MARITIME TRANSPORTATION RESEARCH AND EDUCATION CENTER
TIER 1 UNIVERSITY TRANSPORTATION CENTER
U.S. DEPARTMENT OF TRANSPORTATION

Economic Impact of the Gulf Intracoastal Waterway on the States It Serves
September 2017 to September 2018

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September 2018

FINAL RESEARCH REPORT
Prepared for:
Maritime Transportation Research and Education Center

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ACKNOWLEDGEMENT
This material is based upon work supported by the U.S. Department of Transportation under Grant Award Number 69A3551747130. The work was conducted through the Maritime Transportation Research and Education Center at the University of Arkansas.

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Background

The Gulf Intracoastal Waterway (GIWW), which spans five states, from Texas to Florida, is a core component of the inland navigation system. The GIWW is a 1,100-mile man-made canal that runs from Brownsville, Texas, to St. Marks, Florida (*1,2*). This region is a natural outlet for many of the inland flows in the navigation system. The main freight cargos carried by the GIWW are petroleum products, which amounted to 61.7 percent of cargo in 2016, and chemicals and crude materials, at 18.2 percent and 13.3 percent, respectively (*3*).

While its initial purpose was to serve as a protected waterway to transport goods and troops during World War II, the GIWW has since evolved as a major commercial freight artery for the U.S. Gulf Coast (*2,4*). For context, the U.S. inland waterways cover 25,000 miles, with over 12,000 miles considered navigable waterway, and 239 locks; these comprise the inland navigation system that moves approximately 600 million tons of cargo per year (*1,5*). The system spans 38 states and includes the Atlantic Intracoastal Waterway along the East Coast, the Columbia/Snake River system in the Pacific Northwest, and the GIWW in the South. The entire system is operated and maintained by the U.S. Army Corps of Engineers (USACE). The system supports more than half a million jobs and moves 14 percent of all domestic freight (*5*).

The GIWW is an integral component of this waterway system. In 2016, 111.7 million tons were transported on the GIWW (*6*). The inland waterway system is vital to several industries including the agricultural and energy sectors. Sixty percent of grain exports are moved by barge, and the energy sector moves 22 percent of domestic petroleum and petroleum products along the waterway, as well as 20 percent of coal used to generate electricity (*5*). Industry reliance on this system shows its importance to the U.S. economy and the movement of freight from international markets to the nation's inland states; however, the current state of repair reduces the ability of this network's usage to grow and support further freight movement.

Report Purpose and Objectives

The purpose of this report is to examine the economic impact of the GIWW on the five states it serves: Texas, Louisiana, Mississippi, Alabama, and Florida. As discussed previously, the GIWW is a critical freight transportation thoroughfare that links Gulf Coast economies in these five states together. This report assesses the economic importance of the GIWW as a transportation infrastructure asset.

This project involved several research tasks. First, researchers estimated the economic impact of the GIWW by looking specifically at the impact of the commodities using the GIWW in the relevant coastal counties in each of these five states. Once this task was completed, researchers then estimated the impact of the GIWW on other modes, modeling the possible adverse impacts that would result if the GIWW were to become permanently unavailable and shippers would instead have to use the next economically feasible transportation mode. For example, many petrochemical companies currently depend on the GIWW to transport commodities to other facilities along the Gulf Coast for further processing and refinement. Partial or full closure of the GIWW could mean these companies would be forced to consider more frequent, lighter loads to reduce barge draft depths, or consider alternate modes such as rail or truck transportation—a costly and inconvenient disruption. Researchers examined the cost of shifting additional traffic to other modes of transportation.

Because of the critical importance the oil and petrochemical industry has on the Gulf Coast region, this research also assessed recent trends in the energy industry, including an examination of possible increases in oil and gas production from hydraulic fracturing activity in Texas and Louisiana.

Report Organization

The rest of this report is organized into the following sections:

- **Section 1: Project Description.**
    - **Section 1.1: Current GIWW Conditions.** This subsection provides an overview on the current conditions of the U.S. inland waterway network, providing context for how the GIWW fits into the larger network. This chapter also provides background on the history, development, and administration of the GIWW. Finally, this chapter gives a brief review of the major ports along the GIWW and likely future challenges the waterway is expected to face.
    - **Section 1.2: Literature Review.** This subsection provides a brief review of scholarly literature relevant to this study in the following areas: (a) economic characteristics of inland navigation; (b) models, methods, and data aggregations; (c) impacts of abandonments and closures; and (d) economic impacts of inland waterways through abandonment scenarios.
    - **Section 1.3: Trends in GIWW-Related Energy-Sector Activity.** This subsection summarizes current trends in domestic production and movement of oil, natural gas, and coal, as well as the likely impacts changes in production levels of these commodities have had on GIWW freight flow patterns.
- **Section 2: Methodological Approach.** This section provides an overview of the IMPLAN model and definition of outputs. It details the size and scope of the study area, as well a listing of coastal counties included in the model. This section also summarizes the data sources used as inputs to assess the economic impacts of the freight moved along the GIWW in each state. Additional analysis regarding a closure scenario is also included.
- **Section 3: Results.** Estimated economic impacts are presented for the study area and for individual states. This includes results for the coastal counties, as well as any additional impacts from industry sectors outside of these counties that use the GIWW.

- **Section 4: Impacts of GIWW Closure.** Researchers provide cost estimates for transportation mode shift in response to a GIWW closure or abandonment. This analysis examines cost per mile for both truck and rail compared to current transportation costs using barges.
- **Section 5: Summary.** This chapter summarizes findings from the literature review, GIWW freight flow activity, and economic analysis and presents a few clear findings that have emerged as part of this research. Drawing from these major findings, limitations and future research needs are then presented.

Current GIWW Conditions

Background

The GIWW is a 1,100-mile waterway system that runs along the Gulf of Mexico coastline from Brownsville, Texas, to St. Marks, Florida *(2)*. As shown in Figure 1, the GIWW forms a major component of the U.S. inland waterway system, linking together key ports from South Texas to the Florida panhandle.

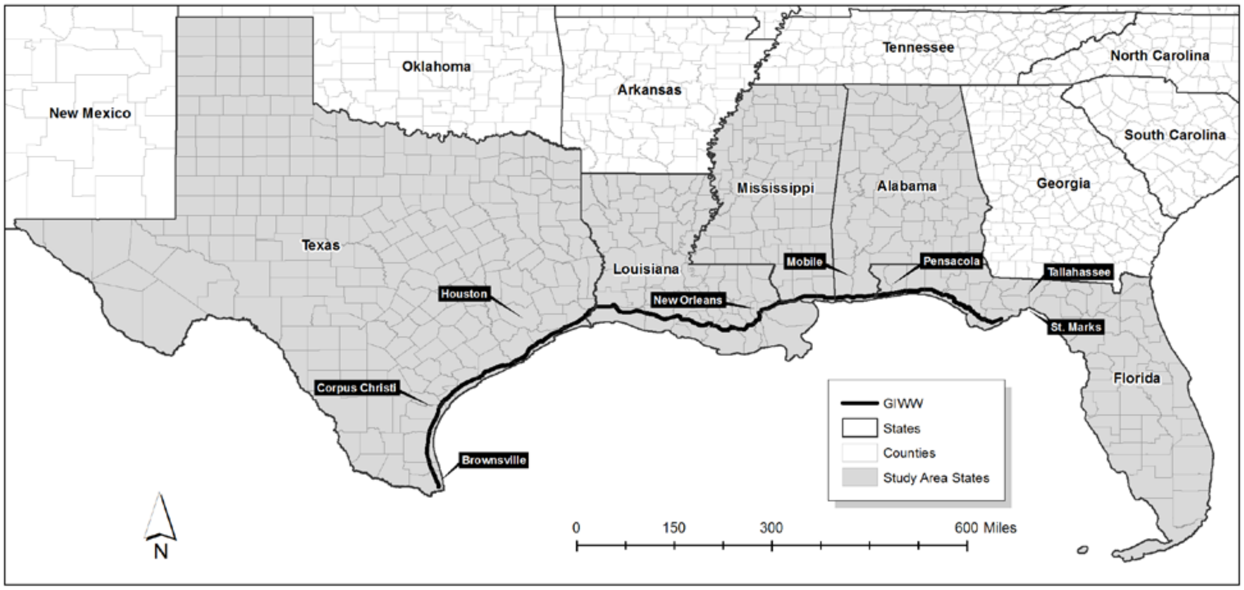

Figure 1. The Gulf Intracoastal Waterway System.

GIWW Freight Flow Characteristics

According to data provided by the Waterborne Commerce Statistics Center (WCSC), approximately 111 million short tons of goods moved through the GIWW in 2016. This number has remained stable in the past 10 years, as shown in Figure 2. Several factors could explain why total barge traffic on the GIWW has remained constant; a recent analysis identified two reasons, inadequate capital and maintenance funding and constraints in authorized GIWW draft depths, as explanations for why barge traffic has not increased at the same rates seen in other countries (*7*).

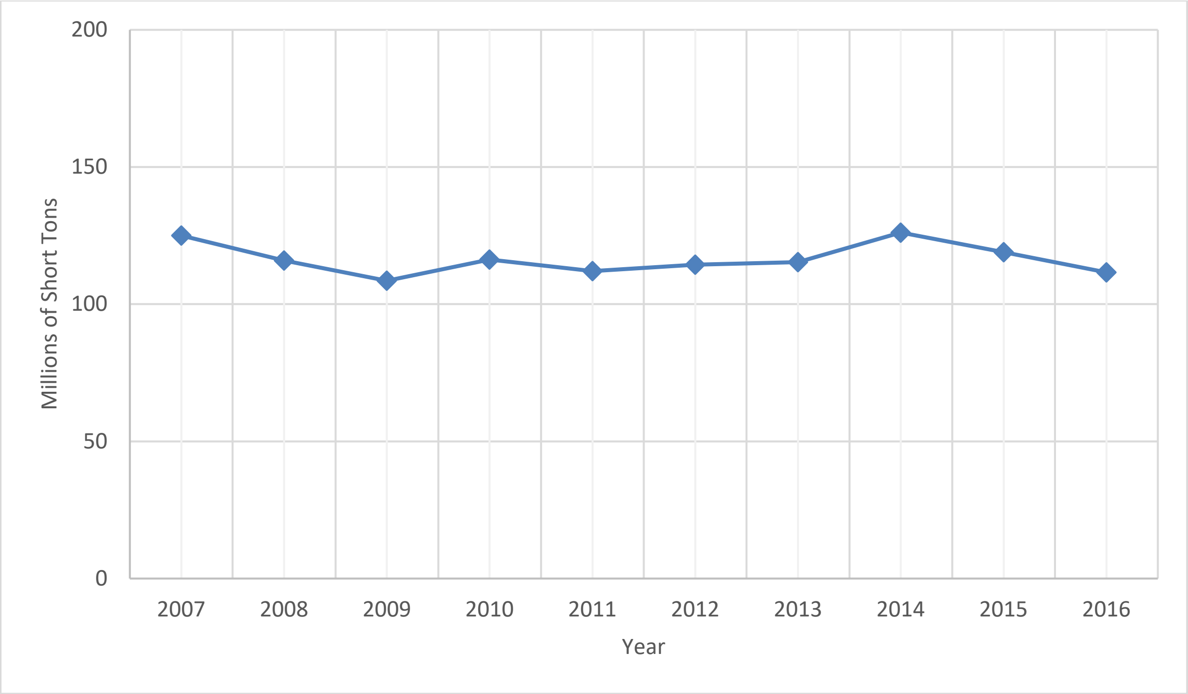

Figure 2. Total GIWW Traffic, 2007–2016.

Source: (*8*).

The primary goods being moved along the GIWW are mostly bulk commodities including oil and chemicals, which supply the numerous refineries and chemical operations along the Gulf Coast. Other major commodities transported on the GIWW include raw ores and agricultural products. As discussed below, petroleum and petroleum products make up a significant share of the total commodity transported on the GIWW.

GIWW Ports[1]

Texas

According to recent data, in 2016, 4.2 million tons of GIWW receipts and 3.7 million tons of GIWW shipments passed through Texas ports.

