.[135] This over-production strategy ensures a considerable reservoir for the colonization of new areas and the replacement of adults for post-disaster recovery.

In considering seafood safety, although sampling tests by federal agencies and state authorities show no evidence of questionable seafood safety, there are still concerns among consumers. For example, the FDA declared Mississippi oysters safe for human consumption on August 15, 2010.[136] However, testing is ongoing and concerns remain. Thanks to their built-in filtration system, adult oysters are resistant to pollution impacts compared to other marine species.[137] However, this does not necessarily mean that surviving oysters are suitable for consumption; toxic compounds can bioaccumulate in oyster tissue to dangerous levels during the filtration process.[138] The MDMR has increased inspections and olfactory tests at seafood processing plants in an ongoing effort to assure the seafood consuming public.[139]

The oil spill exasperated an already challenging situation. Before the Deepwater Horizon, there was the infamous Hurricane Katrina. Katrina wiped out an estimated 90 to 95 percent of Mississippi's commercial oysters and caused major structural damage to vital oyster reefs. The MDMR spent more than $3 million in a cultch-plant program to rebuild the oyster reefs in the western Mississippi sound in 2005.[140] The oil spill did not structurally damage the reef in the same manner as the hurricane, but the long term effect of the spill on the reef structure is unknown.

Long-term Impact on Seafood

Oil contamination may persist in the marine environment for many years after an oil spill. If sediments are contaminated by the oil, then considerable quantities may be held and the likelihood of long-term retention and the potential impacts is greatly increased.[141]

Source: *Deepwater Horizon Response NOAA seafood sensory analysis*

In considering seafood safety, although sampling tests by federal agencies and state authorities show no evidence of questionable seafood safety, there are still concerns among consumers. For example, the FDA declared Mississippi oysters safe for human consumption on August 15, 2010

According to a former FDA regulator, the challenge lies in the unknowns, such as the levels that dictate a toxic effect and the long-term exposure to oil-tainted seafood.[142] This is a challenge because there is much uncertainty associated with the toxicity of dispersed oil and dispersants and oil's location in deep water or far offshore. A large volume of oil contaminants may be dispersed throughout the water column or may penetrate deep into sensitive coastal marshes.[143] Some important inland and offshore habitats such as tidal mud-flats, sea-grass areas, and coral reefs are very sensitive to oil and take years to recover from a heavy pollution event. [144] Because they provide food and protection for many marine organisms that serve as food sources for larger seafood species, the impact of the oil spill eventually extends into deeper water.

Once oil gets into deep water, it can persist for a long time and is unlikely to break down quickly. The oil could be brought to the surface by repeated storms. If this happens, the impact on marine organisms near the surface could be even more long lasting.[145]

Another concern should be focused on the bioaccumulation of hazardous compounds. The most fully understood compounds are PAHs. Although vertebrate marine life can clear PAHs from their system, these chemicals accumulate for years in invertebrates in a relatively wide range of molecular weights.[146] Other hazardous substances exist in crude oil, especially heavy metals like cadmium, mercury, and lead; even trace amounts can accumulate over time in fish tissues, potentially posing health threats from consumption of large finfish such as tuna and mackerel.[147]

From an integrated perspective, the long-term impacts of the oil spill are inseparable with many other critical environmental changes, such as climate change. While the impacts of climate change on marine ecosystems have yet to be thoroughly observed and documented, there are many reasons for concern, including stresses caused by changes in water temperature, acidity, and oxygen levels which can also be influenced by an oil spill; increased stratification of the water column that might impede nutrient upwelling; and inundation of coastal wetlands and estuaries as sea levels rise. The unprecedented rate and extent of these

changes suggest that the impacts on biodiversity will probably be even more severe.[148] Combined with many other environmental factors, it is very difficult to predict the long-term impacts on marine organisms including seafood species. More research specified to species and environmental and ecological interactions are needed in order to effectively understand and respond to oil spills and to allow the scientific community to provide more definitive answers to questions asked by the public.[149]

Recovery of Seafood

Recovery is different from "clean" or "returned to the previous condition". Given the difficulties of knowing exactly what the pre-spill conditions were and how to interpret them in the face of natural ecological fluctuations and trends, it is unrealistic to define recovery as a return to pre-spill conditions. A definition developed by a group of independent scientists takes these problems into account:

"Recovery is marked by the re-establishment of a healthy biological community in which the plants and animals characteristic of that community are present and functioning normally. It may not have the same composition or age structure as that which was present before the damage, and will continue to show further change and development." [150]

The state to which an environment returns after damage is usually very difficult to predict. Re-colonization will depend on the time of year, the availability of re-colonizing forms, biological interactions, climatic and other factors. Marine ecosystems are in a state of continual dynamic flux.[151]

However, as stated previously, the major toxic components PAHs can contaminate the food chain, yielding the perception that petroleum hydrocarbons bioaccumulate in the tissues of marine organisms. It is true that animals such as mussels will concentrate contaminants above ambient levels through their filter feeding mechanisms. However, placed in hydrocarbon free conditions, the contaminants are quickly depurated.[152] Moreover, abundant organisms with highly mobile young stages that are produced regularly in large numbers may repopulate a cleaned-up area rapidly.[153] Because the majority of the seafood reproduces by means of pelagic larvae (forms that float free in the water), in most

Source: *Elise Yablonsky*

Oil causes negative effects on key organisms leading to changes in biological communities. For example, oil indirectly increases the abundance of intertidal algae by directly killing the mollusk species which graze on the algae

cases environmental recovery is relatively swift, being complete within two to 10 years.

Ultimately, the recovery of the sensitive Gulf Coast ecosystem will be the result of natural sedimentation and degradation processes driven by the microbial community, marine animals, and plants. Any invasive remedial efforts are likely to result in even more damage to the ecosystem.[154] Understanding the related natural process and identifying means for appropriately enhancing their effectiveness represent the best means to address the long-term risk posed by the oil.

Impact of Oil Spill on the Food System

The impact of Deepwater Horizon oil spill on Mississippi Gulf Region is far-reaching and involves various environmental, economic and social factors. Directly related to the food system, seafood contamination is a major concern. Although approved by regulatory agencies, Gulf seafood safety is still in doubt as public uncertainty and anxieties cannot be easily smoothed over. Local fishers could possibly experience permanent disruptions to their long-standing livelihoods.[155] The most evident indicator is seafood prices in the Mississippi Gulf Coast, and the Gulf of Mexico (GOM) Region shows the downtrend monthly in 2010 following the oil disaster. Fishing and beach closures also alter the recreation and consumption decisions of residents and tourists. The damage to the natural resources generate changes in the flow of goods and services which will affect not only individual households, but communities as a whole.[156]

Through the tidal flow, storms and hurricanes, the spilled oil could come ashore into inland waterways and wetlands.[157] Although efforts were made to clean near-shore shallows, coastal and inland wetlands, and sand marshes, many marsh areas were and to some extent have to be left to recover naturally because the impact of cleanup efforts would exacerbate the damage. Clean-up activities following an oil spill appear to have detrimental effects on the Gulf Coast marshes due to physical disturbance and compaction of vegetation and soil.[158]

Health and Food Security

The health of Mississippi coast residents relies on food security. This includes how much and what type of food people have access to. Poor diet and physical inactivity are the most important risk factors for diet related diseases such as obesity, cardiovascular disease, hypertension, type two diabetes, osteoporosis, and cancers.[159] In 2009, 14.7 percent of American households could not acquire adequate food to meet the needs due to insufficient money or resources at sometime during the year; for those who have adequate resources, many lack healthy dietary behaviors or have a less than optimal intake of certain nutrients. [160] [161] Mississippi has the third highest food insecurity rate in the nation, with 17.1 percent of households experiencing food insecurity. [162] Prevalence of food insecurity varies among household types: households with incomes under the poverty line had the highest food insecurity at 43 percent, followed by the households with children headed by a single woman (36.6 percent).

Achieving food security requires availability of food, sufficiency of the food, adequate access to food, affordability of food, and the cultural appropriateness of the food.[163] In addition, the emergency food sources or other coping behaviors, socioeconomic and demographic factors, such as household size, homeownership, education attainment, savings rates, access to credit and health insurance, and household income have been shown to be important factors as well. [164]

Food Availability

Access to food and proximity to the available food source is one indicator of food security. The data shows that 27.5 percent of population in Hancock county are low-income and live more than one mile from a supermarket or large grocery store, followed by 22.3 and 18.5 percent for Harrison and Jackson counties, respectively. On average, 3.1 percent of households in the coastal counties do not have a car and are more than one mile from a grocery store.[165] More than 2,400 households are low income and live more than 10 miles from the nearest grocery store in the coastal counties. [166]

Once at a store, the availability of healthy food can be an issue. The USDA found that there is decreasing availability of food generally and of healthy food specifically across the United States, falling 4.5 percent since 2000. There was an estimated 932 pounds of food available per capita in the marketplace in 2008, adjusted for food spoilage and other losses. [167] Only fats and oils increased in their availability during the 2000s, see Figure 4.[168] Fruits and vegetables together account for 31 percent of the total availability, followed by dairy products (20 percent), total meat, fish, eggs, and nuts (16 percent), added fats and oils (18 percent) and grains (15 percent).

Beverages are another contributing factor in unhealthy diets. For example, the average American consumes 600 12 ounce soft drinks per year. The USDA measures beverage consumption in the US, in six categories excluding water and soft drinks.[169] In 2008, there were 85.6 gallons of beverages available per capita, excluding soft drinks.[170] Only 32 percent of available beverages are healthy choices, milk and juice. Alcoholic beverage was the largest category, with nearly 26 gallons available per person per year, and coffee was the close second, shown in Figure 5. Since

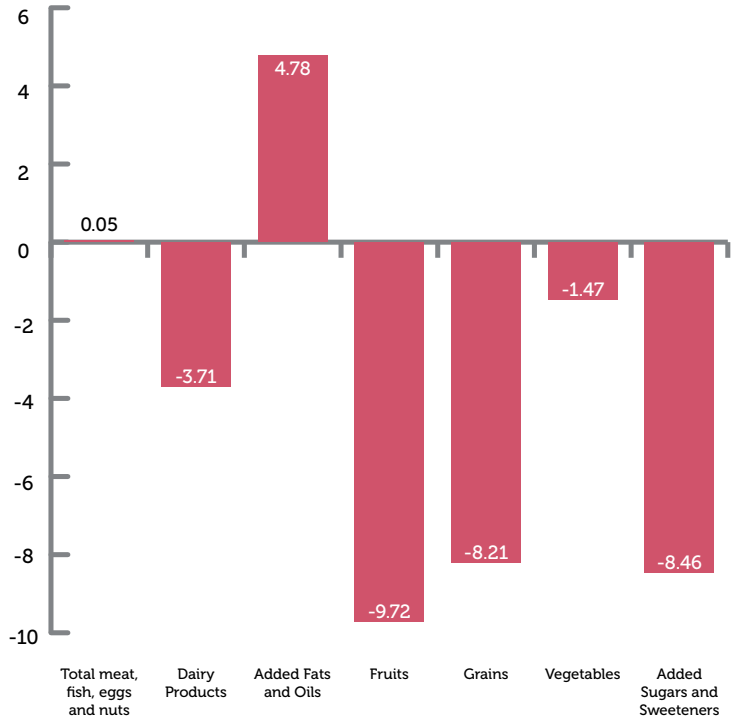


Figure 4
Change in the Availability of Food Between 2000 and 2008
Source: *USDA/Economic Research Service.*

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2000, Americans have increased their consumption of alcoholic drinks (2.7 percent) and tea (2.2 percent), while decreasing their consumption of milk and coffee by about 8 percent.[171]

What We Eat

The Consumer Expenditure (CE) Survey, another data source to measure what people actually eat, monitors the buying habits and household characteristics of Americans annually. It provides information on how consumers allocate spending on various components. The data is for the metropolitan statistical areas (MSA) classified in the south.[172] Residents of the south spent 13 percent of their expenditures on food.[173]

Among food expenditures, over half of the spending was on "food at home" (58 percent) as opposed to "food away from home" in southern metropolitan areas averaging $3,488 per year per household. Spending on food to be eaten at home increased 14 percent between 2004 and 2008, with the biggest increase in spending on less healthy choices as shown in Figure 6.[174]

Resources to Support Food Security

There are a variety of food assistance programs that promote food security. The USDA Food and Nutrition Service (FNS) provides children and low-income households access to healthy food and nutrition education.[175] Major assistance programs include the Supplemental Nutrition Assistance Program (SNAP); the Special Supplemental Nutrition Program for Women, Infants and Children (WIC); Child Nutrition Programs (National School Lunch, School Breakfast, Child and Adult Care, Summer Food Service and Special Milk); and Food Distribution Programs (Schools, Emergency Food Assistance, Indian Reservations, Commodity Supplemental, Nutrition for the Elderly, and Charitable Institutions).

