Cost of Restrictions on Gulf Oyster Harvesting for Control of *Vibrio vulnificus*-Caused Disease

Final Report

Submitted to

David J. Zorn
Center for Food Safety and Applied Nutrition
Food and Drug Administration
Washington, DC 20201

Prepared by

Donald W. Anderson
Richard C. Lindrooth
Brian C. Murray
Jackqueline L. Teague
Center for Economics Research
Research Triangle Institute
Research Triangle Park, NC 27709

RTI Project Number 5159-4

October 1996

RTI Project Number
5159-4

Cost of Restrictions on Gulf Oyster Harvesting for Control of *Vibrio vulnificus*-Caused Disease

Final Report

October 1996

Submitted to

David J. Zorn
Center for Food Safety and Applied Nutrition
Food and Drug Administration
Washington, DC 20201

Prepared by

Donald W. Anderson
Richard C. Lindrooth
Brian C. Murray
Jackqueline L. Teague
Center for Economics Research
Research Triangle Institute
Research Triangle Park, NC 27709

Contents

Tables

Figures

Maps

1 Introduction

Research Triangle Institute (RTI) conducted a study for the Food and Drug Administration (FDA) to estimate the costs of a seasonal harvesting restriction on Gulf of Mexico oysters and a seasonal marketing restriction on the sale of Gulf Oysters for raw consumption. During the course of this study, the 1995 Interstate Shellfish Sanitation Conference (ISSC)[1] adopted a *Vibrio vulnificus* interim control plan for oysters. Therefore, the RTI study includes an estimate of the costs of complying with the ISSC interim control plan.

Since 1979, the bacterial species *Vibrio vulnificus* has been known to cause oyster-related illnesses resulting in acute gastroenteritis and fulminating septicemia and death (ISSC, 1995). *Vibrio vulnificus* naturally occurs in estuarine waters and is a normal flora in oysters. The majority of cases of illness and death have involved the consumption of raw Gulf Coast oysters during the warmer months of the year. Epidemiological data identify the population at greatest risk of *Vibrio vulnificus* infection from consuming raw oysters as individuals with preexisting medical conditions such as blood and liver disorders and immune deficiencies.

In 1988, FDA/state, and local training workshops for the Gulf Coast oyster industry stressed good handling practices and temperature controls following harvest. Also, states issued consumer advisories and medical alerts that received extensive media coverage, and they formed an illness-reporting network among the five Gulf Coast states and the Centers for Disease Control and Prevention (CDC).

[1]Representatives from federal and state regulatory agencies, the shellfish industry, and academia comprise the ISSC, which has reviewed modifications to the National Shellfish Sanitation Program (NSSP) manual since 1982.

Continued reports of illness and death associated with *Vibrio vulnificus* infection suggest that other approaches may be needed to address the safety of raw oysters.

On August 25, 1995, the Interstate Shellfish Sanitation Conference (ISSC) adopted a *Vibrio vulnificus* interim control plan for oysters (ISSC, 1995). The interim control plan states that oysters must be under ambient refrigeration at 45 degrees Fahrenheit within a specified time if they are harvested from state waters that were the confirmed source for two or more *Vibrio vulnificus* illnesses. The time to refrigeration requirement varies depending on the average monthly maximum water temperature (AMMWT) for each growing area based on the previous 5-year monthly maximum. The state shellfish control authority (SSCA) is responsible for establishing the action levels for growing areas within affected states. Table 1-1 shows the Conference Agreement interim control plan action levels, water temperature ranges, and time to refrigeration.

Table 1-1. ISSC Interim Control Plan

Action Level	Average Monthly Maximum Water Temperature	Maximum Time to Refrigeration[a]
Level 1	< 65 degrees F[b]	Present Requirements
Level 2	65 – 74 degrees F	14 hours
Level 3	75 – 84 degrees F	12 hours
Level 4	> 84 degrees F	6 hours

[a]Product must be under ambient refrigeration at 45 degrees F within the hours specified above based on the first shellfish harvested. During Action Levels 2, 3, and 4, the product shall be shaded.

[b]Action Level 1 also applies from November through March.

The ISSC expects to have the interim plan in place by January 1, 1996 (FDA, 1995b).

In an options paper to the ISSC, FDA once recommended that the ISSC consider the following remedies based on historical epidemiological data gathered from illness case histories:

- ➤ a ban on oyster harvesting from the Gulf of Mexico from April 1 through October 31,[2]
- ➤ a ban on interstate sale of oysters for raw consumption from April 1 through October 31, and
- ➤ required labels or point-of-sale advisories on oysters warning against consumption of raw Gulf oysters.

Other potential remedies included various time and temperature requirements such as onboard refrigeration, limitations of the time oysters may be out of the water before being refrigerated or brought to dock for refrigeration, and shelf-life limitations. Thus, the potential remedies included options for harvesting restrictions, marketing restrictions, processing requirements, and labeling requirements.

Seasonal harvesting restrictions or other alternative remedies would directly affect the demand for and/or supply of Gulf oysters. Although the alternative remedies would affect mainly Gulf fishermen and Gulf oyster boat owners (frequently the same individuals), they would indirectly affect workers in other occupations and owners of other capital in the Gulf region and elsewhere. Specifically, indirect effects may occur for the suppliers of oysters from other regions, on workers in Gulf plants that process[3] shucked and in-shell oysters, and on the owners of capital.

The remaining chapters of this report provide a detailed examination of potential consequences of alternative remedies. To estimate the economic costs of alternative remedies, we identify the affected regions, commodity forms, and stakeholders by describing the economically significant trade flows in Chapter 2: *Gulf Oyster Industry Profile*. Seasonal harvesting restrictions or other alternative remedies are likely to directly affect the demand for and/or the supply of Gulf oysters, the economic regions in which the oyster industry is located, as well as the people employed in the industry. In Chapter 3, we describe the methods for analyzing the economic, regional, and displacement effects using a market model, the Regional Input-Output Modeling System (RIMS) (U.S. Department of Commerce, 1992), and a labor displacement model. We present

[2]For convenience, April 1 through October 31 will be referred to as "summer" and November 1 through March 31 as "winter" throughout this report.

[3]"Processing" in this report refers to the activities involved in bringing oysters from "the dock" to "the consumer." For in-shell oysters, processing may involve little more than cleaning, grading, counting (or weighing), and packaging raw oysters (Standard Industrial Classification 2092 and 5146).

the resulting economic, regional, and labor displacement estimates in Chapter 4. Those estimates include changes in relevant prices, quantities, and employment by region, along with sensitivity analyses.

2 Gulf Oyster Industry Profile

To adequately characterize the Gulf oyster industry, RTI staff reviewed published literature and conducted interviews. Our literature review included work by Berrigan et al., 1991; Robinson, Campbell, and Butler, 1994; Lipton and Kirkley, 1994; Dunning and Adams, 1995; Keithly and Roberts, 1988; and Prochaska and Keithly, 1986. Our interviews included telephone and personal on-site interviews in the Gulf region and telephone interviews in the northeast and Pacific regions (see Appendix A for Site Visit Reports). The selection of interviewees intentionally included a mix of industry representatives from trade groups as well as individual harvesters, leaseholders, and processors in Gulf states. We contacted several large, medium, and small firms as well as self-employed individual harvesters in each Gulf region. We interviewed a variety of federal and state regulators responsible for oyster leasing, licensing, and environmental oversight. In addition, we contacted selected trade groups, state authorities, and industry representatives in the Pacific and northeastern regions.

Estimating the economic costs of control options requires that we identify the affected regions, commodity forms, and stakeholders.[1] In this chapter, we identify the potentially affected stakeholders of the U.S. oyster industry and industries linked with it.[2] This characterization essentially describes the stakeholders and the

[1] In this discussion, "stakeholders" refers generically to workers or owners of capital (e.g., boats, plants) who might be directly or indirectly affected—positively or negatively—by one or more of the regulatory options under consideration.

[2] Industries linked backward (e.g., harvesting equipment suppliers) or forward (e.g., oyster processing facilities) to the oyster fishing industry might be significantly affected by the regulatory options.

economically significant trade flows among stakeholders in oyster processing from harvesting to final consumption.

2.1 OYSTER HARVESTING REGIONS

To characterize the stakeholders, we first identify the major oyster harvesting regions of the U.S. and their proportional contributions to oyster landings (i.e., oyster harvests). Control options under consideration will directly affect the Gulf oyster industry and may indirectly affect other regional oyster industries that are not restricted by the options. Our characterization of the industry focuses on the Gulf oyster industry in greater detail.

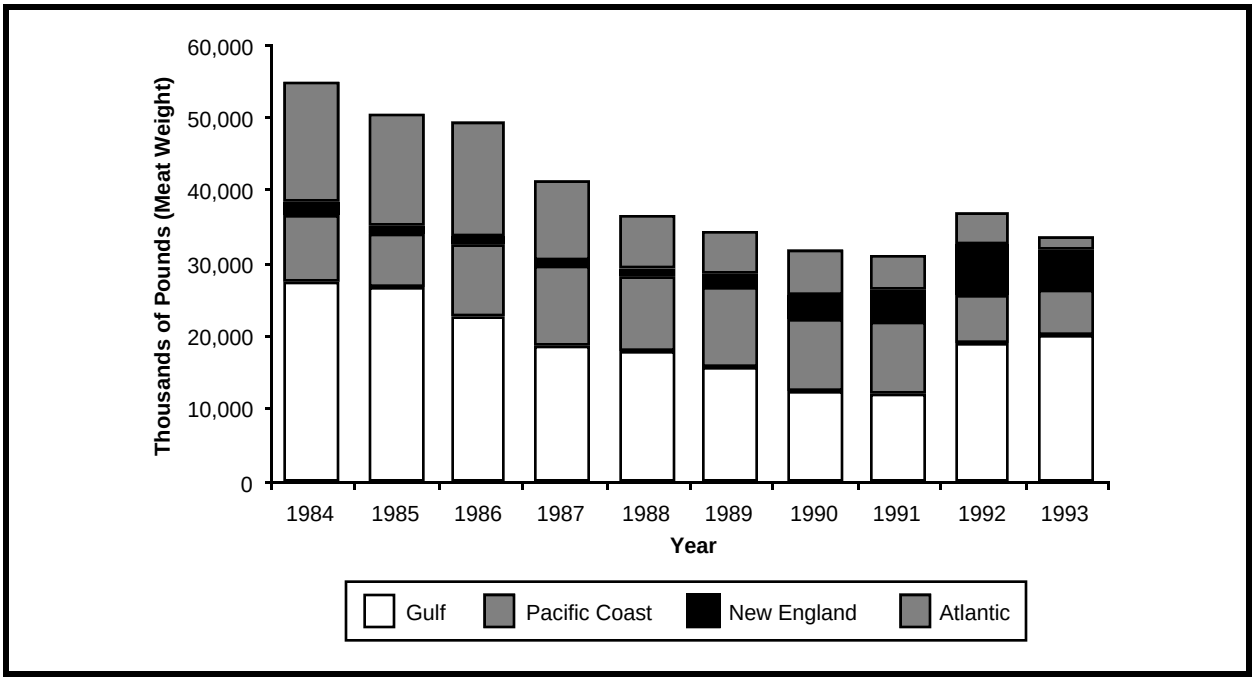
2.1.1 Trends in Nationwide Harvests

As shown in Figure 2-1, nationwide oyster harvests have generally declined since 1984.[3] This decline is explained primarily by the reduction in Chesapeake Bay harvests (part of the Atlantic harvest) (Lipton and Kirkley, 1994). In 1991, the New England harvest was its highest since 1953 as a result of the Connecticut aquaculture development (Lipton and Kirkley, 1994). Since 1990, the Gulf, Pacific, and New England coasts have dominated the regional shares of total landings (see Figure 2-2). Today, the Gulf provides the largest proportion (approximately 50 to 60 percent) of oysters harvested in the U.S. The two other regions that supply substantial harvests, the Pacific Coast (i.e., Washington, Oregon, and California) and New England (i.e., Connecticut, Rhode Island, Massachusetts, and Maine) supply about 25 percent and 15 percent, respectively. As shown in Figure 2-2, the Atlantic region (i.e., Maryland, Virginia, New York, New Jersey, Pennsylvania, Delaware, North Carolina, South Carolina, Georgia, and Florida east coast) has declined from supplying 30 percent of U.S. oyster harvests in 1984 to less than 10 percent in 1993.

U.S. oyster landings are reported as meat weight equivalents by converting the amount of shellstock (i.e., live, in-shell oysters) from the bushel or sack to its approximate meat weight yield. Meat yield

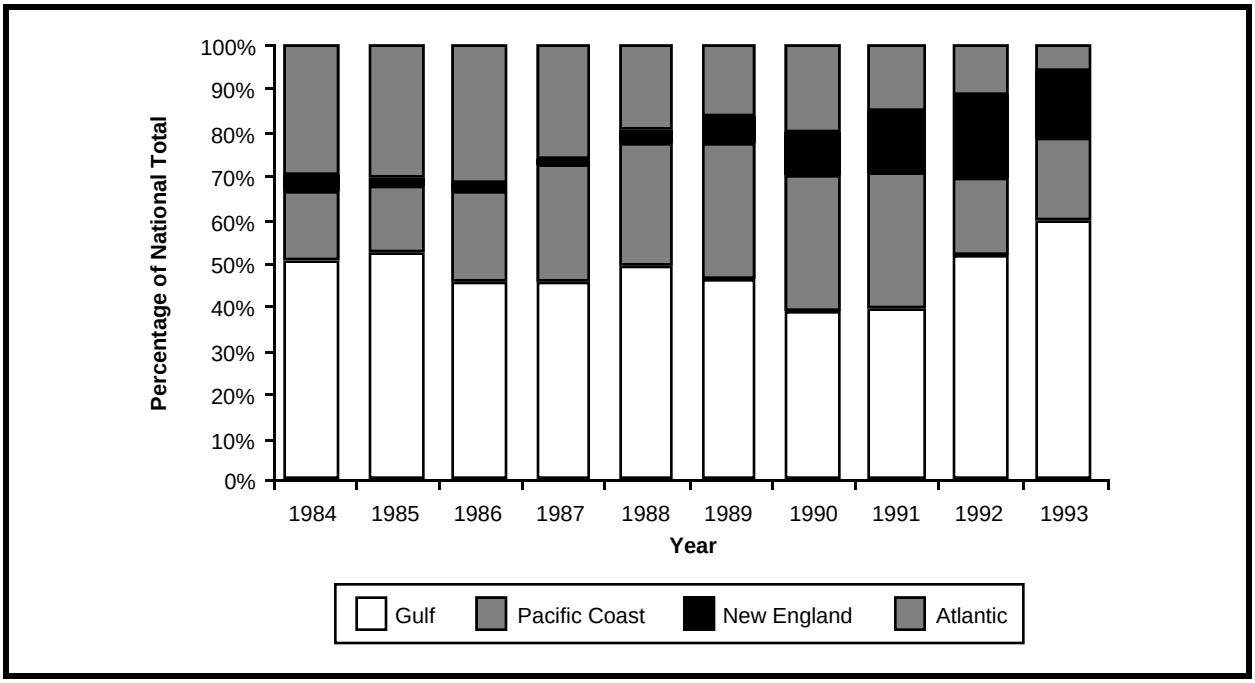
[3]National Marine Fisheries Service (NMFS) provided much of the data necessary for this study. We gratefully acknowledge Dave Sutherland who provided programming support and data analysis using several definitions of regions such as county level and Bureau of Economic Analysis (BEA) regions. Sutherland carefully protected confidentiality while supplying the necessary aggregated data.

Figure 2-1. Nationwide Oyster Harvests, 1984 – 1993
Nationwide oyster landings have declined since 1984.



Source: Unpublished National Marine Fisheries Services (NMFS) data.

Figure 2-2. Percentage Share of Nationwide Oyster Harvests
The Gulf provides the largest proportion of oysters harvested in the U.S.



Source: Unpublished NMFS data.

conversions vary by place and month. Northeast, Atlantic, and Gulf oysters for commercial markets are of the species *Crassostrea virginica,* commonly called eastern oysters. Eastern oysters from northeastern waters generally yield higher meat weight than those from the Gulf. Among Gulf oysters, Florida oysters have the lowest meat yields, and Louisiana and Texas oyster meat yields are between Florida's and the Northeast's. Pacific oysters are *Gigas* oysters that are larger than eastern oysters, have a dark frill, and are native to Asian coastal regions. Gulf meat yields in the summer range between 4 and 6 pounds per sack of shellstock. Oyster meat yields depend mainly on their reproductive cycle and the water temperature; oysters are lower weight in warmer waters and higher weight in colder waters. Northeastern oysters yield 7.7 to 8 pounds of oyster meats per sack (80 pounds of shellstock).

2.1.2 Definition of Gulf Regions

Any control option that directly affects harvesters, processors, or other Gulf oyster industry stakeholders may also have indirect effects on other sectors of the region's economy. These indirect effects occur because direct output and income losses experienced by harvesters and/or processors influence these businesses and their employees to purchase fewer production inputs and consumer goods and services. These reductions, in turn, further "ripple" through the region's economy with a final total regional effect that can be substantially greater than the original direct effect.

One of the most important steps in conducting a meaningful regional economic analysis is determining appropriate "regions" for the analysis (U.S. Department of Commerce, 1992; Coughlin and Mandelbaum, 1991; and Hamilton et al., 1994). If the selected region is too small, the detrimental *absolute* economic impacts (e.g., number of jobs lost) of the control options will be underestimated. If the selected region is too large, the *relative* economic impacts of the control options (e.g., the percentage increase in the region's unemployed labor force) will be underestimated.

While the region of analysis should certainly include the locality(ies) where the direct impact occurs, it should also include surrounding counties where the indirect impacts will largely occur. Both the U.S. Department of Commerce (1992) and Hamilton et al. (1994) recommend using Bureau of Economic Analysis (BEA)-defined

regions for regional I-O impact modeling. BEA regions generally include the place of work and the residence of the corresponding labor forces. Regions comprising one or more BEA regions can thus capture the induced effect of lost spending by households.

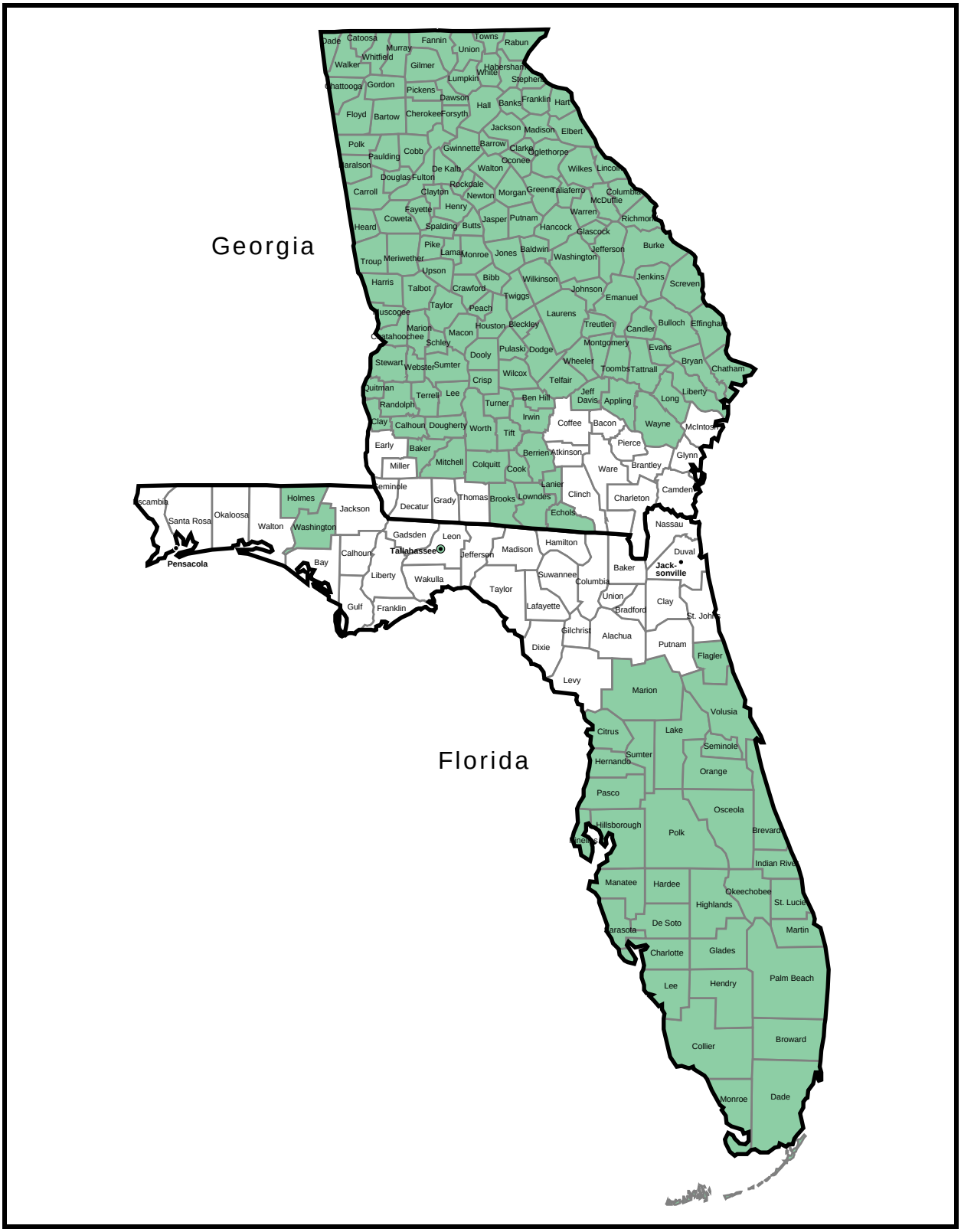
RTI used federal and state data to identify counties in Texas, Louisiana, Alabama, Mississippi, and Florida in which most oysters are landed. We then identified 12 corresponding BEA economic regions that include these counties. These 12 regions were then re-aggregated into four RTI-defined "oyster regions"—Florida (Region 1), Alabama/Mississippi (Region 2), Louisiana (Region 3), and Texas (Region 4). Shown in Maps 1 through 4, these regions comprise counties where oysters are harvested and processed, as well as surrounding counties that are economically tied to the oyster industry.