Texas Receipts

Petroleum and coal products accounted for more than two-thirds (67 percent) of these receipts, while iron, steel, and scrap metal constituted another 12 percent. Building stone, sand, gravel, and other waterway improvement materials also accounted for approximately 10 percent of total GIWW receipts for Texas ports. The remaining receipts included products such as crude petroleum and natural gas, vegetable oils, prepared fish, and nonelectric machinery. However,

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[1] In this and later sections, the term "shipment" refers specifically to the movement of commodities out of a port or waterway segment, while "receipts" refers to commodities that were received at a port or on a waterway segment.

each of these categories represented less than 5 percent of the total value of receipts through Texas ports.

Texas Shipments

Petroleum products accounted for 77 percent of shipments, while natural gas and crude petroleum made up 16 percent of shipments. The remaining 7 percent of shipments was primarily composed of iron, steel, ferroalloy products, and scrap.

Lower Mississippi River

The Lower Mississippi River portion of the GIWW includes the route from Baton Rouge to New Orleans and the Port Allen cut-off. Approximately 15.7 million tons of GIWW receipts and 21.9 million tons of GIWW shipments passed through these ports in 2016.

Lower Mississippi Receipts

A little more than half the tonnage of these receipts (55 percent) was derived from petroleum and coal products, while 23 percent of receipts could be attributed to crude petroleum and natural gas. The remaining 20 percent of receipts primarily included basic organic chemicals, sand and gravel, and limestone. Other categories of shipments passing through the Lower Mississippi ports included building stone, fertilizer, cement and concrete, and grains.

Lower Mississippi Shipments

Petroleum products other than crude petroleum accounted for 64 percent of shipments, while natural gas and crude petroleum comprised 14 percent of shipments. The remaining 22 percent of shipments was primarily made up of coal and basic organic chemicals.

Louisiana

The Louisiana portion of the GIWW is the remainder of the Louisiana GIWW not included in the Lower Mississippi portion. Approximately 2.9 million tons of GIWW receipts and 7.2 million tons of GIWW shipments passed through these ports in 2016.

Louisiana Receipts

Natural gas and crude oil made up 24 percent of receipts, while the remaining petroleum products made up another 24 percent. The remaining 52 percent of receipts was primarily composed of limestone, sand, and waterway improvement materials (28 percent) and clay and non-metal minerals (11 percent).

Louisiana Shipments

Clay and refractory materials made up 51 percent of shipments in the Louisiana segment, with natural gas and crude oil making up another 42 percent of shipments.

Mississippi

The ports of Pascagoula, Biloxi, Gulfport, and East Pearl River make up the Mississippi portion of the GIWW. Approximately 3.5 million tons of GIWW receipts and 7.4 million tons of GIWW shipments passed through these ports in 2016. The port of Pascagoula accounted for 99 percent of shipments and 60 percent of receipts in the Mississippi segment. Biloxi accounted for 23 percent, East Pearl River accounted for 12 percent, and Gulfport accounted for 5 percent of total receipts.

Mississippi Receipts

Across the Mississippi portion of the GIWW, natural gas and crude petroleum accounted for the largest share of receipts at 28 percent, followed closely by limestone, sand, and gravel (25 percent) and petroleum products (25 percent). Basic organic chemicals comprised another 13 percent of the total shipments through the Mississippi ports.

Mississippi Shipments

The vast majority of shipments along the Mississippi portion of the GIWW were petroleum products (85 percent). Basic organic chemicals comprised an additional 12 percent of shipments by tonnage.

Alabama (Mobile)

Approximately 4.8 million tons of GIWW receipts and 4.3 million tons of GIWW shipments passed through the port of Mobile in 2016.

Alabama Receipts

Nearly half of these receipts (45 percent) included natural gas and crude petroleum. Another 13 percent of receipts can be attributed to petroleum products, 12 percent to coal and lignite, 9 percent to basic organic chemicals, and 6.2 percent to wood and wood chips.

Alabama Shipments

Petroleum products made up 28 percent of shipments along the Mobile section of the GIWW, closely followed by coal and lignite at 22 percent. The remaining 50 percent of shipments was made up primarily of lime, cement, and concrete (21 percent); basic organic chemicals (17 percent); and sand and gravel (6 percent).

Florida

Florida ports along the GIWW include Panama City, La Grange Bayou, Escambia Bay, and Pensacola. Approximately 3.1 million tons of GIWW receipts and 70 thousand tons of GIWW shipments passed through these ports in 2016. The ports of Escambia and Pensacola made up the bulk of activity along the Florida GIWW section. Pensacola was responsible for 19 percent of receipts and 73 percent of shipments, while Escambia made up 60 percent of receipts and 27 percent of shipments. The remaining 21 percent of receipts was divided between Panama City (15 percent) and La Grange Bayou (6 percent).

Florida Receipts

The vast majority of Florida GIWW receipts were coal and lignite at 41 percent and petroleum products at 40 percent. The remaining 20 percent was primarily composed of basic organic chemicals at 17 percent.

Florida Shipments

Shipments across the Florida GIWW were low relative to other sections at only 70 thousand tons and were almost entirely made up of iron ore (79 percent) and sand and gravel (16 percent).

Literature Review

A review of existing literature and data sources was conducted to identify available resources and to provide background for the objective of this study. Researchers examined published reports from recent years, as well as historical reports. The review focused on studies that examined the economic impact of the entire waterway system, typical data used in analyses, and available modeling tools. Researchers used the studies to develop a methodology for this analysis.

There are many economic impact analyses, also known as economic impact studies, for ports in the United States. While these studies are a good source for identifying methodologies, data sets, and other considerations, they are ultimately limited in scale. In short, economic impact analyses seek to quantify the economic value of a single port at a specific point in time. This value typically includes direct, indirect, and induced impacts of the port for a single year. However, if the port were to close, those impacts would not necessarily be lost region wide. Industries would relocate to where they could operate at the next lowest operating cost. Therefore, researchers investigated areas of existing literature that supplement the region-wide scale needed for this analysis. The types of relevant literature identified during the literature review process are categorized into the following areas:

- **Economic Benefits and Characteristics of Inland Navigation:** Reviews industrial sectors, economic activity, employment, and other characteristics of waterway industries.
- **Models, Methodologies, and Data Aggregations:** Explores the data needs, available tools, types of analyses, and other considerations.
- **Types and Impacts of Abandonments and Closures:** Explores the historical and hypothetical types of closures and interruptions to waterway operations, with recorded economic impacts where available.
- **Economic Impact Analyses through Abandonment Scenarios:** Reviews existing studies quantifying impact of industries utilizing inland waterways, specifically using abandonment scenarios.

The following sections summarize these categories in further detail.

Economic Benefits and Characteristics of Inland Navigation

Before conducting an analysis of the GIWW, it is important to identify known economic benefits of inland navigation. Water transport is a cost-effective means of transporting large volumes of bulk commodities over long distances. Waterway infrastructure is also significantly cheaper to construct, relative to roadway and rail lines (*9*). This offers the following commonly stated benefits (*10*, *11*):

- Reduced highway congestion.
- Lower-cost option for goods movement.
- Lower environmental costs.
- Increased safety.

The primary benefit is the added fuel efficiency and environmental benefits that come from bulk cargo movements using barges. For example, a single barge (1,500 tons) has the capacity to replace 58 trucks (26 tons each) or 14 jumbo rail hoppers (100 tons each) (*11*). Moreover, several barges can be lashed together to form a tow. These tows usually consist of four to six barges on smaller waterways, up to 15 barges on larger waterways, and up to 40 or more on the Lower Mississippi River. The reduced vehicle need and added efficiency from bulk transport translates into congestion savings along roadways and rails throughout a region.

Because of these benefits, inland navigation as a mode is often considered by industry proponents as a more sustainable means of transportation when higher carry capacity can be used. Given the low costs of movement and infrastructure generated by inland navigation, it is not unexpected that many industries dealing in bulk imports and exports settle along the waterways. The entire inland waterway system serves 38 states and moves around 630 million tons, valued at over $73 billion annually (*11*). The GIWW, as mentioned previously, carries approximately 110 million tons primarily across five gulf states (Texas, Louisiana, Mississippi, Alabama, and Florida). Furthermore, research into the economic importance of the GIWW in Texas by the Texas A&M Transportation Institute (TTI) estimated that the energy and chemical industries heavily dependent on the waterway contributed to over $137 billion in business revenues, over $20 billion in payroll, and over 900,000 jobs, and generated more than $200 million in sales tax revenues in 1993 (*12*). Furthermore, the act of transporting goods along the GIWW generated over 13,000 jobs in transportation and transportation services alone.

Models, Methods, and Data Aggregations

Considerable work has been completed on identifying the tools, data, and metrics involved in economic impact analyses for inland waterways. Many of the studies identified in this project have used proprietary software models in their analysis. While not all of these models will fit this analysis, there are guidelines and examinations of existing tools that are made available for analysis.

Barge Movement Models

USACE completed a report that provides resources for economic impact analyses (*13*). While dated, the report provides a summary of methods, models, and data sources for economic studies of the inland waterway system. These are identified as tools to model and improve waterway congestion and delay, limited disposability of dredge material, and deteriorating structures requiring replacement. The report examines the Commodity Flow Model, Transportation Freight Model, Tow Cost Model, Lock Capacity Function Generator, and Waterway Analysis Model. The authors explored data inputs, outputs, strengths, and weaknesses of each model.

Mode-Shift Impact Models

Research has also been conducted on the tools available to measure impacts to highway congestion and maintenance cost due to a waterway closure (*14*). The Roop et. al report (1993) did not focus on the impact to the industries themselves, but rather the impact that industries would have on the Texas highways if they were to switch freight transportation modes. The study examined the use of an abandonment scenario in the analysis to determine the impacts such a closure would have on the Texas highway system. The analysis assumed that goods moving along the inland navigation system would be forced to use other means of transportation. Unlike the report from Hardebeck et. al (1999), this report simply examined the different factors to be considered when assessing the impact of a GIWW closure in Texas. To accomplish this task, researchers identified the characteristics to be analyzed (modal shift, environmental impact, etc.), and the types of data needed for each analysis. The areas identified included the following *(14):*

- Modal shifts.
- Commodity flows.
- General inland navigation and navigation along the GIWW.
- Traffic flow analysis models.
- Risks and hazards.
- Past GIWW closures.
- Texas Gulf Coast evacuation plans.

The Roop et. Al (1993) report also explored the four alternative models that would be able to assess the roadway impacts of a GIWW closure in Texas. Four model types were identified that would be possible for the analysis. These models focused on the impacts that increased roadway traffic would have in terms of congestion and maintenance costs (*14*). Given the age of this report, these models are dated. However, useful information about the process and necessary data were gathered.

TTI research, however, has investigated claims made by both environmental and industrial advocacy groups that the Corps does not fully account for all costs and benefits when examining new inland navigation investments (*13*). Per the report, environmental groups claim that the Corps fails to fully state the environmental costs of dredging and disposals, and industrial groups claim that the benefits of inland navigation (i.e., economic impact of the waterway versus the alternatives) are under-stated as well. While an examination of the environmental costs of waterway construction and maintenance is out of the scope of this project, researchers are interested in the findings regarding the calculation of benefits of inland navigation.

Methods for Inland Waterway Valuations

TTI researchers conducted a review of valuation and economic impact methodologies found in existing research and literature (12). Authors distinguished between methodologies for both benefit-cost analyses and economic impact analyses and concluded that there is not a universal approach to calculating the impact of new waterway infrastructure. For the purposes of this report, researchers identified flaws of listed methodologies to bolster the analysis.

A more recent study investigated the economic contributions of marine industries of several counties in southwest Florida—four in the West Coast Inland Navigation District, two along the GIWW, and two more inland located along the Waterway to Lake Okeechobee (*15*). Researchers examined commercial and recreational marine-related activities in these areas. The report did not use an abandonment scenario but rather looked at a snapshot of economic activity in 2013. A literature review that investigated ocean economics data, statistical and economic surveys, economic impact studies, and structural change and development studies was conducted. To generate impacts, researchers utilized IMPLAN: Economic Impact Analysis for Planning as an economic modeling tool, with data sources including the National Ocean Economics Program, Bureau of Labor Statistics (BLS), and Bureau of Economic Analysis. The results showed that marine activity in that area of Florida generated nearly 80,000 jobs, $12.2 billion in revenues, and $6.1 billion in value added in 2013 (*15*).

Types and Impacts of Abandonments and Closures

Outside of direct economic impact using abandonment of a waterway as a scenario, literature that addresses more specific impacts that come from abandonment or sudden closure of waterway facilities and transportation has been identified. Research in this field of study is limited and primarily investigates specific types of closures and subsequent impacts. Examples of disasters may include earthquakes or erosion, while man-made closures could include labor strikes or terrorist attacks (*16*).