Supplemental Nutrition Assistance Program (SNAP)

SNAP replaced the federal Food Stamp Program in 2008. According to the USDA Economic Research Service (ERS) Food Environment Atlas, less than one-third of the low income households in the coastal counties are receiving SNAP benefits,

Figure 5
Availability of Beverages for Consumption
Source: *USDA/Economic Research Service.*

26.2 percent in Hancock, 28.6 percent in Harrison, and 30.2 percent in Jackson county. [176] [177] [178] In 2009, Hancock County had 32 SNAP-authorized stores, Harrison County had 153 stores, and Jackson County had 94 stores.[179]

Special Supplemental Nutrition Pro gram for Women, Infants and Children (WIC)

WIC provides supplemental foods, health care referrals, and nutrition education at no cost to low-income pregnant, breastfeeding and non-breastfeeding postpartum women, and to infants and children up to age five found to be at nutritional risk. [180] The FNS is responsible for the program at the national and regional levels, while the State Department of Health (DOH) is responsible for the state level. [181] Average monthly WIC participation for WIC in Mississippi for the year 2010 was 102,224 (persons) and benefit per person was $52.24.[182] WIC provides a distribution center in each county. WIC participants must go to the distribution center, rather than a store as with the SNAP program. This limits the ability of WIC participants to redeem their benefits. For example, in October 2010 only 45 percent of WIC recipients redeemed their benefits in Jackson County, while the redemption rate was 75 percent in Hancock County and 76 percent in Harrison County.[183]

Child Nutrition (CN) Programs

National School Lunch Program (NSLP) was established in 1946 and operating in public and non-profit private schools and residential child care institutions.[184] Participating schools receive cash subsidies and donated commodities from the USDA for each meal they serve. In return, the schools provide free or reduced-price lunches which meet the Dietary Guidelines. [185] [186] As seen in Figure 7, Hancock County had about 65 percent of students eligible for free-lunch in 2008, the highest among the three coastal counties. Harrison and Jackson County had 50 and 46 percent, respectively, of students eligible for free lunch. The School Breakfast and Summer Food Service Programs operate similarly providing access to meals. [187] [188]

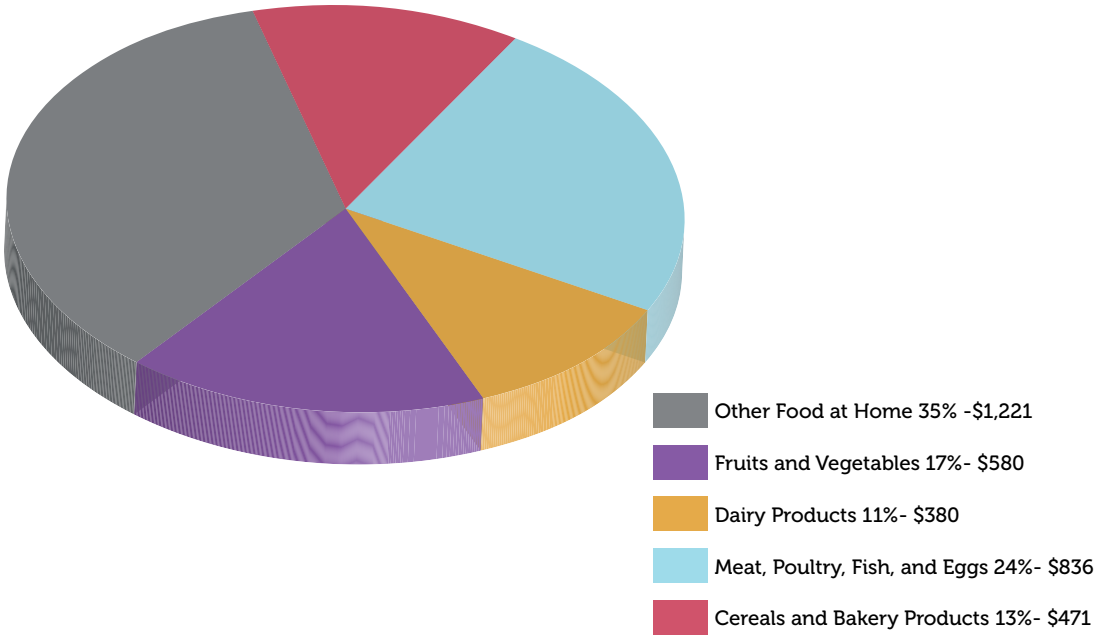


Figure 6
Expenditures on Food for Preparation at Home
Source: *Consumer Expenditure Survey, U.S. Bureau of Labor Statistics, October, 2010*

The Consumer Expenditure (CE) Survey, another data source to measure what people actually eat, monitors the buying habits and household characteristics of Americans annually. It provides information on how consumers allocate spending on various components. The data is for the metropolitan statistical areas (MSA) classified in the south.[172] Residents of the south spent 13 percent of their expenditures on food.

Child and Adult Care Program (CACFP) "serves nutritious meals and snacks to children and adults attending eligible day care programs".[189] The child care or adult care component may be administered by eligible public or private nonprofit child care centers, outside-school-hours care centers and other institutions which are licensed or approved to provide day care services, family or group day care homes, at-risk afterschool care programs, adult day care facilities serving to nonresidential adults functionally impaired or aged 60 and more, and emergency shelters for homeless children and youth. According to the number of meals served to enrolled children, the sponsoring day care organizations receive reimbursement in cash or cash-in-lieu of USDA foods.[190]

For the above mentioned programs, qualifications are based on poverty levels: "participants from families with incomes at or below 130 percent of the Federal poverty level are eligible for free meals. Those with incomes between 130 percent and 185 percent of the poverty level are eligible for reduced-price meals."[191] [192]

Food Distribution (FD) Program

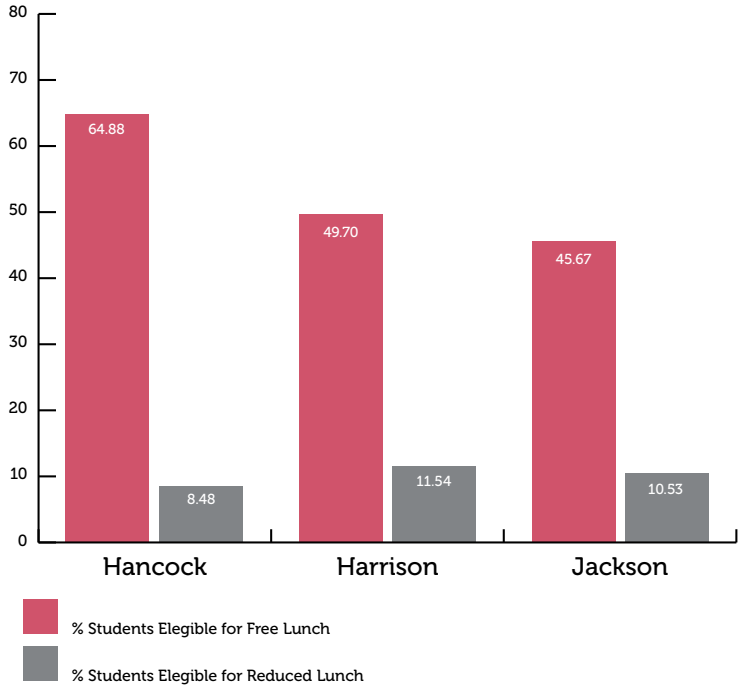
FD Program is to "strengthen the nutrition safety net through USDA Foods distribution and other nutrition assistance to low-income families, emergency feeding programs, Indian Reservations, and elderly".[193] [194] Other related services are commodity processing and supplemental food program, fresh fruit & vegetable program, nutrition services incentive program, disaster assistance and emergency food assistance program. In Mississippi, Department of Human Services runs the Emergency Food Assistance Program (TEFAP) entirely founded by the USDA.[195] This program provides food to food pantries, for example.

Diet-Related Health Problems

Diabetes is a major cause of heart disease and stroke.[196] Mississippi ranked second (11.4 percent) among all states for diabetes.[197] The Mississippi Gulf Coast has higher rates of diabetes than the state as a whole, 12 percent in the Gulfport-Biloxi MSA and 11.7 percent in the Pascagoula MSA.[198]

Figure 7
The Portion of Students Eligible for the Free or Reduced Lunch Program
Source: *USDA, ERS, Food Environment Atlas*

National School Lunch Program (NSLP) was established in 1946 and operating in public and non-profit private schools and residential child care institutions. Participating schools receive cash subsidies and donated commodities from the USDA for each meal they serve. In return, the schools provide free or reduced-price lunches which meet the Dietary Guidelines.



Overweight or obesity, one of the diet-related health risk factors monitored by the Centers for Disease Control and Prevention, Behavior Risk Factor Surveillance System (BRFSS), has become a major health concern for the whole nation. The Selected Metropolitan Statistical Area Risk Trends (SMART) data from BRFSS shows that Gulfport-Biloxi MSA also had an obesity rate (32.9 percent) higher than the national average (26.9) but lower than the State average (35.4).[199] The obesity rate for Pascagoula MSA was 34.3 percent, close to the state average.[200] Preschool obesity is also a concern with all of the coastal counties having a rate above 11 percent, Jackson County (11.9 percent), Harrison County (12.4 percent), Hancock County (13.3 percent).[201]

The County Health Rankings model developed by the Robert Wood Johnson Foundation and the University of Wisconsin Population Health Institute takes into consideration health factors and health outcomes to determine the overall health condition of the counties.[202] The study found that the coastal counties have the worst environmental quality in the state based on water quality, air quality, lack of healthy food access, and access to recreational facilities. This combination of factors lead to higher mortality rates.[203]

Food Economy

This analysis of the food economy reveals strengths and weaknesses in the foodshed, including food industries and major food related employers in the region. An understanding of the food economy makes it easier to answer questions about the coastal counties' specific eating habits, what industries contribute the most to the local economy, and where improvements are needed to supply the coastal counties with healthier food sources.

Food Manufacturing

Within the foodshed there are 235 food and 20 beverage and tobacco manufacturing establishments. Nine percent, or 21, of these establishments are located in the coastal counties. Table 6 (see appendix) shows the food manufacturing facilities in the coastal counties and the foodshed. There is a wide variety of food manufacturers. Fresh and frozen seafood processing is the largest category due to the strong commercial fishing and aquaculture industry and shipping imports. In the foodshed retail bakeries represent the largest number of manufacturing establishments.

The foodshed is also home to 14 animal food manufacturing establishments. According to the US Census Bureau these facilities process animal foods from products such as grains, oilseed mill products and meat products. This may be an important outlet for by-products from human food manufacturing processes.

There are many food manufacturing plants across the foodshed; however, most of them employ a small number of people. Figure 8 shows a breakdown of the number of manufacturers based on employment numbers for the coastal counties and the foodshed. Only five percent of the industry employs greater than 250 people in the foodshed. Forty percent of the manufacturers located in the coastal counties have four or less employees.

Food Wholesalers

Harrison County is the only Mississippi county in the foodshed with food wholesalers. There are 17 grocery wholesalers and two of those are more specifically fruit and vegetable wholesalers. Louisiana has a much greater number and variety of wholesalers. In Louisiana parishes there are 94 grocery wholesalers, five fall under the category of coffee, tea and powdered drink mix wholesalers. Another nine, considered "other grocery and related products," are primarily bottled water wholesalers. Louisiana also has 12 raw farm product wholesalers, such as grain.

The Harrison county wholesalers employed 210 people in 2007 and had annual sales of $223 million. The grocery wholesale industry in Louisiana employed 1,752 and had annual sales of $1.1 billion.[204]

Food Establishments

Food service establishments and stores are an important part of a community. Table 7 lists the number of food service and drinking places and the number of food and beverage stores for major cities in the foodshed. The populations of each city are also provided along with the number of people per establishment or store. The average number of people per establishment for the coastal counties is higher than counties elsewhere in the foodshed with 53 total establishments and 517 people per establishment.

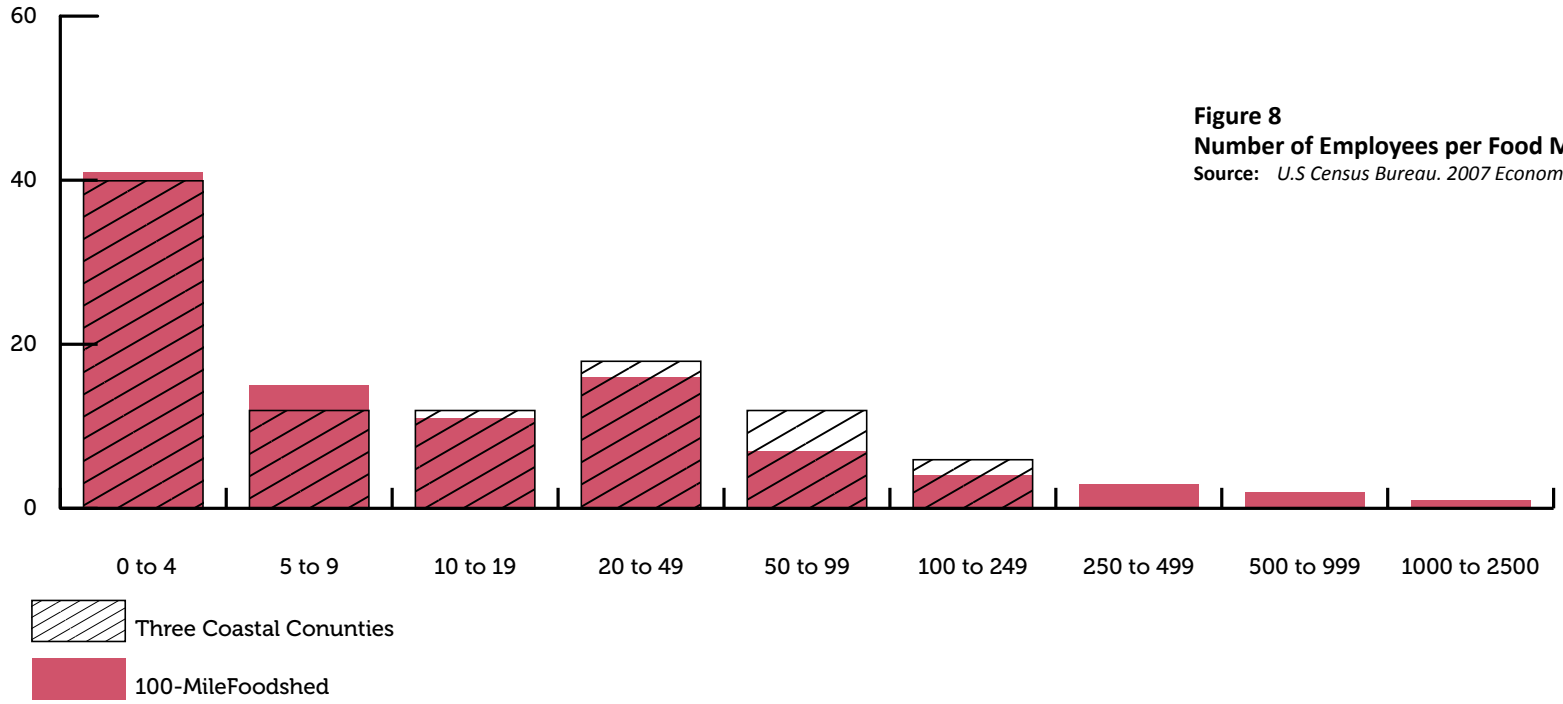


Figure 8
Number of Employees per Food Manufacturing Facility
Source: *U.S Census Bureau. 2007 Economic Census*

However, the coastal counties do have a lower ratio of people per food and beverage store than the US average with 28 stores and 1,480 people per store. The other counties average more than 6,500 people per store.

Labor in Food Related Positions

Reporting accurate figures on the number of people employed in food related positions is difficult. This is because the Economic Census does not include positions that are not covered by unemployment insurance or for self-employed individuals and some agricultural employees. [205] The result is that federal data sources undercount the number of employees and that there are inconsistencies between the number of employees reported in the Economic Census and the County Business Patterns. Because of these inconsistencies the data was examined for trends but actual employment numbers are not reported in this section. As an example, MSU estimates the total economic impact from landings and process is more than one billion dollars annually.[206] Yet, the employment data shows only 60 people employed in fishing. This is underreported because most fishers are self-employed. The data are more accurate for food manufacturing and processing. Seafood processing is 12.9 percent of Food Manufacturing employment (1.9 percent of the overall manufacturing sector) and 1.2 percent of the state's manufacturing payroll.