2.1.3 Average Gulf Harvests

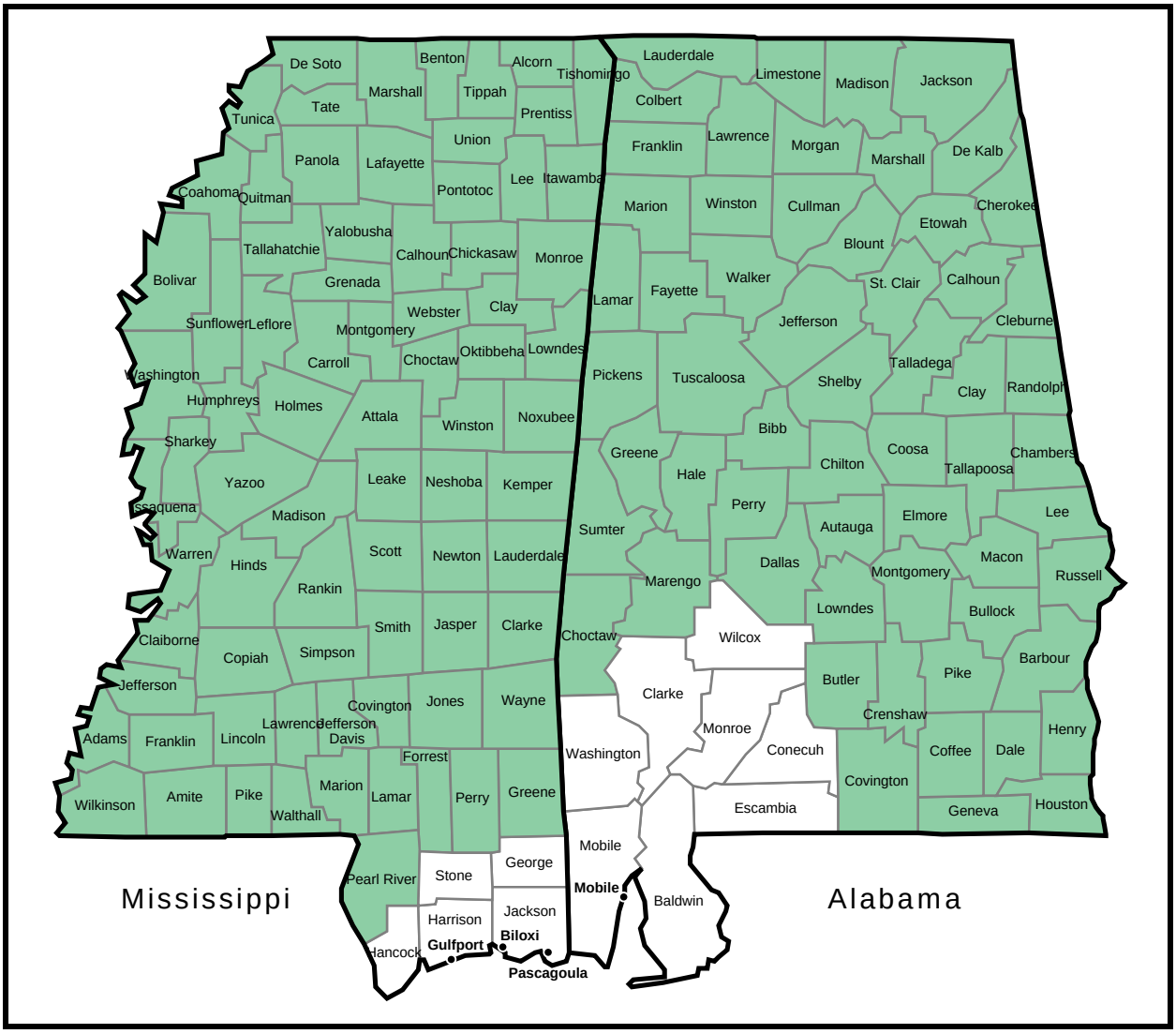
The data on oyster landings from 1989 to 1993 indicate significant harvests in the five Gulf states: Florida Gulf Coast, Mississippi, Alabama, Louisiana, and Texas. Table 2-1 shows the average landings in those years by season for each region of the Gulf Coast. Averaging across the 5 years, 50 percent of Florida Gulf Coast oysters, 30 percent of Alabama, 17 percent of Mississippi oysters, 58 percent of Louisiana oysters, and 36 percent of Texas oysters are harvested in the summer months. The average seasonal prices reported in Table 2-1 were calculated from the total value and quantity data. The 5-year average presents a stable baseline estimate of the Gulf oyster industry but does not account for unpredictable, short-term fluctuations.

Table 2-1 indicates some state-level price differences that require further explanation. Economic theory suggests that geographic differences in the price of a commodity should be explained by differences in transportation costs, other transaction costs, or differences in product characteristics. The data indicate some price variability at the state level. Louisiana and Florida prices are roughly equal year-round, and Texas prices are roughly equal to Louisiana and Florida prices in the winter but sizably lower in the summer (summer price shown in Table 2-1 is adjusted). Alabama

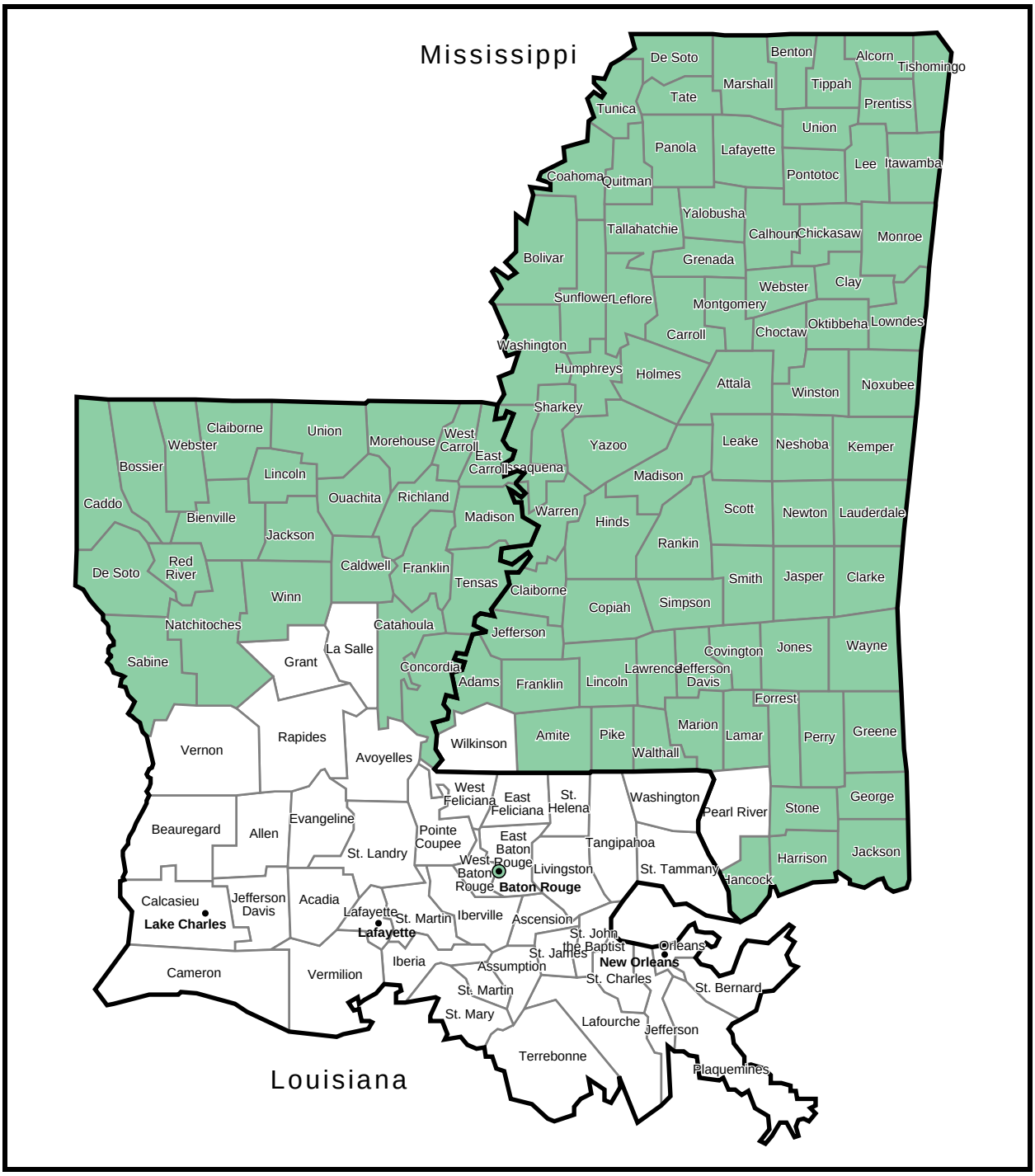
Map 1. Oyster Region 1—Unshaded (BEA Areas 29, 35, 81)
The primary Florida oyster counties, Franklin and Levy, are economically tied to counties in both Florida and Georgia.



Map 2. Oyster Region 2—Unshaded (BEA Areas 80, 82)
The economies of the Gulf Coast counties in Alabama and Mississippi closely affect eight inland counties.



Map 3. Oyster Region 3—Unshaded (BEA Areas 83 – 86)
Most counties in Louisiana are economically connected to oyster harvesting counties.



Map 4. Oyster Region 4—Unshaded (BEA Areas 87, 131, 132)
Texas oyster counties are economically tied to most of southeastern Texas.

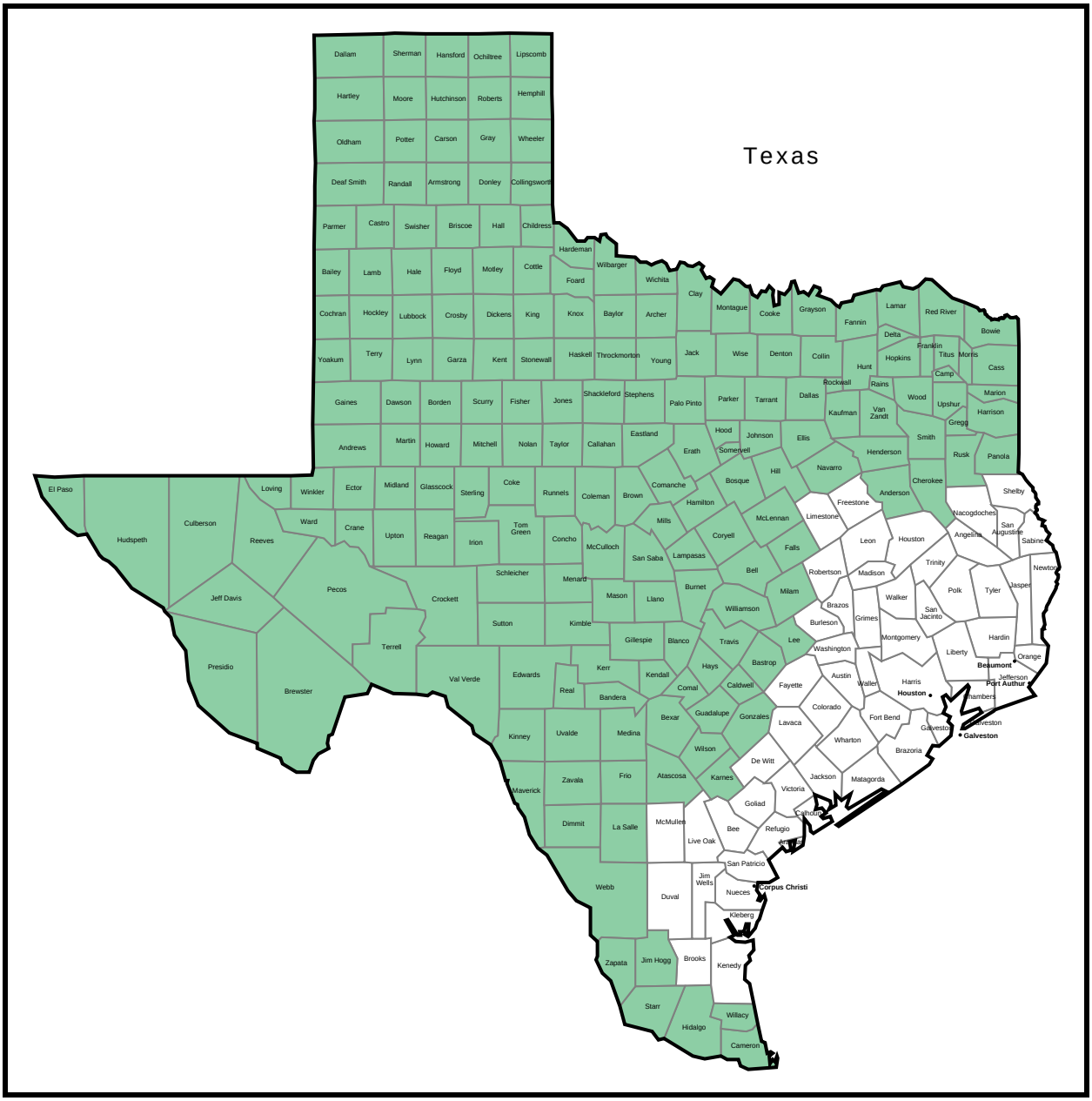


Table 2-1. Average 1989 – 1993 Oyster Landings (Quantity, Prices, and Value) for Gulf States, by Season
Louisiana and Florida harvest more oysters during the summer (April through October).

	Winter (November – March)			Summer (April – October)		
State/Region	**Quantity[a]**	**Price[b]**	**Value**	**Quantity[a]**	**Price[b]**	**Value**
Florida/1 (Gulf)	1,165,390	$2.50	$2,910,315	**1,143,490**	$2.62	$3,000,656
Alabama/2	247,859	$1.37	$340,031	**239,199**	$1.40	$335,948
Mississippi/2	258,569	$1.33	$343,979	**92,552**	$1.14	$105,565
Louisiana/3	3,852,322	$2.34	$8,998,223	**5,397,886**	$2.40	$12,961,185
Texas/4	1,280,672	$2.36	$3,024,504	**746,870**	$2.64	$1,970,139
Gulf Total	6,804,812	$2.30	$15,617,053	**7,619,995**	$2.41	$18,373,494

[a]Quantity is provided in pounds of meat weight.
[b]Average price per pound equals value divided by quantity.

Source: Quantity and values from unpublished NMFS data.

and Mississippi prices are lower than the other Gulf states year-round. Transportation costs are relatively low among the Gulf states and therefore should not be the source of large interstate price differences within the Gulf. Also, by most accounts, differences in the physical characteristics of oysters harvested from waters off the various Gulf states are relatively minor; thus we would not expect to see large quality premiums for oysters from different states in the region. Therefore, price differences must result from either transaction cost factors or errors in the published data.

To investigate the divergence of prices in the summer, we queried officials at NMFS who informed us that NMFS collects the price and meat yield data in Alabama but not in Texas. Texas independently provides NMFS with price and meat yield values. According to a Texas Parks and Wildlife official,[4] Texas uses a constant conversion factor of 17.5 pounds of meat weight per barrel in the summer and in the winter. This annual average overstates the summer meat yield. Because the price (not shown in Table 2-1) was simply the Texas value of shipments divided by the estimated meat weight, this overestimate of meat weight led to an underestimate of the summer price. After adjusting the meat yield to a more realistic summer level of 15 pounds per barrel, the adjusted Texas price is $2.64 per pound of meat yield, which is closer to Louisiana ($2.40) and Florida prices ($2.62).

[4]Personal communication, Lynn Benefield, Texas Parks and Wildlife officer overseeing Galveston Bay area.

The price difference between Alabama and Mississippi is more difficult to explain. According to the NMFS port agent in Bayou le Batre[5], there are no data anomalies present in the Alabama/Mississippi data since prices and meat yields are updated monthly or more frequently if necessary. Discussions with stakeholders in these states reveal several possible explanations for the price gap. One stakeholder said that it may not be economical for shippers to haul oysters out of Alabama to other states because there are so few harvesters, thus isolating the Alabama/Mississippi market from the other states. However, the fact that oysters are shipped in from other states to be processed in Alabama and Mississippi suggests that this market is not isolated from the rest of the Gulf. Under competitive market conditions, Alabama and Mississippi processors would pay the same net delivered price for oysters from their own state that they pay to ship in oysters from other states. One possibility, then, is that Alabama/Mississippi processors possess buyer power in their local oyster markets that allows them to depress local prices below the Gulf price. Given the relatively large number of processors in Alabama and Mississippi, the market power explanation seems unlikely; however, we did not perform any empirical test of the market power hypothesis.

Another possible explanation for the lower prices in Alabama and Mississippi is that many harvesters also work as oyster shuckers, according to respondents in Alabama. These individuals harvest the oysters in the morning and shuck them in the afternoon at the processors' plant. They receive payment for the finished product, and thus the "observed" shellstock price for Alabama/Mississippi oysters may not be based on actual transaction values, in contrast to the other Gulf states.

Whatever the cause, the Alabama/Mississippi price divergence seems to be a relatively recent phenomenon. Analysis of historical price series from the region indicate that Alabama and Mississippi prices were similar to the other Gulf prices through the mid-1980s, but have moved somewhat independently since the late 1980s.

[5]Personal communication, Ted Flowers, NMFS port agent located in Bayou le Batre, Alabama.

The 1989 to 1993 oyster landings summer averages reported in Table 2-1 under summer quantity are also shown in Table 2-2 as the average for each state (see highlighted values). Table 2-2 shows that summer oyster harvests for each state fluctuated considerably between 1989 and 1993. For example, Florida summer harvests increased from less than 1 million pounds in 1989 to more than 1.3 million pounds in 1993. Summer harvests in Texas nearly doubled from 1989 to 1991 then remained high from 1991 to 1993. Louisiana's 1993 harvests were less than the 1989 peak but were nearly 50 percent higher than 1991 harvests. Still, Louisiana's 1993 harvests were about 1.2 million pounds less than they were in the summers of the early 1980s. Alabama and Mississippi showed dramatic fluctuations. In some years, natural disasters reduced landings to zero (Berrigan et al., 1991). The combined harvests have varied from 716 pounds in 1989 to 635,288 pounds in 1993. In the early 1980s, Mississippi and Alabama's combined summer harvests were significantly higher at just below 3 million pounds.

Table 2-2. 1989 – 1993 Summer Oyster Landings for Gulf States (pounds)
Summer harvests vary widely depending on weather, demand, and state restrictions.

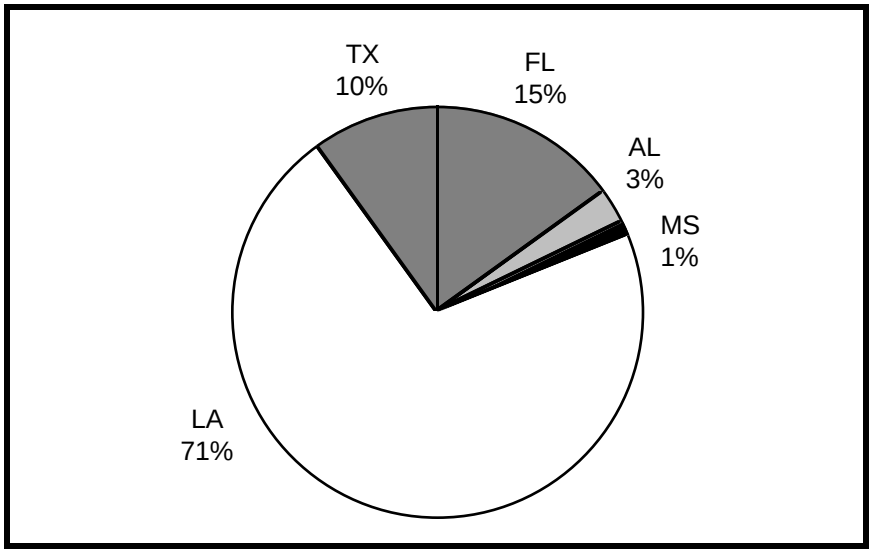
Year	Florida	Alabama	Mississippi	Louisiana	Texas	Gulf Total
1989	828,176	716	0	6,663,703	451,464	7,944,059
1990	1,185,076	2,537	0	4,513,626	512,296	6,213,535
1991	950,718	59,290	24,486	4,391,966	888,577	6,315,037
1992	1,417,342	653,018	281,584	5,471,245	861,148	6,684,337
1993	1,336,136	480,433	156,688	5,948,888	1,020,862	8,943,007
Average	**1,143,490**	**239,199**	**92,552**	**5,397,886**	**746,870**	**7,619,995**

Source: Unpublished NMFS data.