The methodology for studying each type of impact varies by location, size, and scale. For example, some literature has studied the impacts of labor disputes, lock and dam maintenance, and network shutdowns that lasted less than two weeks (*17*, *18*, *19*). These types of closures have an economic impact, but the effects will, most likely, be only temporary shifts in transportation activities. It is unlikely that a short-term closure of operations will force any established industry to cease operations (*17*). Instead, historically, short-term closures have resulted in increased costs. For example, the literature makes mention of the McAlpine Lock repair project, which lasted 11 days, caused 180 companies to seek alternative transportation, and caused one company to spend $3 million on railcars (*18*).

Waterways can have longer-term disruptions that can carry higher consequences for industries. One study examined the operation of coal-fired power plants receiving shipments of coal along the Ohio River (*17*). The study found that there would be significant negative impacts in the form of higher transportation costs, and consequently higher consumer costs, if the closure was prolonged. Research investigated the hypothetical impacts a terrorist attack would have on the Port of Los Angeles/Long Beach through an input/output (I/O) simulation model using available data (*20*). The study found that import disturbances would total $27 billion, while the loss in exports would total $9.4 billion if the port were to close for one month due to an attack. This analysis shows the critical role that major waterway facilities, specifically ports, have nationally.

While there are limited studies that directly identify the economic impact of waterway facilities due to abandonment or closures, literature discussing abandonment of port systems and historical accounts of waterway closures reveals the economic importance of these facilities.

Economic Impact Analyses through Abandonment Scenarios

The GIWW provides a transportation mode option that has allowed for the creation of niche industrial sectors along the Gulf Coast. Primary users of this transportation network include those producing and moving energy-related products and bulk chemicals.

Calculating the effects of an abandonment scenario illustrates both the economic impacts of the GIWW and industry change. The key reason for this use is to determine how industrial sectors will react to the closure, and what the cost of this reaction will be. For example, a chemical company located along the GIWW shipping 2,000 tons of chemicals by barge would be forced to make a mode shift. If the next best option is to ship those same chemicals by truck, there would need to be several changes made. From a logistical perspective, changes would have to be made in how those deliveries are picked up, and how they are received by the destination. This includes infrastructure costs for truck loading/unloading bays, the cost of hiring a carrier, or the cost of providing the shipping services in-house. One can safely assume that all of these costs would exceed the costs currently incurred. If they did not exceed current costs, the industry would already be moving their goods in this way.

Literature examines this abandonment scenario using a variety of modeling tools and data sources. Much of the literature examines the impact that the abandonment or closure of a single inland port or waterway segment has on the rest of the inland navigation system. One such report used a Multiregional Dynamic Inoperability I-O model to simulate what the closure of a single inland water port in Oklahoma had on existing businesses, and their predicted mode shifts (21). However, a review of the literature found only one report that estimated the economic impact of the inland water system through an abandonment scenario. Given the limited work being done in quantifying the impacts of the U.S. waterway system, specifically the GIWW, those analyses that have been conducted are examined similarly to case study example. The purpose, methodology, data, and results are summarized.

Grossardt, Bray, and Burton (2014) examined the total impact of the entire inland navigation system in the event of an immediate closure (*1*). Researchers assessed how present industries would react to permanent closure of the waterways to determine the overall economic impact of the inland waterways system. The study used base commodity data from USACE and cost differentials from WCSC. However, some confidential data received from the Corps was used in the analysis to determine transportation savings data afforded by the presence of the waterway. Per the report, the raw data included data from a 10-year timeframe and represented barge movements across the whole of the inland navigation system (*22*).

The analysis assumed that no businesses would cease operations given closure of the inland water system but instead respond by choosing an alternative form of transportation. The report specifically mentions that producers will account for change in transportation options in a variety of ways. Some will switch modes without changing production behavior, others will alter production levels, and some will exit the market. These are responses, however, to higher production costs and not the absence of barge transportation.

To calculate this change, researchers used the Regional Economic Models Inc. (REMI) Policy Insight (PI+) model to simulate the functioning of regional economic models in the event of waterway closure. The simulation tool, built from a variant of an I/O economic model, was applied both to counties along the waterway and the first inland adjacent county along the entire inland navigation system. These counties were then divided into five geographic sub regions during the analysis.

The simulation results showed that the abandonment of the inland waterway system would result in the loss of 541,000 jobs and $124.2 billion in output compared to the current conditions in the first year. As sectors switched modes of transportation and recovered 10 years following closure, outputs would stabilize, but there would still be a deficit of 388,000 jobs nationwide.

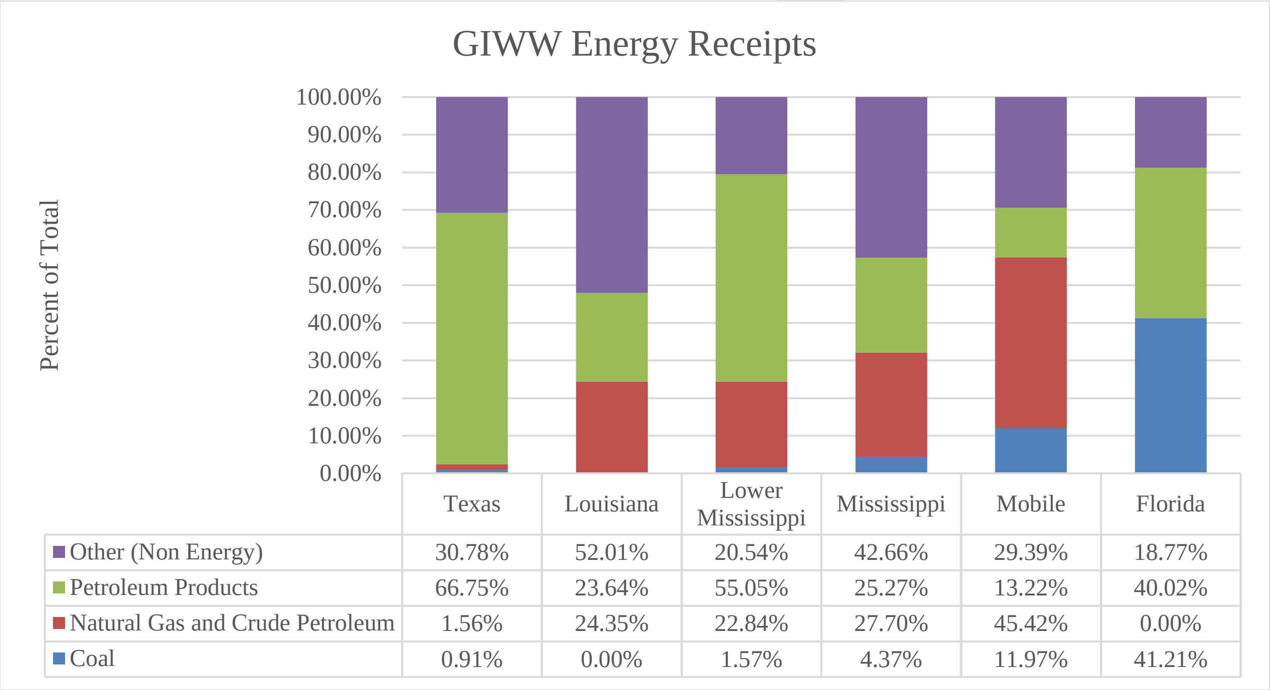
This report, as well as the literature examined in this section, highlights the complexity of such an analysis and provides key insights into data needs and methodologies.

Trends in GIWW-Related Energy-Sector Activity

Energy-Sector Shipments and Receipts

Much of the economic value of the GIWW is derived from energy-sector activity along the U.S. Gulf Coast. This activity is primarily based around crude oil and crude oil products; however, coal and natural gas make up a significant portion as well. For the purposes of this analysis, these commodities are broken down into three categories: coal, crude petroleum and natural gas, and petroleum products. The petroleum products category is made up of several refined petroleum products, which include gasoline, kerosene, and various other petroleum-derived products. These figures show that energy-sector activity makes up the majority of economic activity on the GIWW. This suggests that any changes in the energy sector will have a significant effect on the economic value of the GIWW.

Figure 3 displays the volume of energy-related activity as a percent of the total volume of receipts along each segment of the GIWW. Petroleum products are a substantial portion of receipts across all segments of the GIWW, while crude petroleum and natural gas receipts are primarily in the Louisiana, Lower Mississippi, Mississippi, and Mobile segments. Coal makes up a substantial portion of the receipts in the Florida segment; however, it is limited in quantity elsewhere. Though not displayed in the table, total energy receipts make up 72.2 percent of receipts across the GIWW as a whole.



	Texas	Louisiana	Lower Mississippi	Mississippi	Mobile	Florida
🟪 Other (Non Energy)	30.78%	52.01%	20.54%	42.66%	29.39%	18.77%
🟩 Petroleum Products	66.75%	23.64%	55.05%	25.27%	13.22%	40.02%
🟥 Natural Gas and Crude Petroleum	1.56%	24.35%	22.84%	27.70%	45.42%	0.00%
🟦 Coal	0.91%	0.00%	1.57%	4.37%	11.97%	41.21%

Figure 3. GIWW Energy Receipts by Analysis Region.

Source: (*8*).

Figure 4 also displays the volume of energy-related activity but as a percent of the total volume of shipments along each segment of the GIWW. Once again, petroleum products make up the bulk of shipments across most segments of the GIWW, excluding the Louisiana and Florida segments. The Florida segment has no significant energy shipments. Crude petroleum and natural gas shipments account for 41 percent of shipments in the Louisiana segment, about 15 percent of shipments in both the Texas and Lower Mississippi segments, and 2 percent of shipments from the Mississippi segment. Coal shipments primarily take place in the Mobile segment but make up a small amount of shipments from every segment, except the Louisiana and Florida segments. Total energy shipments make up 75.1 percent of shipments across the GIWW as a whole.