Table 8 (see appendix) lists other food related industry employee numbers in the foodshed and the coastal counties. Forty seven percent of fruit and vegetable merchant wholesaler employees are located within the three coastal counties. According to Table 8 (see appendix), there are no employees of fish and seafood markets in the coastal counties. This is unlike the foodshed as a whole where there are 377 fish and seafood wholesaler employees and 297 people working at fish and seafood markets, according to Table 8 (see appendix). Of food manufacturing employees overall 6.5 percent work in the coastal counties.

Table 9 reveals the number of employees in food related occupations reported for metropolitan and non-metropolitan areas within the foodshed. These are combined under each state.

City, State	Population 2009	Food services and drinking places	Number of people per establishment	Food and Beverage Stores	Number of People per Store
Biloxi, MS	**45,766**	**73**	**627**	**83**	**551**
Gulfport, MS	**70,794**	**147**	**482**	**21**	**3,371**
Long Beach, MS	**12,245**	**21**	**583**	**7**	**1,749**
Moss Point, MS	**13,952**	**21**	**664**	**6**	**2,325**
Ocean Springs, MS	**17,363**	**59**	**294**	**11**	**1,578**
Pascagoula, MS	**23,692**	**42**	**564**	**53**	**447**
Pass Christian, MS	**4,073**	**10**	**407**	**12**	**339**
Average All	57,413	121	452	25	5,164
Average Three County	26,841	53	517	28	1,480
Average Other Counties	68,677	146	428	24	6,521
U.S. Total	301,621,159	571,621	528	146,084	2,065

Table 7
Food Establishments and Stores by City
Source: *U.S Census Bureau. 2007 Economic Census*

There are significantly more people employed in the food service industry than agriculture and food production combined.

Location Quotient

The location quotient for each industry provides a ratio on how an industry in the foodshed compares to the same industry in the US as a whole. The industries in Figure 9 were selected to show the strengths and weaknesses of the foodshed, but the undercounting of employment denotes that caution should be used in interpreting these results. Full-service restaurants have a location quotient of 1.08. This means that the number of employees of full-service restaurants in the foodshed is proportionate to that of the US as a whole. Fish and seafood markets as well as fresh and frozen seafood processing are over 2.5 times that of the US as a whole, with location quotients of 2.67 and 2.65 respectively. This is most likely due to the coastal location of much of the foodshed. Other food sectors are significantly smaller than the US as a whole. This could imply local production is not meeting consumer demand in the foodshed.

Multipliers

The Bureau of Economic Analysis computes the Regional Input-Output Modeling System (RIMS II) multipliers. Multipliers are a useful tool in determining the economic impact one industry has on all industries. Table 10 displays some of the multipliers for food related industries located in the coastal counties. In the Output column, animal slaughtering, rendering and processing has one of the highest positive economic impacts for each additional dollar of output it delivers. This means that for each additional one dollar in output in that industry, output in all industries increase by $1.51 in the region. This includes the original one dollar that the slaughtering industry contributed. The additional 51 cents is added to other industries in the region. If a slaughtering facility in the region's demand increases and it delivers one million dollars of output to meet that new demand, the region's output as a whole would increase by $1.5 million. Again, this number includes the original one million dollars from the slaughtering facility which creates $500,000 in output for other industries.

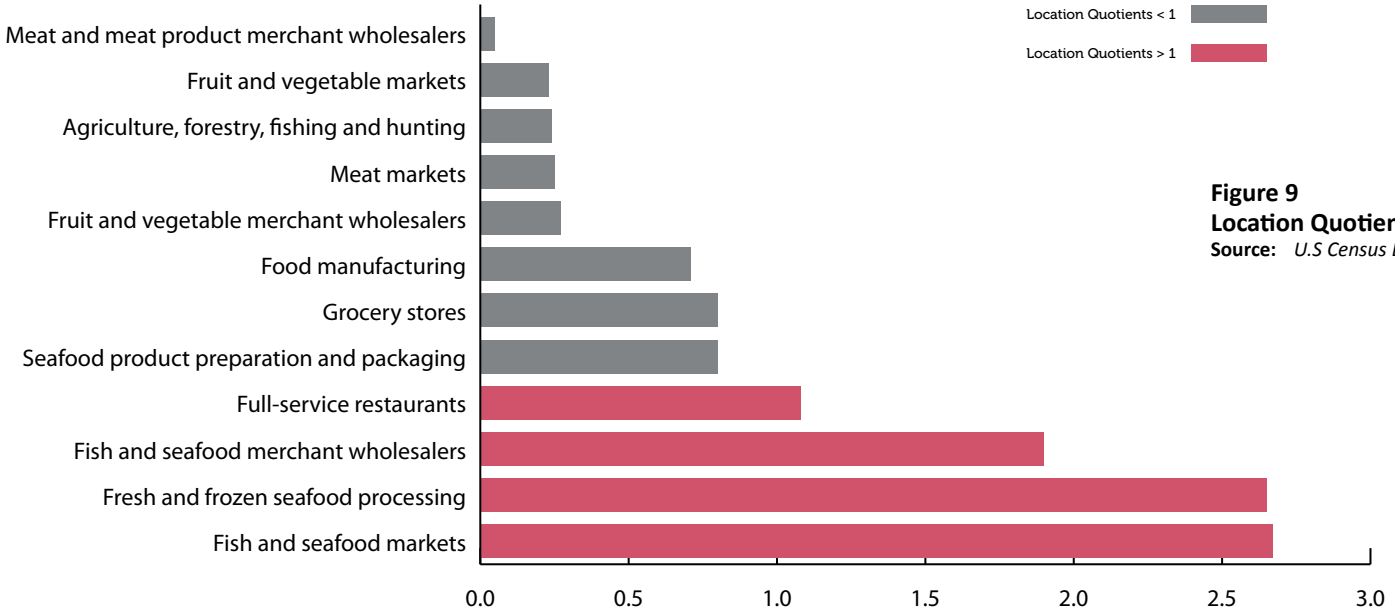


Figure 9
Location Quotient for Select NAICS Industries in the Foodshed
Source: *U.S Census Bureau. 2007 Economic Census*

The multipliers under Direct Effect are interpreted differently than those under Final Demand. The change under Final Demand occurs with each additional dollar of output. Under Direct Effect however, the additional job hired directly increases employment in all industries despite the effects on output. For example, for each additional job created in the animal slaughtering industry in the coastal counties, 1.22 jobs are created in addition to that job. There are currently no animal slaughtering, processing or rendering facilities located in the coastal counties. Of the facilities located in other counties within the foodshed, the majority fall under the zero-to-four employees category. For example, if a larger facility were to open up to meet demand for local processing in the coastal counties and hired 50 employees, this would add another 61 jobs to the region in other industries.

Consumption

Consumption data provides information on how much of what product a region is consuming. This better enables a foodshed to assess its ability to meet demand through local production rather than importing food. Using the Leopold Center's US Food Market Estimator[207] method, the 2008 total consumption for the coastal counties was found by multiplying the county population by the US per capita consumption rate of each commodity. These values are listed in Table 11. While these are estimates from the U.S. per capita consumption rate, they do provide a starting point for understanding potential demand from the coastal counties.

INDUSTRY	Multiplier	
	Final Demand Output ($)	Direct Effect Employment (jobs)
Animal (except poultry) slaughtering, rendering, and processing	1.51	2.22
All other crop farming, including sugarcane and sugar beet farming	1.51	1.46
Bread and bakery product manufacturing	1.48	1.73
Oil seed and grain farming	1.48	1.53
Greenhouse, nursery, and floriculture production	1.41	1.23
Soft drink and ice manufacturing	1.39	2.13
Vegetable and melon farming	1.39	1.21
Fruit and tree nut farming	1.39	1.18
Seafood product preparation and packaging	1.38	1.63
Cattle ranching and farming	1.36	1.53
Dairy cattle and milk production	1.33	1.35
Cookie, cracker, and pasta manufacturing	1.32	1.73
Animal production, except cattle and poultry and eggs	1.28	1.35
Poultry and egg production	1.27	1.44
Confectionery manufacturing from purchased chocolate	1.26	1.78
Breweries	1.21	1.58

Table 10

Multiplier Effect of Food Related Industries in the Three Coastal Counties

Source: *Adapted from the Regional Input-Output Modeling Systems (RIMS II), Regional Product Division, Bureau of Economic Analysis*

NOTE—Multipliers are based on the 2002 Benchmark Input-Output Table for the Nation and 2007 regional data.

Product	US Per Capita	Hancock County	Harrison County	Jackson County	Three Coastal Counties Total
Dairy	600.5	23,768,433	105,652,361	77,842,249	207,263,044
Fats and Sugars	223.3	8,837,767	39,284,499	28,943,923	77,066,189
Fruit	250.9	9,928,320	44,132,082	32,515,511	86,575,914
Grains	196.5	7,778,312	34,575,144	25,474,177	67,827,633
Vegetables	392.7	15,543,220	69,090,709	50,904,458	135,538,388
Fish, Poultry and Red Meat	287.4	11,372,148.00	50,549,997.00	37,244,085.00	99,166,230.00

Table 11

Total Consumption in Pounds

Source: *US Department of Agricultural Economic Research Service. (2010). Food Availability (Per Capita) Data System.*

Food Distribution

The Mississippi Gulf Coast region maintains thriving ports that represent a significant portion of US commodity traffic and are supported by well-established highway and railroad systems. The unique intermodal characteristics provide the infrastructure for food to travel into, out of, and within the region. To best explain movement through different transportation modes, a Food Freight Analysis Framework (FAF) was constructed for the Mississippi Gulf Coast. The US Department of Transportation Federal Highway Administration manages a comprehensive data set that allows for an overall understanding of regional food distribution and ultimately explains how food travels to where it is consumed.

Gulf Coast's Distribution Network

This section examines the ports, highways, and railroads that make up the distribution network in the Mississippi Gulf Coast and the surrounding foodshed.

Ports

There are eight ports within the foodshed. In the Mississippi coastal counties, there are three facilities: Port Biloxi, Port of Gulfport, and Port of Pascagoula, though only Port of Gulfport and Port of Pascagoula handle food imports and exports.

The Port of Gulfport situated in Harrison County has a depth of 36 feet in the Gulf Coast,[208] and among the ports of interest, it handles the least tonnage, with around two million tons in 2009.[209] The port is still undergoing extensive recovery from the 2005 Hurricane Katrina; in 2009, 235 ships and 2.04 million tons of cargo were processed, compared to 353 ships and 2.4 million tons in 2004.[210] Food-related cargo makes up roughly 45 percent of total overall tonnage processed, which includes vegetable products, grain, feed, fresh and frozen meat.[211]

Most notably, bananas are a major commodity handled at Gulfport, making up nearly 75 percent of imports by tonnage.[212] Chiquita and Dole have established berth space in Gulfport operations; the port offers facilities specifically for the firms' use to accommodate trade flow.[213] In April 2010, the Mississippi State Port Authority broke ground to construct a new terminal for Chiquita to be completed by 2013.[214] The construction efforts will ensure improved hurricane resistance, as the aftermath of Katrina forced Chiquita to relocate, before returning in September 2009.[215] Dole ships products in from Guatemala and Honduras twice a week.[216]

The Port of Pascagoula resides on the Pascagoula River and Bayou Casotte in Jackson County.[217] It was ranked 16th among U.S. ports for most tonnage in 2009, transporting roughly 37 million tons.[218] Pascagoula mainly handles petroleum, but food and farm products made up almost eight percent of tonnage, nearly all of which were fresh and frozen meats.[219] In 2010, concerns over disinfection processing resulted in a Russian ban on US frozen poultry, impacting cargo tonnage in Pascagoula by 23 percent with frozen poultry exports dropping by 54 percent overall.[220]

Other ports in the foodshed handling food products:

- Port of South Louisiana handled the most tonnage in the

US in 2009; food and farm goods made up nearly half of total cargo, most notably grain and oilseeds[221]

- Port of New Orleans was ranked sixth in 2009 US tonnage; about 30 percent was food and farm goods, grain and oilseeds being the most significant products[222]
- Port of Mobile was ranked 12th in 2009 US tonnage; only 4 percent of it was food and farm goods, notably oilseeds, fresh and frozen meats, miscellaneous food products, and alcoholic beverages[223]

Highways

Interstate Highway 10 is considered to be one of the major transportation arteries in the continental US. Of the country's total freight tonnage, 29 percent begins or ends in an area that includes the Interstate Highway 10 region.[224] Including the 77 miles in Mississippi, Interstate Highway 10 runs through eight southern states: California, Arizona, New Mexico, Texas, Louisiana, Alabama, and Florida.[225]

Truck flows along the interstate tend to stay within the eight states of the Interstate Highway 10 region, accounting for 78 percent of total volume and 64 percent of value.[226] Of the intraregional flows, food, farm and related goods make up almost nine percent of volume, or roughly 10 percent of value.[227]

For movement into and out of the Interstate Highway 10 region, the South Atlantic, New York/New Jersey/Pennsylvania and Great Lakes areas are the leading trade areas. Food and related products (not including farm goods) make up 15 percent of interregional tonnage, or nine percent of value. This implies Interstate Highway 10 is a major route for food to travel from port areas to metropolitan areas across the US, particularly for high volume, low value commodities.[228]

In the foodshed, the three major cities to note are New Orleans, Biloxi, and Mobile. New Orleans ranks second in total flow of freight in the Interstate Highway 10 region, responsible for roughly 40 percent in weight and value. Biloxi observes four percent of tonnage and value, and Mobile with one percent in weight, and two percent of value.[229]

Total flows observed in Mississippi make up roughly 7 percent of freight tonnage moving in the US, or about 6 percent of value. Food, farm, and related goods account for about 7 percent of the tonnage and value in the state.[230]

US Highway 90 is another important roadway. At 79 miles in length, it runs parallel to Interstate Highway 10 along the Mississippi coastline until two miles east of the Mississippi-Alabama state line where they converge.[231] US Highway 90 is used as a local distribution line and by residents for travel to neighboring cities.