In addition to changes in regulation (i.e., local closures), weather and consumer demand shocks have influenced the quantities supplied. Hurricanes and floods have reduced oyster harvests in some years. Part of the decline in the late 1980s has been attributed by some persons we interviewed to major restaurant chains removing raw oysters from their menus.

In the Gulf, Florida and Louisiana harvest more oysters during the summer than in the winter. Averaging across 1989 to 1993, Louisiana is the primary supplier of Gulf oysters during the summer (see Figure 2-3). The remaining 29 percent of summer Gulf harvests comes from Florida (15 percent), Texas (10 percent), or Alabama and Mississippi (4 percent).

Figure 2-3. Composition of Summer (April 1 through October 31) Gulf Harvests
Louisiana harvests more oysters than the other Gulf states combined.



Note: Percentages are average shares of meat weight from 1989 to 1993.

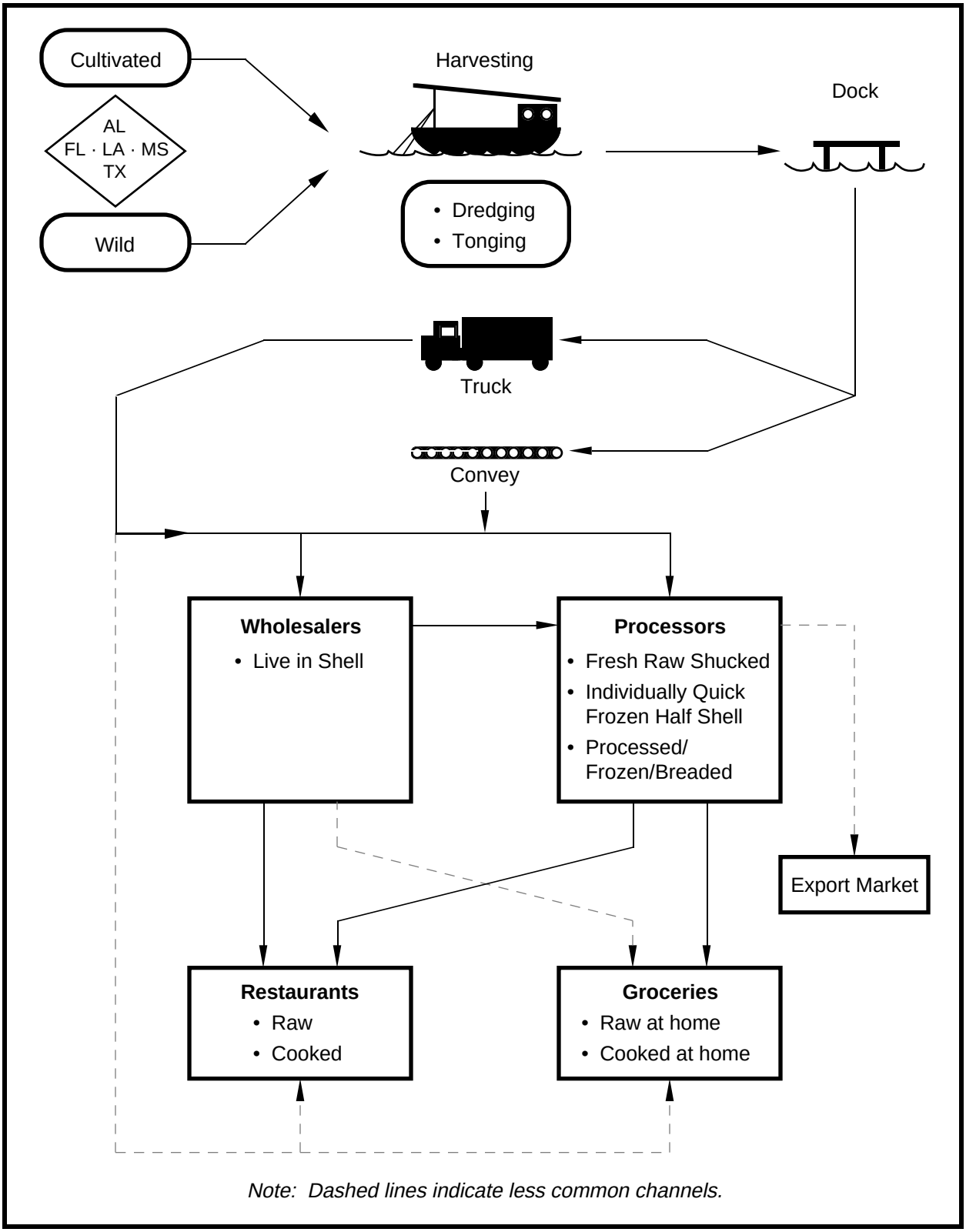
Source: Unpublished NMFS data; authors' calculations.

The stakeholders in the oyster industry vary not only by location, but also by type of job in the industry (e.g., harvester, processor) and the type of capital (e.g., leases, boats, processing plants) they own, as well as by geographic region. Next, we identify stakeholders by examining the movement of oysters from harvest to consumption.

2.2 PROCESSING FROM HARVEST TO CONSUMPTION

Figure 2-4 is a simple schematic showing the movement of Gulf oysters through harvesting, processing and distribution, and consumption.

Figure 2-4. Gulf States Oyster Harvesting and Processing
From water to table, oysters move through a variety of channels.



2.2.1 Harvesting

Harvesters gather Gulf oysters from leased and public waters. Within their jurisdiction, state authorities issue leases for oyster harvesting in certain portions of the waters. Leaseholders may cultivate, mariculture, or aquaculture the leased bottom depending on the intensity of their tending activities (such as raking and transplanting) and the regulatory requirements for issuing leases in the state. Wild harvests refer to oyster harvests from public waters although some harvesters form cooperatives to conduct relaying—where shellstock is moved from one bed to another to cleanse the oysters of impurities from the first bed—of oysters (primarily a lease-holder activity) in some public waters. Leaseholders have exclusive rights over oysters on their leases and may exercise their property rights by contracting with others to cultivate or harvest their leased bottoms and by bringing legal challenges against unauthorized harvesters.

In the Gulf, oysters are harvested year-round in some wild areas such as those off Alabama and Florida; and from private leases in Galveston Bay, Texas; and along the coast of Louisiana. In Texas, public waters are closed from May 1 to November 1. In Louisiana, public waters are closed from April until September. However, harvesting is permitted on private leases all year in Texas and Louisiana.

Mississippi also closes waters seasonally. Every state conducts sanitary surveys and other inspections to assess the safety of waters. They conduct additional evaluations and periodically close conditionally approved waters throughout the year when water quality deteriorates, especially following heavy rainfall. During certain times of the year when closures are common, oysterers have to check daily to see whether harvesting is permitted.

Commercial Gulf oysterers harvest the oysters using dredges or tongs. Few oysterers gather oysters by hand in shallow waters (known as “cooning”) except for recreational purposes. Dredges, which usually have motorized mechanical shovels, are most often used for commercial Gulf oyster harvesting. Dredge boat captains or boat owners often hire a crew of two to four people. Tongers are individual harvesters who lift the oysters manually into a small boat and occasionally are assisted by another person onboard to cull the

catch. Oyster fishing is often a family business with husband and wife tonging or brothers dredging.

During the summer, the time spent on the water varies by geographic area and by harvesting method. For example, in Apalachicola Bay, Florida, the high temperatures and intense physical exertion mean that tongers seldom spend more than 8 hours daily on the water. Alabama tongers have been restricted to a 6-hour harvesting day for the past 3 years. In Galveston Bay, Texas, where the summer leases are located, access to the oyster beds is unobstructed; however, a dredger may spend 3 to 4 hours looking for oysters. For Texas dredgers, 10 to 12 hours is a typical oyster fishing day on the bay. In Louisiana, the rivers and bayous present multiple obstructions to the oyster fishermen. Louisiana processors report harvesters' time on the water ranges from 12 to 20 hours. Some Louisiana harvesting areas are so remote that large dredge boats travel overnight. Few of these boats have refrigeration on board. However, other areas are 4 hours out of port requiring about 8 hours for the travel time round trip. The more remote Louisiana locations are inaccessible and are often closed due to pollution and bad weather during the shorter days in winter (they may experience up to 75 percent closures).

Some harvesters deliver landed product directly to restaurants or markets. Usually though, harvesters bring their oysters to wholesalers or processors.

2.2.2 Processing and Distribution

As shown in Figure 2-4, wholesalers purchase shellstock (live, in-shell oysters) from harvesters or other wholesalers to repack in sacks, boxes, and bushels. Commonly, wholesalers and processors who receive oysters from harvesters are located at waters edge with a loading dock to convey the oysters from the boat into the wholesaler's or processor's facility or refrigerated trucks. Dealers must receive NSSP certification to receive or ship any shellfish products in interstate commerce. Wholesalers ship shellstock to restaurants, groceries, or oyster processors. Processors purchase shellstock from harvesters and wholesalers and shucked oysters from other processors. Processors repack, shuck, can, freeze, smoke, stew, or bread oysters. However, very few processors in the Gulf region today smoke, can, stew, or bread oysters. Some Gulf

processors today quick-freeze oysters in the half shell for later consumption as raw or baked half-shell oysters in restaurants, oyster bars, and other retail establishments.

Wholesalers and processors ship shellstock, shucked, or other processed product to other manufacturers, retail distributors (such as grocery stores and fish markets), and hotels, restaurants, and institutions. According to industry representatives, Gulf oysters are sold predominantly in the southeast, but some Gulf oysters are shipped nationwide and into Canada.

Many oyster processors in the Gulf region are also leaseholders who hire harvesters to work on their leases. Several industry representatives in Texas, Louisiana, and Florida reported owning oyster leases, oyster dredge boats, oyster processing plants, and semi-tractor-trailer rigs for delivering the oysters out of state. Integrated Gulf oyster processors control substantial assets (e.g., leases, boats, plant, and equipment) and may employ 100 or more people.

Processors report that Gulf oysters compete with oysters from the northeast in the live in-shell market. They report that northeastern oysters are less plentiful in the summer and that the Gulf oyster is more competitively priced. Connecticut oyster regulators report that the state is promoting oystering by laying cultch (i.e., the layers of shell that create a foundation for oyster production) and subsidizing oyster processors' travel to trade shows to promote Connecticut oysters. The Chesapeake was once a major oyster industry competitor but MSX, a disease that kills the oyster but presents no public health threat to humans, has nearly destroyed the once plentiful natural oyster resource.

Gulf oyster processors, in general, do not consider oysters from the Pacific region as competing in the same markets for raw consumption. Pacific oyster trade group representatives report that Pacific oysters are primarily marketed overseas in Asian markets or in U.S. regions with concentrations of Asian immigrants (mainly California) because their product is the same native Asian oyster preferred by those consumers. However, Pacific oyster representatives report that their distribution includes other regions such as Chicago, and Washington, DC, in restaurants that offer the product as an exotic variety or as a safer raw product. Pacific

oysters are shucked and processed in the U.S. and compete nationwide with Gulf oysters as shucked product.

Foreign imports, primarily from Korea, currently dominate canned and smoked oyster markets, whereas almost all U.S. processors have left this market.

2.2.3 Consumption

To gather information regarding regional markets for oysters and specifically in-shell and shucked products, we interviewed oyster processors, industry representatives, and regulators during personal on-site interviews in the Gulf region (See Appendix A for Site Visit Reports). In addition, we interviewed oyster trade representatives and regulators in the northeast and Pacific regions by telephone. National data do not report the quantity of oysters sold to households or to hotels, restaurants, and institutions.

As shown in Figure 2-4, consumers enjoy oysters in their homes and away from home in restaurants and hotels. For in-home consumption, household consumers purchase oysters from grocery stores or fresh seafood markets. Oyster processors report that most oysters sold to grocery stores are shucked and shipped in pint size containers for stewing or frying. Although restaurants and hotels also purchase shucked product, oyster wholesalers and processors report shipping significant amounts of oysters in shell to restaurants and hotels. Consumers order these oysters in restaurants and hotels either as raw half-shell oysters or as prepared half-shell oysters such as steamed oysters or Oysters Rockefeller. In general, oysters consumed raw are eaten in restaurants. Oysters consumed at home are usually cooked.

Industry representatives reported that consumers prefer raw oysters in “cup”-shaped shells because they are more attractive. Oysters from Apalachicola and Galveston Bays are often cup-shaped and well suited for the half-shell market; however, they tend to be too small for efficient shucking. Louisiana oysters are often larger, and processors in other states report buying Louisiana oysters for shucking during the summer months. Alabama and Mississippi oyster plants deal primarily in the shucked meats trade. Table 2-3

Table 2-3. Summer Oysters Bound for Raw Consumption
Consumers prefer raw oysters in cup-shaped shells.

State/Region	Percentage Bound for Raw Consumption in Summer	
	Harvest	Plant Output
Florida	90	60
Alabama	10	3
Louisiana	50	75
Texas	65	60

Source: Oyster Industry Interviews.

shows the proportion of the harvest and of oyster plants' output that is bound for the half-shell trade according to industry respondents.

Although oyster bars and seafood restaurants serving oysters are everywhere, they are concentrated in coastal regions near oyster landings according to processors and industry trade representatives. Gulf oysters are primarily distributed in the southeast, some along the eastern seaboard, and some in the midwest and western states. Individual processors report shipping 70 to 100 percent of their oyster products within the southeast. According to processors and industry trade representatives, approximately half of the annual Gulf oyster harvest is destined for the half-shell market.

Gulf oysters are consumed year round with demand peaks during the winter holiday season and during the summer vacation and travel season. Oyster industry representatives report a high consumer demand for *shucked* oyster meats during the winter holiday season in November and December. During the summer travel and vacation season, consumer demand is high for in-shell oysters suitable for raw or cooked half-shell consumption.

In summary, stakeholders in oyster processing include harvesters (i.e., leaseholders, boat owners, captains, and crew members); wholesalers, processors, and distributors (i.e., employees and owners); retailers, groceries, and restaurants (i.e., employees and owners); and consumers.

2.3 PRODUCTION OF OYSTERS—CAPITAL AND LABOR

As we have seen, each region includes several types of stakeholders who require numerous inputs for the production of Gulf oysters. For example, harvesting oysters requires both the labor of harvesters and the necessary equipment and materials (i.e., boats with dredges or tongs). Processing oysters requires the labor of production employees as well as plant, equipment, materials, and supplies.

Describing the various stakeholders in the oyster industry as well as their alternative opportunities improves our ability to estimate the potential impacts of control options for the Gulf oyster industry.

2.3.1 Harvesters and Boats

As discussed previously, oysterers primarily use two harvesting methods: tonging and dredging. Commercial harvesters usually use tongs only if required, since dredging operations are more productive. Florida prohibits dredging, and Louisiana prohibits dredging in Lake Calcasieu. Alabama requires the use of tongs on all public reefs and waterbottoms (Berrigan et al., 1991). Most Louisiana, Mississippi, and Texas harvesters use dredges to harvest oysters.

RTI staff met with several tongers in Franklin County, Florida, where 85 to 90 percent of the state's oyster industry is located. The typical harvester is male, white, 35 to 40 years old, has a tenth-grade education, and 20 years of experience oystering. According to some interviewees, the high school dropout rate is high in Franklin County, partly because oyster harvesting and processing have traditionally presented a relatively high earning potential to pregraduation teenagers. Tonging requires upper body strength to manually pull the oysters from the water bottoms into the boat using the tongs. It also requires knowledge of the oyster beds and endurance. Generally, tongers are self-employed and own their equipment.

Gross annual income for an Apalachicola Bay tonger ranges from $25,000 to $35,000; expenses range from $4,000 to $10,000. Almost all tongers (98 percent) own their own boats; very few rent them. Basic harvesting activities include transporting the boat to a put-in location, traveling by boat to the oyster bed, working the bed

with tongs to extract the oysters, culling the oysters according to regulatory limits and product quality constraints, traveling back to the put-in location, and hauling the shellstock in the harvester's truck to a certified dealer.

Florida tongers typically deal with one or two processors and negotiate a prearranged price per 60-pound bag (bushel) for shellstock harvested from certain beds. Shellstock bound for the half-shell market typically is more profitable for processors, and they may pay more for a bag that contains more half-shell ("cup") oysters, which have been harvested from a particular bed. However, the harvester will not receive a different price for each bag based on the half-shell content. If the harvester delivers substandard shellstock, his relationship with the processor is jeopardized.

In Texas, we met with several small and large leaseholders who also own dredge boats. They hire deck hands and sometimes captains to harvest from their leases. They report that dredge boat crew members are somewhat similar to the Florida tongers: manual laborers who are typically males between the ages of 20 and 50 who have been oystering their entire adult life and do not have a high school diploma. Unlike tonging, dredging uses mechanical shovels to pull the oysters into the boat. The crew manipulates the dredges, sacks the oysters, and relies on the captain's knowledge and skill for making the catch.

Gross income for a Galveston Bay oysterer ranges from $30,000 to $40,000, and half of that income results from summer harvesting. Basic harvesting activities include traveling by boat to the oyster bed, working the bed with dredges by swinging the boat in a circle to extract the oysters, culling the oysters according to regulatory limits and product quality constraints, sacking the oysters, traveling back to the dock, and unloading the sacks at the dealer's facility.

The typical captain is a white male between the ages of 25 and 35 who has a high school education or GED. Some captains are hired, but others own their own boats. During the summer, leaseholders more often hire captains for their boats although perhaps 80 percent of winter captains own their boats. The harvesting operation typically requires a three- to five-man crew. The typical deck hand

is a white male 20 to 30 years old who has less than a high school education. Experienced deck hands can become boat captains.

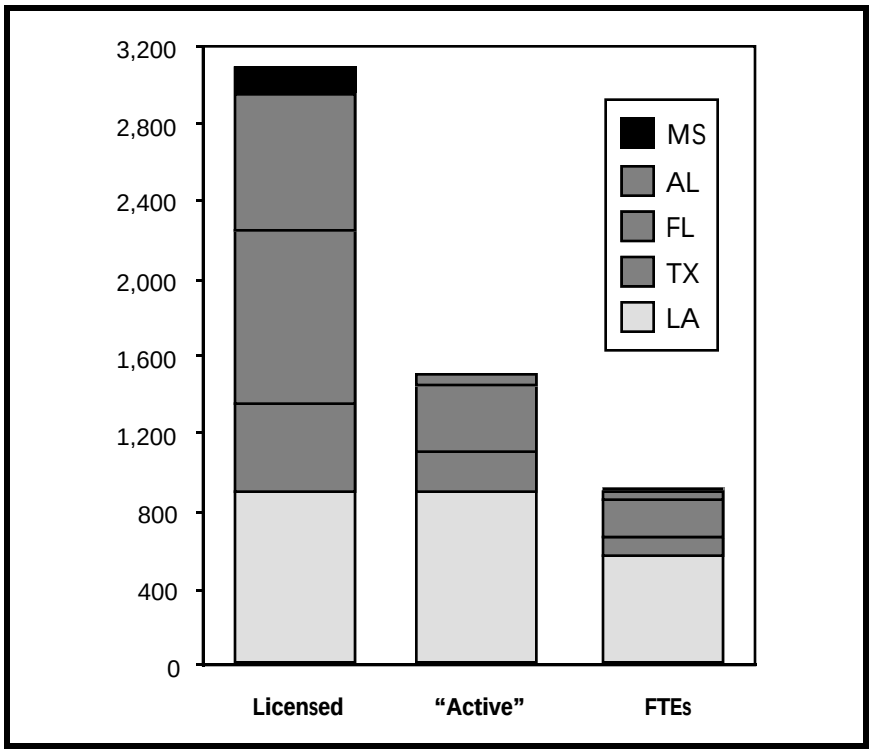
Texas dredgers typically deliver product to one dealer or leaseholder and receive a single price per 90- to 100-pound bag (bushel) for shellstock harvested from leased beds.

In Louisiana, there are about 900 licensed oyster harvesters including resident and nonresident harvesters. The typical dredge boat captain is a male of foreign descent (e.g., Yugoslavian, Hispanic) who is 35 to 40 years old; some have a high-school education or GED. Most captains in Louisiana own their boats. Typically, harvesting requires a three- to four-man crew, but smaller single-dredge boats may have only two men. Deckhands are paid to handle oysters on a per-sack basis unless they are transplanting or cultivating a lease, whereupon they are paid by the day. A day's wage is around $105 or $1.25 or $1.50 per sack harvested; typically a deckhand earns $125 to $150 harvesting 100 sacks in a day.