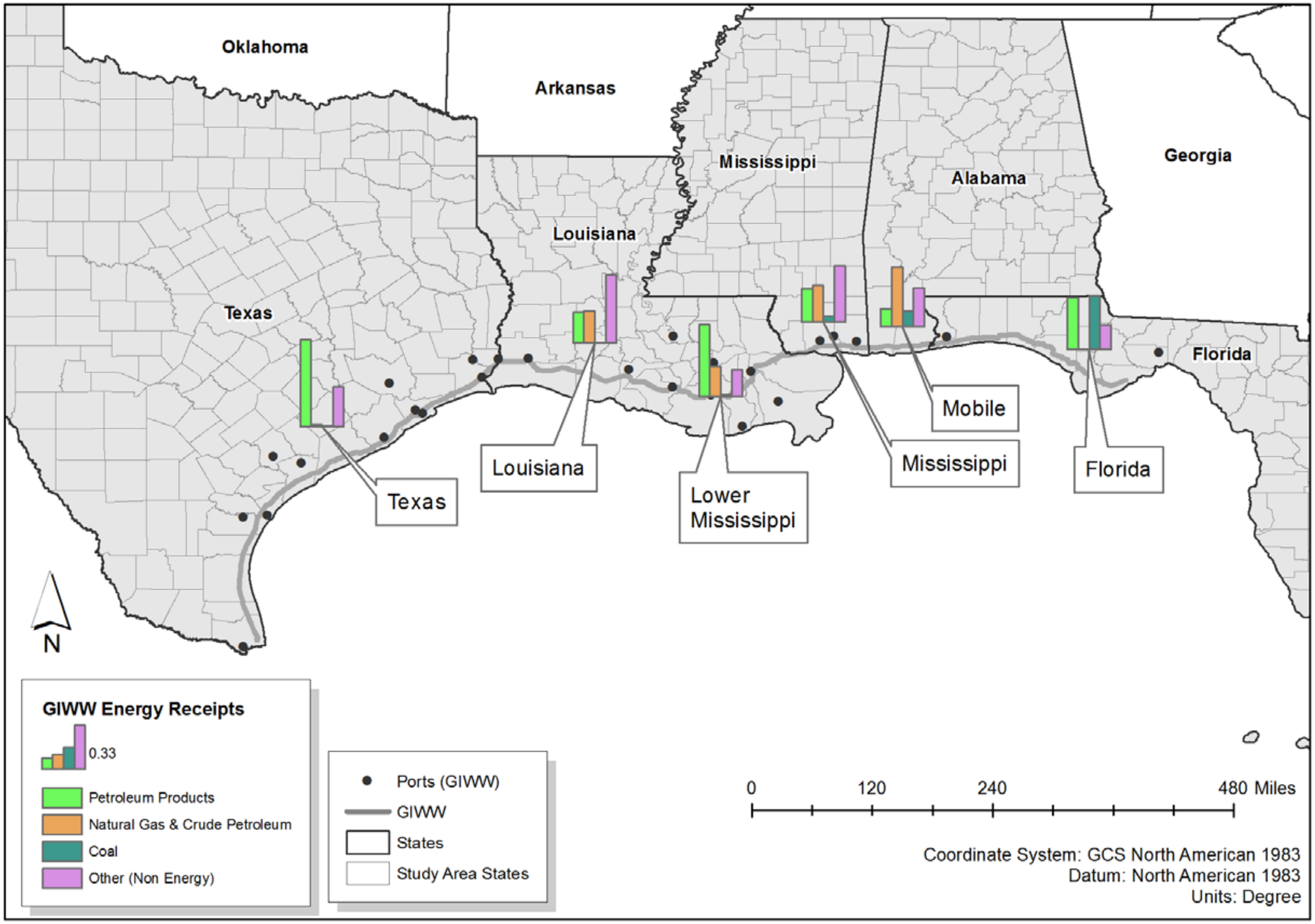
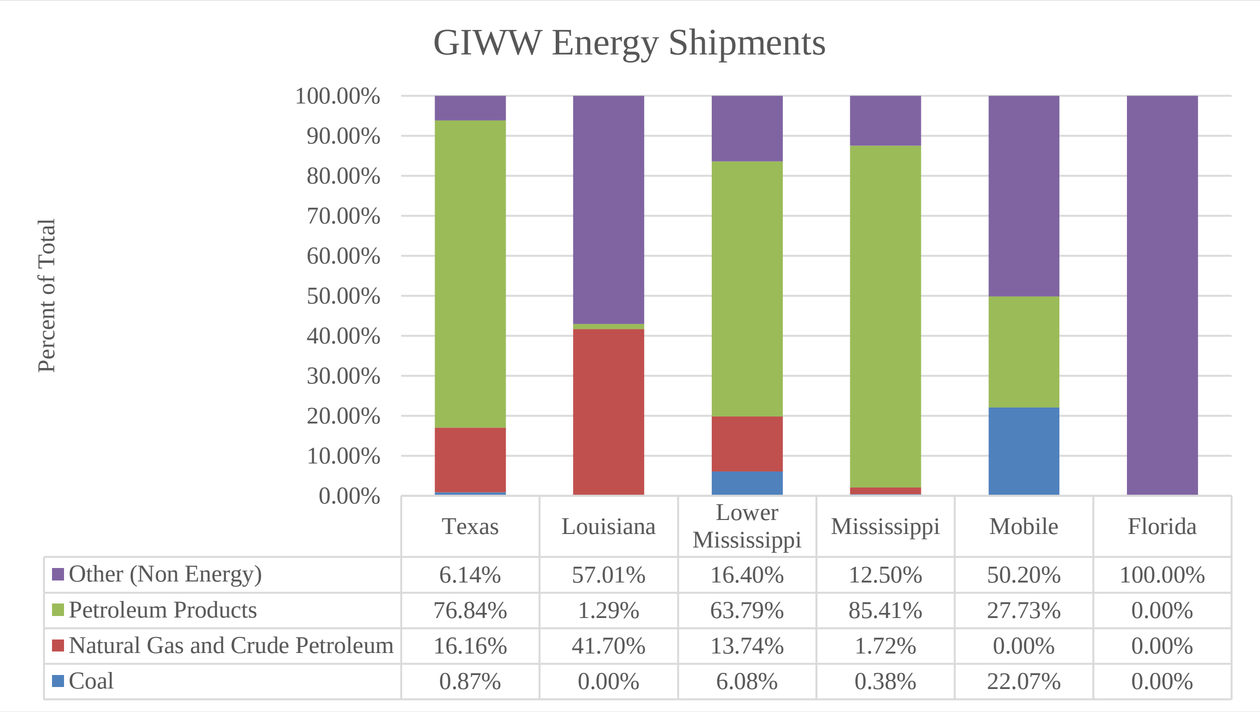


Figure 4. Map of GIWW Energy Receipts by Analysis Region



	Texas	Louisiana	Lower Mississippi	Mississippi	Mobile	Florida
🟪 Other (Non Energy)	6.14%	57.01%	16.40%	12.50%	50.20%	100.00%
🟩 Petroleum Products	76.84%	1.29%	63.79%	85.41%	27.73%	0.00%
🟥 Natural Gas and Crude Petroleum	16.16%	41.70%	13.74%	1.72%	0.00%	0.00%
🟦 Coal	0.87%	0.00%	6.08%	0.38%	22.07%	0.00%

Figure 5. GIWW Energy Shipments by Analysis Region.

Source: (*8*).

Figure 5 shows the geographic layout of refineries and coal plants across GIWW states. The majority of petroleum refineries across these states are situated along the GIWW. This accounts for the high volume of petroleum goods being moved on the GIWW. Likewise, there are many natural gas plants along the GIWW. The large percentage of coal being moved on the Florida section of the GIWW is explained by the presence of several coal-fired power plants and the lack of petroleum and natural gas refineries.

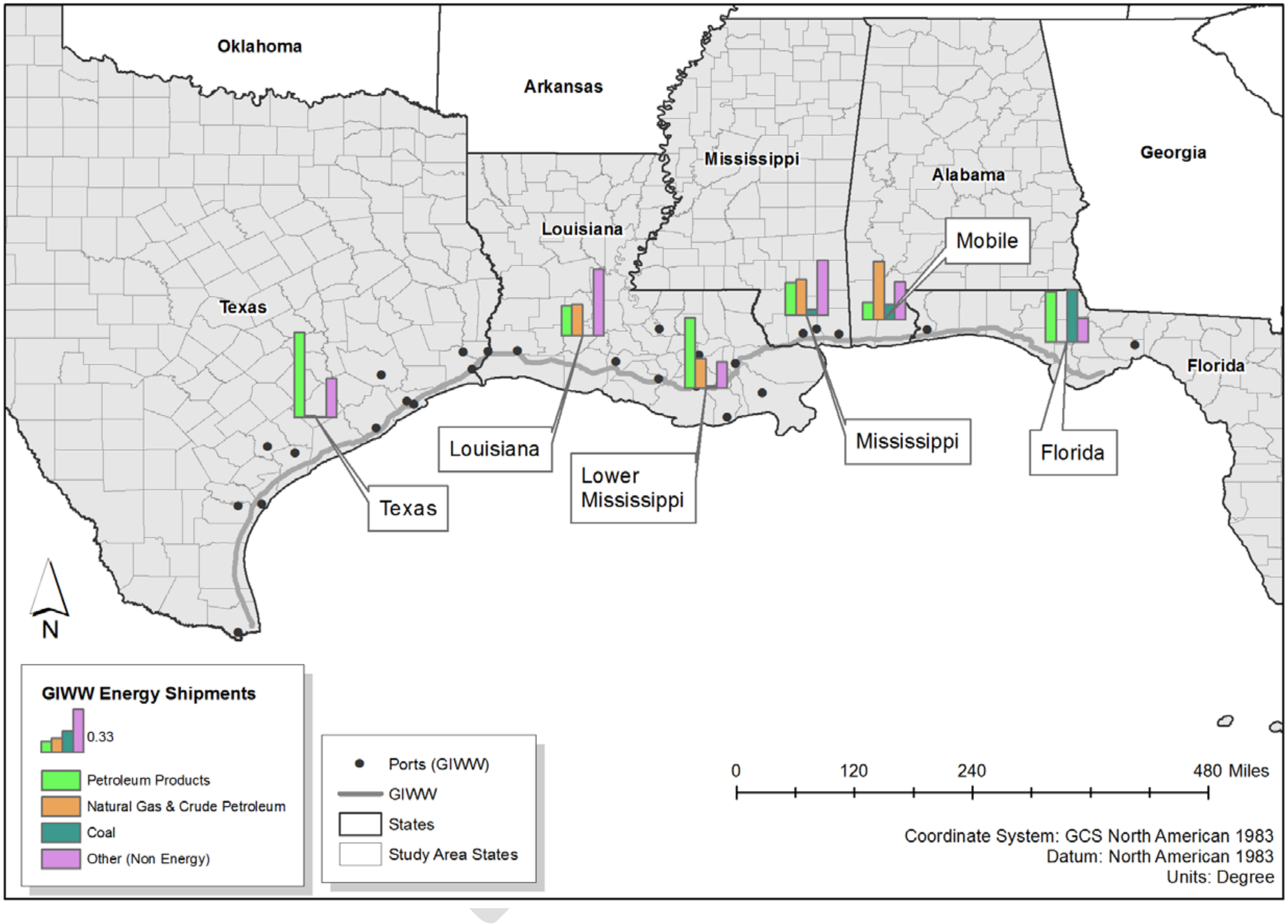


Figure 6. Map of GIWW Energy Shipments by Analysis Region

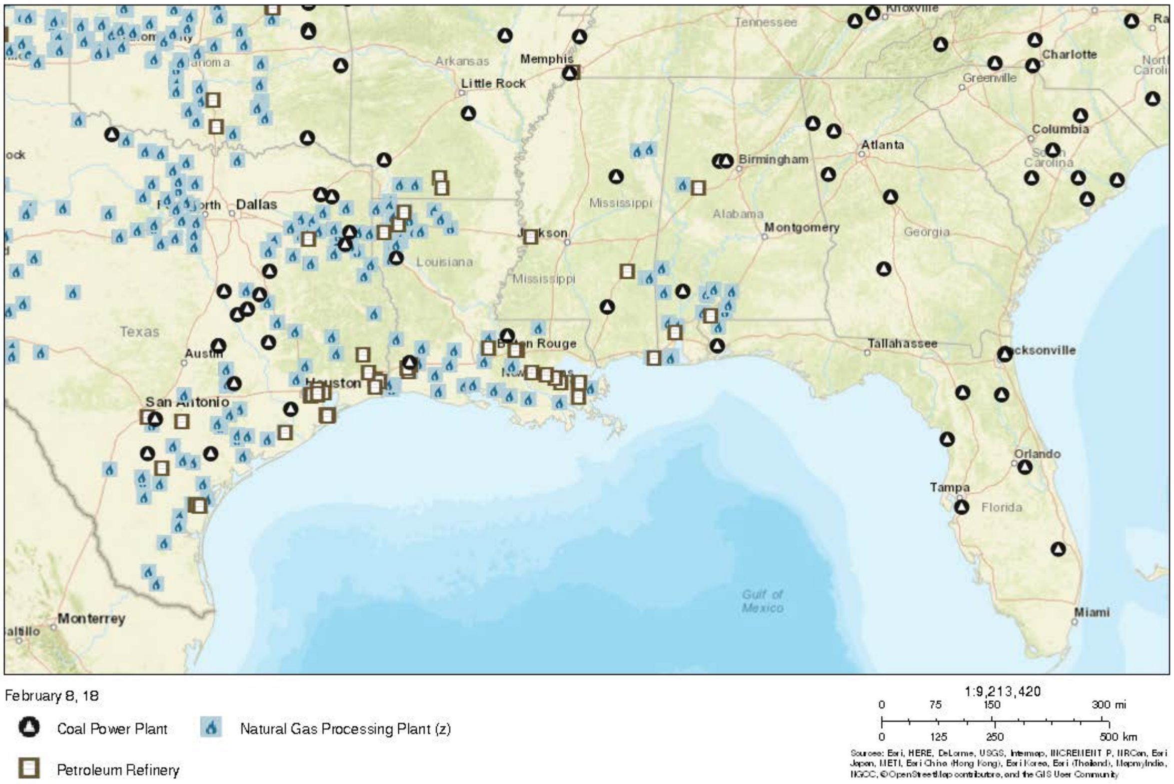


Figure 7. Petroleum Refineries, Coal Power Plants, and Natural Gas Processing Plants in the U.S. Gulf Coast.

Source: (*22*).

Energy-Sector Current Trends

Based on the amount of GIWW economic activity derived from the energy sector, it is likely that any changes in energy prices or production will have an impact on GIWW activity. Crude petroleum and natural gas together make up 21.7 percent of receipts and 10.0 percent of shipments on the GIWW. Additionally, refined petroleum products make up 45.4 percent of receipts and 65.1 percent of shipments on the GIWW. Finally, coal makes up 7.3 percent of receipts and 6.3 percent of shipments. As shown in these statistics, prices and production of these commodities significantly affect freight activity on the GIWW.