Other significant highways within the foodshed:

- Interstates 55 and 59 lead to Jackson and Hattiesburg, metropolitan areas in Mississippi
- US Highways 84, 98, and 45 connect to Alabama
- Interstate 12 links to Interstate Highway 10 from Louisiana[232]
- Interstate 65 provides a north-southwest route from Mobile[233]

Railroads

The main railroad servicing Mississippi is CSX Transportation. There are 94 miles of rail statewide, running through Gulfport, Biloxi, and Pascagoula between Interstate Highway 10 and US Highway 90. CSX reaches all Gulf Coast and Atlantic ports, making it an important component of the intermodal transportation system. Within the Gulf Coast region and beyond, CSX maintains extensive service, totaling nearly 21,000 rail miles in the US.[234] Agricultural products include grain, flour, oil, and sweeteners, representing roughly $960 million, or 11 percent of 2009 revenue.[235] [236] Food and consumer goods were reported together as $261 million, or 3 percent.[237] Refrigerated and frozen foods, rice, edible beans, peas, lentils, alcohol, canned goods, and tomato products make up food goods transported by CSX.[238]

Other secondary railroads in the coastal counties and foodshed:

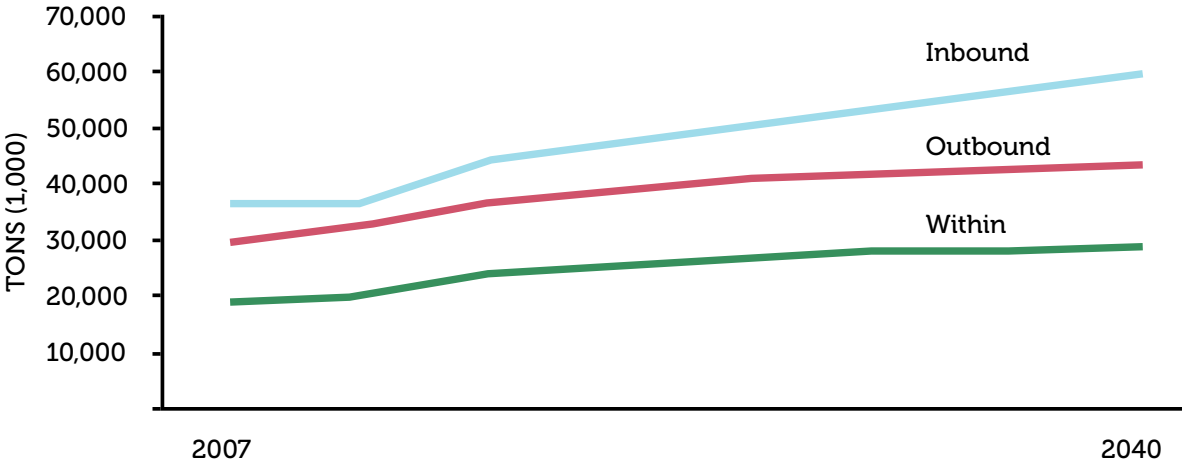


Figure 10
Type of Movements in Mississippi
Source: *US DOT Federal Highway Administration*

- Port Bienville Railroad connects to CSX in Hancock County[239]
- Kansas City Southern Railroad lies in Harrison and Jackson Counties[240]
- Canadian National reaches Gulfport and New Orleans[241]
- Mississippi Export (subsidiary of Canadian National) reaches Port of Pascagoula[242]
- Norfolk Southern (subsidiary of Canadian National) services Louisiana and Alabama[243]
- Burlington Northern Santa Fe, Union Pacific, New Orleans Gulf Coast offer transport to Louisiana ports[244]

The Freight Analysis Framework

The Freight Analysis Framework (FAF) tracks and forecasts freight movement in the US, organized by state, major metropolitan areas, and modes of transportation.[245] The most recent reported data is available for 2007 and estimates are provided through 2040. Food products are established in eight categories.

The main limitation of using FAF is the parameter in which the data was reported. Freight movement is not captured at the county level, so Mississippi movement is presented statewide. However, New Orleans and Mobile are reported as a designated FAF metropolitan area. Therefore, interpretation of the Mississippi Gulf Coast and foodshed will be an overestimation since the data sets include additional counties.

Eight categories of food and agricultural products are collected in the FAF:[246]

- Live animals and fish include live cattle, poultry, and fish
- Cereal grains include wheat, corn and rye
- Other agricultural products include vegetables, fruits, nuts, and oilseeds
- Animal feeds are straw and other farm remains destined for animal consumption
- Meat/seafood are meats and seafood prepared fresh, chilled, or frozen
- Milled grain products include milled flours and bakery products
- Other foodstuffs are dairy, processed vegetables, fruits, and other edible preparations
- Alcoholic beverages are beers, wines, and spirits

Mississippi vs. US Freight Movement

Total freight by weight and value offers a perspective on the distribution of goods in Mississippi and in the US. Overall

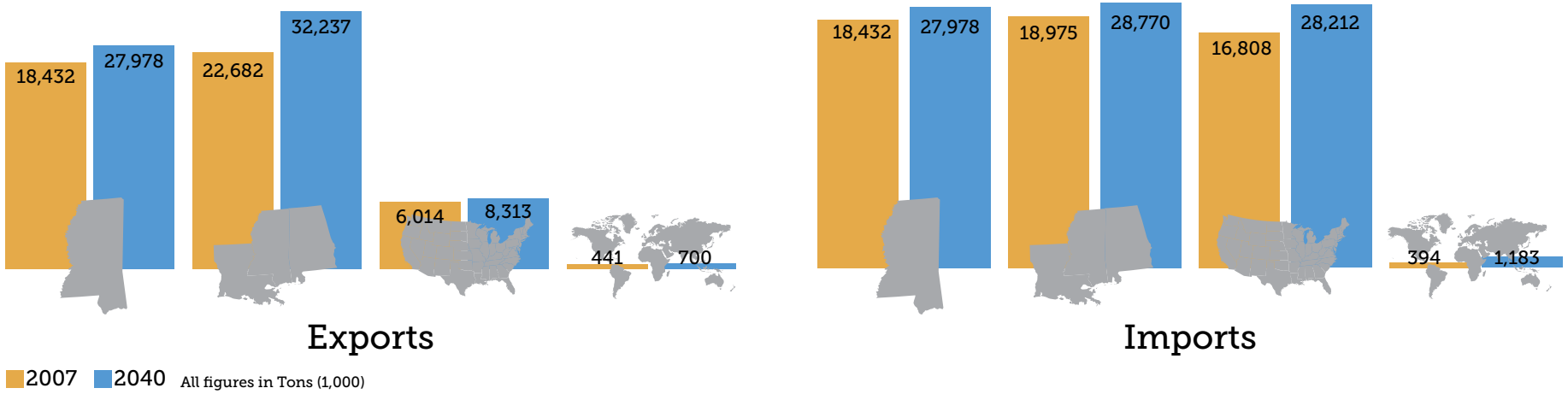


Figure 11
Projected Increase in Food Imports and Exports
Source: *US DOT Federal Highway Administration*

freight movement in Mississippi closely mirrors US patterns; food products make up roughly 15 percent of both commodity movements. Mississippi has a smaller share of food products in weight than the U.S. average but observes more movement when compared in value. This implies that the commodities transported through Mississippi tend to be lower in volume, but of higher value than the food products moving throughout the US.

Types of Food Movements

Freight transport associated with Mississippi is assessed by three different types of movements:

- Inbound movement follows goods destined for Mississippi, of domestic or foreign origins
- Outbound is product moving from Mississippi to destinations outside, including US exports

Within movement consists of goods of origins and destinations within Mississippi (this is included in both outbound and inbound movement)

All types of food movements are predicted to increase, tonnage within and outbound by a third, inbound by roughly half. [247] The trends indicate state reliance on imports for food products, and possible infrastructure pressures to accommodate increasing incoming tonnage. Mississippi is not completely self-sufficient to meet the demands of its residents and relies on imports. Destinations of food originating from Mississippi are presented in Figure 11.[248]

Of the food destined for Mississippi, they are evenly sourced within the state and from states outside the foodshed. Areas within the foodshed beyond Mississippi and international sources are a small fraction of inbound tonnage, pointing to Mississippi's status as a minor entry for US imports. Overall, all categories of food origins are expected to increase through 2040.

Of the food originating within Mississippi, over 60 percent of food stays within the state, 20 percent ends up in regions outside the foodshed, and the remaining goods are transported to New Orleans and Mobile. This may be due to the major transportation capabilities in New Orleans and Mobile serving as an intermediary

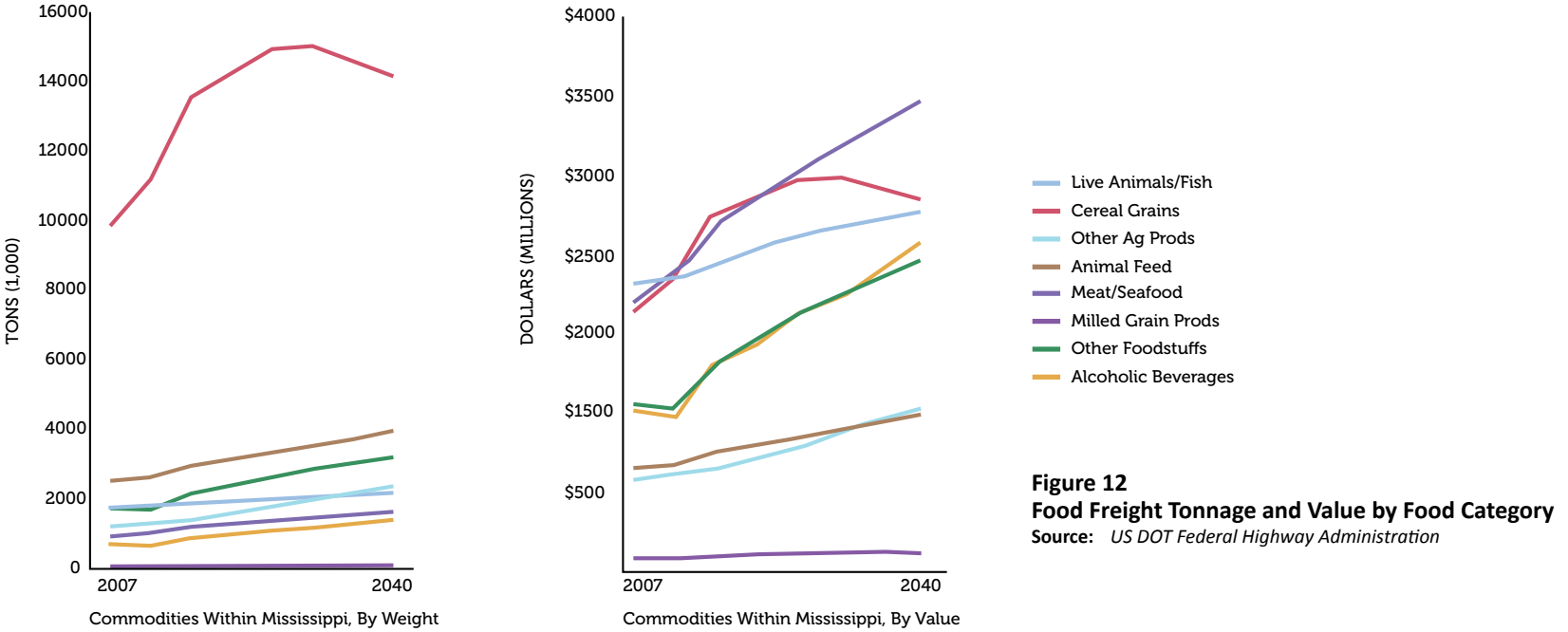


Figure 12
Food Freight Tonnage and Value by Food Category
Source: *US DOT Federal Highway Administration*

for food products to reach other parts of the US. Furthermore, New Orleans has a concentrated population cluster of 1.2 million residents, nearly half of the entire state of Mississippi, indicating significant demand.[249] Tonnage is expected to increase across the board by about half.

Total Weight and Value of Food Movements

The Mississippi freight movements of the eight food categories from 2007 through 2040 are illustrated in Figure 12. In terms of tonnage, cereal grains makes up the largest portion of food products, at over 50 percent, followed by animal feed and other foodstuffs. [250] But the top three in value are meat and seafood, cereal grains, and live animals and fish. This demonstrates that cereal grains are high tonnage, low value goods, while meat and seafood and live animals and fish are the reverse. Other similar high value goods are alcoholic beverages and other foodstuffs.

All commodities are expected to increase through 2040, except for cereal grains, which experience a downturn in 2030. This may be due to Mississippi's limited capability to manage the increase in grain tonnage. Trucks and waterways are the only modes of transportation for grains, and while both face a decline, no other mode helps offset the loss; possibly a supply side limitation, such as infrastructure capabilities, or demand side decline results in this trend. On the other hand, meat and seafood products face a significant increase in sales, over 75 percent from 2007 to 2040. Yet, the tonnage does not change as dramatically, indicating these products are predicted to experience substantial price hikes in the next 30 years.

Food Waste and Materials Management

As the global population races towards the projected 8.92 billion in 2050, the waste situation becomes paramount. In 2009, the US Environmental Protection Agency estimated that Americans generated 243 million tons of trash, of which, 14 percent or 34 million tons was food waste. [251] Using similar estimates, Hancock, Harrison, and Jackson Counties produced 84,700 tons of food waste collected at the two Municipal Solid Waste facilities within the three county region. [252] By employing the principles of the USEPA & USDA Food Waste Recovery Hierarchy, a significant portion has the potential for diversion. The food waste recovery hierarchy comprises the following activities, [253] with disposal as the last option, as seen in Figure 13.

Regulatory Framework

The Mississippi Department of Environmental Quality (MDEQ) is the regulatory body charged with safeguarding the state's air, land, and water. The Office of Pollution Control's Environmental Permits Division, which hosts the Solid Waste Policy, Planning, and Grants Branch, "conducts a variety of policy, planning, regulatory and financial assistance activities involving the management and disposal of non-hazardous solid wastes in the state of Mississippi."[254] Currently, the MDEQ has regulatory programs for both commercial and non-commercial waste, combined with composting, beneficial use determinations, and land application that might provide opportunities to capitalize on the Food Waste Recovery Hierarchy's Principles. Additionally, MDEQ provides support for the process of assembling regional Municipal Solid Waste plans.