Traditionally, about one-half of oyster harvesters also generate income from fishing for nonoyster species such as mullet, shrimp, and crab. However, about 90 percent of harvesting income is typically from oystering. Other income-generating activities for harvesters include relaying. Payment for relaying in Apalachicola Bay is drawn from a fund comprising state trust fund moneys and local license fees. Leaseholders in Texas and Louisiana pay captains and deck hands to relay and transplant. For the leaseholder/boat owner in Texas, operating a boat costs about $500 a day: $150 a day for the captain and about $100 a day for each of the three or four deck hands. The harvesters we interviewed in Florida and Texas indicated that they typically generate little nonfishing income.

For comparison purposes, Figure 2-5 reports three estimates of the number of Gulf oyster harvesters: licensed harvesters, active harvesters, and full-time equivalent (FTE) harvesters. We collected estimates of the number of people who derive all or part of their income from oyster harvesting and have acquired licenses to harvest oysters. The estimate of all workers is from industry and government interviews and licensing reports. Approximately 3,000 people in the Gulf may be part- or full-time oyster harvesters, as shown by the first bar in Figure 2-5. The number of harvesters

Figure 2-5. Estimates of Oyster Harvesters Comparing Licenses with Reports of Active Harvesters
Licensing records show that most oyster harvesters work part-time.



represented as "Active" are those who rely on oysters for their year-round income, according to industry and regulator estimates. Some fisherman rely on shrimping during the summer; however, some continue to oyster for their primary livelihood. The third bar in Figure 2-5 shows the number of FTE harvesters reported in detail in Table 2-4.

Table 2-4. Number of FTE Oyster Harvesters in the Gulf States
Average oyster landings require fewer FTE harvesters than the number of oystermen in each state.

State/Region	Winter	Summer
Florida	212	208
Alabama	42	41
Mississippi	38	14
Louisiana	408	572
Texas	137	80
Gulf Total[a]	836	914

[a]Numbers may not sum to total due to rounding.

Source: FTE worker estimates are based on 1989 to 1993 average NMFS landings data and productivity estimates gathered during industry interviews. Estimates of the number of individuals are based on industry and state authority interviews during 1995.

Table 2-4 estimates the number of FTE Gulf oyster harvesters based on the 1989 to 1993 average NMFS landings data (shown in Table 2-1) and productivity estimates gathered during industry interviews that we verified using published estimates (e.g., Berrigan et al., 1991; Melancon and Condrey, 1992).

Based on interviews with harvesters and regulatory officials, the productivity averages reported by Berrigan et al. (1991) calculated from total landings and total licensed harvesters underestimate the productivity of the full-time harvester. This is because many fishermen retain an oystering license for themselves or their boats for only occasional oyster harvesting. Therefore, we collected information about the typical daily catch per boat (including tong boats, small single-dredge boats, medium double-dredge boats, and large double-dredge boats); the number of days spent harvesting during the 7-month summer; and the typical meat yield for the summer months (see Table 2-5).

Table 2-5. Summer Boat Productivity Estimates
Summer FTE boats are estimated using productivity per boat and oyster landings data.

	Florida	Alabama	Louisiana			Texas
	Tong	Tong	Small	Medium	Large	Dredge
Bags per Day	11	10	40	75	100	100
Days	90	100	60	75	75	75
Crew Size	1	1	2	3	4	4
Bags per Boat	990	1,000	2,400	5,625	7,500	7,500
Bags per Worker	990	1,000	1,200	1,875	1,875	1,875
Meat per Bag	5.56	5.88	5.88	5.88	5.88	5.00
Meat per Worker	5,504	5,880	7,056	11,025	11,025	9,375
Meat per Boat	5,504	5,880	14,112	33,075	44,100	37,500

Note: We define an FTE boat in each Gulf state using the meat weight per boat during the summer months.

Sources: Industry interviews (1995); Melancon, Earl J., Jr., and Richard Condrey. 1992. "Economics of a Louisiana Oyster Seed Bedding Fishery and Influence of Lease Yield on Expenses to Operate." *Journal of Shellfish Research* 11(1):143-147.

For example, in Texas, we divided the average summer landings (746,870 pounds in meat weight) by the typical daily dredge boat productivity (100 bags of shellstock or 500 pounds of meat weight) to estimate the total number of summer harvesting trips (approximately 1,494 trips). Dividing the number of trips by 75 working days during the summer months results in an estimated

19.92 FTE summer boats. To estimate the number of summer harvesters, we multiplied the 19.92 boats by 4 (the typical number of crew and captain), which resulted in the 80 FTE harvesters during the summer in Texas shown in Table 2-4. Productivity estimates per boat and per worker during the summer months for Texas and other Gulf states are shown in Table 2-5.

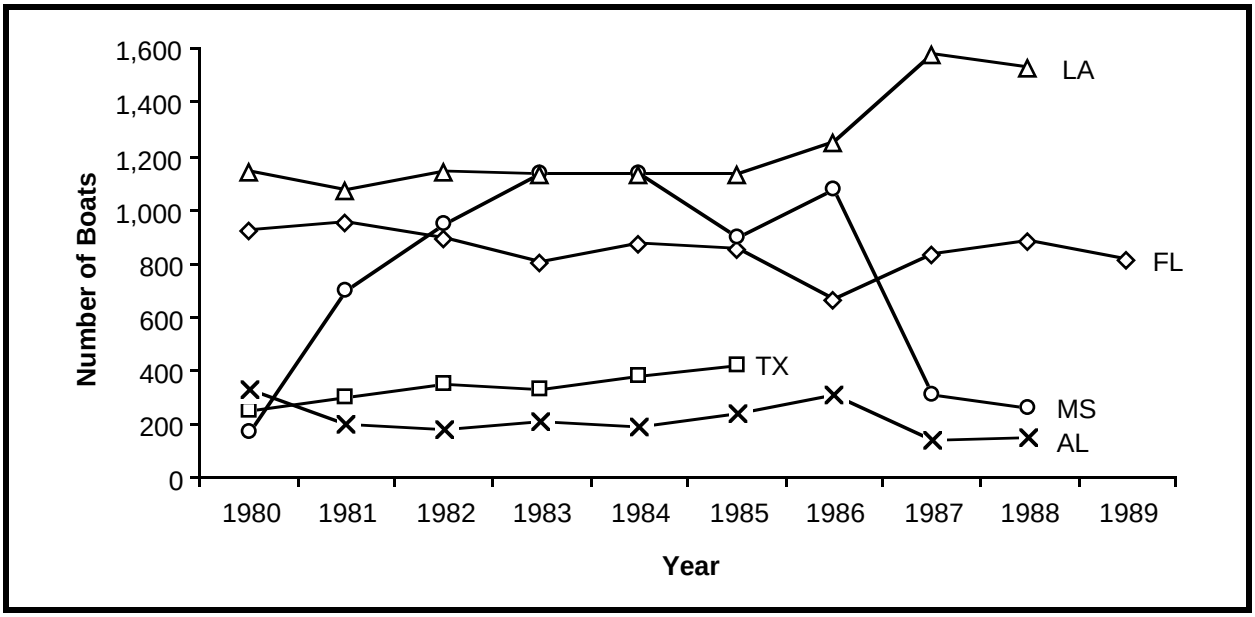
The revenue and income estimates implied by the NMFS landings and value data and information reported during the interviews are consistent with the FTE estimate. The FTE estimates are sensitive to assumptions regarding dredge boat productivity and the number of working days. Reducing the estimated dredge boat productivity would increase the number of FTE boats and crew members; however, it would also necessarily decrease the average income per harvester (e.g., estimated $17,795 average April 1 to October 31 income in Texas).

The higher landings in the summer support more harvesters in Florida and Louisiana. Mississippi closes during much of the summer season. Texas supports fewer harvesters in the summer since only the lease acres are open during the summer months; however, the summer harvesters are the full-time oysterers.

Figure 2-6 shows the number of licensed oyster harvesters in the Gulf during the 1980s. Harvesters may hold licenses in several states, so individuals who hold multiple licenses (especially in Alabama, Mississippi, and Louisiana) may be double counted. The hurricane damage may explain the drop after 1986 in Alabama and Mississippi oyster harvesters.

Florida regulators informed us that 742 harvesters held oyster licenses in Franklin County in 1995. Franklin County accounts for 85 to 90 percent of Florida landings (Berrigan et al., 1991). Franklin County harvesters reported that approximately 150 to 350 harvesters are on the water any given day. This information is consistent with the historical data. In 1995, Texas regulators reported that Texas has 400 to 500 licensed oyster harvesters including public and private harvesters; about 200 are year-round harvesters in Texas. This indicates an increase in Texas during the 1990s. Louisiana oyster harvesting licenses records indicate 897 oyster harvester licenses were issued in 1994. Although this is a higher number than the

Figure 2-6. Oyster Harvesters by State
Historical trends confirm many fishermen harvest oysters.



Source: Berrigan et al. March 1991. *The Oyster Fishery of the Gulf of Mexico, United States: A Regional Management Plan.* Ocean Springs, MS: Gulf States Marine Fisheries Commission. Number 24.

FTE estimate (572), it is not necessarily inconsistent since buying a license doe not indicate full-time commercial employment.

Table 2-6 and Figure 2-7 indicate the number of tong boats in the Gulf during the 1980s. Florida requires tonging, so most tong boats are in Florida, which averages close to 700 boats. Only small portions of Louisiana (e.g., Lake Calcasieu) require harvesters to use tongs; there are fewer than 100 boats most years. In Mississippi, tong boats declined from near 400 to nearly 100 during the 1980s. Alabama tongers declined after the 1986 hurricane; however, they have recovered during the 1990s.

In 1995, Florida harvesters reported that the required capital equipment for tonging includes a boat, engine, tongs, a pick-up truck, and trailer. The total capital value is approximately $10,000 "as is." A new boat costs approximately $2,500 and lasts 8 to 12 years. A new engine costs between $3,000 to $5,500 and lasts about 4 years. Many harvesters buy used engines every year or two with financing. Tongs last about a year and cost $200. Tonging is typically a "one-person" activity; therefore, the number of tong boats and the number of tong harvesters are approximately the same.

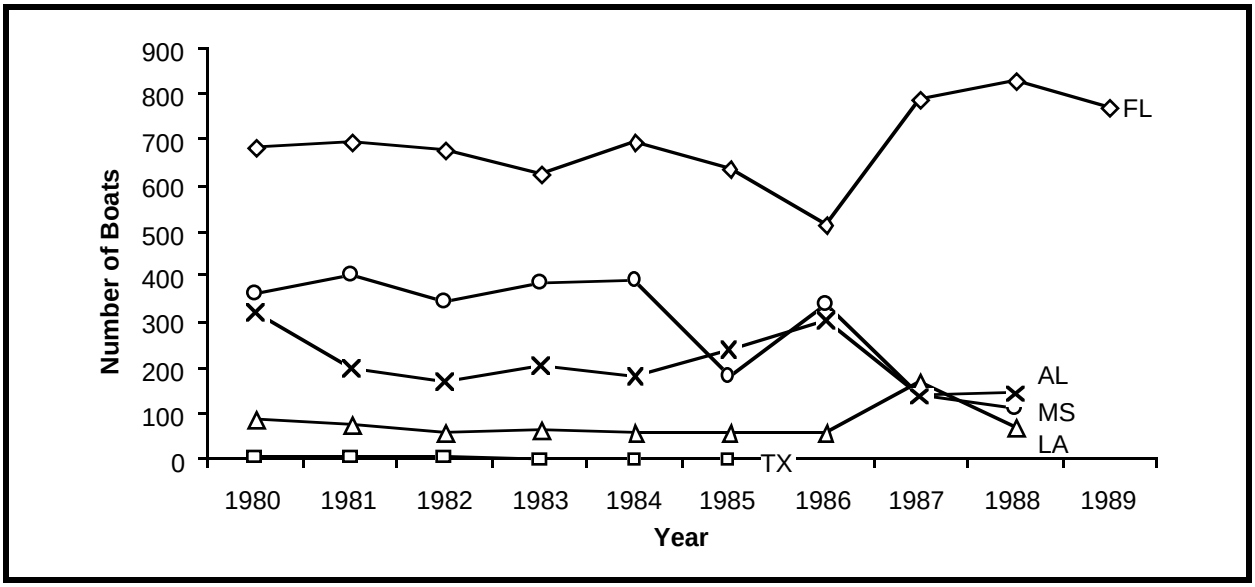
Table 2-6. Tong Boats from 1980 to 1989
Although tonging has declined in Alabama and Mississippi, Florida remains stable.

	FL	AL	MS	LA	TX
1980	683	326	364	90	3
1981	695	199	400	75	4
1982	677	172	344	62	2
1983	627	208	385	65	1
1984	696	184	390	59	1
1985	637	238	186	58	0
1986	516	305	340	62	
1987	790	138	141	172	
1988	830	143	109	71	
1989	771				
Average	692.20	212.56	295.44	79.33	1.83
1995	742+	700	60	153	0

Source: Berrigan et al. March 1991. *The Oyster Fishery of the Gulf of Mexico, United States: A Regional Management Plan.* Ocean Springs, MS: Gulf States Marine Fisheries Commission. Number 24.

Values shown for 1995 were gathered during site visits and telephone interviews.

Figure 2-7. Number of Tong Boats by State
Most tong boats are in Florida.



Source: Berrigan et al. March 1991. *The Oyster Fishery of the Gulf of Mexico, United States: A Regional Management Plan.* Ocean Springs, MS: Gulf States Marine Fisheries Commission. Number 24.

Where permitted, dredging is the preferred method for commercial oyster harvesting except in Alabama where public sentiment is strongly opposed to dredging. Florida does not permit dredging.[6] Most Texas, Louisiana, and Mississippi harvesters use dredge boats. Table 2-7 and Figure 2-8 indicate the number of dredge boats used during the 1980s. The figures may include some double counting of dredge boats, especially among Louisiana, Alabama, and Mississippi, since a single boat may obtain multiple state licenses.

In 1995, Texas respondents reported that approximately 50 dredge boats operate in Galveston Bay during the summer months. Published statistics indicate total commercial oyster boat licenses between 1990 and 1993 averaged 504—473 residential and 31 nonresidential licenses per year (see Robinson, Campbell, and Butler, 1994). Two types of dredge boats are used for oystering in Texas. One is the primary oyster dredge boat and the other is a shrimp boat that is occasionally used for oystering. Primary oyster dredge boats are typically 40- to 50-foot boats with the cabin on the stern. The boats generally last for 40 years and are valued at between $80,000 and $100,000 each; however, new replacement value is closer to $140,000. Larger 65-foot oyster boats are valued at approximately $240,000. Shrimp boats that are occasionally converted to oystering are 45-foot shrimp boats with the cabin on the bow. These shrimp boats are valued at approximately $50,000 to $60,000 and cost $3,000 per season to convert to oystering.

Approximately 1,014 resident and 46 nonresident dredges are licensed in Louisiana according to preliminary 1994 data from the Department of Wildlife and Fisheries. One or two dredges are carried on each boat, representing a minimum of 530 boats. Three types of boats with dredges are used for oystering in Louisiana. Large 50- to 60-foot luggers, each worth $150,000 to $225,000, accommodate overnight trips to remote areas; few have refrigeration on board. According to industry representatives, few harvesters—perhaps only 150 to 200—own luggers. Medium-sized oyster boats are 40- to 50-foot dredge boats with a cabin on the stern. These boats are valued at between $60,000 and $100,000 each.

[6]One industry representative in Franklin County reported that a recent legal challenge resulted in allowing the few leases (ten leases in Apalachicola Bay) to be retained and to permit the use of dredges on those leases; therefore, there may be one to two dredge boats in Florida as of 1995.

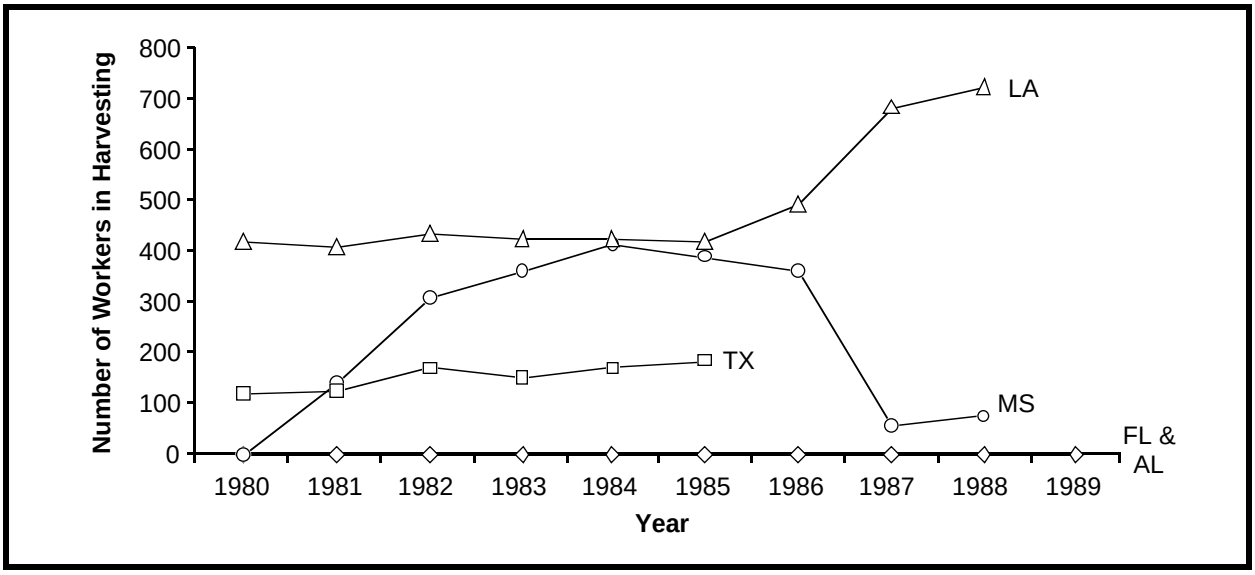
Table 2-7. Dredge Boats from 1980 to 1989
When permitted, oysterers have preferred dredge boats.

	FL	AL	MS	LA	TX
1980	0	0	0	417	120
1981	0	0	139	408	124
1982	0	0	310	434	168
1983	0	0	360	422	147
1984	0	0	415	424	171
1985	0	0	387	421	186
1986	0	0	359	495	
1987	0	0	54	686	
1988	0	0	74	723	
1989	0	0			
Average	0	0	233	492	153
1995[a]	1	0	97	1,250[b]	504[c]

[a]Values shown for 1995 were gathered during site visit and telephone interviews.
[b]Includes 300 to 400 resident and 900 nonresident dredge boat licenses.
[c]Includes 473 resident and 31 nonresident dredge boat licenses (Robinson, Campbell, and Butler, 1994).

Source: Berrigan et al. March 1991. *The Oyster Fishery of the Gulf of Mexico, United States: A Regional Management Plan.* Ocean Springs, MS: Gulf States Marine Fisheries Commission. Number 24.

Figure 2-8. Number of Dredge Boats by State
Historically, most dredge boats are licensed in Louisiana.



Source: Berrigan et al. March 1991. *The Oyster Fishery of the Gulf of Mexico, United States: A Regional Management Plan.* Ocean Springs, MS: Gulf States Marine Fisheries Commission. Number 24.

Respondents estimate there are 100 to 150 medium-sized boats. Industry representative report the majority of oyster boats—about 300 to 400 boats—are smaller and are worth $15,000 to $20,000 each. These smaller boats are called Lafitte skiffs and accommodate a single dredge. In addition to oystering, the skiffs can be used for shrimping and other fishing. Tong boats are smaller than the dredging skiffs and are used in the Calcasieu Lake public tonging grounds. Louisiana regulators report issuing 153 tong licenses in 1994.

2.3.2 Leases and Leaseholders

In addition to obtaining labor and boats, harvesters may lease oyster-growing water bottoms from the state or have permission from the leaseholder who leases from the state. Leaseholders own the rights to harvest oysters from areas that they lease from the state. Leasing requirements and the amount of acreage available for lease vary from state to state. Lease acreage is limited in Florida, Alabama, and Mississippi; however, the acreage is significant in Texas and Louisiana.

Louisiana and Texas offer a significant number of acres of water bottom for lease to plant and harvest oysters (i.e., 360,000 acres in Louisiana, 2,322 acres in Texas). In Louisiana, more than 66 percent of the annual harvest comes from leases (Keithly and Roberts, 1988). Once leased, leaseholders may retain their leases as long as they meet the usually minimal state requirements (i.e., pay the annual $2 tax per acre). The rights to leases are traded among individuals. Respondents reported the sale price of a leased acre from one leaseholder to another ranged between $100 and $6,000, depending on the quality of the cultch (the layers of shell that create a foundation for oyster production). Another measure of value that respondents mentioned were recent damage assessments awarded in court (e.g., leaseholders vs. oil companies). Market values rather than damage awards usually reflect the economic value of goods that are traded freely in a competitive market.