Oil Production

Figure 6 compares monthly crude oil production of each state in the GIWW region against the average monthly spot price of West Texas Intermediate (WTI) crude oil. (Offshore oil production in the Gulf of Mexico is also included.) As noted in Figure 6, crude oil production in the GIWW region occurs in Texas and the Gulf of Mexico.

Production in the Gulf of Mexico and all GIWW states (except Texas) has remained relatively constant. During the same time, production in Texas has soared from 38 million barrels per month in 2000 to 117 million barrels per month in 2017, a 208 percent increase. This increase is largely due to the advent of hydraulic fracturing (i.e., "fracking") in the Eagle Ford Shale Play and the Permian Basin. The change is visible in the figure starting in 2012. This trend in production seems unlikely to change in the short term.

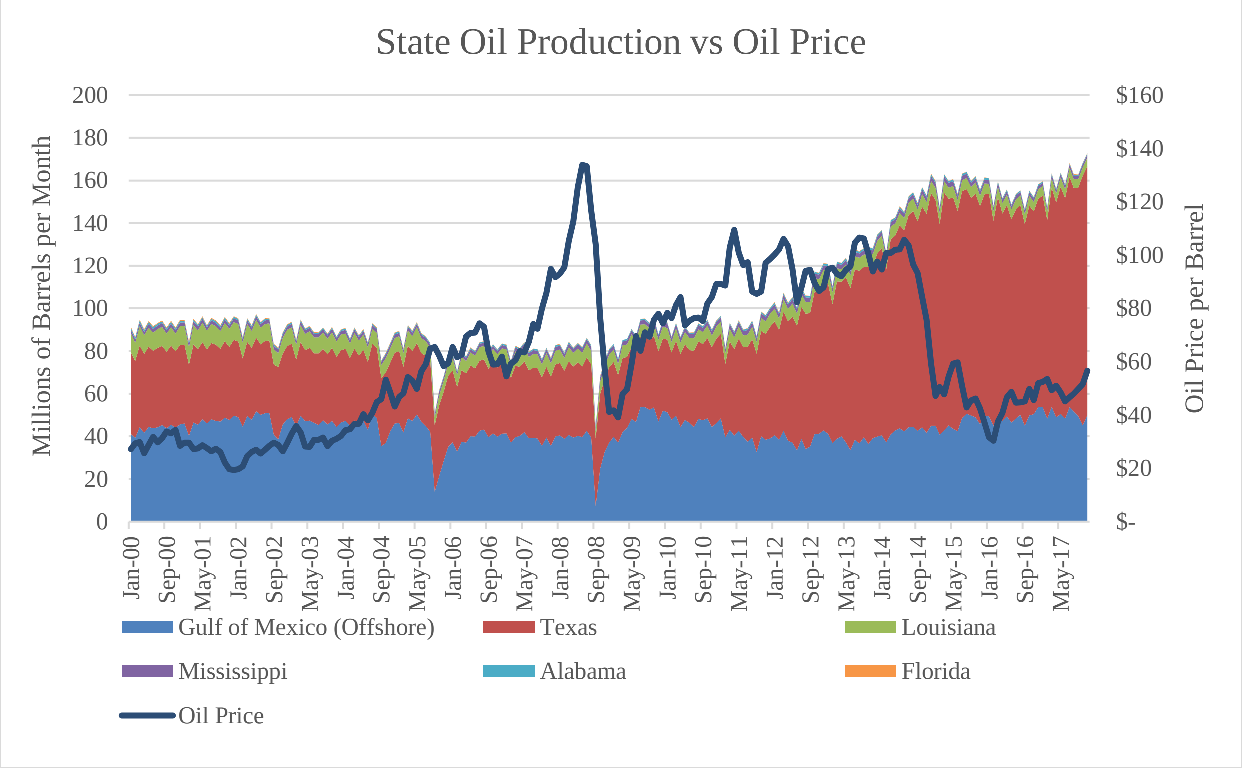
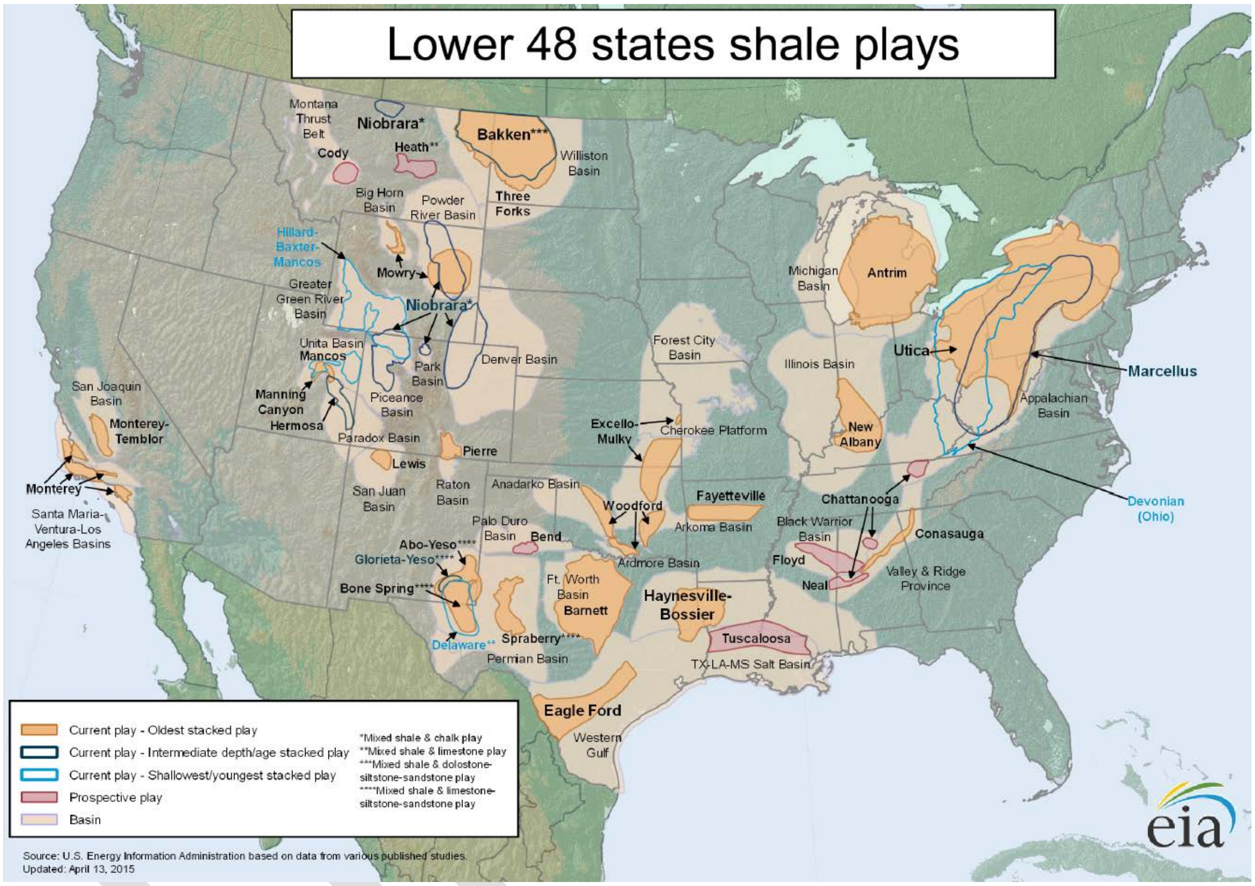


Figure 8. Oil Production and WTI Oil Average Monthly Spot Price, 2000–2018.

Source: (*23*, *24*).

The other important takeaway of these data is the low short-term correlation between oil price and oil production. The large price drop in 2008 had little effect on production in the region. The second large price drop in 2014 did result in a minor decrease in production several months later; however, production is again rising. This suggests that fracking will remain a viable extraction method even at the historically low prices of the present. It is likely that production will continue to increase in the near future, barring another major decrease in oil prices.

Figure 7 displays the close proximity of the Eagle Ford Shale Play to the GIWW. While production in Eagle Ford peaked in 2014, production remains stable at about 36 million barrels per month, or almost one-third of Texas' total oil production (*25*). Also visible in Figure 7 are several potential shale oil plays near the GIWW that may be developed in the coming years. The Tuscaloosa Marine Shale could especially impact the GIWW. It is situated very near the GIWW and may contain up to 7 billion barrels of oil (*26*). Additional production in the Permian Basin, located in west Texas, could also impact volumes on the GIWW. While it is likely that additional production in any of these basins would impact GIWW volumes, it is difficult to estimate the exact impact without additional market data. More precise estimates of future volumes would require oil industry origin-destination data. Without such data it is impossible to know how and where to additional crude oil would be shipped.



Source: U.S. Energy Information Administration based on data from various published studies.
Updated: April 13, 2015

Figure 9. U.S. Shale Plays.

Source: (*27*).

Natural Gas Production

Figure 8 shows natural gas production in each GIWW state and the Gulf of Mexico, as well as the price of natural gas, back to the year 2000. Unlike oil, natural gas production has remained fairly stable. However, similarly to oil, short-term changes in price appear to have minor impacts on overall production. The price more than doubled from 2002 to 2005; however, production only slightly decreased. In 2009, the price then returned to its 2002 level; however, there was little change in production.

Like oil, recent changes in natural gas production can be explained by the increased production of shale gas. Offshore gas production has steadily fallen since 2000; however, beginning in the mid-2000s, much of this decline was offset by increased shale gas production in the Barnett

Shale Play in Texas. It appears unlikely that natural gas production will significantly decrease in the future since prices are already relatively low. It is possible that natural gas production could increase as additional shale plays are developed and begin producing natural gas. Increased natural gas exports may also increase production as more facilities such as the Sabine Pass LNG[2] Terminal come online. These terminals will likely have a large impact on GIWW activity since they are situated along the Gulf Coast.

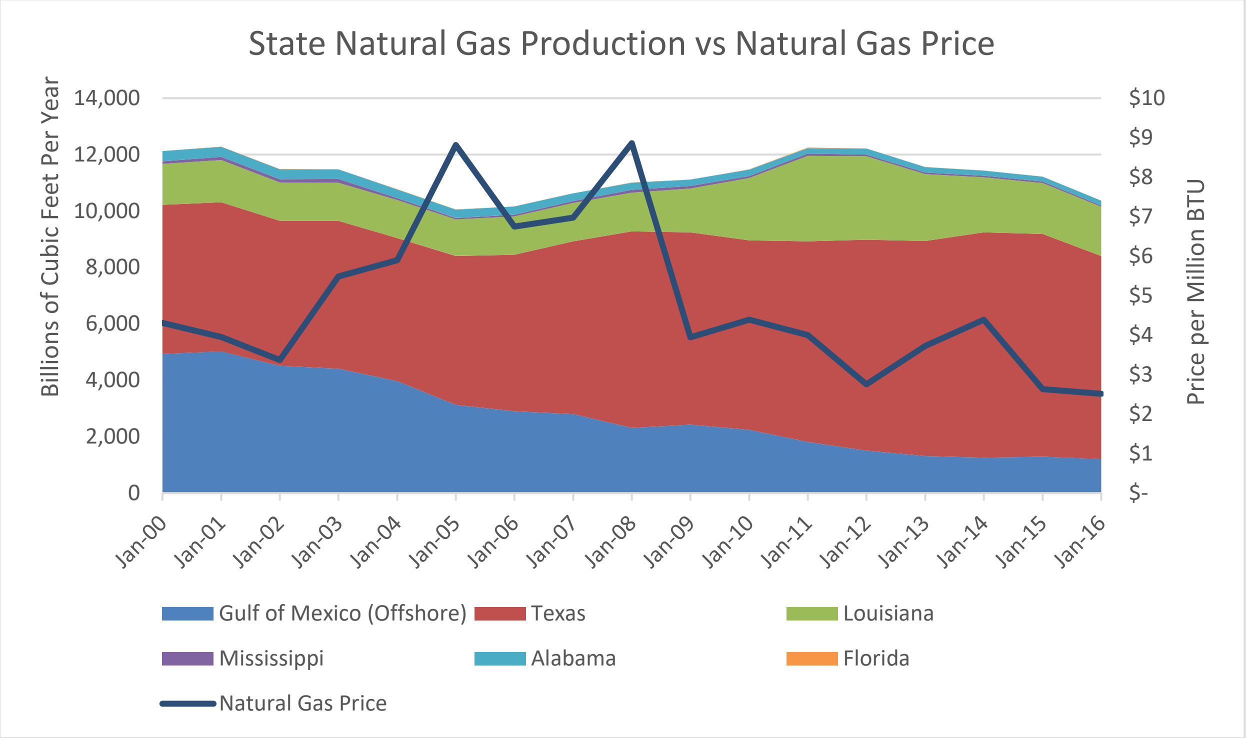


Figure 10. Natural Gas Production and Henry Hub Average Annual Spot Price, 2000–2018.