MDEQ's primary waste disposal facilities are commercial solid waste disposal facilities. This classification includes Municipal Solid Waste (MSW) landfills and class I and II rubbish sites. MSW are permitted to collect a variety of nonhazardous solid waste that includes household garbage, and commercial business waste. Class I and II rubbish sites are used as a compartment of the municipal waste stream that collect a noteworthy amount of compostable items such as cardboard, vegetation, sawdust, and wood chips.[255]

In the 1990's, MDEQ adopted regulations to permit composting of organic materials. To that end, three variations are set in the MDEQ regulatory definitions. First, the large "composting facility" means a facility that produces compost, excluding backyard composting or vermi-composting, or normal farming operations.[256] Secondly, "Composting or compost plant," for the operation where solid wastes are broken down through microbial action to a material offering no hazard or nuisance factors to public health.[257] Additional permitting requirements exist for composting facilities under Section IX "Composting Facility Requirements" for composting yard waste, rubbish, household garbage, wastewater sludge, animal wastes, and other solid waste with similar properties or characteristics.[258]

Also, MDEQ regulates land application sites and beneficial use determinations. Both currently do not permit food-waste in particular, but might merit modification consideration. Land application sites regulate specific areas that apply solids, such as sludge or Biosolids, through incorporation, injection, or other biodegradation purposes. Whereas, beneficial use permits, set

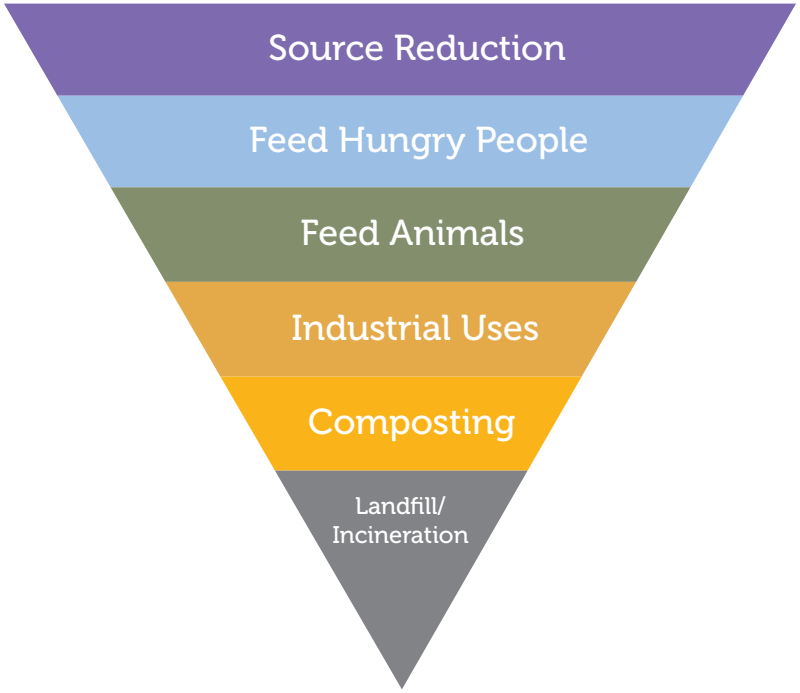


Figure 13
Food Waste Recovery Hierarchy
Source: *U.S. Environmental Protection Agency*

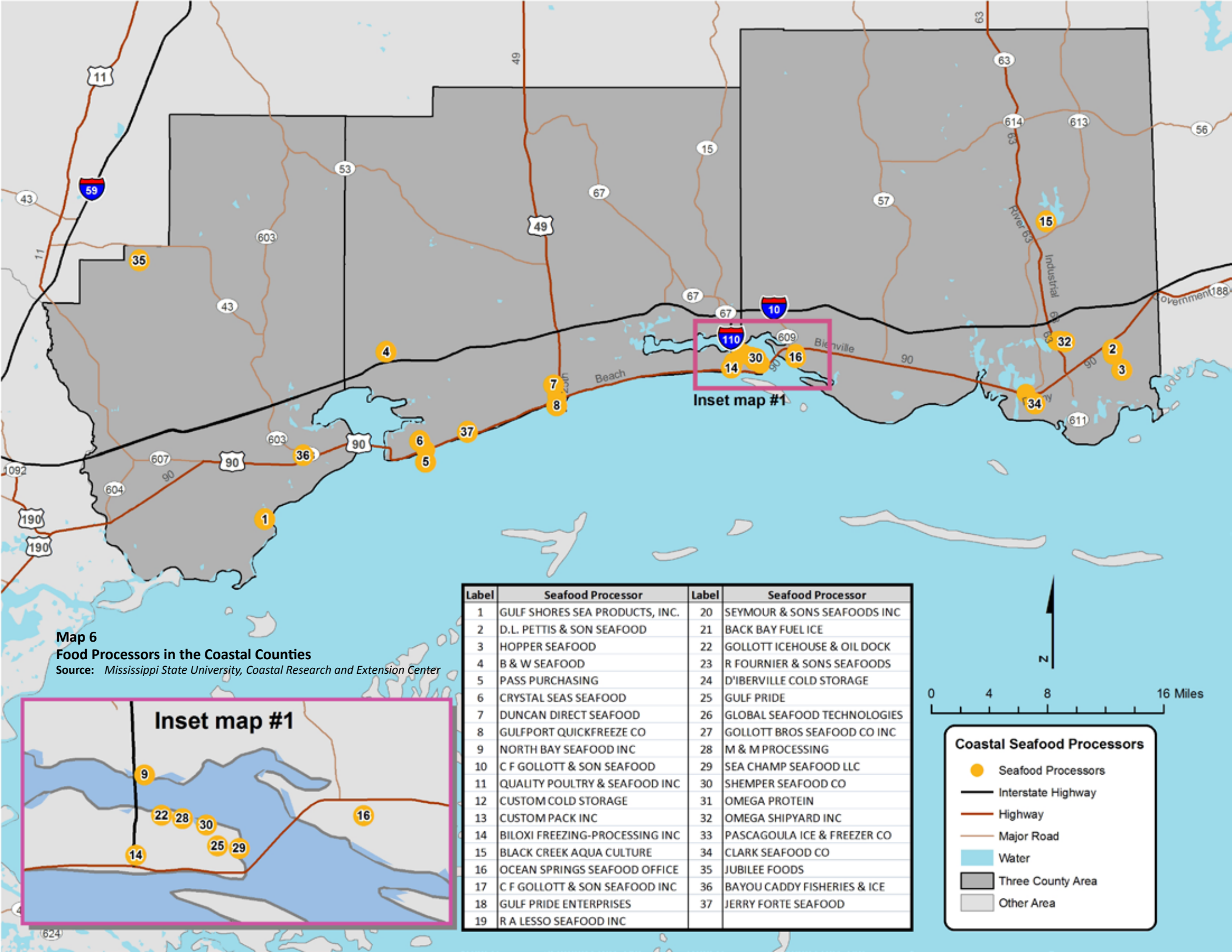
In 2009, the US Environmental Protection Agency estimated that Americans generated 243 million tons of trash, of which, 14 percent or 34 million tons was food waste.

the legal framework for repurposing particular materials, such as dewatered fiber sludge for soil amendments.[259] Together, they show opportunity for regulatory foundations that might enable food scrap repurposing.

Additionally, the Mississippi State Legislature adopted the Nonhazardous Solid Waste Planning Act of 1991 that requires local governments prepare, adopt, and submit a local solid waste management plan to the Mississippi Commission on Environmental Quality. In 2002, the Mississippi State Legislature made available state funds through a grant program administered by MDEQ. As a result, MDEQ developed a comprehensive guideline document that includes documents on the process and critical plan components.[260] Since then, Jackson County adopted a ten year plan in June of 2009, and Hancock and Harrison counties are working through the planning process.

At the Federal level, the Bill Emerson Good Samaritan Act of 1996 created limited liability for food donations to nonprofits by minimizing liability to donors. In particular, the act states that, "absent gross negligence or intentional misconduct, persons, gleaners, and nonprofit organizations shall not be subject to civil or criminal liability arising from the nature, age, packaging, or condition of apparently wholesome food or apparently fit grocery products received as donations."[261] While this establishes a national definition that sets a minimum level of protection and helps to ensure quality and labeling standards, it should be noted that it may not entirely replace all statues.

Another federal level regulatory agency is the U.S. Food and Drug Administration (FDA) who is responsible for protecting the public health by assuring that food is safe, wholesome, sanitary and properly labeled. In this context, the FDA has a limited set of policies regarding food waste for animal feed. The policies are primarily targeted at stopping the spread of Bovine Spongiform Encephalopathy, commonly known as mad cow disease. In specific, "the regulation prohibits the use of proteins derived from mammalian tissue in feeding ruminant animals."[262]



Map 6
Food Processors in the Coastal Counties
Source: *Mississippi State University, Coastal Research and Extension Center*

Label	Seafood Processor	Label	Seafood Processor
1	GULF SHORES SEA PRODUCTS, INC.	20	SEYMOUR & SONS SEAFOODS INC
2	D.L. PETTIS & SON SEAFOOD	21	BACK BAY FUEL ICE
3	HOPPER SEAFOOD	22	GOLLOTT ICEHOUSE & OIL DOCK
4	B & W SEAFOOD	23	R FOURNIER & SONS SEAFOODS
5	PASS PURCHASING	24	D'IBERVILLE COLD STORAGE
6	CRYSTAL SEAS SEAFOOD	25	GULF PRIDE
7	DUNCAN DIRECT SEAFOOD	26	GLOBAL SEAFOOD TECHNOLOGIES
8	GULFPORT QUICKFREEZE CO	27	GOLLOTT BROS SEAFOOD CO INC
9	NORTH BAY SEAFOOD INC	28	M & M PROCESSING
10	C F GOLLOTT & SON SEAFOOD	29	SEA CHAMP SEAFOOD LLC
11	QUALITY POULTRY & SEAFOOD INC	30	SHEMPER SEAFOOD CO
12	CUSTOM COLD STORAGE	31	OMEGA PROTEIN
13	CUSTOM PACK INC	32	OMEGA SHIPYARD INC
14	BILOXI FREEZING-PROCESSING INC	33	PASCAGOULA ICE & FREEZER CO
15	BLACK CREEK AQUA CULTURE	34	CLARK SEAFOOD CO
16	OCEAN SPRINGS SEAFOOD OFFICE	35	JUBILEE FOODS
17	C F GOLLOTT & SON SEAFOOD INC	36	BAYOU CADDY FISHERIES & ICE
18	GULF PRIDE ENTERPRISES	37	JERRY FORTE SEAFOOD
19	R A LESSO SEAFOOD INC		

Source: *Jim Melka*

The Mississippi Gulf Coast has a variety of food waste generators. Generally, the key areas are industrial processing, institutional, agricultural, commercial, and residential. Specifically, the Mississippi Gulf Coast has seafood processors, municipalities, educational institutions, food stores, farms, military base, and residential. Together, the core areas highlight the key waste generators for the region.

Waste Generators

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Seafood Processing

Mississippi Gulf Coast seafood processors are significant organic waste generators. On average, only 30–40 percent of the global fishery production is consumed fresh. The remaining 60–70 percent is processed for human consumption and other purposes.[263] In 2010, 25 seafood-processing plants covered the Mississippi Gulf Coast with a concentration of 15 seafood processors on the Back Bay of Biloxi, as seen in Map 5. The three coastal counties have six major types of seafood processors with over 70 percent of processors producing shrimp or oysters. Depending on type, Mississippi seafood processing plants will have different inputs and outputs. Primary, inputs include whole fresh or iced seafood, water, ice, calcium hypochlorite and other chemicals, packaging materials, electricity, and liquid for cleaning.[264] Outputs might include fresh or chilled seafood for consumption, skins or shells, remaining fats, carcasses, items rejected for poor quality, wastewater with varying qualities and quantities, blood, and waste heat from ice manufacturing.[265] Together, seafood processors are key sources of waste.

The levels of input fluctuate seasonally, producing different levels of waste. For example, a 1998 study found that, during the month of June, Mississippi shrimp processors alone created just under three million pounds of wet processing waste and approximately 1.5 million pounds of dry processing waste.[266] Compared to April, the shrimp processing industry yielded closer to 250,000 pounds of wet and roughly 200,000 pounds of dry waste. While the gross numbers have likely changed, given the oil spill and natural disasters, the fluctuations undoubtedly remain.

SIC	Industry	Food (% of Waste Disposed)	Food Disposed (tons/employee/yr)
54	Retail Trade – Food Stores	45.1%	1.25
58	Retail Trade-Restaurants	43.9%	1.10
51	Wholesale Trade-Nondurable Goods	29.6%	0.40
82	Services-Education	24.2%	0.13
20	Mfg.-Food & Kindred Products	23.0%	0.41
70	Services-Hotels/Lodging	15.3%	0.18
Varies	Public Administration	11.4%	0.05
80	Services-Medical/Health	7.0%	0.04

Table 12
Sources of food waste
Source: *Food Waste Recovery: A Model for Local Government Recycling and Waste Reduction*
http://www.calrecycle.ca.gov/LGCentral/Library/innovations/FoodWaste/

Shrimp processing is one of the largest waste producers. The Harrison County Feasibility Study estimated annual shrimp production at 53 million pounds of raw product yielding just less than 32 million pounds of processed shrimp.[267] This number illustrates there would be approximately 21 million pounds of waste resulting just from the shrimp based on the maximum production of 36 peeling machines operating 10 hours a day, 21 days a month for seven months.[268] The resulting organic waste from shrimp processing has a disposal cost of roughly $145,000 a year.[269]

Food Stores

The Mississippi Gulf Coast has a mix of commercial food stores that range in size, goods, and management. Convenience stores, grocery stores, and super stores all contribute to the waste stream, see Table 12.[270] For instance, the average grocery store with 150 fulltime employees will generate approximately 500 tons of waste annually, see Figure 14. [271] In this context, the approximately 38 grocery stores in the three-county area will generate an estimated 19,000 tons of waste per year. However, 75-90 percent of most grocery store waste is compostable, after recycling cardboard, paper, and plastics.[272] Compostable materials typically include discarded food, waxed and wet cardboard, paper, renderings, soil, and plants. At the low end, a typical grocery store is generating 375 tons of compostable waste; with 38 grocery stores in the region, an estimated 14,250 tons of waste is available for potential diversion.

Since August of 2010, Walmart has been contracting for food waste to be picked up and transported to Franklinton, Louisiana. Between August and December of 2010, Walmart composted 748,700 pounds of food waste in the three counties instead of shipping to a landfill.[273] If this early data is typical of monthly collection, then Walmart alone could divert 1.8 million pounds of food waste annually. This number could grow as Walmart adds meat and seafood waste.