Table 2-8 shows the estimated acres of leases and number of leaseholders in each of the Gulf states based on industry representatives' reports of typical market trading values. In Louisiana, 2,000 people hold 360,000 acres of oyster leases. In Texas, eight families control the 2,322 acres of leases in Galveston Bay.

Table 2-8. Oyster Leases by State
Leases are valuable assets in Louisiana and Texas.

State	Number of Acres	Number of Leaseholders
Florida	656 acres[a]	10 leases
Alabama	Negligible	5 leases
Mississippi	Negligible	25 leases
Louisiana	360,000 acres	2,000
Texas	2,300 acres	43 (8 families)

[a]Oyster leases in Apalachicola Bay.

Source: Berrigan et al. March 1991. *The Oyster Fishery of the Gulf of Mexico, United States: A Regional Management Plan.* Ocean Springs, MS: Gulf States Marine Fisheries Commission. Number 24.

Leaseholders are capital owners who either harvest their leases or contract with others to harvest. They cultivate their leases by building cultch, relaying oysters from polluted areas to their leases for cleansing, transplanting oysters from public grounds, and raking the oysters to prevent clumping. The value of the leases derives mainly from summer harvesting when all public waters in Louisiana and Texas are closed.

Often, leaseholders are also wholesalers and processors who distribute oysters locally, regionally, or nationally. Leases are generally family assets that are bequeathed from generation to generation.

2.3.3 Plants, Owners, and Employees

After being harvested from public or private waters, oysters are taken to a certified dealer usually in a wholesale or processing facility. At RTI's request, the National Marine Fisheries Service (NMFS) compiled a specific summary of 1990 through 1993 oyster wholesale and processing plant and employment data for this study (hereafter cited as 1990 – 1993 NMFS data). RTI requested the summary of oyster plants and employment for each RTI-defined oyster region (see Section 2.1). NMFS used the list of counties to aggregate the data into the RTI-defined oyster regions. This aggregation served two purposes:

- ➤ It protected the confidentiality of oyster processors through aggregation.
- ➤ It facilitated the comparison of NMFS data with regional I-O modeling system data that will be used later in this study.

NMFS defines three types of oyster facilities: wholesalers that conduct wholesaling activities only, processing plants that perform processing activities only, and plants that do both wholesaling and processing. Wholesalers wash and pack the shellstock oysters in sacks or bushels. Processing plants shuck the shellstock oysters and place them into pint- or gallon-size containers for shipment. Processing plants may also conduct further processing such as breading and freezing. Plants that ship shellstock and shucked product fall into both categories. Since few plants are processing only, we report the plants for processing only and both wholesaling and processing as one category: Processing or Both.

Table 2-9 reports the average number of oyster plants for each state or region by type of facility for 1990 to 1994. As shown in Table 2-9, Louisiana has the most oyster wholesaling or processing plants in the Gulf regions, and Alabama has the fewest. The Alabama and Mississippi region shows a majority of processing plants. The other states have more wholesaling-only plants than processing plants. Nonetheless, the Gulf has more plants that conduct processing than those that conduct wholesaling only according to NMFS 1990 to 1994 data.

Table 2-9. Processing Plants by State and Type of Processing
Most oyster plants are located in Alabama/Mississippi and Louisiana.

State/Region	Wholesalers	Processing or Both	Total
Florida	31	22	53
Alabama/Mississippi[a]	9	63	72
Louisiana	61	45	105
Texas	14	11	25
Gulf Total	115	141	255

[a]Alabama and Mississippi are reported together to protect confidentiality.

Source: 1990 to 1994 average NMFS data.

For comparison, a more comprehensive accounting of certified shippers may be found in the Interstate Certified Shellfish Shippers List published by the FDA. Table 2-10 reports the number of certified shellfish shippers for each state. As one would expect, these figures are greater than those reported in Table 2-9 for two reasons. First, Table 2-10 reports all certified shippers including those who ship clams and mussels as well as oysters. Second, the

Table 2-10. Interstate Certified Shellfish[a] Shippers in the Gulf
The shippers list provides an upper bound estimate of oyster plants.

State	Certified Shippers
Florida	127
Alabama	59
Mississippi	24
Louisiana	146
Texas	50
Total	406

[a]Fresh and frozen oysters, clams, and mussels.

Source: U.S. Food and Drug Administration (FDA). April 1, 1995a. *Interstate Certified Shellfish Shippers List*. Washington, DC: U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration.

owner of a refrigerated truck may be a certified shipper. Being a certified shipper does not necessarily mean that the facility is an oyster processing plant since shippers may merely distribute previously processed product. Therefore, the estimates in Table 2-9 more accurately indicate potentially affected oyster processing plants. The most significant difference in the shippers list figures is for Florida: clams are a significant form of shellfish in Florida, which is not the case for the other Gulf states. Also, the Florida data in Table 2-10 report 1995 values in all of Florida, but Table 2-9 shows the 1990 to 1994 average number of plants for only the RTI-defined Region 1.

Accounting for all certified shellfish shippers, Louisiana has the most shellfish shippers and Florida, Alabama, Texas, and Mississippi complete the list of certified shippers in the Gulf.

According to industry representatives, most processing facilities are owner operated by an individual or a husband and wife. A typical plant owner is in his late 40s or early 50s and has a high school diploma and occasionally some college. Typically, his work experience is entirely in the seafood industry. The majority of Gulf owners have only one plant. The oyster processors who also process shrimp, crab, or other species own larger operations and hire 75 full-time oyster employees among 180 to 275 total employees.

Several owners have a variety of assets including the processing plant. Larger processors also own two or three semi-tractor-trailer trucks and three or four boats, as well as private oyster leases. Two

processors that we interviewed reported recently constructing processing plants. A new plant costs about $250,000 to $300,000 in either Texas or Mississippi.

In Louisiana, plant owners report that an oyster plant is worth between $250,000 and $500,000 with a few larger ones worth $1 million or more. Larger processors with shucker-packer certification also often own two or three semi-tractor-trailer trucks and three or four boats, as well as private oyster leases. Processors in Louisiana often send trucks to the docks to transport the oysters to their shucking plants. Respondents report that about half of the shellstock shippers do not own a permanent building but own a truck with a refrigerated trailer (i.e., a "reefer"). Reshippers also do not require a permanent building either. The other shellstock shippers usually own a dock with a refrigerated storage area to collect sacked oysters from harvesters during the day to load on refrigerated trucks as they arrive.

In Texas, processors employ from 5 to 100 people, though a fairly large processor has 40 to 50 employees, including 30 to 40 shuckers. Small processors who ship shellstock exclusively employ only about five people. Typically, sales are around $1 to $2 million although they range from $0.5 to $7 million. Only 15 to 20 percent of the owners have more than one plant. Owner income from operations ranges from $100,000 to $200,000; $100,000 to $150,000 is common among larger processors in Florida. Sales for plants in the Apalachicola region in Florida range from $0.5 to $5 million.

Each oyster plant has employees who wash, repack, or process the oysters. In Louisiana, Mississippi, and Alabama, industry representatives report that processors employ from 5 to 100 people. Processing plant employees include shuckers, packers, truckers, clerical/administrative, and salespeople. Typically, a processor has 10 to 35 employees who are primarily shuckers.

Industry representatives report that shuckers are usually paid by the piece ($5.50 per gallon of shucked meats) and can earn between $60 and $90 per day. In Florida, shuckers sometimes earn between $300 and $600 per week when meat yields are high. They may work year round, but some voluntarily take off in the summer when meat yields are lower. Shuckers are provided with mandated benefits (Social Security and Workers Compensation) but seldom with health

insurance. Several processors report that shuckers are contracted as "self-employed" individuals who are responsible for their own Social Security and other benefit contributions. Some of the other plant workers do receive health benefits. Typically, shuckers in Texas are men who have less than a high school education. Shuckers in Louisiana, Mississippi, Alabama, and Florida typically are women who have less than a high school education; a significant number of these shuckers are minority women.

Table 2-11 shows the 1990 to 1994 average number of employees in each type of oyster plant and each Gulf oyster region according to NMFS data. Although NMFS selected only those plants that processed oysters, some employees may be part-time or may process other seafood (e.g., crab, shrimp). From the table, we see some differences among the four oyster regions in the Gulf states. Overall, Alabama and Mississippi have the most total oyster plant employees (nearly 1,300) as well as the most processing plant employees. This is in contrast to the relatively few harvesters (200) in Alabama (see Table 2-4). Alabama and Mississippi processors depend on Louisiana for oysters during the summer. In wholesale only, Louisiana employs the most people. Louisiana and Florida have similar totals with more employment in processing facilities.

Table 2-11. Oyster Plant Average Employment by Region and Type of Processing
Oyster plant employment is highest in Alabama/Mississippi and Louisiana.

State/Region	Wholesale Only	Processing Only and Both	Total
Florida	131	848	979
Alabama/Mississippi[a]	29	1,230	1,259
Louisiana	239	756	994
Texas	53	257	311
Gulf Total	452	3,091	3,543

[a]Alabama and Mississippi are reported together to protect confidentiality.

Source: 1990 to 1994 average NMFS data.

2.3.4 Alternative Opportunities for Workers and Owners

Leased water bottoms, boats and oystering gear, and specialized processing equipment have few alternative uses. The alternative use of the oyster plant would depend on the real estate location. Plants with docks on the water in remote areas have few, if any, alternative

uses; however, plants that receive oysters shipped by truck may have more alternatives.

During site visits, people reported that alternative employment opportunities are few in the oystering regions around the Gulf. Plant workers and owners, boat captains, and crew reported that oystering has been their living for a long time, and they were not sure how they could adapt to the harvesting or marketing restrictions under consideration. Shuckers and harvesters have specialized skills that are not easily transferable to other employment in the region. Other manual laborers, such as loaders and packers, also typically have no high school education, but their skills do not appear to be as specialized.

Consumers currently have alternatives to Gulf oysters. Industry and trade group representatives from the Pacific and Northeast consider oysters from those regions to be adequate substitutes for Gulf oysters. Gulf oyster representatives disagree. Pacific oysters have a different taste, color, and size than eastern oysters. Traditionally, Pacific oysters have competed with eastern oysters primarily in the shucked product market and not as in-shell product in the U.S. Oysters from Connecticut and other northeastern states are the same eastern oyster variety; however, their price is significantly higher relative to Gulf oysters. To what extent consumers in the Southeast or other regions of the U.S. will purchase in-shell oysters from the Pacific or northeastern regions as an alternative is a topic of speculation.

2.4 SUMMARY

To estimate the economic costs of control options, we identified the affected regions, commodity forms, and stakeholders by describing the economically significant trade flows. Affected stakeholders are individuals who, in their capacity as workers or capital owners, are employed in industries and regions significantly affected by the control options.

Seasonal harvesting restrictions or other control options are likely to directly affect the demand for and/or the supply of Gulf oysters. As shown in the industry characterization in this section, the control options will directly affect Gulf fishermen, Gulf oyster boat owners, Gulf oyster leaseholders, Gulf oyster plant owners (frequently the

same individuals), and Gulf oyster wholesaling and processing employees. Also, suppliers of oysters from other regions such as Washington and Connecticut may experience significant indirect effects.

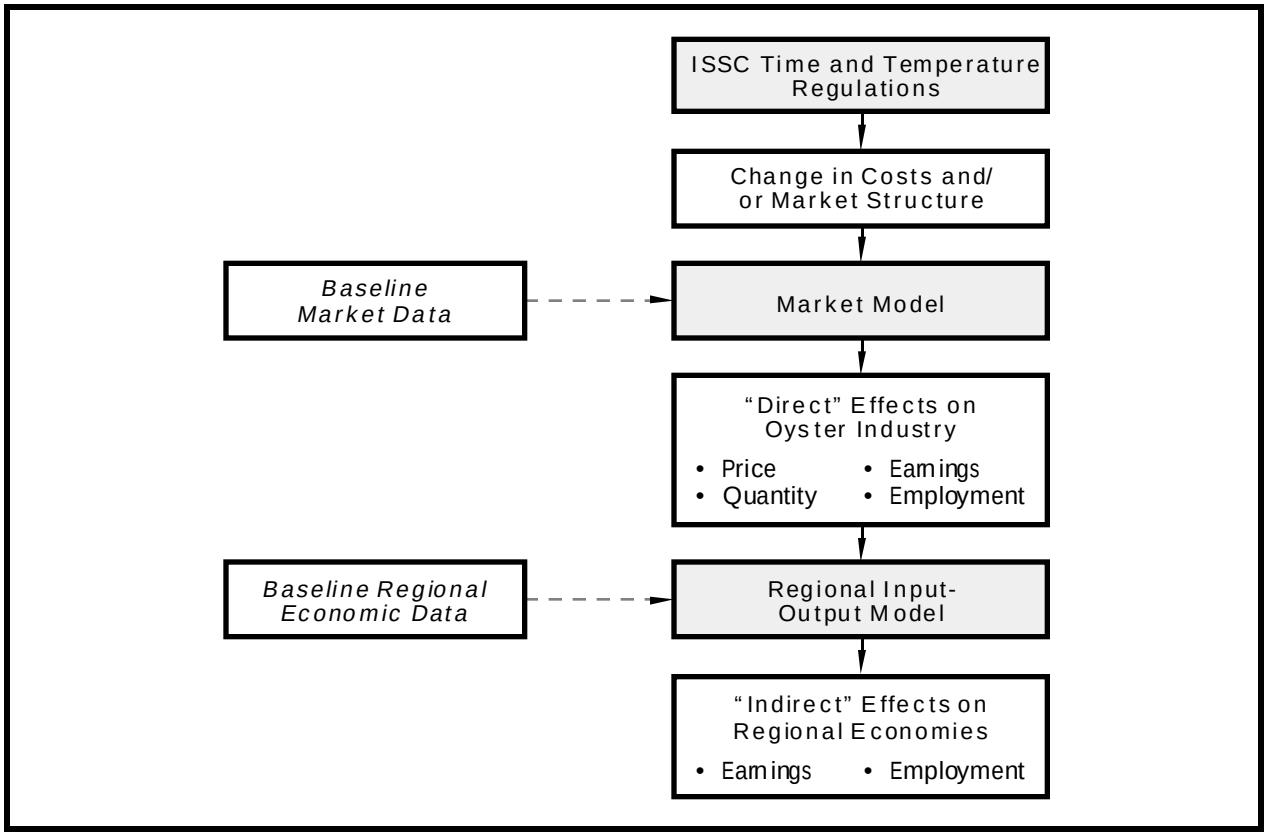
3 Methods: Economic, Regional, and Worker Displacement Models

The primary purpose of this study was to assist FDA in evaluating options once recommended to the ISSC by the Agency for reducing the morbidity and mortality caused by exposure to *Vibrio vulnificus* in raw Gulf of Mexico oysters. Any control option could certainly impose some costs on Gulf oyster producers. Some of these costs would directly affect oyster producers in each of the Gulf states. Those impacts on the oyster industry would then, indirectly, affect other industries in the Gulf.[1] The direct impacts on the oyster industry may include reductions in the oyster harvesting and processing workforce. Consequently, these employment changes would induce worker dislocation or displacement costs. To capture the possible direct, indirect, and worker displacement effects, we employed a multifaceted methodology that includes a model of Gulf oyster markets, a regional economic model, and a worker displacement model.

Figure 3-1 illustrates an overview of the approach used to estimate economic impacts. Compliance with a control option imposes additional costs on oyster production (harvesting) and may restrict the movement of oysters through certain market channels (i.e., the market for raw consumption). These factors will cause changes in oyster prices and quantities consumed and will thereby have a direct impact on various stakeholders in the oyster industry

[1]Although economic impacts on Gulf oystering could have impacts beyond the Gulf, we will limit the scope of this analysis to the economic impact in the Gulf region.

Figure 3-1. Approach for Estimating Economic Impacts



(e.g., leaseholders, harvesters, boat owners, processors, processing plant owners, final consumers). These direct effects will generate further economic impacts elsewhere in the affected regional economies. These latter impacts are termed "indirect" effects of the option.

Estimating direct effects requires characterizing how the market responds when cost increases and/or market restrictions are imposed. To accomplish this, we developed an economic model of the Gulf oyster market. The market model transforms costs and restrictions into changes in the market variables used to measure the direct effects. The market model is designed to capture the direct effects of the option on oyster prices and harvest quantities.

The Gulf oyster market model builds on the conceptual framework of supply and demand to estimate the changes in oyster prices as well as the changes in oyster market output. Using the baseline information reported in the industry profile, the market model

estimates the direct effects on oyster harvesting and processing employment and earnings following a change. We examine the oyster market Gulfwide and for each oyster region in the Gulf. These direct effects include estimates of the potential changes in oyster harvesting revenues, employment, and earnings.

Estimating indirect effects within an economic region stemming from the direct effects on the region's oyster industry requires characterizing how other regional industries are affected by changes in oyster industry activity. These effects are captured with a regional input-output (I-O) model. The I-O model developed for this project builds on the direct effect outputs from the market model. Economic impacts on one sector of a regional economy will have consequences that extend to other sectors of the region. Regional I-O modeling is the appropriate method for estimating these indirect effects on the region. Because standard I-O multiplier models may over- or underestimate impacts, we adjust the standard estimates by correcting for their inherent assumption that the affected resources (i.e., labor) have zero opportunity costs (Hamilton et al., 1991). The regional multiplier model developed in this study allows us to more accurately estimate the changes in regional employment and earnings for the Gulf and for each oyster region in the Gulf.

Finally, our model of worker displacement examines both the quantitative and qualitative effects of workers losing their employment. Worker displacement may result in workers finding similar jobs in other industries, changing occupations altogether, experiencing a period of unemployment, or suffering extended joblessness. Although the Gulf oyster market model and regional model capture the earnings impacts, our worker displacement model examines the nonearnings impacts on those displaced from the oyster industry.

Using this methodology of modeling market, regional, and worker displacement effects, we provide a multifaceted study of the potential impacts of changes for the Gulf oyster industry. In this chapter, we present the conceptual and operational elements underlying each of our three models. Chapter 4 reports the results of the analysis.

3.1 MARKET MODEL

To capture the direct effects of control options on the oyster industry, we developed an economic model of the Gulf oyster market. Using the baseline information reported in the industry profile, the market model is used to estimate the direct effects on oyster harvesting and processing employment and earnings following a change. These direct effects include estimates of the potential changes in oyster harvesting revenues, employment, and earnings. This section presents the conceptual and operational underpinnings of the model as well as attendant strengths and weaknesses.

3.1.1 Methodology

To estimate the economic effects on the market, we incorporate the responses of both producers (suppliers) and consumers (demanders). The model is structured to accommodate product substitution among Gulf states, recognizing that effects will probably differ across states. Producers from a state not heavily affected by a particular control option will have some ability to make up for supply losses from more heavily affected states.

For this study, we focus on two separate control approaches:

- "option 2," a marketing restriction once recommended to ISSC by FDA to prohibit the sale of Gulf oysters for raw consumption from April through October
- time and temperature controls for summer harvesting (i.e., the ISSC option).

To develop the model, we collected information about baseline market data, model parameters quantifying supply and demand responses, and empirical characterizations of the various supply or demand shocks caused by each control option.

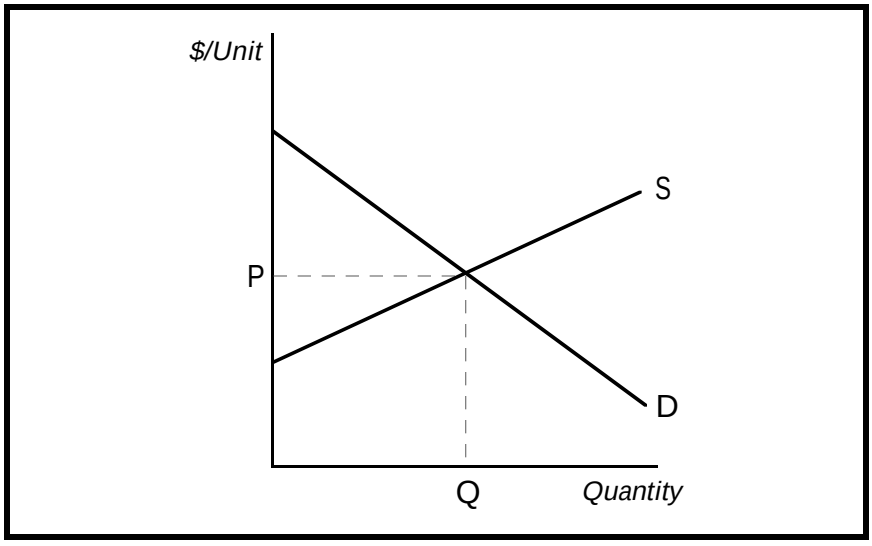
Market Model Structure

The market model builds on the neoclassical theory of product supply and demand, first introduced by Alfred Marshall (1890). Products are supplied to a market by producers and purchased in markets by consumers. Producers and consumers choose how much of the product to supply (consume) based on the price prevailing in the market. In market equilibrium, the price reflects the exact rate at which the quantity of the good willingly purchased

by consumers equals the quantity of the good willingly supplied by producers. Market model analyses generally rely on the concept of equilibrium to project how prices and quantities will change in response to some shock to the market system such as a control option, tax, or technological innovation.