Source: (*28*, *29*).

Coal Production

Figure 9 shows coal production in each GIWW state and coal price back to 2008.[3] Similar to natural gas, coal production has remained relatively stable over the last 10 years. There has been a small downward trend in production; however, the price has remained stable at just over $40 per ton. It is unlikely that this trend will change substantially in the short term. As seen in Figure 5, the multiple coal-fired plants along the GIWW suggests that coal will remain an important part of GIWW economic activity in the coming years.

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[2] LNG = liquefied natural gas.

[3] Florida data were not available.

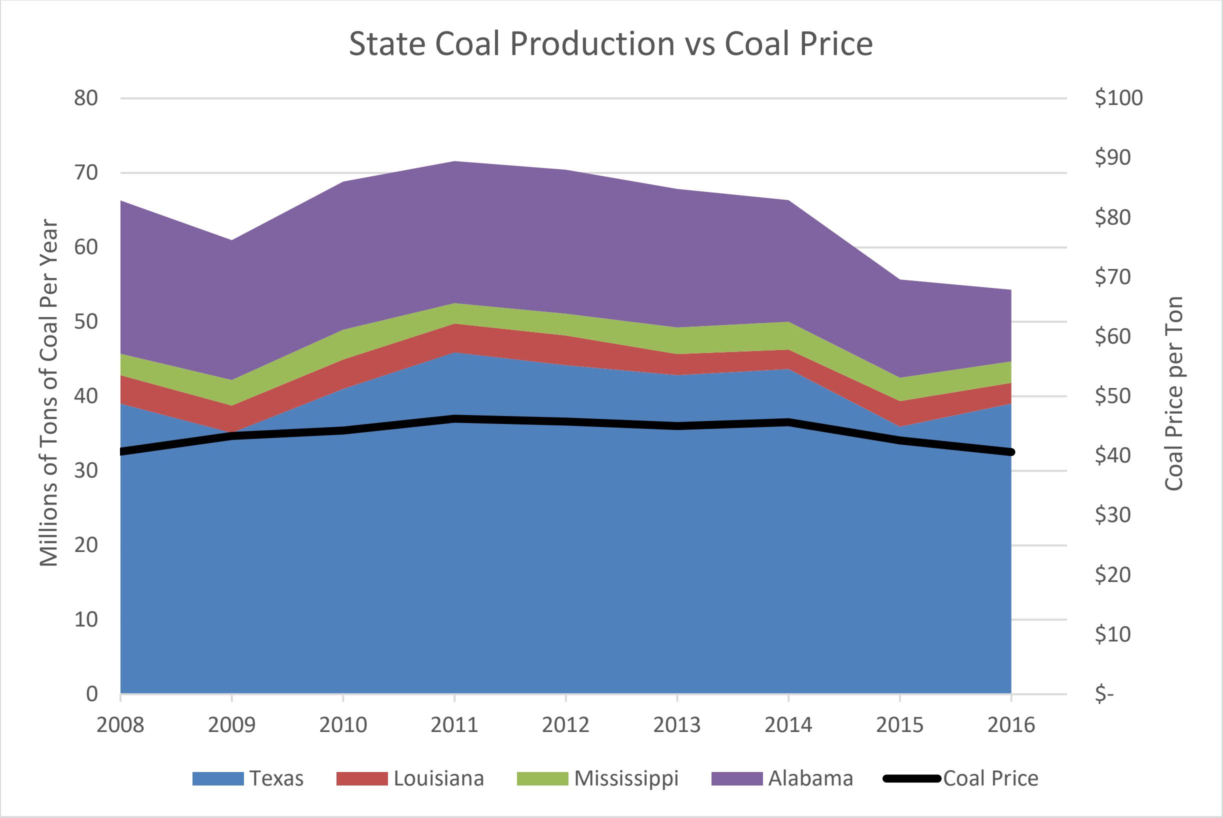

Figure 11. Coal Production and Average Coal Price, 2008–2018.

Source: (*30*).

METHODOLOGICAL APPROACH

After a review of the existing literature and studies, researchers determined that the use of an I/O economic model would produce reliable estimates of the economic impact of the goods traveling on the GIWW. An I/O model examines inter-industry relationships within an economy. For this study, researchers utilized the IMPLAN: Economic Impact Analysis for Planning model to calculate the impacts.

The primary data sources for the economic impact estimation were GIWW traffic data from WCSC and commodity price data from various industry sources. Researchers then joined these barge movement data with the estimated commodity prices of the goods being moved. By joining these data, researchers derived an estimate of the value of production occurring within the various economic sectors. Economic multipliers were then applied in each sector to estimate the total economic impact of the GIWW. See Figure 10.

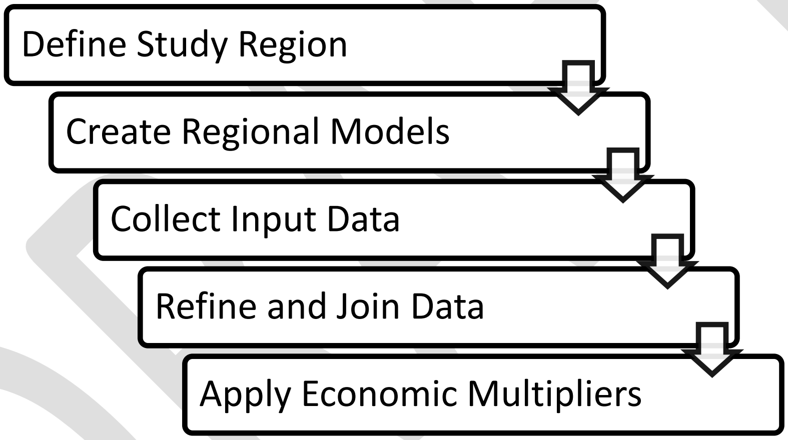

Figure 12. Economic Analysis Process.

IMPLAN Model

The IMPLAN model is an advanced modeling tool that expands on the traditional I/O modeling approach by integrating industry to institution[4] transactions within regions, as well as transactions occurring between institutions (*31*). This allows the model to capture all monetary market transactions within a given time.

The model was used to estimate direct, indirect, and induced economic impacts of industry sectors that utilized the GIWW in 2016. These impacts are calculated by applying multipliers to a series of data inputs in the model. As with a traditional I/O model, direct impacts, which are the initial impacts resulting from a change in production, are calculated through multipliers on

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[4] In IMPLAN, institutions include Households (broken down into nine income categories), Administrative Government, Enterprises (basically corporate profits), Capital, Inventory, and Foreign Trade.

a per-million-dollar basis. This simply means that employment estimates are calculated based on how much is typically needed for $1 million worth of production in each industry (*32*).

The IMPLAN model then applies multipliers to these initial, direct impacts to estimate indirect and induced impacts. Indirect effects are comprised of the business-to-business transactions that contribute to the final production of a good, but not the good itself. This forward and backward spending through the economic supply chain adds value until all money leaks from the local economy. Induced impacts result from the spending of labor income. This is simply the workers spending their wages on goods and services in the economy. This includes expenditures made in the service and retail sectors, for example.

To calculate the indirect and induced impacts, IMPLAN uses Regional Social Accounting Matrices to provide information on non-market financial flows. This includes inter-industry expenditures, tax payments, and transfers.

The direct, indirect, and induced impacts of production are represented in terms of jobs, labor income, value added, and total output. These are described in the model as the following:

- **Employment** numbers represent total annual average jobs. This includes self-employed and wage and salary employees, and all full-time, part-time, and seasonal jobs, based on a count of full-time/part-time averages over 12 months (*33*). Results are not reported as full-time equivalent (FTE) jobs, but rather as individual job-years. A job-year is one year of one job.
- **Labor income** is the amount paid to workers within a region. This includes both employee and proprietor income and is the source for induced impact calculations.
- **Value added** is comprised of labor income, property income, and indirect business taxes. It demonstrates the difference in value of production over the costs of purchasing services and goods to produce a good or product.
- **Output** represents the total value added, as well as any intermediate expenditures for materials and services (i.e., purchases that go into production).

Study Area

Researchers created five separate IMPLAN models, one for each state located along the GIWW. In addition, researchers created a sixth model for the Lower Mississippi area since shipments and receipts in this area of the GIWW are spread throughout the Louisiana and Mississippi border. Each model consisted of the coastal counties located in proximity to the waterway. For this analysis, researchers chose counties bordering the Gulf of Mexico, as well as one inland county adjacent to the coastal counties. In some regions, such as Florida and Alabama, the coastal counties extended much farther inland. In these cases, only the coastal counties were selected. After analyzing the available literature, researchers concluded that the majority of all production, and subsequent economic impact of the GIWW, takes place in the selected counties. A map of chosen counties can be seen in Figure 11, and a list of selected counties can be found in Table 1. Selecting these counties ensured that the most accurate regional multipliers were applied to input values in each sector.

In some cases, industry-sector multipliers were not included in the selected counties. This exclusion indicated that those commodities were being produced outside of these study areas. In those limited cases, statewide models were created to capture the full value of production.

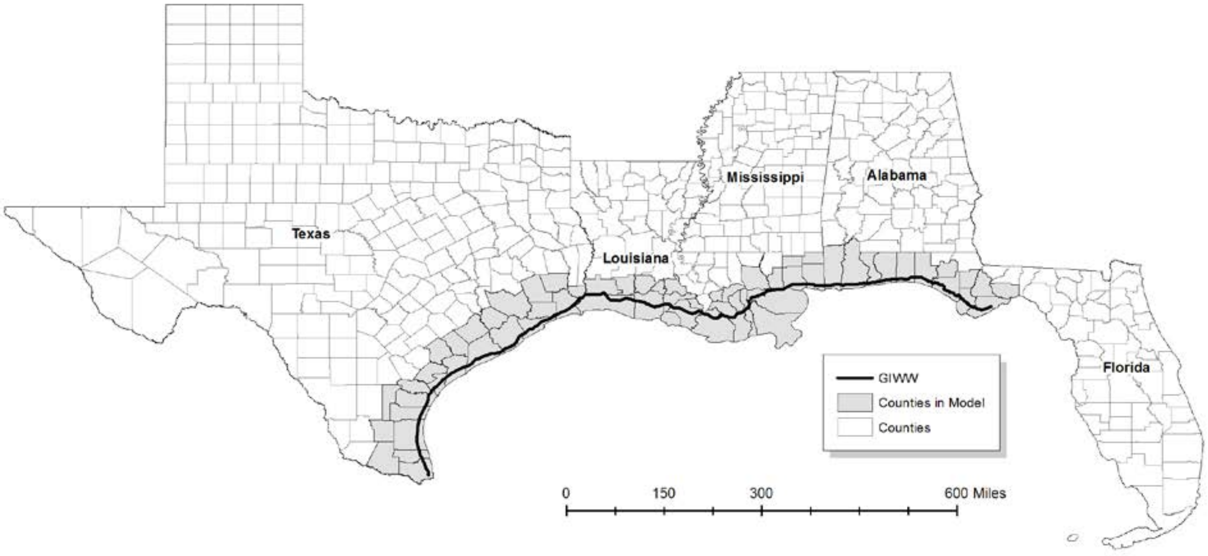

Figure 13. Economic Analysis Study Area.

Table 1. Counties Included in IMPLAN Models.