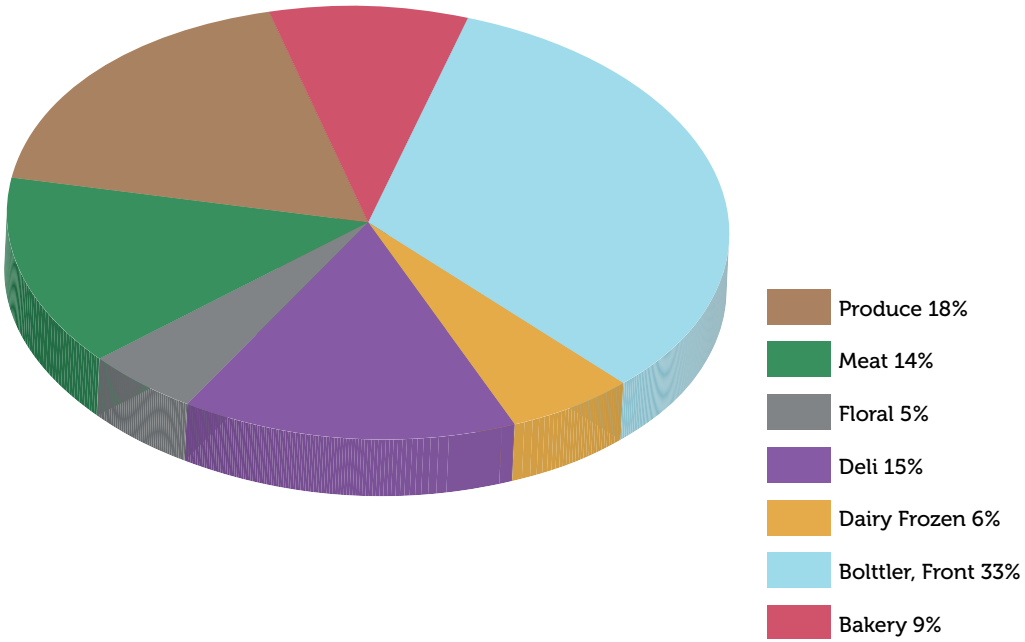

Figure 14
Estimated Average Daily Percent of Total Volume of Compostable Waste for Grocery Stores by Department

Source: *Michel, Frederick C., Drew, Susan, Reddy, C.A., Forney, Larry and Esther Trondle (1995). Feedstock Opportunity – Characterizing Supermarket Organics. Biocycle.*

Military Bases

The Mississippi Gulf Coast is home to several military bases with mixed waste streams: The John C. Stennis Space Center in Hancock County, The Naval Construction Battalion Center in Gulfport, the Air National Guard, Department of Homeland Security, Keesler Air Force Base, and Pascagoula Naval Complex. In Fiscal Year 2010, the Naval Construction Battalion Center, with support from departments within the Stennis Space Center, recovered 230 tons of cardboard and paper, 1100 tons of scrap metals and plastics, 23 tons of brass; however, no organic materials.[274] More importantly, Keesler Air Force Base is currently separating food scraps; however, scraps are sent to the landfill because presently no facility exists.

Disposal Facilities

The State of Mississippi annually collects an average of 3.13 million tons of municipal solid waste.[275] The Mississippi Gulf Coast receives roughly 19 percent of the state's total at two municipal solid waste landfills.[276] First, the Harrison County Pecan Grove Landfill, located at 85 Firetower Road Pass Christian, receives approximately 409,156 tons per year, which is one of the highest in Mississippi.[277] Second, Jackson County's Macland Disposal Center, positioned at 11300 Highway 63 North Moss Point, accumulates around 191,186 tons per year.[278] Permitted in the late 1980's, both landfills have approximately 18 years of life remaining.[279]

Class I and II rubbish sites account for 16.9 percent and 2.9 percent of Mississippi's total waste respectively.[280] The Mississippi Gulf Coast is home to 14 class I and 22 class II rubbish sites across the three counties. The rubbish sites received a significant portion of the Katrina debris. Additionally, the rubbish sites receive Carbon rich items such as cardboard, sawdust, and wood chips that are an important ingredient for achieving a balanced carbon-to-nitrogen ratio (C:N ratio) in compost. Research shows that a 25-30:1 ratio is best for quick decomposition and odor mitigation, which can be achieved through a mixture of woody and food scraps materials.[281] The class I and II landfill on Seaman Road, Jackson County, is already capitalizing yard waste materials to product compost.

In 2009, the Mississippi Department of Environmental

Source: *Benjamin Kerrick*

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Quality had 29-permitted land application sites; however, only 14 were active during the calendar year. The Hancock County Breaux Landfarm is permitted for 1,096 acres and spreads approximately 4,886 tons of dry waste per year. Additionally, the West Jackson County Land Application Site, owned by the Mississippi Gulf Coast Regulatory Waste Water Authority, has 160 acres permitted and spreads roughly 1,229 tons of dry waste per year. Collectively, the two facilities comprise over 20 percent of the total waste applied in Mississippi.[282]

Anaerobic Digester

Anaerobic or 'Bio' Digesters are emerging as a real solution to harvest organic waste for energy production. Digesters capitalize on the process of anaerobic digestion by harvesting one of the by-products, methane, which is used to create energy. A national example, Brinson Farms, can be found at the fringe of the 100 mile food shed in Prentiss Mississippi. Started as a chicken farm, Brinson Farms boasts that one ton of chicken litter produces over 5 million BTUs of methane gas, which is noted to cover the farm's annual energy expenses plus sell electric back to the grid at 3.5 cents / Kwh.[283]

Climate Change

How the Food System Contributes to Climate Change

The complexity of the food system, from crop and livestock production to processing, distribution, preparation and consumption, as well as management of food by-products along the system, means that food can contribute to global warming in myriad ways. Greenhouse gases are emitted and energy is used at all points along any food product's journey. Trade-offs between efficiencies of scale and local- or regional-scale food systems come into play when assessing how the food system's contribution to climate change can be mitigated. The implications of food waste are also significant yet sometimes overlooked in considerations of greenhouse gas emissions and food system energy use.

Greenhouse Gas Emissions

Greenhouse gases, which trap heat in the earth's atmosphere, are at the root of human-induced climate change. The most important greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, all of which emanate from the food system. Nitrous oxide, which has about 300 times the warming impact of CO_2, is released by synthetic agricultural fertilizers and livestock manure, while methane, which has about 25 times the warming impact of CO_2, is a natural byproduct of ruminant livestock digestion.[284] Fluorinated gases are used as refrigerant in the transport of food products; food waste produces methane, carbon dioxide, and nitrous oxide as it decomposes;[285] and greenhouse gases from energy use and fuel combustion are associated with all segments of the food system. In all, the food system intersects with nearly every greenhouse gas-emitting sector, including transportation (27.2 percent of U.S. emissions in 2003), electricity and heat (32.4 percent), and industry and industrial processes (16.9 percent).[286] In 2006, agriculture was responsible for 8.6 percent of the country's greenhouse gases.[287] It should also be noted that while agriculture contributes significantly to greenhouse gases, agricultural practices such as cover cropping and no-till farming, as well as forestry, have the potential to sequester carbon, off-setting some portion of carbon released.[288] [289] Along Mississippi's coast, however, the projected temperature increases and diminished water resources may convert the area's forests to grasslands, potentially minimizing the potential for carbon sequestration in forestry. Composting and anaerobic digestion of food waste can also sequester carbon by returning it to soil and plant biomass: according to Sally Brown, Research Associate Professor at the University of Washington, storing more carbon in soil and plants is "the best, easiest, and cheapest way we know to sequester carbon."[290]

Greenhouse gas emissions inventories are a way for states, counties, or municipalities to assess their contribution to global greenhouse gases. Mississippi has not conducted a greenhouse gas emissions inventory since 1992, but at that time the state's per capita emissions were almost double the national average, largely due to high emissions from the agricultural sector. Agriculture accounted for about two-fifths of the state's greenhouse emissions. Energy use was the highest contributor to the state's emissions inventory, with the industrial, transportation, and utility sectors accounting for the bulk of energy use.[291]

The vast majority of food scraps on the Mississippi Gulf Coast are sent to landfills where they break down under anaerobic conditions releasing methane, carbon dioxide, and negligible amounts of nitrous oxide.[292] At 14.1 percent of total municipal solid waste in the US, food waste constitutes the third largest component of the waste stream – and only 2.5 percent of it is recovered for composting.[293] Hancock, Harrison, and Jackson counties sent 405,000 tons of municipal solid waste to Mississippi landfills in 2008; assuming the national average of 14.1 percent, approximately 57,000 tons were food waste.[294] According to the US EPA's Waste Reduction Model (WARM) calculator, this amount of food waste produces 11,663 metric tons of carbon equivalent, or about the same annual emissions as nearly 7,800 typical passenger vehicles.[295] Aside from reducing greenhouse gas emissions, diversion of food waste to composting or anaerobic digestion facilities has the added benefits of creating soil amendments that increase soil fertility and sequester carbon, and in the case of anaerobic digestion, producing energy from biogas capture.[296]

Energy Use in the Food System

Because the food system is woven through so many energy-using sectors, the task of assessing the food system's use of energy is difficult and complex, although some attempts have been made. A 1996 analysis of existing research, summarizing nine different studies that mostly used data from the mid-1970s, found that the US food system accounted for 15.6 percent of the nation's energy use (Figure 15).[297]

A 2010 national USDA study found that while domestic energy use increased only 3.3 percent between 1997 and 2002, food-related energy use increased more than six times that, at 22.4 percent; food-related energy flows were responsible for more than 80 percent of the domestic energy increase over that five-year period. The primary drivers of food-related energy increases were population growth, shifts in spending patterns, and changes in energy technologies, as food processing was increasingly outsourced to the manufacturing sector.[298]

Other studies have examined individual sectors more closely. In agricultural production, for example, fertilizer and pesticides account for 40 percent of all energy use in US agriculture, while in the processing sector, significant energy goes toward the processes of canning, dehydration, freezing, and refrigeration. In the transportation sector, the concept of "food miles", or the distance food travels from production to consumption, has been used to illustrate the value of local food systems. However, the "food mile" concept oversimplifies the varying efficiencies of scale and inherent differences in transport types: based on these differences, according to one assessment, the same amount of fuel can transport five kilograms of food one kilometer by personal car, 43 kilometers by air, 740 kilometers by truck, 2,400 kilometers by rail, or 3,800 kilometers by ship.[299] A study evaluating the potential differences in conventional versus local/regional food systems in Iowa, however, found that an Iowa-based local/regional system was indeed more efficient than a conventional system, with the conventional system using four to 17 times as much fuel and releasing five to 17 times more CO_2.[300] Regional, rather than local, food systems may maximize efficiency while still minimizing "food miles"; similarly, mid-sized family farms appear to be more efficient consumers of farm resources than larger or smaller farms.[301] Notably, significant portions of the food system's energy budget can be found at the consumer end of the system, as illustrated by the 25 percent of food system energy use occurring during home preparation (Figure 15), and the personal car being the least efficient of transport modes. Finally, an often-overlooked flow of energy use in the food system is the energy embedded in discarded food waste, which accounts for two percent of total annual energy consumption in the US. The energy lost through food waste exceeds the energy available from annual ethanol production or annual petroleum available from drilling in the outer continental shelf.[302]

Climate Change on the Mississippi Gulf Coast

The Mississippi coast's warm, humid climate has been characterized by variation over the past century, with more profound changes likely to occur and accelerate in the future as the effects of global warming intensify. The state's temperature has risen about 1 degree[303] since the 1960s, and the southern portion of the state now experiences more than 10 fewer freezing days each year than it did in the 1970s.[304] The past century has also

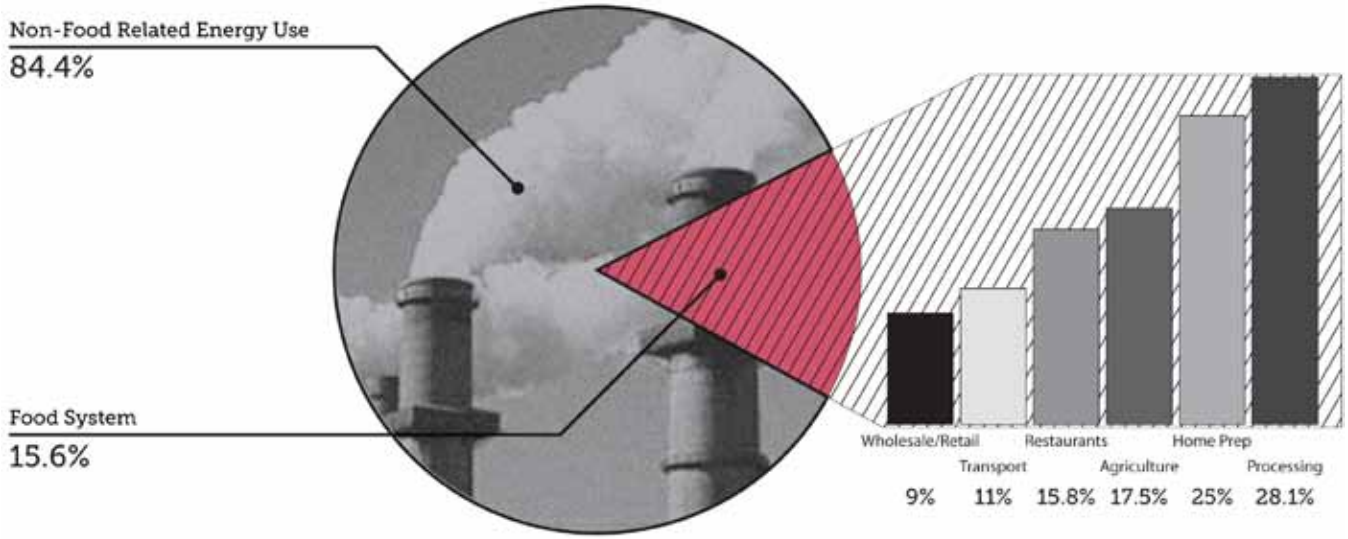

Figure 15
Energy Use in the U.S. Food System

Source: *Energy use in the U.S. food system. Data source: Hendrickson, J. (1996). Energy Use in the U.S. Food System: A Summary of Existing Research and Analysis. Madison, WI: Center for Integrated Agricultural Systems, Univ. of Wisconsin.*

seen increases in extreme rainfall events and about eight inches of sea level rise along the state's 360-mile coastline.[305] Despite the difficulty of extracting county- or state-level data from global projections of warming trends and impacts, a number of reports and studies have assessed the likely influences of climate change at varying regional scales, many of which are directly relevant to Mississippi's coast. These studies have assessed potential impacts to the area in terms of four primary drivers: temperature, precipitation, relative sea level rise, and storm activity. These studies are described and linked to the potential impacts on food systems in the following subsections.