Figure 3-2 illustrates the equilibrium concept in the market for a commodity. The supply function is given by S and the demand function by D. Equilibrium is found where the supply and demand functions intersect, because this point defines a price, P, for which the quantity supplied equals the quantity demanded. Equilibrium market quantity is given by Q.

Figure 3-2. Market Equilibrium for a Commodity

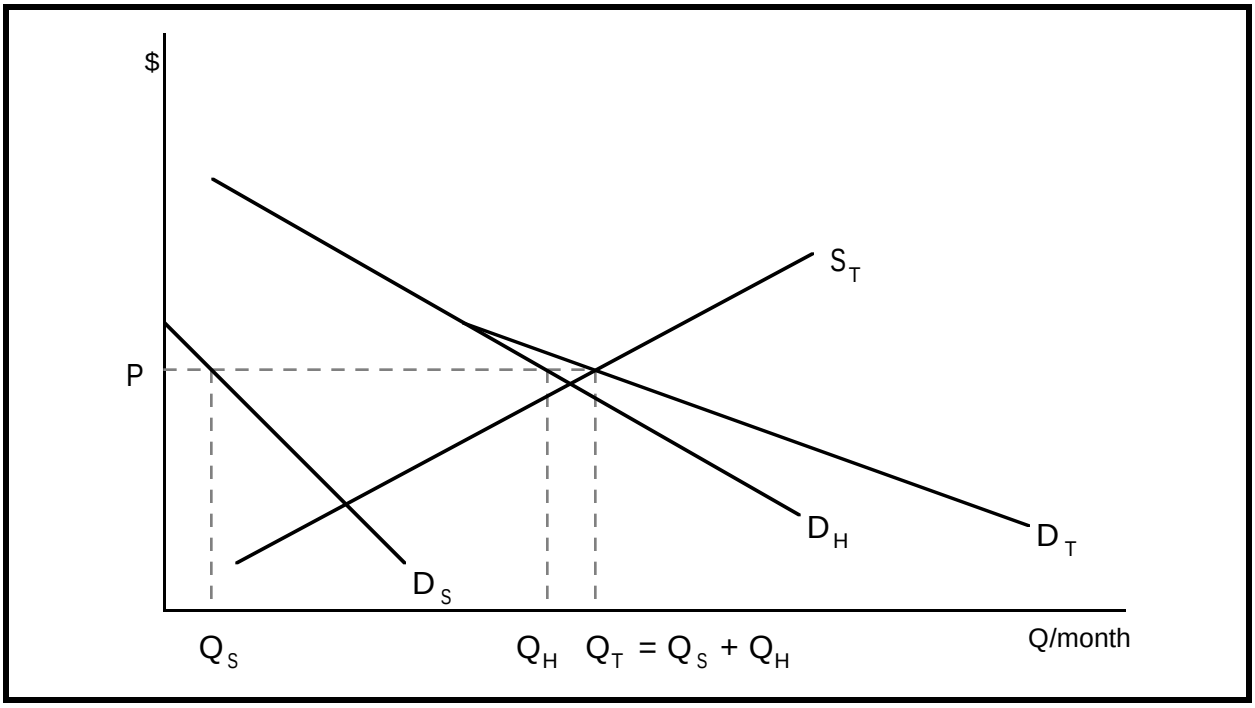


Certain complexities must be added to apply this framework to the Gulf oyster market. First, our model centers on the market for harvested oysters (shellstock) because this is where the control options would have been directly imposed. Ultimately, the effects modeled in the shellstock market generate impacts elsewhere in the oyster industry as well as the other related industries in the affected regions. Shellstock "producers" are oyster harvesters, and the shellstock "consumers" are oyster processors. Market quantities are expressed in pounds of meat from shellstock, and the price is expressed in dollars per meat pound at the dockside, also referred to as the *ex vessel* price.

The demand for oyster shellstock is derived from the consumer demand for halfshell oysters and shucked meats. Retailers purchase wholesale oysters from processors at prices that differ—one price for boxed in-shell product and another price for shucked meat product in pints or gallons. Processors purchase sacked oysters from harvesters or dealers, typically at a single price with the expectation that a proportion of the oysters will be suitable for the halfshell trade (i.e., single, symmetrical, cup shaped oysters). Currently, harvesting costs do not differ enough for harvesters to require higher prices for oysters bound for the halfshell than for those bound for the shucked meats market. In other words, a single price for shellstock usually arises from the market.

Figure 3-3 illustrates these aspects of the Gulf shellstock market. It is important to recognize that Figure 3-3 demonstrates the current structure of the Gulf shellstock market. As discussed later, the control options would be expected to fundamentally alter this structure.

Figure 3-3. Simplified Model of Gulf Oyster Market: Current Structure



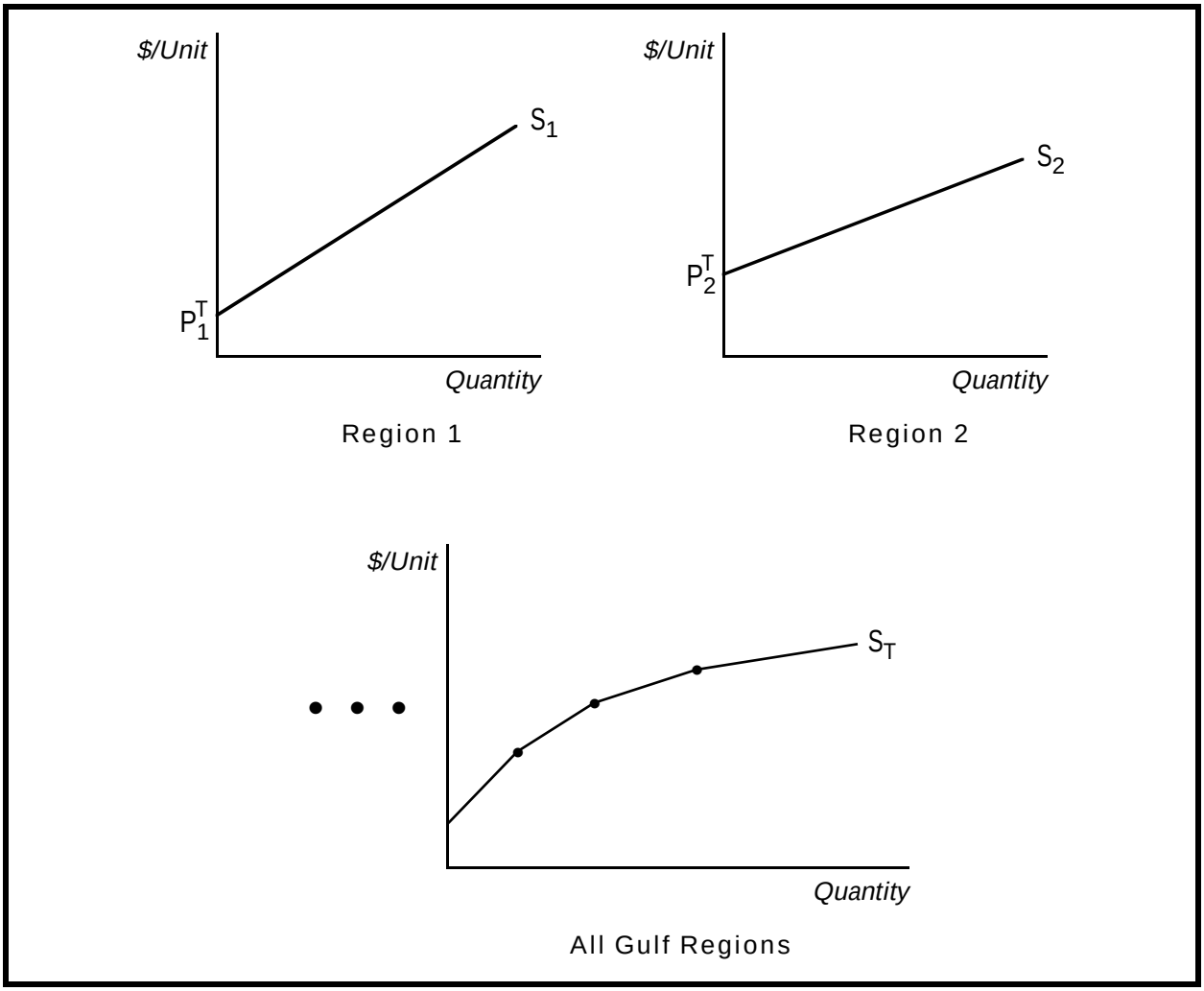
In Figure 3-3, the supply function for shellstock is S_T. The shellstock demand function, D_T, is the sum of D_H, shellstock demand derived from the halfshell/raw consumption market and from D_S, demand derived from the shucked meat market. In this example, the demand derived from the halfshell market is greater than the demand derived from the shucked meat markets, but this varies by region and season.

The equilibrium *ex vessel* price for shellstock is P, which is determined by the intersection of the supply function and the total demand function. Total shellstock quantity is Q_T. Total shellstock quantity is separated into that bound for the halfshell market, Q_H, and that bound for the shucked meat market, Q_S.

Admittedly, Figure 3-3 is a simplified view of the Gulf shellstock market; however, its purpose is to convey the basic structure of our market model. The actual model we use to estimate economic impacts accounts for many of the complexities left out of Figure 3-3. For example, "Gulf" oyster supply is actually the sum of oysters supplied from each region in the Gulf. The supply function in Figure 3-3, then, can be viewed as the sum of the supply functions from each region. As indicated in Chapter 2, harvesting technology can differ substantially across regions; the eastern side of the Gulf (Florida and Alabama) primarily uses tonging methods and the western side of the Gulf (Louisiana and Texas) primarily uses dredge boats. Moreover, Louisiana has several different types of dredge boats with differing levels of productivity and skills needed to operate them. Interregional differences in technology and labor may mean that the supply functions from each region are also quite different.

Figure 3-4 shows the different supply functions for each region summed together to make up a Gulf supply function. Note that the supply function for the Gulf is "kinked," and each kink indicates a threshold price for one of the regions. In other words, below the threshold price, one of the regions would no longer continue to produce because its per-unit costs would exceed the price. In the example in Figure 3-4, Region 1 would drop out at threshold price P_1^T, but the other regions would continue to operate.

Figure 3-4. Region-Level and Gulf-Level Supply Functions



Although clarifying that our model incorporates these nonuniformities in the Gulf supply function is important, we will continue the conceptual discussion with the depiction of a smooth, uniform supply function, as shown in Figures 3-2 and 3-3, so that we can focus on other important aspects of the model.

Modeling Economic Effects

The control options, in one form or another, restrict trade between consumers and producers. In the case of the in-shell consumption marketing restriction, some of these trades would no longer be allowed. Prohibition of trade would be based on region of origin (Gulf), time of year (summer), and form of consumption (in-shell,

raw). In the case of the ISSC control option, the trades are restricted to comply with time and temperature controls.

In a direct sense, the marketing restriction affects the demand side (processors, consumers), and the ISSC rule affects the supply side (harvesters). However, the cost of the control option is generally shared between both sides of the market. Both suppliers and demanders are necessary for a market to operate. Any direct effects on suppliers will shift the market supply, alter price, and then affect demanders. The same is true in reverse for demand-side effects on suppliers. Recognizing these interactions is important when determining who bears the burden of regulation (see Spulber, 1989). Under some market conditions, the costs of controls can be largely passed on to demanders in the form of higher prices, and under other conditions, producers may have to absorb the losses (in the short run) without the benefit of price increases.

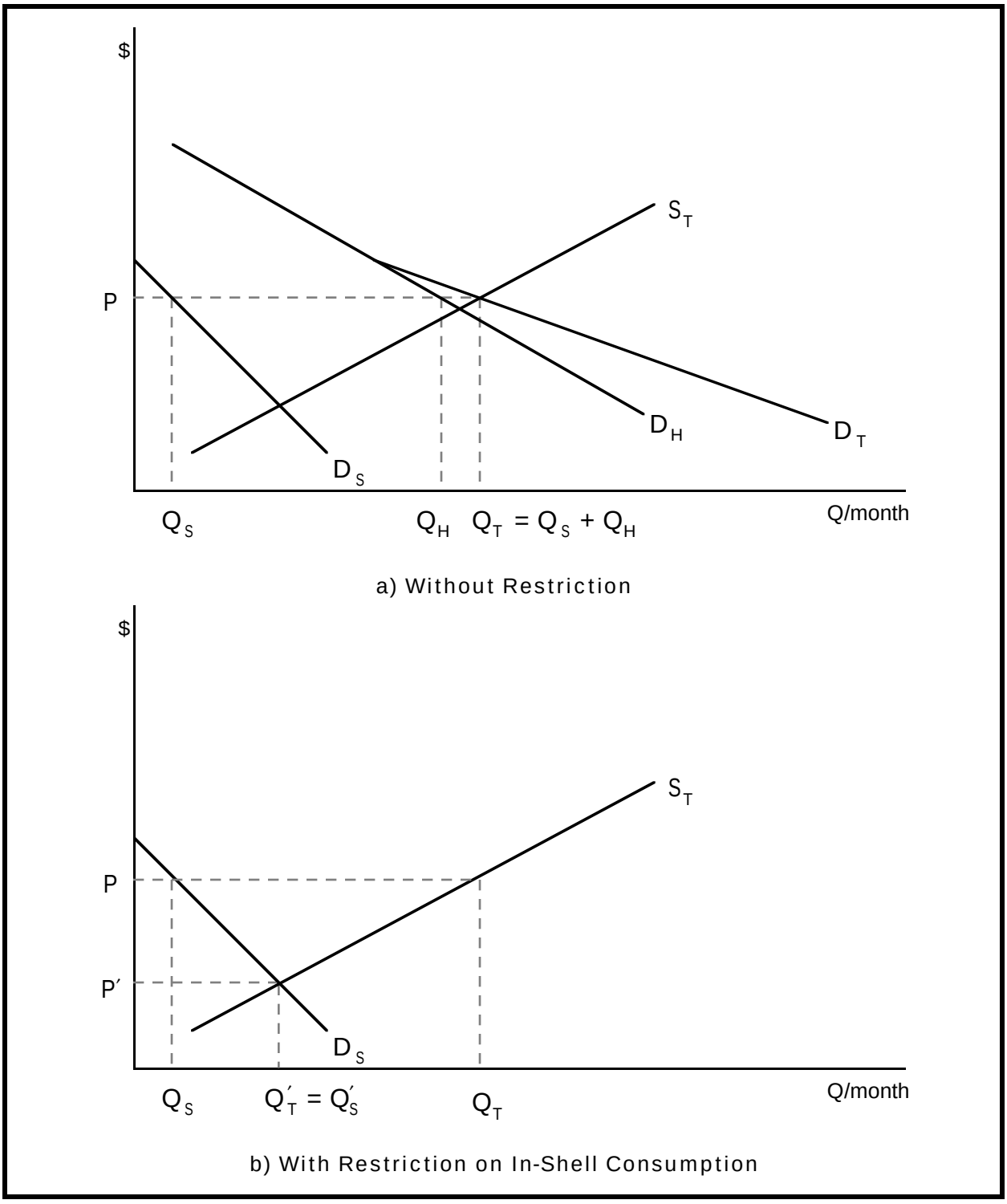
Eliminating or restricting trades between parties will, through the market-clearing process, reorder the terms of trade in the markets: how much is traded, at what price, and between which parties. This reordering will negatively affect some parties and, if the restrictions fall unevenly, may positively affect other parties. We demonstrate how the market model captures these effects in the following sections.

Marketing Restriction. Figure 3-5 demonstrates the effects of a summer in-shell market restriction of the type once recommended by FDA. Panel (a), which is identical to Figure 3-3, illustrates the market without the restriction. With the in-shell market restriction, total Gulf shellstock demand contracts to just the shucked component of the market (see panel b).[2] This change leads to a reduction in the summer oyster price from P to P' and a reduction in harvest quantity from Q_T to Q_T'.

We want to emphasize several important results of the process in Figure 3-5. First, harvested oyster prices and harvest levels decline

[2]Industry observers indicate that consumers typically do not view shucked and in-shell oysters as close substitutes. Therefore, we assume that the restriction on in-shell consumption has no effect on the demand for shucked oysters other than that induced by a change in the price of shucked meats.

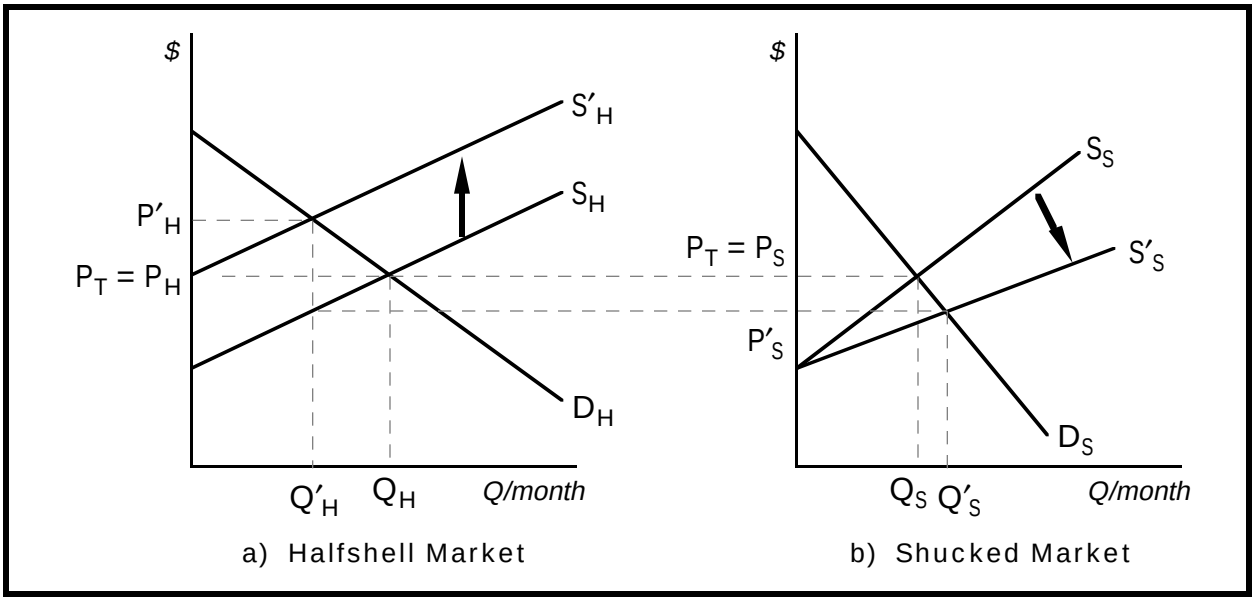
Figure 3-5. Effects of a Marketing Restriction on In-shell Consumption



relative to baseline in the summer with the control option in place. Second, a less obvious but very important result is that some of the decline in oyster harvest due to elimination of the in-shell market is offset by increased sales in the shucked market. The magnitude of this effect will of course depend on oyster prices, harvesting costs, nonoyster harvesting labor opportunity costs, and any informational effects of the control options on shucked oyster demand. These factors will determine the control option's effect on the returns to labor and capital in the summer.

ISSC Time and Temperature Controls. Under the ISSC rule, costs of production will differ for oysters bound for the halfshell market and oysters bound for the shucked meat market. The time and temperature controls cause a subtle but important change in the structure of the shellstock market. Figure 3-6 illustrates the effect.

Figure 3-6. Time and Temperature Controls—Halfshell Oysters



Because of the difference in costs, halfshell bound and shucked-bound shellstock now have separate supply functions. Now the shellstock market can be viewed as two separate markets, each with a unique supply and demand function, instead of the single market in place before the control option. Figure 3-6 illustrates the effects in each market. The time and temperature controls increase the per-unit costs of harvesting oysters for the halfshell market. This

raises the supply function (to S'_H), as shown in panel (a). At the same time, these changes will lead to some substitution of effort from the halfshell-bound to the shucked-bound market, which will not be subject to the same controls. This change is represented by the outward shift in the shucked-bound supply function to S'_S in panel (b). The upward shift in the halfshell market segment raises prices there, while the outward shift in the shucked segment pushes down prices to P'_S in panel (b). In equilibrium, the difference in prices between the two markets will just equal the difference in the cost of serving those markets.

In summary, the ISSC controls lead to a restriction in supply of halfshell oysters that will result in increased prices (a movement along the demand curve for halfshell oysters). Although the supply of halfshell oysters will be reduced, the supply of shucked meat oysters will increase with a resulting decrease in shucked meat prices (a movement along the demand curve for shucked oysters). We expect to see changes in revenues and in the incomes of those in the oyster industry. Total revenue changes for each state/region and for the Gulf will vary depending on the changes in price and quantity. We can use the estimates of price and quantity changes produced by the market model to estimate revenue effects at the individual state and Gulf level.