Alabama	Baldwin	**Louisiana**	Acadia	**Texas**	Aransas	Orange
	Mobile		Calcasieu		Brazoria	Refugio
Florida	Bay		Cameron		Brooks	San Patricio
	Calhoun		Iberia		Calhoun	Victoria
	Escambia		Jefferson		Cameron	Wharton
	Franklin		Jefferson Davis		Chambers	Willacy
	Gulf		Lafayette		Fort Bend	
	Liberty		Lafourche		Galveston	
	Okaloosa		Orleans		Hardin	
	Santa Rosa		Plaquemines		Harris	
	Wakulla		St. Bernard		Hidalgo	
	Walton		St. Charles		Jackson	
	Washington		St. James		Jefferson	
Mississippi	George		St. John the Baptist		Jim Wells	
	Hancock		St. Martin		Kenedy	
	Harrison		St. Mary		Kleberg	
	Jackson		St. Tammany		Liberty	
	Stone		Terrebonne		Matagorda	
			Vermilion		Nueces	

Data Inputs

Once models for each region were created, data inputs were needed to produce impact estimates. The following sections provide additional details on the different data inputs used in the economic modeling process.

Barge Movements

This economic analysis relies heavily on historical waterborne commercial vessel movement data collected by USACE. These data, known as waterborne commerce statistics, are maintained by USACE's Institute for Water Resources (IWR) and are used to analyze the feasibility of new projects and to establish priorities for new investments. USACE has collected these data in some form for nearly a century; the Rivers and Harbors Act of 1922 authorizes USACE to collect, process, distribute, and archive waterborne commercial vessel trip and cargo data *(34)*. Furthermore, this legislation also requires domestic waterborne commercial vessels to report their movements directly to USACE.

According to USACE, the following domestic vessel movements are reported: dry cargo ships and tankers, barges (loaded and empty), towboats (except harbor assistance and barge shifting), crew boats and supply boats, and the first move of newly constructed vessels. Vessel movements that are not reported in the waterborne commerce statistics include recreation, commercial fishing, fire, police, patrol, and military vessels, as well as vessels used in construction activities*(35)* Table 2 provides an overview of the major processes used by the IWR to collect and report these data.

Table 2. Waterborne Commerce Statistics Data Flow Process.

Collection	Input	Data Processing	Distribution
Partnership with: • Carriers • Customs • Port & Terminal Operators • USACE Operators • USACE Regulatory • USACE Navigation Decision Center (NDC) Staff	Supported by: • Contractors • USACE Offices • USACE NDC Staff • Customs • Census • Coast Guard	Internal Activities: • Editing • Enforcement • Routing • Information Generation • Decision Support • Publishing	• Fact Card • Waterborne Commerce of the U.S. • Lock Information • Port Facilities • Dredging Statistics • Other Business Line Products

Source: (*36*).

IWR reports both domestic and foreign traffic. For domestic traffic, IWR reports vessel traffic in geographical categories (e.g., coastwise, lakewise, internal, intraport, through, intra-waterway, and intra-territory), direction (e.g., upbound, downbound, inbound, and outbound), and port receipts and shipments *(37)*. WCSC also reports these movements by commodity, broadly following Standard International Trade Classification (SITC) commodity code guidelines.[5] The SITC is a standardized classification of goods used by most economic analyses for comparing different countries and years.

First, GIWW traffic data were obtained directly from IWR. Traffic movements by GIWW segment and commodity type[6] for FY 2016 were collected and analyzed. The data set includes the ports for each state along the waterway with corresponding commodities, total tonnage, and whether the commodity movement was a receipt, shipment, or an intraport movement. Tonnage figures in the data set are represented in short tons. Receipts are those commodities that were received by the port via the GIWW, while shipments are those commodities leaving each port via the GIWW. The remaining intraport movements are between ports within the same state along the waterway. While receipts, shipments, and intraport data were reported, origin and destination data for each commodity are not included making exact commodity movements impossible to determine.

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[5] The Waterborne Commerce Statistics Center (WCSC) publication codes correspond with the Lock Performance Monitoring System (LPMS) commodity codes. Both LPMS and WCSC codes were standardized to reflect the hierarchical structure of the SITC Revision 3 commodity codes. Using SITC, Rev. 3 allows direct comparisons with U.S. imports and exports, as well as with commodity movements of other countries.

[6] Commodity types reported per SITC Revision 3 commodity code.

Commodity Price

Price data for each commodity were not included in the original data set obtained from WCSC. To conduct the analysis using the IMPLAN model, researchers were tasked with estimating the total value of the commodities being moved along the waterway. This total, in turn, would be used to estimate the total value of production from sectors utilizing the GIWW to transport goods.

Researchers acquired data from various sources and used a baseline year of 2016. If 2016 data were not available, the Producer Price Index (PPI) from BLS was used to adjust the price to 2016 dollars. The PPI varies by industry, so the closest industry match to commodity provided an accurate adjustment to the baseline year. BLS provides both seasonally adjusted and non-seasonally adjusted PPIs for most industries. Seasonally adjusted indices reduce price volatility over the year and were selected for this model where possible. Prices are in dollars per short ton, or were converted from dollars per metric ton, and are for the entire Gulf Coast region. If only prices by state were available, an average was calculated to provide a price for the region.

The U.S. Energy Information Administration (EIA) provided prices for coal and petroleum products. The EIA has historic price data in dollars per barrel or gallon for the Gulf Coast region; the conversion to short ton used industry standard rates. EIA conducts regular surveys of suppliers and retailers to aggregate costs for each commodity. Certain petroleum-derived product prices were not available through EIA, so Independent Chemical Information Service (ICIS) provided spot prices.

Prices for chemicals, organic materials, and certain petrochemicals were taken from ICIS market and commodity reports. ICIS provides information on over 180 commodities in the petrochemical sphere including energy and fertilizer products. ICIS generates prices through reports from both buyers and sellers in each market. ICIS provided the research team with spot prices for the U.S. market, which were adjusted to 2016 dollars.

Metals, minerals, and their derived product prices were located at the U.S. Geological Survey National Minerals Information Center. The Mineral Industry Survey and the Commodity Summaries have price data either for the United States or by region. The Mineral Industry Survey collects data monthly, quarterly, or annually from key industry members. The Commodity Summary is an annual report that compiles information on reserves, domestic industry breakdown, and value of over 90 minerals. This information is derived from a variety of sources including a survey of industry members.

Data from the U.S. Department of Agriculture Economic Research Service (ERS) were used for agricultural commodities, such as wheat and corn. Conversions from dollars or cents per bushel were calculated where necessary. ERS collects data through producer surveys every four to eight years and then estimates annual changes to production and price.

For the remaining commodities, the research team utilized the Freight Analysis Framework (FAF) by the Federal Highway Administration. The FAF uses the U.S. Census Bureau's Commodity Flow Survey (CFS) as the baseline for its model and then projects or forecasts from that baseline. The FAF does include businesses that are not generally included in the CFS to provide a more accurate picture of freight movement and value.

Input Refinement and Joining

After collecting both commodity and price data for goods being moved along the GIWW, researchers refined a list of commodities that would be used as inputs into the created IMPLAN models. Researchers were tasked with determining a total value of production to be used as total industry sales within the region. Total values for each commodity were calculated by simply multiplying the total tonnage being moved from each port along the GIWW with the average 2016 price.

Last, researchers assigned an economic sector within the IMPLAN model that corresponded with the total value of each good being moved. The IMPLAN model converts the North American Industry Classification System (NAICS) (2017) into a 536-sector model. The values calculated by TTI researchers represent the value of production in each economic sector, and these values were matched to the most appropriate IMPLAN sector. For example, crude petroleum tonnage was assigned to IMPLAN Sector 20, Extraction of natural gas and crude petroleum.

Model Assumptions

The refinements to the data, and the input of those data into the IMPLAN model, required two major assumptions regarding economic importance of the GIWW.

First, researchers assumed that the production of any good being shipped from a port (listed as shipments in the data set) were produced in one of the adjacent coastal counties. The reasoning behind this assumption was that the local economy typically consists of the various states and counties that are adjacent to the waterway, and the corresponding economic activity present in these regions. It was assumed that all production is occurring within the coastal counties shown in Table 1. However, some selected industry sectors were not present within the IMPLAN models created for the coastal counties. In those cases, a separate "Rest of State" model was created to estimate those additional impacts outside of the study region to ensure the full impact of production was being accounted for. These models used statewide multipliers instead of county specific multipliers.

Second, it was assumed that the GIWW provides the lowest cost transportation option for those industries located on and using the inland waterway. It was reasonable to assume that if there were a cheaper means of moving goods, such as by rail, truck, or pipeline, these industries would already be using those modes. This resulted in the assumption that either the alternative mode of transportation was not cost effective in terms of price per ton per mile or the cost to develop the infrastructure to receive the lower costs (i.e., buying the necessary rights of way and constructing pipelines) would result in a higher cost than would be saved once the infrastructure was completed compared to the use of the waterway. Given this assumption, researchers concluded that any goods moving along the GIWW would be negatively impacted if the waterway were not available. As such, the calculation of impacts of the production of these goods would mirror the loss in economic activity, in the short term, if the GIWW were to have an immediate and full closure. As noted in the literature, industries would change their behavior, in terms of production levels, costs, etc., to react to the change in transportation costs (*1*). This would result in some industries changing their operations to remain competitive in the market, while having other industries either move to another location or outright close their operation.

RESULTS

The results are divided into coastal county and statewide results. As stated in the assumption section, not all industries producing goods that move along the GIWW are within counties in proximity to the waterway. In these cases, an additional table is provided which shows additional production utilizing the GIWW outside of the study region.

The results indicate that there are approximately 134,000 and 142,000 jobs created in coastal counties and statewide economies, respectively. Looking at statewide totals, full employment from production utilizing the GIWW can be estimated. These impacts are shown in Table 3. These figures are presented as annual totals in 2018 dollars.

Total Impact

The total estimated annual economic impact of the activity directly associated with the GIWW is estimated to be approximately 143,000 jobs and over $61.5 billion in total economic output. Researchers assume that this amount would be the loss in economic activity if the GIWW were to experience an immediate closure.

Table 3. Economic Impact of the GIWW.

Impact Type	Employment	Labor Income ($M)	Total Value Added ($M)	Output ($M)
Direct Effect	47,167	$ 8,524.7	$ 19,601.2	$ 41,372.4
Indirect Effect	36,773	$ 3,308.3	$ 5,608.2	$ 12,098.5
Induced Effect	59,111	$ 2,694.3	$ 4,731.8	$ 8,088.7
Total Effect	143,050	$ 14,527.4	$ 29,941.2	$ 61,559.6

These results do not assume that these jobs/impacts would be irreplaceable, but rather that these are the jobs that would be immediately impacted by closure. As existing literature notes, industries would be required to shift modes to continue operation (1). This shift would cause an immediate, short term loss of some jobs, with the effect becoming less pronounced in the long run.

Statewide Impacts

As mentioned in the Study Area section of this analysis, not all economic sectors are represented in the IMPLAN models for the selected coastal counties; the employment reliant on the GIWW is not fully represented in these counties. Results in this section are presented as Gulf County Impacts and Rest of State Impacts. Gulf County Impacts are the impacts to counties directly adjacent to the GIWW, while Rest of State Impacts are the impacts to all counties in each state. Texas and Louisiana Gulf County models both included all industry sectors corresponding to the goods being produced, therefore a Rest of State model was not needed. For the Lower Mississippi River (region), Mississippi, Alabama, and Florida, there were some industries not included in the selected counties. In these cases, researchers ran these missing sectors in statewide models to ensure the full impact of production was being accounted for. These are shown in the Rest of State models.

Texas

Table 4 shows the economic impacts occurring to the Texas gulf counties. The combined economic impact totaled more than $31.7 billion in output and supported nearly 65,000 jobs.

Table 4. Texas Gulf County Impacts.

Impact Type	Employment	Labor Income ($M)	Total Value Added ($M)	Output ($M)
Direct Effect	14,275	$ 5,163.4	$ 9,401.5	$ 19,351.3
Indirect Effect	17,056	$ 1,937.4	$ 3,356.3	$ 7,664.2
Induced Effect	33,529	$ 1,643.4	$ 2,809.4	$ 4,748.4
Total Effect	64,860	$ 8,744.1	$ 15,567.1	$ 31,763.9

Louisiana

Table 5 shows the economic impacts occurring to the Louisiana gulf counties. The combined economic impact totaled more than $12 billion in output and supported over 38,000 jobs.

Table 5. Louisiana Gulf County Impacts.