Temperature

Warm summers and mild winters characterize current average temperatures along Mississippi's coast. Gulfport, for example, sees average summer highs in the low 90s, and winter lows in the low 40s.[306] Historically, data shows variability in temperature over the past century, with a slight but statistically significant cooling trend from 1905 to 2003; however, since the century's coolest period in the 1960s, Mississippi's coastal counties have seen a fairly steady warming trend.[307]By 2050 temperatures could rise by two to four degrees, with an accompanying rise in the number of days per year that exceed 100 degrees.[308] Over the longer term, summer temperatures could increase 3-7 degrees by 2100, with winter lows warming by 3-10 degrees and the July Heat Index, a measure combining temperature and humidity, increasing by as much as 10-25 degrees.[309] Cold spells will become less frequent, and the frost line will shift north.

Precipitation

Average rainfall along Mississippi's coast currently exceeds 60 inches per year; average annual precipitation in Gulfport, for example, is 65 inches.[310] Historically, as with temperature, the area saw variation over the past century, with particularly wet periods in the 1940s, late 1950s/early 1960s, and 1990s, with the 98-year period from 1905 to 2003 showing a statistically significant increasing trend in precipitation.[311] Climate projections predict a moderate decrease in precipitation for the area, with estimates of decrease ranging from 0.58 inches for Jackson County to 0.75 inches for Harrison County and 1.15 inches for Hancock County

by 2050.[312]However, slightly reduced precipitation combined with higher evapotranspiration rates from increased temperatures are likely to result in substantially reduced runoff and soil moisture.[313] Precipitation is also likely to occur in more intense rainfall events, with longer dry periods between rainfall.[314]

Relative Sea Level Rise

Relative Sea Level Rise (RSLR) is the combined effect of eustatic sea level rise, defined as rise that is due to increased ocean volume from thermal expansion and ice melt, combined with local land subsidence. The Gulf Coast region is particularly vulnerable to impacts from RSLR because of its flat topography and high rates of regional subsidence; the coastline along Mississippi and Alabama, however, has a lower subsidence rate (0.013 inches per year) than further west portions of the Gulf Coast and will therefore not experience the most dramatic RSLR.[315] While sea level rose eight inches over the past century, sea level along Mississippi's coast could rise as much as 45 inches by 2100, with mid-range estimates expecting a rise of 15 inches during that period, based on eustatic sea level rise and continued subsidence.[316] [317] In the nearer term, RSLR predictions for Pensacola, Florida, which has comparable rates of subsidence and eustatic sea level rise, range from just over five inches to more than 11 inches by 2050; mid-range estimates are between seven and eight inches.[318]

Storm Activity

Changes in storm and hurricane activity may take the forms of increased frequency and intensity, as well as potential for greater storm surges. Although climate models are uncertain about whether storm intensity and frequency in the Gulf of Mexico will increase[319], a 10 percent increase in intensity and up to four more hurricanes per year are possible for the Gulf of Mexico during this century, with one to two additional hurricanes each year plausible by 2050.[320] Even if intensity does not increase, however, the impact of storms will escalate as sea levels rise. Storm surge potential is currently approximated at 22-24 feet for Category 3 storms. Prior to Hurricane Katrina, the highest Gulf Coast storm surge on record resulted from Hurricane Camille, a Category 5 storm in 1969 that created a surge of 20.4 feet at Bay Saint Louis; the storm surge during Hurricane Katrina reached a maximum of 27.8 feet at Pass Christian.[321] Based on projected climate change and sea level rise, a Category 5 storm could generate a surge of 30 feet or more under worst-case conditions.[322]

Climate Change's Impact on the Food System

The potential impacts of climate change on the region's food system are complicated and far-reaching, affecting basic needs such as availability of freshwater, influencing food production from agriculture, aquaculture, and marine fisheries in myriad ways, and with the potential to seriously impact all modes of transportation, hindering the distribution of foods into, out of, and within the region. Although the complex interplay of these factors complicates the task of predicting likely outcomes, certain patterns and trends are likely to occur based on analysis of the aforementioned climate drivers.

Water Resources and Availability

Many impacts to the production end of the food system will result directly from changes in water resources and availability. Higher temperatures, changes in precipitation patterns, and increased demand will place substantial pressures on the region's freshwater supply. A 2010 national study projected county-level risk of water shortage based on the presence of five indicators: high projected demand for water from precipitation, high projected demand for ground water, susceptibility to drought, substantial growth in water demand, and increased need for summer storage.[323] Indicators were assessed for the year 2050 based on projected population growth, water resources, and climate change. Counties meeting two of the criteria were classified at "moderate" risk, and those meeting three of the criteria were "high" risk. The report found that all three coastal counties in Mississippi showed high groundwater demand and increased need for summer storage. Harrison and Hancock counties were thus classified at moderate risk, while Jackson County, because it also met the criterion for substantial growth in water demand, was classified at high risk. Of the additional 41 counties or parishes in the foodshed, 13 were classified at high risk and 16 at moderate risk.[324]

Source: *FeiFei Hu*

A 2010 national study projected county-level risk of water shortage based on the presence of five indicators: high projected demand for water from precipitation, high projected demand for ground water, susceptibility to drought, substantial growth in water demand, and increased need for summer storage.

According to the Ground Water Protection Council, Mississippi is more dependent on its ground water resources than any other state in the US, with more than 80 percent of its water supply (and 93 percent of its potable water) coming from freshwater aquifers. In addition to supplying the vast majority of the state's drinking water, these aquifers also supply water for irrigation, which accounts for 66 percent of the state's ground water use, and aquaculture, accounting for 15 percent.[325] Sea level rise will place the Coastal Lowlands aquifer system, which extends along the coast from the Florida panhandle to the southern tip of Texas, underlying the entire foodshed, at greater risk of saltwater intrusion, potentially contaminating important freshwater sources. Reduced precipitation, higher evapotranspiration rates, and increased demand resulting from accelerating human development and greater irrigation needs will all contribute to decreased freshwater flow, resulting in reduced surface water and slowed aquifer recharge. Additional consequences of reduced freshwater will be seen in coastal ecosystems, as higher salt concentrations and less nutrient input will result in lower water quality in estuarine habitats. Furthermore, as precipitation is focused into more intense rain events, extreme levels of runoff and flooding could overload sewage systems, posing additional contamination risks to surface and coastal waters.[326] [327] A report from the Union of Concerned Scientists assigns "high confidence" to the likelihood that climate impacts will include more competition for freshwater, increased salinization of ground water, and saltwater intrusion into coastal aquifers.[328] Jackson County's classification of high risk for water shortage due to substantial increase in demand demonstrates that increasing pressures from human development are also likely to play a major role in depleting coastal aquifer levels.

Agriculture and Forestry

Not surprisingly, the agriculture and forestry sectors are likely to be significantly affected by the drivers of climate change. Crop responses will result primarily from the interplay of three factors: changing water resources, warmer temperatures, and higher concentrations of atmospheric carbon dioxide (CO2), which can have a fertilizing effect on plant growth.[329]Although CO_2 fertilization has the potential to increase forest and crop

productivity, however, these gains are largely unpredictable in the context of warmer, drier conditions, as limited water availability is likely to reduce or cancel out any potential gains from CO_2.[330]

Because agriculture and forestry depend so heavily on freshwater from precipitation and ground water, reductions in water availability and soil moisture are likely to cause the greatest impacts to these sectors. Warmer temperatures and drier soils will require more irrigation, intensifying pressure on water resources. Severe water stress will also make plants more susceptible to pests and disease.[331]

Warmer temperatures, particularly in the winter, are likely to increase pest populations, requiring heavier use of pesticides and herbicides,[332] [333] while some of the state's most important crops, such as corn, rice and cotton, will respond to warmer conditions with faster growth and reduced yields.[334] Additional consequences of higher average temperatures include reduced productivity in livestock and crops due to thermal stress, greater energy demands to maintain temperatures for indoor poultry production, and northward shifts in crop production zones.[335] [336] As droughts become more frequent, the forestry sector is likely to be affected by more wildfires, while higher temperatures and drier soils are likely to drive loss of forests shifting to grasslands.[337] [338]

Marine Fisheries and Aquaculture

Reduced freshwater flow and availability, loss of coastal wetlands to sea level rise, and temperature-induced changes to aquatic ecosystems are the primary climate factors likely to impact both the marine fisheries and aquaculture industry.

Aquaculture's high demands on freshwater make the industry vulnerable to drier conditions and saltwater intrusion. A severe drought in 1999 and 2000, for example, led to saltwater contamination of southwest Louisiana's groundwater, severely impacting crawfish production.[339] As water demand from aquaculture, irrigation, and human development increases, the reduced freshwater flow will lead to higher salt concentrations and lower overall marine water quality along the coast. Resulting changes in the coastal ecosystem could lead to reduced fish and shellfish production.[340]

Sea level rise poses additional risks to Mississippi's coastal wetlands, which function as important estuarine habitats for fisheries such as shrimp, blue crab, and menhaden. According to most sea level rise scenarios, the ecosystem's tolerance to inundation will be exceeded, resulting in loss of wetlands.[341] And according to one study exploring potential loss of blue crab habitat in the northern Gulf of Mexico, "accumulated over large areas, relatively small local losses of estuarine marsh edge and SAV (submerged aquatic vegetation) habitats could have long-term negative effects on the sustainability of the fishery."[342] If wetlands are able to migrate inland as sea levels rise, associated fishery yields could potentially increase if the new habitat is larger and/or of better quality; however, this is highly dependent on sufficient potential habitat being conserved and not lost to development.[343]

Warmer coastal waters may increase the productivity of some marine fisheries, but these gains are likely to be offset by more significant disturbances and loss of habitat. Temperature changes may also favor invasive marine species while shifting the spawning times and migration dates and routes of harvested species.[344] Furthermore, warmer waters and lower water quality are likely to promote pathogens in aquatic habitats, potentially contaminating fish and shellfish. One example is Perkinsus marinus, which causes high mortality in oysters and prefers warmer waters and higher salinity.[345] The Union of Concerned Scientists assigns "medium confidence" to higher incidence of marine pathogens under climate change conditions.[346]

Transportation and Distribution

Another crucial sector of the region's food system is transportation, which will be significantly impacted by the effects of climate change. Transportation infrastructure facilitates the distribution of food into, out of, and within the foodshed. The coastal area plays a vital role in the larger regional and national food system as well, situated as it is at the crossroads of important freight routes including the Gulf of Mexico, the Mississippi River, and the Gulf Intracoastal Waterway, the latter two of which are the nation's first and third leading inland waterway systems.[347] The majority of the Gulf Coast region's port tonnage is petroleum and related products, though food and farm products account for

most of the non-petroleum tonnage; 38 percent of the freight through Mississippi River ports is food and food products.[348] Mississippi has three major freight-handling ports, Gulfport, Biloxi and Pascagoula. The region's transportation system, a complex network of roads, freight rail, waterways, marine facilities, airports and intermodal linkages, is highly vulnerable to the impacts of climate change, particularly sea level rise, increased storm activity, and warmer temperatures.

Sea level rise estimates vary widely along the Gulf Coast: depending on local subsidence rates, assumed emissions, and the climate projection model used, RSLR by 2100 could be as low as nine inches (at Pensacola, FL) or as high as 6.5 feet (at Grand Isle, LA); although the mid-range estimate for Mississippi is 15 inches, estimates for Pensacola (assumed to be comparable for Mississippi) range from nine to 45 inches.[349] In a study by the U.S. Climate Change Science Program (CCSP) evaluating potential impacts on the Gulf Coast between eastern Texas and the Florida panhandle, sea level rise scenarios were assessed at two and four feet of increase, which are plausible mid-level RSLR estimates for the study area. Assuming two feet of sea level rise, affected infrastructure would include 64 percent of the region's port facilities, 137 miles of Interstate Highway 10 east of New Orleans, the CSX rail line between Mobile and New Orleans, and portions of the Mississippi Export and Port Bienville rail lines. Sea level rise of four feet would cause further degradation, potentially inundating a quarter of the region's arterial roads and interstates, and nearly three-quarters of its port facilities, including significant impacts to freight facilities at the ports Pascagoula, Bienville, and to a lesser degree, Gulfport and Mobile. Rail connections to the ports in Pascagoula and Gulfport/Biloxi are among the most at-risk in the region. Aside from the inundation risks it poses, sea level rise also raises the water table, leading to more flooding during normal precipitation.[350]

Greater frequency and intensity of storms likewise have the potential to severely impact the region's transportation infrastructure, especially with regard to storm surge. The CCSP report assessed storm surge at 18-feet and 23-feet scenarios, finding that even at just 18 feet, more than half of the region's arterials and interstates, a third of the rail lines, and nearly all of the port facilities are vulnerable to inundation. When wave crests meet or exceed the heights of bridges, even more dramatic damage can occur, as when the Saint Louis Bay Bridge was destroyed during Hurricane Katrina.[351]

Warmer temperatures in the region, particularly the increasing frequency of hot days, will also affect the transportation network. Some concrete loses strength over 90 degrees, speeding degradation, while thermal stress to workers and infrastructure can negatively impact the construction and maintenance of facilities. Furthermore, as temperatures rise, more energy will be required to refrigerate food products during transport and storage.[352]

The myriad effects of climate change are certain to impact the food system in many ways and on many scales. Mississippi's coastal counties are likely to be particularly affected by imminent threats to water availability, agriculture and forestry, aquaculture and marine fisheries, and transportation infrastructure. While exploring ways to mitigate the potential influence of these threats, attention should also be given to the ways in which the food system contributes to global warming through emissions and energy use. By evaluating the food system on a comprehensive level, Mississippi's Gulf Coast can prepare for resilience against the threats of climate change, while also minimizing its own contribution to that change.