3.1.2 Data and Model Application

Quantifying the market effects demonstrated in our conceptual discussion requires translating the control-induced changes into numerical terms. As a result, the market model is expressed as a series of mathematical equations representing supply and demand in each affected market. The equations represent the relationship between market prices and the quantity supplied (or demanded). Thus, we need data on market prices and quantities for each affected market as well as values for the mathematical parameters that quantify the relationship between market prices and the demand (or supply) responses.

Price and Quantity Data

The market price and quantity data for each of the Gulf states were gathered from secondary data sources. Chapter 2 explains details of the data collection process and descriptive statistics of the data. All

price and quantity values used in the model are for the summer period (April to October). The market model will generate post-control values for these values. Chapter 4 will report these values.

Model Parameters

To operate the market model the key model parameters must be set to appropriate values. Table 3-1 lists the key model parameters. Chapter 2 provides specific values for most of these parameters. The demand and supply parameters are discussed below. The impacts on and supply responses from the harvesting sector depend critically on the parameters associated with harvesting productivity (with and without the control options) and harvesting income. The supply function (for each producing region) is computed using these data and the method described below.

Because of significantly different harvesting conditions within the Gulf, we defined six distinct suppliers:

- Florida
- Alabama/Mississippi
- Louisiana small boats
- Louisiana medium boats
- Louisiana large boats
- Texas

Demand Function Estimation

Modeling demand responses to changes in price requires a demand function specific to Gulf oysters. This function was estimated econometrically using monthly time-series data for Gulf prices and quantities (National Marine Fisheries Service data) in a simultaneous equations framework. In addition to the Gulf oyster price, Gulf oyster demand was estimated as a function of Gulf income, Northeast U.S. oyster price, Pacific oyster price, and a time-trend variable.

The estimated value for the elasticity of Gulf demand with respect to Gulf price is approximately -1.1, meaning that the percentage change in the quantity of Gulf oysters demanded would be slightly higher than the percentage change in price. Our estimate is virtually identical to Cheng and Capps' (1988) estimated

Table 3-1. Key Market Model Parameters

Baseline harvesting productivity
Bags per day
Days per boat per season
Number of workers per boat
Days per season spent maintaining lease
Average round-trip time to/from beds
Average time spent harvesting
Effects of time and temperature controls on harvesting productivity
Percentage of summer under ISSC Level 4 (6 hour limit)
Percentage of summer under ISSC Level 3 (12 hour limit)
Ratio of operating costs (e.g., gas, supplies) to total variable costs (including labor)
Harvester income/expenses
Revenue
Operating costs
Depreciation
Labor "reservation" wage
Own-price supply parameter (computed from harvest productivity and income parameters)
Own-price demand parameter (estimated with econometric model)
Shellstock demand shares
Percentage of summer output to halfshell market

elasticity for oysters. Cheng and Capps and other studies (Kearney, 1993) show that oyster demand is somewhat more elastic than the demand for other fish species. However, Thurman and Easley (1992) show more elastic demand for red drum (approximately -4.7) than we find for oysters.

Under the marketing restriction, the inward shift of the Gulf demand function is accomplished by reducing Gulf demand quantity by the amount of summer halfshell demand and assuming that the new "shucked-only" demand function has the same relative price

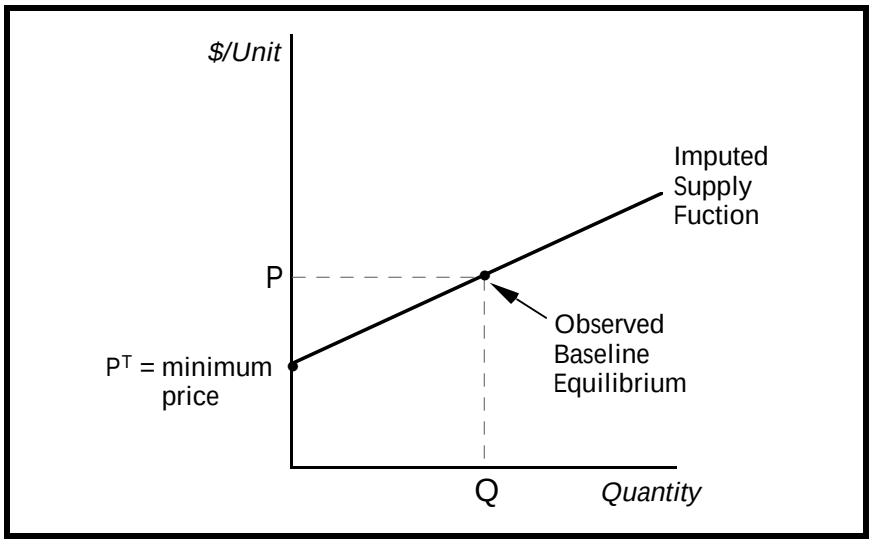
responsiveness (elasticity) as the original demand function including both halfshell and shucked.

Supply Function Estimation

Estimating the supply function for a fishery product is notoriously difficult because of the inherent variability of supply conditions, particularly natural factors such as weather and/or population fluctuations (Kearney, 1993). Consequently, rather than estimate a supply function econometrically, we constructed supply functions using economic principles and the data provided to us in our site visits with harvesters.

Figure 3-7 Illustrates construction of the supply function for a particular region. The minimum "threshold" price, P^T, is the shellstock price at which the corresponding returns to harvesting labor are equal to the minimum wage. This threshold price implicitly assumes that no harvesting would be conducted if the returns to harvesting efforts were less than the minimum wage.

Figure 3-7. Supply Curve Construction



The region's supply function is then constructed, graphically, by connecting a line from the threshold price on the vertical axis to the observed baseline equilibrium price and quantity (P,Q). The slope of this line suggests how elastic (responsive) supply is to changes in price. A flat slope indicates very responsive (elastic) supply and a steep slope indicates a relatively inelastic supply response.

The threshold prices are computed individually for each region based on the average daily boat yield and nonlabor cost data we obtained from site visits. In each case, these threshold prices are connected (via a mathematical equation) to the summer baseline price and quantity values to construct state-specific supply functions.

The post-control supply functions (in the case of the ISSC control option) are then modified to capture the alteration in daily yields obtainable with the time and temperature controls, which will raise the threshold price and shift up the supply function as illustrated in Figure 3-6. The post-control supply function for the Gulf is the sum of the separate supply functions for each region, as illustrated in Figure 3-4.

Model Solution

Each control option imposes a change in one or more of the markets in the system that translates to a change in the associated equations. The change in the equation system means that a new set of prices and quantities provide the *equilibrium* solution to the system. The new solution is computed by iterating supply and demand responses until the new supply quantity equals the new demand quantity at the same price. The iterative solution algorithm is programmed directly into a spreadsheet software package. These new prices and quantities are then compared to the baseline prices and quantities to measure the change in these key values and thus drive the analysis of impacts.

3.1.3 Strengths and Limitations

The objective of this study was to measure the economic impacts of alternatives to restrict oyster harvesting activity for the purpose of controlling *Vibrio vulnificus*-related health effects. Because these restrictions will be imposed directly on the markets for harvested Gulf oysters, measuring the economic impacts begins with quantifying the effects in the market for harvested oysters. Quantifying market effects requires explicit modeling of the behavioral responses of the affected suppliers (harvesters) and demanders (processors) and recognizing that the process of equilibrium will generate new prices and market quantities after the

control option-induced supply and/or demand conditions are incorporated into the system.

The strengths of this approach are perhaps best illuminated by comparing it with the alternative of estimating economic impacts without accounting for supply and demand responses in the oyster market. Suppose that the economic impacts of the marketing restriction were estimated by simply reducing Gulf summer harvests by exactly the amount of the foregone halfshell production and ignoring any effect on shellstock prices. By not recognizing the market responses highlighted above, the "naive" model would, among other things,

- ➤ overestimate harvest reductions,
- ➤ underestimate shucked meat output, and
- ➤ fail to estimate harvester income losses due to a decline in the shellstock price.

These omissions, as we will see in the next chapter, would lead to a significant mischaracterization of economic impacts, as they work through other channels (regional effects, displacement effects) in the impacts model. Similar arguments of accuracy can be made for the time and temperature effects as well. In short, the market model structure for estimating direct effects has both subtle and profound benefits for estimating the size and distribution of economic impacts of the control options.

Perhaps the greatest limitation of the approach is that our model does not explicitly capture all relevant market responses. For instance, control options may induce harvesters and processors to engage in all sorts of innovative activities that are not explicitly captured in the model. Examples of proven and potential innovations uncovered in our background research include

- ➤ installation of on-board refrigeration on oyster boats,
- ➤ introduction of refrigerated "buy boats" or "mother boats" that purchase oysters from the harvesters on the water,
- ➤ individual quick-freezing of oysters during the winter for halfshell sale in the summer, and
- ➤ pasteurization to significantly reduce *Vibrio vulnificus* presence in summer-harvested oysters.

These innovations could significantly affect market outcomes, relative to outcomes projected under to the control option but

absent these innovations. Although we cannot explicitly model the innovation process, we can model special cases (e.g., on board refrigeration for a subset of producers) and estimate their effect on market outcomes.

On the consumer side, our model does not capture the potential effects of the control option on consumer perceptions of product safety. Many individuals associated with the Gulf oyster industry have indicated in personal interviews that the publicity surrounding *Vibrio vulnificus* has led to a significant reduction in the demand for Gulf oysters. If true, projecting the effect of implementing the control options is difficult. On one hand, it may reinforce consumers' concerns about the safety of consuming Gulf oysters; on the other hand it may reinstill some confidence because wary consumers perceive that measures are being taken to make the product safer. Without detailed consumer research, an activity outside of the scope of this study, the consumer confidence question must remain open.

3.2 REGIONAL MODEL

In this section we present the methodology, data requirements, and strengths and limitations of our regional modeling approach.

3.2.1 Methodology

The Gulf oyster market model can only estimate the direct effects of a control option. When a control option is expected to affect a particular geographic region, regional (I-O derived) multiplier models are typically employed to determine the higher-order impacts on that region (Coughlin and Mandelbaum, 1991; Hamilton et al., 1991). I-O models are frequently used to estimate a control option's indirect and induced impacts on employment, earnings, and output in many industries (Coughlin and Mandelbaum, 1991). Indirect impacts are those that occur in "upstream" markets. For example, the effects on sales of harvesting equipment (e.g., dredges, tongs) are indirect effects of a control option that affects the oyster processing industry. Induced impacts are those that occur in "downstream" markets through consumer income effects. For example, the effects on sales of appliances, groceries, and other consumer goods are induced effects of a control option that affects the oyster processing industry.

In general, a positive relationship exists between the size of a region and the size of the multiplier effect. For example, the multiplier for a state will generally be greater than that for an *n*-county substate region, and that for the *n*-county region will in turn be higher than that for any single county in that region. Appropriately defining the "region of analysis" is a very important issue. If the region is defined too "narrowly," the absolute magnitude of the impact will be understated because the multipliers will be too low to capture the entire effects. If the region is defined too "widely," the multipliers will capture the full impacts but the relative magnitude of the impact will be understated because the population base actually affected will be overstated. Ideally, the analyst should keep the region small enough to accurately identify who will experience the impact, while large enough to accurately estimate the full extent of the impact.

Thus, many analysts advocate conducting multiplier analyses using regions defined by real economic boundaries, rather than historical or political boundaries (Hamilton et al., 1991; BEA, 1992). Trade flows often defy political boundaries, so the full effects of a local economic change may not extend to—or be limited by—the state in which it occurs. The Bureau of Economic Analysis of the U.S. Department of Commerce defines "BEA Economic Areas" (hereafter Areas), which consist of one or more economic nodes—metropolitan areas or similar areas that serve as centers of economic activity—and the surrounding counties that are economically related to the nodes (Johnson, 1995). As the 172 BEA Areas represent "functional economic areas" as Hamilton et al. (1994, p. 78) suggest, they represent ideal "units of analysis" for regional multiplier work.

The economic multiplier data used in this analysis were obtained from the U.S. Department of Commerce, Regional Economic Analysis Division. Regional Input-Output Modeling System (RIMS II) multipliers were obtained for each oyster region. Although several forms of multipliers are available from RIMS II, we actually employed the Total Direct Effect Multipliers. A Total Direct Effect Multiplier for employment (earnings) expresses the total regional economic impact (direct, indirect, and induced) relative to a direct change in employment (earnings). Because we have available, from the Gulf oyster market model, estimates of direct control-induced

changes in employment and income, we elected to use the direct effect multipliers.

Although the geographic level of detail (county level) with which the Regional Economic Analysis Division works is quite good, the industry level of detail is less precise than we would have liked for this analysis. The RIMS II multipliers are actually for industries like "fishing" and "fish processing" rather than "oyster harvesting" and "oyster processing." Consequently, the actual total employment effects of losing a job in oyster processing may be greater or less than the estimated total employment effects of losing a job in fish processing.

To compensate for this weakness, we employed a technique recommended by Brucker, Hastings, and Latham (1990) to provide an improved estimate of total impact through use of primary (survey-based) labor market data. In effect, we have independent and reliable estimates of the number of oyster harvesters in each region. Consequently, we do not have to rely on the RIMS II multiplier relationship between fish processing employment and fishing employment. To take advantage of this information, we estimated a "net of harvesting multiplier" in each region by subtracting out the RIMS II fishing employment estimate from each total multiplier and adding back the oyster harvesting employment estimate derived from survey data.

3.2.2 Data

Gulf waters, which are responsible for nearly all *Vibrio vulnificus* deaths, would more likely be targeted for controls than other regions. Summer oyster landings data for 1993 indicate that 87 percent of all oysters harvested in the U.S. are landed in just five states: Louisiana (35 percent), Washington (18 percent), Florida (15 percent), Connecticut (12 percent), and Texas (7 percent). Alabama lands only about 3 percent and Mississippi less than 2 percent of the U.S. total.

Naturally, oyster harvesting and processing is geographically concentrated even within these states. Using county-level data for oyster harvesting, we identified the major counties where oyster harvesting is concentrated in the five Gulf states. We then selected four combinations of BEA Areas that include these major oyster-

producing counties. Each oyster region is composed of between two and four BEA Areas, and the four oyster regions together comprise the "Gulf Oyster Region." By selecting regions for analysis using BEA Areas as building blocks, we attempted to avoid over- or understating the impacts of the control option. (See Chapter 2 of this report for the composition and boundaries of these regions.)

Table 3-2 presents the employment multipliers used in this analysis. The total multiplier for a given region expresses the total change in that region's employment that can be expected as a result of a direct one-job change in the oyster processing industry in that region. For example, a direct control-induced loss of one job in the oyster processing industry in the "Florida" oyster region would result in a total job loss of 3.06 jobs in the region (including the direct job loss itself).

Table 3-2. Regional Economic Multipliers—Employment

	Florida	MS/AL	Louisiana	Texas
Total multiplier	3.06	2.32	2.71	2.41
Net multiplier	2.80	2.18	2.48	2.27

Note: See Chapter 2 of this report for the definitions of these four regions.

The net multipliers are also shown in Table 3-2. The net multiplier for the Florida region, for example, indicates that 2.80 jobs in all industries except oyster harvesting depend on each job in the processing industry. Multiplying this net multiplier times the estimated direct job loss in the Florida region attributable to a control option yields the estimated employment loss in the region in all industries except oyster harvesting. Adding back our survey-based employment estimate for the harvesting sector yields, we believe, an improved total impact estimate.

Table 3-3 presents the earnings multipliers used in this analysis. The total multiplier for a given region expresses the total change in that region's earnings that can be expected as a result of a direct one-dollar change in earnings in the oyster processing industry in that region. For example, a direct control-induced loss of $1,000 in earnings in the oyster processing industry in the "Florida" oyster

Table 3-3. Regional Economic Multipliers—Earnings

	Florida	MS/AL	Louisiana	Texas
Total multiplier	3.34	2.75	3.31	3.09
Net multiplier	3.05	2.59	3.02	2.91

region would result in a total earnings loss of $3,340 in the region (including the direct earnings loss itself).

The net multipliers are also shown in Table 3-3. The net multiplier for the Florida region, for example, indicates that $3,050 in earnings in all industries except oyster harvesting depend on each $1,000 of earnings in the processing industry. Multiplying this net multiplier times the estimated direct earnings loss in the Florida region attributable to a control option yields the estimated earnings loss in the region in all industries except oyster harvesting. Adding back our survey-based earnings estimate for the harvesting sector yields, we believe, an improved total impact estimate.

3.2.3 Strengths and Limitations

The main advantage of the multiplier-based approach employed in this analysis is its recognition that the employment and earnings impacts of control options to control *Vibrio vulnificus* in Gulf oysters would not be confined to the harvesting and processing industries alone. Instead, economic impacts can reverberate through a region—especially a region that is heavily dependent on the regulated industry.

The limitations of the approach are common to any regional multiplier analysis. The multiplier estimates are only as good as the estimates of the direct impacts and the multipliers themselves. We have attempted to address both of these limitations by employing an economic impacts model of the Gulf oyster industry specifically designed to yield good estimates of the impacts of control options to control *Vibrio vulnificus* and by carefully defining our regions of analysis and incorporating primary survey data into the model to fine-tune the RIMS II multipliers.

3.3 DISPLACEMENT MODEL

Our economic market model and the regional I-O model capture the potential employment and earnings impacts for the Gulf oyster industry. To examine additional impacts on people who would be displaced from the oyster industry, we include a worker displacement model. Our model of worker displacement examines both the quantitative and qualitative effects of workers losing their jobs. Generally, worker displacement may result in workers finding similar jobs in other industries, changing occupations altogether, experiencing a period of unemployment, or suffering extended joblessness. The qualitative costs of worker dislocation include loss of health insurance and increased stress and stress-related health problems. These qualitative effects of worker displacement may be significant depending on the economic conditions for the individuals and their communities.

Primarily, two disciplines examine the costs of worker displacement: health and economics. Typically, health researchers, such as physicians and psychologists, are concerned about the mental and physical health of individuals who suffer from economic insecurity or lose their jobs. Economists, in general, concern themselves with studying the permanent income losses that result from labor displacement. Some health economists and policy analysts also investigate the health impacts of income losses. Here, we examine research in several fields of study to characterize the potential worker displacement effects of changes for the Gulf oyster industry.

3.3.1 Methodology

As a result of being displaced, workers' re-employment wages may be lower than their earnings prior to their displacement. Many economists have examined this cost of worker displacement. Economists characterize this cost as a change in an individual's long-run permanent income path that often results from a worker being displaced from his or her occupation or industry. Ideally, we would like to adopt and transfer estimates of these net wage losses from published studies of displaced workers (e.g., Addison, Fox, and Ruhm, 1995; Fallick, 1993; Carrington and Zaman, 1994; Jacobson, LaLonde, and Sullivan, 1993; Carrington, 1993; Farber, 1993; Kletzer, 1992; Ruhm, 1991a and 1991b; Hamermesh, 1989;

Horvath, 1987). However, transferring estimates of re-employment earnings, length of unemployment, and worker dislocation costs from previous studies is invalid for this investigation of the Gulf oyster industry for several reasons.

The previous economic research estimating the costs of worker displacement focuses on blue collar manufacturing workers (e.g., plant closures). The data used for these analyses either explicitly exclude agricultural workers in farming, fishing, and forestry from analysis or include only a meager number of industry observations (e.g., Fallick [1993] includes farming but only 1.5 percent of the observations are in this industry). Evans and Leighton (1995) clearly state that, although the Displaced Worker Survey of the U.S. Bureau of Labor Statistics includes agricultural workers, researchers almost always exclude agricultural workers from their analyses.

Although we can rely on the previous research to indicate the direction of changes that may be expected for Gulf oyster fisherman and shuckers, we cannot generalize the previous estimates of changes in wages and employment because these estimates are not representative of the fishing industry.

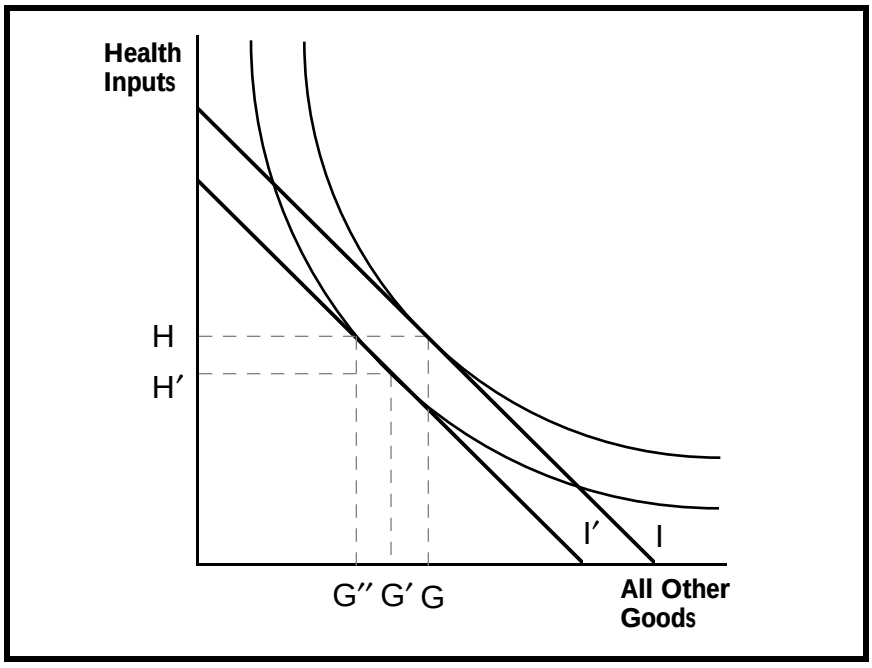
The literature characterizing or estimating the nonearnings consequences and costs borne by displaced workers suggests that the qualitative costs and consequences include health insurance loss as well as adverse mental and physical health effects. Control changes can affect the health of people earning their livelihood in the Gulf oyster industry through several mechanisms:

- ➤ increased unemployment and joblessness,
- ➤ reduced health insurance coverage, and
- ➤ reduced expenditures on health-producing goods and services resulting from reduced permanent income.