Impact Type	Employment	Labor Income ($M)	Total Value Added ($M)	Output ($M)
Direct Effect	17,585	$ 1,678.1	$ 4,536.7	$ 8,927.1
Indirect Effect	8,546	$ 612.9	$ 1,004.3	$ 1,858.8
Induced Effect	12,153	$ 522.5	$ 939.2	$ 1,607.7
Total Effect	38,285	$ 2,813.4	$ 6,480.2	$ 12,396.0

Lower Mississippi River

Table 6 shows the economic impacts occurring to the Lower Mississippi River region gulf counties. The combined economic impact totaled more than $10.5 billion in output and supported over 20,000 jobs. Outside of the study region, there is an additional estimated $177 million in total output with over 450 jobs supported by the GIWW. See Table 7.

Table 6. Lower Mississippi River Gulf County Impacts.

Impact Type	Employment	Labor Income ($M)	Total Value Added ($M)	Output ($M)
Direct Effect	7,105	$ 1,000.6	$ 3,926.2	$ 8,041.8
Indirect Effect	5,777	$ 453.3	$ 773.7	$ 1,497.8
Induced Effect	7,762	$ 326.7	$ 595.2	$ 1,027.9
Total Effect	20,643	$ 1,780.7	$ 5,295.1	$ 10,567.4

Table 7. Lower Mississippi River Rest of State Impacts.

Impact Type	Employment	Labor Income ($M)	Total Value Added ($M)	Output ($M)
Direct Effect	100	$ 8.7	$ 40.8	$ 114.1
Indirect Effect	218	$ 14.3	$ 22.7	$ 45.1
Induced Effect	137	$ 5.4	$ 9.9	$ 17.8
Total Effect	455	$ 28.4	$ 73.5	$ 176.9

Mississippi

Table 8 shows the economic impacts occurring to the Mississippi gulf counties. The combined economic impact totaled nearly $870 million in output and supported over 6,800 jobs. Outside of the study region, there is an additional estimated $3.6 billion in total output with over 8,500 jobs supported by the GIWW. See Table 9.

Table 8. Mississippi Gulf County Impacts.

Impact Type	Employment	Labor Income ($M)	Total Value Added ($M)	Output ($M)
Direct Effect	6,032	$ 66.2	$ 192.7	$ 724.0
Indirect Effect	378	$ 19.5	$ 35.4	$ 94.0
Induced Effect	398	$ 13.2	$ 27.5	$ 49.5
Total Effect	6,808	$ 98.9	$ 255.7	$ 867.5

Table 9. Mississippi Rest of State Impacts.

Impact Type	Employment	Labor Income ($M)	Total Value Added ($M)	Output ($M)
Direct Effect	2,682	$ 402.6	$ 949.1	$2,634.0
Indirect Effect	2,710	$ 159.4	$ 234.3	$ 567.1
Induced Effect	3,129	$ 109.7	$ 213.9	$ 393.1
Total Effect	8,521	$ 671.7	$1,397.3	$3,594.2

Alabama

Table 10 shows the economic impacts occurring to the Mississippi gulf counties. The combined economic impact totaled nearly $1.8 billion in output and supported over 4,400 jobs. Outside of the study region, there is an additional estimated $1.8 billion in total output with over 220 jobs supported by the GIWW. See Table 11.

Table 10. Alabama Gulf County Impacts.

Impact Type	Employment	Labor Income ($M)	Total Value Added ($M)	Output ($M)
Direct Effect	1,395	$ 145.7	$ 455.6	$ 1,333.9
Indirect Effect	1,584	$ 82.4	$ 137.3	$ 281.5
Induced Effect	1,423	$ 51.8	$ 96.6	$ 170.3
Total Effect	4,402	$ 279.9	$ 689.6	$ 1,785.7

Table 11. Alabama Rest of State Impacts.

Impact Type	Employment	Labor Income ($)	Total Value Added ($)	Output ($)
Direct Effect	71	$ 145.7	$ 455.6	$1,333.9
Indirect Effect	83	$ 82.4	$ 137.3	$ 281.5
Induced Effect	69	$ 51.8	$ 96.6	$ 170.3
Total Effect	223	$ 279.9	$ 689.6	$1,785.7

Florida

Table 12 shows the economic impacts occurring to the Mississippi gulf counties. The combined economic impact totaled an estimated $5.8 million in output and supported approximately 22 jobs. Outside of the study region, there is an additional estimated $16.5 million in total output with an estimated 67 jobs supported by the GIWW. See Table 13.

Table 12. Florida Gulf County Impacts.

Impact Type	Employment	Labor Income ($M)	Total Value Added ($M)	Output ($M)
Direct Effect	11	$ 0.5	$ 0.7	$ 4.3
Indirect Effect	7	$ 0.3	$ 0.5	$ 1.0
Induced Effect	5	$ 0.2	$ 0.3	$ 0.6
Total Effect	22	$ 0.9	$ 1.5	$ 5.8

Table 13. Florida Rest of State Impacts.

Impact Type	Employment	Labor Income ($)	Total Value Added ($M)	Output ($)
Direct Effect	25	$ 1.2	$ 2.2	$ 10.0
Indirect Effect	24	$ 1.3	$ 2.0	$ 3.9
Induced Effect	18	$ 0.8	$ 1.4	$ 2.5
Total Effect	67	$ 3.3	$ 5.7	$ 16.5

IMPACTS OF GIWW CLOSURE

Following the economic impact analysis, researchers estimated the increase in transportation costs resulting from a hypothetical scenario involving an immediate closure of the GIWW. This estimation assumed a worst-case scenario, where all goods currently transported by barge through the GIWW were forced to shift to rail or truck. This scenario resulted in a 48 percent to 590 percent increase in transportation costs, based on the assumed allocation of goods between truck and rail.

Methodology

The increase in transportation costs of a GIWW closure are based on a modal shift from barge to truck and rail. The shift from relatively less expensive barges to more expensive trucks and freight rail results in a substantial increase in freight transportation costs. This increase was determined by calculating current ton-mile costs,[7] developing a ton-miles traveled model using USACE barge movement data, and applying the ton-mile costs to the total estimated ton-miles. The costs in this analysis are presented in 2016 dollars.

Ton-Mile Costs

The first step of the analysis was to determine the current ton-mile cost for barge, truck, and rail freight transportation. BTS provides historical costs for all three modes; however, it did not have costs available for 2016 *(38)*. Barge costs were available only up to 2004, truck to 2007, and rail to 2015. PPI data from the Federal Reserve were used to inflate these costs to 2016. Barge costs were inflated using the Inland Waterways Towing Transportation Index, *(39)* rail costs were inflated using the Rail Transportation of Freight and Mail Index, *(40)* and truck costs were inflated using the Long Distance Truckload Producer Price Index *(41)*. The estimated ton-mile costs are listed in Table 14.

Table 14. Cost per Ton-Mile ($2016).

Transportation Mode	Estimated Cost per Ton-Mile
Barge	$0.0261
Rail	$0.0385
Truck	$0.1800

GIWW Ton-Miles Traveled Model

The next step of the analysis was the development of a ton-miles traveled model for GIWW traffic. This model estimates the traffic between each port along the GIWW based on freight data from USACE.

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[7] The cost to transport 1 ton of freight 1 mile.

The first step in building the model was to determine the tonnage being shipped and received at each port. This information was obtained using the Corps data set. The data set provides only a total for Texas; therefore, it was necessary to estimate the percentage of the Texas total being shipped from each Texas port. This task was accomplished by using additional Corps data to determine the total amount of domestic cargo being shipped from the 10 largest Texas ports. This information was used to calculate a percentage of the total for each port. Researchers then used this percentage to determine each Texas port's percentage of the Texas GIWW total. For example, the Port of Houston made up 43 percent of the domestic shipments from the top 10 Texas ports; thus, Texas total GIWW shipments were multiplied by 43 percent to determine the portion of Texas GIWW shipments originating in the Port of Houston.

The next step was to estimate the origin and destination of the freight being shipped along the GIWW in order to calculate the estimated miles of travel. Because the Corps barge movement data list only the tonnage shipped and received at each port and not the origin of the receipts or destination of shipments, it was necessary to estimate the origin and destination of shipments using the available data. In order to accomplish this task, it was assumed that if a port made up x percent of the total shipments, it would therefore make up x percent of the receipts at every other GIWW port. For example, the Port of Lake Charles accounted for ~15 percent of total GIWW shipments; therefore, it was assumed that ~15 percent of the receipts at every other port originated in Lake Charles.

The next step was to determine the miles traveled along the GIWW between each GIWW port. These distances were obtained from the Canal Barge Company Inland Waterways Mileages Guide *(42)*. Distances from each GIWW port to every other GIWW port were calculated. This calculation accounted for unique factors at each port because many of the ports themselves are offset some distance from the central GIWW (e.g., the Houston Ship Channel).

The final step of the ton-miles traveled model was to take these distances and apply them to the estimated tonnage origin and destination data. With each port's received tonnages broken down by the estimated shipment origin, the tonnages were multiplied by the calculated distance to determine ton-miles for each origin/destination pair. These pairs were summed, giving the total estimated ton-miles of travel for the entire GIWW. Finally, the ton-mile costs for each transportation mode were multiplied by the total GIWW ton-miles, giving a total transportation cost for each transportation mode.

This methodology has some limitations in that it assumes that because a port makes up x percent of total shipments, every port receives x percent from that port. In reality, shipments would not be evenly distributed across ports in this manner and likely vary substantially based on industry and distance between ports. Because the data set does not include origin and destination information, researchers estimated origin and destination information based on state- and system-wide data.

Results

The ton-miles traveled model estimated a total of 23.8 billion ton-miles transported along the GIWW annually. The earlier estimated cost per ton-mile was applied to this number to calculate the total estimated transportation cost by mode. The results are displayed in Table 15.

Table 15. Total Estimated Transportation Cost by Mode ($2016).

Transportation Mode	Total Estimated Transportation Cost ($M)
Barge	$622
Rail	$917
Truck	$4,287
50% Truck, 50% Rail	$2,602

The $622 million barge transportation cost represents the estimated transportation cost in the existing scenario, where goods are moved by barge along the GIWW. The rail and truck scenarios show the estimated transportation cost if 100 percent of the existing traffic were shifted from barge to rail and truck, respectively. The fourth scenario, 50 percent truck, 50 percent rail, shows the total transportation cost if half the existing barge traffic shifted to rail, while the remaining half shifted to truck.

The rail and truck scenarios essentially show a best-case and worst-case scenario for transportation costs, were the GIWW to experience a full closure. This methodology estimates a $295 million to $3.665 billion increase in transportation costs were the GIWW to shut down. This represents a 48 percent to 590 percent increase in total transportation costs.

It is also possible that some of the liquid cargo would shift to pipelines; however, this shift would only be possible in the long term since additional pipeline capacity would need to be constructed. It is also likely that it would no longer be economically viable to ship some goods, reducing the total amount of goods shipped.

SUMMARY

This report reviewed existing literature on the economic value of the GIWW, reviewed the importance of the GIWW to the energy industry, examined the overall economic impact of the GIWW to the states it serves, and estimated the increases in transportation costs resulting from an immediate closure in the GIWW. Overall, this report estimates that the GIWW has an economic impact of $61.5 billion annually, supports 143,000 jobs, and saves up to $4.3 billion in transportation cost savings annually.

The review of the GIWW's relationship to the energy sector highlighted the importance of the GIWW to the gulf coast's energy sector. Data shows that 72 percent of all GIWW activity was energy related, with natural gas, crude petroleum, coal, and petroleum products making up the majority of this. Because of the GIWW's proximity to both the Eagle Ford Shale and many coastal petroleum refineries, it is likely that the GIWW will remain crucial to the nation's energy sector.

Next, this report examined the total economic impact of the GIWW across all sectors shipping goods along the waterway, in the states that it serves. Using IMPLAN, this report estimated the economic impact of the GIWW to be $61.5 billion annually. Of this, $31.8 billion was generated in Texas, $23.1 billion in Louisiana, $4.5 billion in Mississippi, $1.9 billion in Alabama, and $0.2 billion in Florida. Furthermore, the GIWW supports 143,000 jobs and generates $14.5 billion in labor income annually, with the majority of this occurring in Texas and Louisiana. This was done through an estimation of the value of industry sales through an analysis of goods moving along the GIWW to, from, and between states along the waterway.

Finally, this report estimated the increase in transportation costs resulting from an immediate closure of the GIWW. The resulting shift from barge to truck and rail was estimated to result in $300 million to $3.7 billion in increased transportation costs annually. Though not quantified, this closure would result in additional congestion costs on road and rail networks as traffic increases. As such, not only does the GIWW offer manufacturers and shippers a more cost efficient mode of transportation, the system as a whole complements the highway system and rail network, requiring less additional investment to add capacity.

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