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Appendix A Tables

Table 6
NAICS Food and Beverage Manufacturing Establishments in the Foodshed
Source: *U.S. Census Bureau. 2007 Economic Census.*

Industry Name	Three Coastal Counties	All Other Counties/Parishes in Foodshed	Total for foodshed
Flour milling	0	1	1
Soybean processing	0	1	1
Sugarcane mills	0	3	3
Cane sugar refining	0	3	3
Chocolate and confectionery manufacturing from cacao beans	0	1	1
Confectionery manufacturing from purchased chocolate	1	14	15
Nonchocolate confectionery manufacturing	0	6	6
Fruit and vegetable canning	0	1	1
Dried and dehydrated food manufacturing	0	2	2
Fluid milk manufacturing	0	6	6
Dry, condensed, and evaporated dairy product manufacturing	0	1	1
Animal (except poultry) slaughtering	0	15	15
Meat processed from carcasses	0	17	17
Rendering and meat byproduct processing	0	2	2
Poultry processing	0	9	9
Seafood canning	0	2	2
Fresh and frozen seafood processing	10	29	39
Retail bakeries	3	39	42
Commercial bakeries	1	18	19
Frozen cakes, pies, and other pastries manufacturing	0	1	1
Cookie and cracker manufacturing	0	5	5
Flour mixes and dough manufacturing from purchased flour	1	2	3
Roasted nuts and peanut butter manufacturing	0	1	1
Other snack food manufacturing	0	1	1
Coffee and tea manufacturing	0	7	7
Flavoring syrup and concentrate manufacturing	0	2	2
Mayonnaise, dressing, and other prepared sauce manufacturing	0	6	6
Spice and extract manufacturing	0	5	5
Perishable prepared food manufacturing	0	1	1
All other miscellaneous food manufacturing	0	2	2
Beverage and tobacco product manufacturing	4	0	4
Soft drink manufacturing	0	3	3
Bottled water manufacturing	1	3	4
Ice manufacturing	2	6	8
Breweries	0	3	3
Distilleries	0	1	1
Total	**23**	**219**	**242**

Table 7
Food Establishments and Stores by City
Source: *U.S. Census Bureau. 2007 Economic Census.*

City, State	Population 2009	Food services and drinking places	Number of people per establishment	Food and Beverage Stores	Number of People per Store
Biloxi, MS	**45,766**	**73**	**627**	**83**	**551**
Gulfport, MS	**70,794**	**147**	**482**	**21**	**3,371**
Hattiesburg, MS	53,582	186	288	30	1,786
Laurel, MS	18,855	67	281	19	992
Long Beach, MS	**12,245**	**21**	**583**	**7**	**1,749**
McComb, MS	13,645	49	278	1	13,645
Moss Point, MS	**13,952**	**21**	**664**	**6**	**2,325**
Ocean Springs, MS	**17,363**	**59**	**294**	**11**	**1,578**
Pascagoula, MS	**23,692**	**42**	**564**	**53**	**447**
Pass Christian, MS	**4,073**	**10**	**407**	**12**	**339**
Picayune, MS	12,023	46	261	18	668
Bogalusa, LA	12,601	27	467	5	2,520
Covington, LA	9,224	70	132	16	577
Denham Springs, LA	10,375	57	182	14	741
Hammond, LA	20,049	102	197	13	1,542
Laplace, LA	27,684	53	522	40	692
Mandeville, LA	12,557	88	143	6	2,093
Marrero, LA	36,165	64	565	6	6,028
Metairie, LA	146,136	377	388	4	36,534
New Orleans, LA	654,850	902	726	34	19,260
Slidell, LA	27,447	161	170	9	3,050
Thibodaux, LA	14,428	60	240	223	65
Daphne, AL	19,542	27	724	6	3,257
Mobile, AL	193,205	412	469	9	21,467
Theodore, AL	6,811	10	681	6	1,135
Tillmans, AL	15,685	11	1,426	2	7,843
Average All	57,413	121	452	25	5,164
Average Three County	26,841	53	517	28	1,480
Average Other Counties	68,677	146	428	24	6,521
U.S. Total	301,621,159	571,621	528	146,084	2,065

Table 8

Number of Employees per NAICS Industry Sector

Source: *U.S. Census Bureau. 2007 Economic Census.*

Code	Industry Type	Foodshed Total 2009	Three Coastal Counties 2009
311	Food manufacturing	9077	594
3113	Sugar and confectionery product manufacturing	111	0
31161	Animal slaughtering and processing	2086	0
311712	Fresh and frozen seafood processing	771	0
3118	Bakeries and tortilla manufacturing	1267	17
31181	Bread and bakery product manufacturing	138	0
311811	Retail bakeries	164	0
311812	Commercial bakeries	351	0
3119	Other food manufacturing	1218	0
31194	Seasoning and dressing manufacturing	368	0
3121	Beverage manufacturing	71	0
31211	Soft drink and ice manufacturing	56	56
4244	Grocery and related product wholesalers	4633	480
424410	General line grocery merchant wholesalers	593	0
424420	Packaged frozen food merchant wholesalers	68	0
424430	Dairy product merchant wholesalers	89	0
424450	Confectionery merchant wholesalers	238	0
424470	Meat and meat product merchant wholesalers	17	0
424480	Fruit and vegetable merchant wholesalers	191	89
424490	Other grocery product merchant wholesalers	1309	211
4245	Farm product raw material merch. whls.	6	0
4248	Alcoholic beverage merchant wholesalers	1189	0
445	Food and beverage stores	21583	1989
4451	Grocery stores	17552	1570
445110	Supermarkets and other grocery stores	13316	1670
44512	Convenience stores	33	0
445120	Convenience stores	750	38
4452	Specialty food stores	1683	187
445210	Meat markets	106	13
445220	Fish and seafood markets	297	0
445230	Fruit and vegetable markets	79	0
44529	Other specialty food stores	705	105
445291	Baked goods stores	19	0
445292	Confectionery and nut stores	59	0
445299	All other specialty food stores	408	0
445310	Beer, wine, and liquor stores	802	149
446191	Food, health, supplement stores	284	0
493120	Refrigerated warehousing and storage	339	0
624210	Community food services	18	0
721191	Bed-and-breakfast inns	28	0
722	Food services and drinking places	94526	10605
722110	Full-service restaurants	42267	4711
72221	Limited-service eating places	50976	5754
722211	Limited-service restaurants	38025	5112
722212	Cafeterias, grill buffets, and buffets	2486	369
722213	Snack and nonalcoholic beverage bars	3059	240
7223	Special food services	4328	527
722310	Food service contractors	3142	461
722320	Caterers	174	66
722410	Drinking places, alcoholic beverages	4325	259

Table 9
Number of Employees per Occupation
Source: *U.S. Census Bureau. 2007 Economic Census.*

SOC Code	Occupation	Three Coastal Counties	Total foodshed
119051	Food Service Managers	390	1570
191012	Food Scientists and Technologists	0	0
350000	Food Preparation and Serving Related Occupations	34880	122,530
351011	Chefs and Head Cooks	250	1020
351012	First-Line Sups/Mngs of Food Prep and Serving Workers	2960	9780
352011	Cooks Fast Food	4280	8620
352012	Cooks Institution and Cafeteria	2060	6410
352014	Cooks Restaurant	2880	9470
352015	Cooks Short Order	240	1020
352019	Cooks All Other	100	310
352021	Food Preparation Workers	5410	21000
353011	Bartenders	980	5400
353021	Comb Food Prep and Serving Workers Including Fast Food	3530	10900
353041	Food Servers Non-restaurant	440	1840
359099	Food Preparation and Serving Related Workers All Other	0	240
450000	Farming Fishing and Forestry Occupations	2280	4470
451011	First-Line Suprs/Mngs of Farming Fishing and Forestry W	40	130
452011	Agricultural Inspectors	40	140
452041	Graders and Sorters Agricultural Products	0	80
452092	Farmworkers and Laborers Crop Nursery and Greenhouse	30	320
452093	Farmworkers Farm and Ranch Animals	250	340
513011	Bakers	220	790
513021	Butchers and Meat Cutters	360	1220
513022	Meat Poultry and Fish Cutters and Trimmers	4840	6050
513023	Slaughterers and Meat Packers	2640	2640
513091	Food and Tobacco Roasting Baking and Drying Machine Operators and Tenders	0	90
513092	Food Batchmakers	50	590
513093	Food Cooking Machine Operators and Tenders	0	60

Appendix B Glossary

Agritourism is the tourism generated by agriculture activities such as berry picking and corn mazes.

Anaerobic (or 'Bio') Digestion is the biological process of breaking down waste in the absence of oxygen to produce methane gas, which is flared or used as an energy source.

Aquaculture is a practice of raising fresh-water fish and shellfish species in ponds or tanks. Unless otherwise noted, aquaculture ventures in this document raise species for human consumption.

Bioaccumulation is the buildup of substances in an organism that become harmful to humans as they accumulate in the body. More specifically to the Gulf Coast, bioaccumulation refers to compounds in oil and dispersants that build up in larger, edible fish after eating smaller organisms through the food chain.

Biodegradation is the chemical dissolution of materials by bacteria or other biological means.

Biogas is gas produced by the biological breakdown of organic matter in the absence of oxygen with a high methane content that can be used as a renewable energy.

Beneficial Use is defined by the Mississippi Department of Environmental Quality as the legitimate use of a solid waste in the manufacture of a product or as a product for construction, soil amendment, or other purposes, where the solid waste replaces a natural or other resource material by its utilization.

Commercial Solid Waste is defined by the Mississippi Department of Environmental Quality as all types of solid waste generated by stores, offices, restaurants, warehouses, and other nonmanufacturing activities, excluding residential and industrial wastes.

Community Supported Agriculture (CSA) is where consumers pay a subscription to a farm and receive a portion of the produce, usually on a weekly basis.

Compost is defined by the Mississippi Department of Environmental Quality as the resulting product from a composting facility after having undergone biological decomposition, less residuals or recyclables, and which has been stabilized to a degree that it is potentially beneficial to plant growth and which is used or sold for use as a soil amendment, artificial topsoil, growing medium amendment, or other similar uses.

Composting (Backyard or Vermicomposting) is defined by the Mississippi Department of Environmental Quality as the composting of organic solid waste, such as yard waste and household garbage, generated by a homeowner or tenant of a single or multi-family residential unit, where such composting occurs at the site of the residence

Cover Crops are used as ground cover in the off growing season to reduce soil erosion and retain nutrients.

Dredging is a method of removing sediment from the bottom of water bodies (typically a harbor when referring to the Gulf Coast) by scooping or sucking with a dredge machine. Dredging is used to create deep channels for ports along The Sound. It is also often used as a method of harvesting oysters.

Eustatic Sea Level Rise is sea level rise resulting from the increase in volume of the world's oceans due to polar ice melt and thermal expansion.

Evapotranspiration is the water lost to the atmosphere from the ground surface, evaporation from the capillary fringe of the groundwater table, and the transpiration of groundwater by plants whose roots tap the capillary fringe of the groundwater table, according to the US Geological Survey.

Farm is defined by the USDA as any operation that sells at least $1,000 of agricultural commodities or that would have sold that amount of produce under normal circumstances.

Farmers' Markets are usually open air markets in a public location where farmers sell their farm raised products directly to consumers.

Fish Hatcheries are where fish eggs are artificially fertilized and hatched. The hatcheries can be operated by the government or private industry.

Foodshed is a term used to describe the path food takes from production to consumption. For the Mississippi Gulf Coast there is a 100-mile radius foodshed. The Alabama counties included in the foodshed are Baldwin, Choctaw, Clarke, Escambia, Mobile, Monroe and Washington. The Mississippi counties included in the foodshed are Amite, Clark, Covington, Forrest, George, Greene, Hancock, Harrison, Jackson, Jasper, Jefferson Davis, Jones, Lamar, Lawrence, Lincoln, Marion, Pearl River, Perry, Pike, Smith, Stone, Walthall, and Wayne. The Louisiana parishes included in the foodshed are Ascension, Jefferson, LaFourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. Helena, St. James, St. John the Baptist, St. Tammany, Tangipohoa, and Washington. Escambia County in Florida is also within the 100-mile foodshed.

Food Miles are the miles food travels from the source of production to the consumer.

Freshwater Prawn has become a general term used to describe freshwater shrimp and prawn species raised in aquaculture facilities or found in the wild. Prawns are very similar to shrimp but can be distinguished by their gill structure.

Greenhouse Gases (GHG) trap heat in the atmosphere. These include carbon dioxide, methane, nitrous oxide and fluorinated gases.

Hazardous Waste is waste that is dangerous or potentially harmful to our health or the environment. Hazardous wastes can be liquids, solids, gases, or sludges. They can be discarded commercial products, like cleaning fluids or pesticides, or the by-products of manufacturing processes.

Land Application is defined by the Mississippi Department of Environmental Quality as the incorporation of waste into the soil, the injection of waste below the land surface or other application of waste to the land for soil amendment or conditioning purposes or for biodegradation of the waste.

Mariculture is the cultivation of marine species for human consumption or other commercial uses.

Metropolitan Statistical Areas (MSA) have at least one urbanized area of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties.

The **Mississippi Sound** is a 70-mile section of the Gulf of Mexico running from Mobile, Alabama to Lake Bourne, Louisiana. Navigation Channels, sometimes artificially made paths deep enough to facilitate the movement of large ships in otherwise too-shallow water, are used throughout the Sound.

Municipal Solid Waste is defined by the EPA as durable goods, non-durable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes. The Mississippi Department of Environmental Quality defines it as any nonhazardous solid waste resulting from the operation of residential, commercial, governmental, industrial or institutional establishments except oil field exploration and production wastes and sewage sludge.

Navigable Waterway according to the US Army Corps of Engineers is a waterway subject to the ebb and flow of the tide, and/or the water body is presently used, or has been used in the past, or may be susceptible for use for commercial transportation.

Non-Hazardous Solid Waste is any garbage or refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities.

No-till Farming is a method of farming where no type of tillage equipment is used. This equipment includes an implement that works the soil to any extent. No-till farming is used to reduce soil erosion. It is used as minimally as not tilling before planting certain crops to farmers choosing to not till any fields for as long as they run that farm.

Polycyclic Aromatic Hydrocarbons (PAHs) are derivatives from fossil fuels that are known to be carcinogenic in mammals a major contaminant in coastal marine environments.

Relative Sea Level Rise is the combined effect of eustatic sea level rise and land subsidence, or sinking of the earth's surface at a given location.

Rubbish is defined by the Mississippi Department of Environmental Quality as solid wastes, excluding ashes, consisting of both combustible and non-combustible wastes.

Rubbish Class I is identified by the Mississippi Department of Environmental Quality as the following types of wastes: Construction & demolition debris (wood & metal); Brick, mortar, concrete, stone, and asphalt; Cardboard; Appliances (other refrigerators and air conditioners) with the motor removed; Furniture; Plastic, glass, crockery and metal, except containers; plus, Sawdust, wood shavings, and wood chips.

Rubbish Class II is identified by the Mississippi Department of Environmental Quality as the following types of wastes: Natural vegetation, such as tree limbs, stumps and leaves; Brick, mortar, concrete, stone and asphalt;

Subsidence is the sinking or settling of ground surface caused when soil or rock collapses into a void. Subsidence can be natural, a sink hole, or human induced, due to underground mining or pumping of petroleum or water.

Tonging is a method of harvesting oysters where two long handheld poles are used like tongs to scoop oysters out of the beds.

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