Analysts have examined the association between health or mortality and changes in disposable and permanent income (Wildavsky, 1979; Keeney and Winterfeldt, 1986; Duleep, 1989; Graham, Hung-Chang, and Evans, 1992; Chapman and Hariharan, 1994; Lutter and Morrall, 1994). Economists examine the relationship in terms of consumers' demand for health inputs such as nutrition, safety devices, and medical care. With a reduction in income, consumers can no longer purchase the same bundle of goods and services as they purchased prior to the shift in their budget

constraint. Figure 3-8 illustrates the case. Prior to the income reduction, a consumer's income constraint permitted the purchase of H amount of health inputs and G amount of all other goods. The income reduction would shift the income constraint to I'. To continue consuming H amount of health inputs, a consumer would have to reduce consumption of all other goods from G to G''. However, it is more likely that a consumer would continue to trade off health inputs with other goods and services in such a manner as to reduce consumption of health inputs from H to H' and consumption of all other goods and services from G to G'. This illustrates the observation that richer is safer and poorer is riskier.

Figure 3-8. Health Consumption Indifference Curve



However, others have observed that increased incomes may be associated with poorer health (Ruhm, 1995). People may purchase more tobacco, alcohol, high cholesterol foods, or travel that may put them at greater risk of morbidity and mortality. Employment itself may put individuals at risk of injury or greater stress (Viscusi, 1994; French and Dunlap, 1995; Zemke, 1991; Kottage, 1992; Malik, 1993). Nonetheless, the comparative risks to health from employment relative to joblessness are open to speculation.

Health risks may increase with worker dislocation if the dislocation results in the loss of health insurance. According to several studies,

workers may indeed lose their health insurance with their loss of employment (Horvath, 1987; Podgursky and Swaim, 1987; Gruber and Madrian, 1995). As shown in January 1992 Current Population Survey (CPS) data, 33 percent of displaced workers who had health benefits during their previous employment were no longer covered by any form of health insurance (Gardner, 1993). Without health insurance, individuals or family members may delay seeking treatment for medical ailments until they have become more severe.

Although the precise mechanisms or epidemiology of health outcomes is unclear, research shows that individuals often suffer physical and mental health problems following job loss (Bjorkland, 1985; Catalano, 1991; Fenwick and Tausig, 1994). Their suffering is characterized by physical and mental outcomes, including stigma, anxiety, illnesses, substance abuse, and suicide (Schapiro and Ahlburg, 1982-1983). According to van Raaij and Antonides (1991), the health effects from unemployment or joblessness include reduced activity and stimulation, feelings of reduced self-worth from being an increased burden to family members, and feelings of reduced social contribution and usefulness.

People across ages, locations, and education levels may suffer significant mental distress when jobless. Certain characteristics (e.g., higher education and age, lower local unemployment rate) are associated with greater distress (Clark and Oswald, 1994). High levels of stress and distress have been shown to be associated with cognitive, emotional, and behavioral dysfunctions (U.S. Public Health Service, 1990). Suicide, substance abuse, and violent behavior are among the most deleterious dysfunctions.

Research focusing on the health effects of economic uncertainty show strong correlation between job loss and psychological distress as well as nonspecific physiological illness (Catalano, 1991; Jin, Shah, and Svoboda, 1995). Studies investigating the life events common among those who commit suicide indicate that financial trouble, job problems and unemployment often precede the suicide (Heikkinen et al., 1995). In other research, poor economic conditions have been linked to increased suicide rates (Yang, 1992).

Dooley and Catalano (1980) present a model relating economic change to behavior disorder. According to their model, the determinants of mental illnesses related to economic change

include whether the economic change affects the community or only the individual. When the community is affected, the individual has reduced social support. Reduced social support further stresses the individual in the community. If only the individual is affected, the social supports may facilitate coping or treatment seeking behaviors in the individual. In Dooley and Catalano's model, the likelihood that an individual will experience mental illness depends on society's economic environment as well as the individual's economic situation.

Recent research confirms that feelings of self-worth and depression vary significantly among the unemployed and the employed (Sheeran, Abrams, and Orbell, 1995). Among the unemployed, high unemployment rates are related to less distress. Sheeran, Abrams, and Orbell explain this phenomenon by stating that self-blame is less if unemployed people attribute their job loss to external factors, such as recessions, than if they attribute their loss to personal factors such as laziness.

3.3.2 Data

Stress or distress is often the identified risk indicator for physical and mental health effects (e.g., cardiovascular disease, suicide) in many studies of workers' response to joblessness and unemployment. To identify the level of economic and psychological stress, we examined the employment to working age population ratio and the unemployment rate. The unemployment rate indicates the number of individuals seeking employment in a specific area. The employment to working age population ratio indicates the proportion of the population that is gainfully employed. Together, these two indicators describe the prevalence of unemployment in an area. Joblessness carries greater stigma in areas with higher employment (i.e., less unemployment). However, the economic stress of being unemployed is greater in areas with higher unemployment. For these reasons, we examined the level of employment in each BEA oyster region and in those counties with the greatest Gulf oyster landings.

To gather information about next-best employment opportunities and net-wage impacts, RTI staff conducted site visits and telephone interviews with industry and regulatory representatives in the Gulf states. We also consulted with academic experts and reviewed

published literature to directly determine current and next-best opportunities for oyster industry employment. We relied on the previous research to indicate the direction of changes that may be expected for Gulf oyster fisherman and shuckers. However, we did not generalize from the previous estimates of changes in wages and employment because these estimates are not representative of the fishing industry.

3.3.3 Strengths and Limitations

The inclusion of qualitative effects is the primary strength of our worker dislocation model. By examining the employment to population ratio and the unemployment rate in each oystering county, we will be able to explore the potential for physical and mental health effects that may result from worker dislocation in the Gulf oystering industry. Our review of the literature provides insights into the potential health effects of worker dislocation.

Another strength of our model is that we directly observe the current and next-best opportunities of workers in the Gulf oyster industry. Our use of personal interviews, Bureau of Labor Statistics data on growth industries, and previous research identifies current and potential opportunities and challenges for oyster industry workers.

Unfortunately, our quantitative estimates are limited to descriptive statistics. Our primary data collection does not yield a sample large enough to produce statistically reliable estimates of worker dislocation costs. Individual responses to worker dislocation may vary widely depending on unobservable personal characteristics that may decrease or increase the health effects for oyster industry workers and their families.

We discourage using our results to generalize specific point estimates for health or net-wage effects. Our research provides substantial insight into the potential worker dislocation effects for oyster industry workers and their families. The focus on their employment outlook reveals industries that may offer them opportunities and identifies the level of employment and unemployment in their communities. Overall, this model of worker dislocation presents a landscape of opportunities and challenges that oyster industry workers may face.

3.4 SUMMARY

In this chapter we have presented our analytical approach for estimating the economic impacts of alternative remedies for controlling *Vibrio vulnificus*-related illness. Evaluating the economic impacts involves considering the direct effects of the control option on the Gulf oyster industry, the indirect effects on other regional industries linked to the oyster industry, and the economic costs associated with worker displacement. We describe the conceptual and operational underpinnings of the models we developed to estimate these impact components and discuss the strengths and limitations of our selected modeling approaches. In the next chapter, we present the results of the economic impact analysis.

4 Results: Direct and Indirect Effects and Displacement Effects

As discussed previously, the ISSC interim agreement or other control options once recommended to the ISSC by FDA would impose some costs on Gulf oyster producers. Those costs and resulting economic impacts on the oyster industry would then, indirectly, affect other industries in the Gulf.[1] The direct impacts on the oyster industry would include reductions in the oyster harvesting and processing workforce. These employment changes would induce worker displacement costs. To capture the possible direct and indirect effects and worker displacement effects of the ISSC interim agreement and control options that were once recommended to the ISSC by FDA, we employed a multifaceted methodology that includes an economic model, regional model, and worker displacement model.

Using this methodology of modeling economic, regional, and worker displacement effects, we analyzed the potential impacts of control changes for the Gulf oyster industry. In Chapter 3, we present the methodology, data requirements, and strengths and limitations underlying each of our three models. In this chapter, we report the results of our study for direct and indirect effects and displacement effects.

[1] Although economic impacts on Gulf oystering could have impacts beyond the Gulf, we will limit the scope of this analysis to the economic impact in the Gulf region.

4.1 DIRECT AND INDIRECT EFFECTS

This section presents the results of our analysis quantifying both the direct effects of the control alternatives on the oyster industry and the indirect effects on other sectors of the economy affected by oyster restrictions. We first define the baseline against which the impact comparisons are made and then describe the projected impacts of the different options.

The first control option evaluated is the in-shell marketing restriction, because it was the focus of FDA's control efforts at the time this project began (i.e., FDA "Option 2"). Over time, however, the more relevant approach has evolved toward the enactment of time and temperature controls for oyster harvesting, such as those specified in the ISSC interim agreement. Therefore, we devote most of this discussion to the estimated impacts for the ISSC time and temperature controls.

As we wrote this report, the ISSC interim control plan was still being refined. We will see below that subtle changes in the control option can have important effects on the resulting economic impacts. Therefore, the estimated impacts here should be interpreted with a fair amount of caution. To address this uncertainty, we repeatedly modify control and other assumptions and generate different impacts. This approach provides a range of estimates and a broader sense of likely impacts of a range of control options.

4.1.1 Baseline Conditions

Table 4-1 presents the price, quantity, employment, and processing information for each Gulf state. The data represent our best estimate of the baseline for our simulations. Chapter 2 describes the characteristics of these data. Note that the baseline reflects the summer (April through October) levels of these variables averaged over the period 1989 to 1993.[2]

Some harvesters and some boats are only engaged in harvesting oysters part-time, and some harvesters and equipment are more efficient than others. To place all harvesting activity on a comparable basis, we convert all employment and boat activity to a Full-time Equivalent (FTE). For example, two harvesters spending half of their time harvesting oysters and the rest of their time on other activities equals one FTE harvester.

[2]Prices from different years were converted to real dollars (base year 1993) using the consumer price index (Monthly Labor Review, October 1995).

Table 4-1. Baseline Conditions (April through October)
Louisiana boats harvest the largest share of Gulf oysters.

	Gulf Baseline	Florida Baseline	Alabama Baseline	Lousiana Baseline	Texas Baseline
Quantity of Oysters Harvested	7,527,444	1,143,490	239,199	5,397,886	746,870
Quantity Sold as Halfshell	4,261,388	1,029,141	47,840	2,698,943	485,465
Quantity Sold as Shucked	3,266,055	114,349	191,359	2,698,943	261,404
Price of In-shell Meat	$2.41	$2.62	$1.40	$2.40	$2.64
Price of Shucked Meat	$2.41	$2.62	$1.40	$2.40	$2.64
Value of Harvested Oysters	$18,267,928	$3,000,656	$335,948	$12,961,185	$1,970,139
Number of FTE Tong Boats	248	208	41	0	0
Number of FTE Dredge Boats	230	0	0	210	20
Income per Harvester[a]	$17,158	$11,423	$5,237	$19,690	$21,791
Number of FTE Processing Workers	899	190	223	392	94
Number of FTE Harvesters	900	208	41	572	80
Number of Other FTE Workers Dependent on Oyster Industry	1,305	341	264	580	119
Total Employment Dependent on Oyster Industry	3,104	739	527	1,545	293

Note: FTE = Full-time equivalent.
[a]Income includes profits to boat owners.

The number of "Other FTE Workers" is calculated based on regional RIMS employment multipliers using processing employment as a base.

4.1.2 Economic Impacts of an In-shell Marketing Restriction

The in-shell marketing restriction, once recommended to the ISSC by FDA, refers to prohibition of the sale of Gulf-harvested oysters for (presumptively raw) in-shell consumption during the months of April through October. As a result, all shellstock harvested during those months would have to be shucked prior to sale and labeled "not for raw consumption." As indicated in Chapter 3, this prohibition is equivalent to eliminating the entire summer halfshell market for Gulf oysters. This forced reduction in shellstock demand is projected to reduce the Gulf price and total Gulf harvests.

Table 4-2 provides the results of a marketing restriction simulation. The quantity of oysters harvested in the entire Gulf would decline by roughly 40 percent if the marketing restriction were imposed. The number of harvesters would decline by 42 percent and the number of processing employees would fall by nearly 8 percent. The overall decline in oyster-dependent employment would decrease by 17 percent.

The effect of the restriction is mitigated in the processing sector because the processing of shucked oysters is more labor intensive than the processing of oysters for the halfshell market. Also note that the restriction actually leads to an increase in shucked output by 37 percent; therefore, some of the in-shell processing jobs lost are replaced by shucking jobs. The over 6 percent decline in other jobs represents employees in shipping, retail, packaging, and other industries related to the oyster industry.

The largest absolute impact of the marketing restriction would, of course, be felt in Louisiana because of its dominant role in Gulf oyster production. The relative effect, however, would be somewhat smaller in Louisiana than in other states, partly because processors there principally shuck oysters. Because of this specialization, many of the jobs in halfshell processing would be offset by job gains in shucking. Harvesting in Louisiana, however, declines somewhat more than harvesting in Texas, primarily because technological factors (the existence of a sizable small boat fleet) cause Louisiana harvesters to be more price responsive overall.

Table 4-2. Marketing Restriction for In-Shell Consumption

Total Gulf harvest declines by 40 percent and prices fall by 25 percent. The effect of the restriction is mitigated in the processing sector because the processing of shucked oysters is more labor intensive than for in-shell oysters.

	Gulf		Florida		Alabama		Lousiana		Texas	
	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact
Quantity of Oysters Harvested	4,520,578	–39.9%	603,474	–47.2%	0	–100.0%	3,407,041	–36.9%	510,064	–31.7%
Quantity Sold as Halfshell	0	–100.0%	0	–100.0%	0	–100.0%	0	–100.0%	0	–100.0%
Quantity Sold as Shucked	4,520,578	+38.4%	603,474	+427.7%	0	–100.0%	3,407,041	+26.2%	510,064	+95.1%
Price of In-shell Meat	$1.82	–24.6%	$2.03	–22.6%	N/A	–42.2%	$1.81	–24.7%	$2.04	–22.5%
Price of Shucked Meat	$1.82	–24.6%	$2.03	–22.6%	N/A	–42.2%	$1.81	–24.7%	$2.04	–22.5%
Value of Harvested Oysters	$8,429,563	–53.9%	$1,225,775	–59.1%	$0	–100.0%	$6,160,738	–52.5%	$1,043,050	–47.1%
Number of FTE Tong Boats	110	–55.9%	110	–47.2%	0	–100.0%	0	+0.0%	0	+0.0%
Number of FTE Dredge Boats	141	–38.5%	0	+0.0%	0	+0.0%	128	–39.2%	14	–31.7%
Income per Harvester[a]	$13,005	–24.2%	$8,160	–28.6%	$0	–100.0%	$14,343	–27.2%	$16,233	–25.5%
Number of FTE Processing Workers	831	–7.6%	164	–13.6%	133	–40.3%	439	+11.9%	94	+0.8%
Number of FTE Harvesters	520	–42.3%	110	–47.2%	0	–100.0%	356	–37.8%	54	–31.7%
Number of Other FTE Workers Dependent on Oyster Industry	1,223	–6.3%	295	–13.6%	158	–40.3%	649	+11.9%	120	+0.8%
Total Employment Dependent on Oyster Industry	2,572	–17.1%	569	–23.0%	291	–44.9%	1,444	–6.5%	269	–8.0%

Note: FTE = Full-time equivalent.

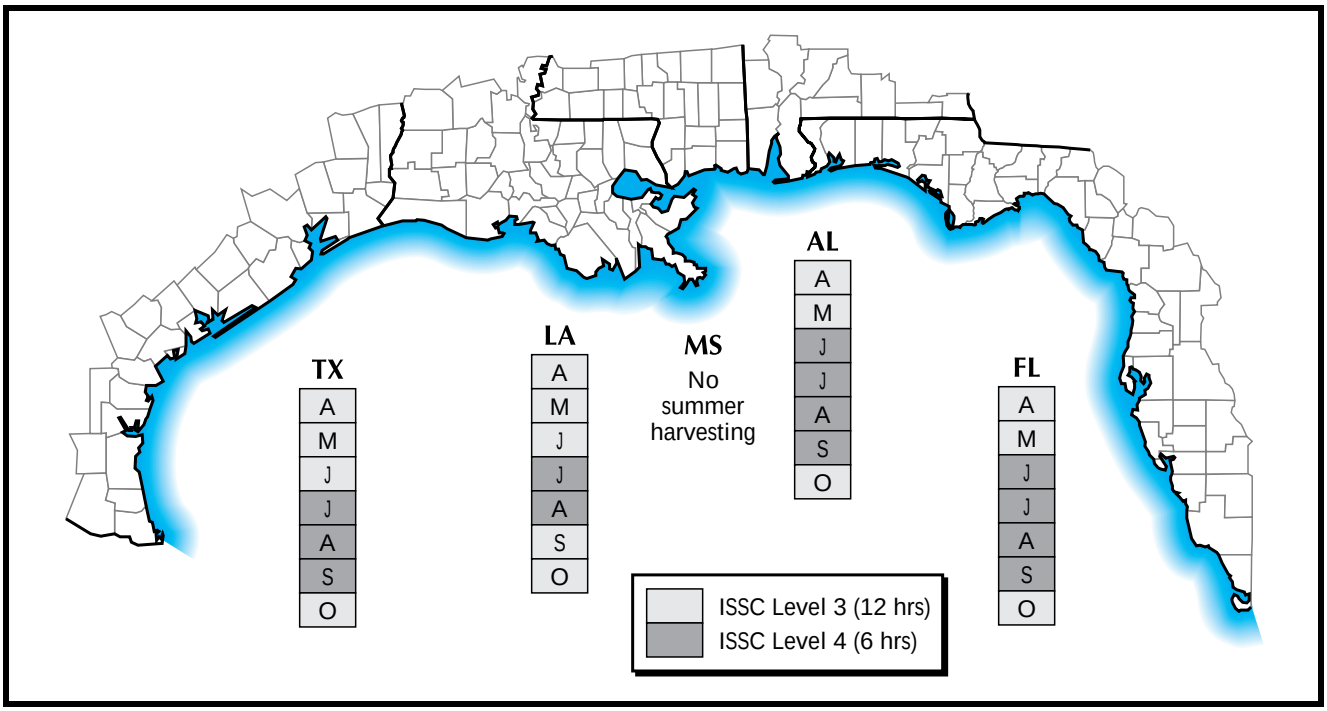
[a]Income includes profits to boat owners.

Under the marketing restriction, Alabama harvesters are projected to withdraw from the summer market. Alabama harvesters exit because the price of oysters in Alabama falls to a level that makes harvesting unprofitable. By assumption, Alabama processors will continue to import oysters from other Gulf states, principally from Louisiana. However, Alabama processing employment is projected to fall by 40 percent under this control simulation.

4.1.3 Economic Impacts of Time and Temperature Controls

Under the ISSC interim agreement time and temperature controls place limits on the amount of time between the oyster harvest and storage in an environment with ambient temperature below 45 degrees Fahrenheit. Any oysters destined for the raw in-shell market must comply with these time limits. The time limits depend on the month of the year and that month's average water temperature for the previous 5 years. Figure 4-1 illustrates the months for which the different states will be under the different levels of restriction.

Figure 4-1. ISSC Restriction Levels — Morning Temperature Basis
All four affected states are at ISSC Levels 3 or 4 all summer-long.



As explained in Chapter 3, time and temperature controls restrict the productivity of oyster harvesting activity by reducing the amount of time spent harvesting each day. The effects are most extreme under the Level 4 (6-hour) restriction, which would substantially shorten daily harvesting time for many, but not all, Gulf harvesters. The exception is for tongers in Alabama and Florida. Alabama harvesters are already effectively subject to a 6-hour restriction for the entire summer, and Florida harvesters typically harvest for not much more than 6 hours in the summer and have relatively short trips from the harvesting beds to the processors (where refrigeration is located). The situations in Alabama and Florida contrast with dredging operations in Louisiana and Texas, where the dredge boats often make trips of 2 to 4 hours each way between port and the harvesting beds. Therefore a 6-hour restriction can be very binding for those producers.

The ISSC "standard" scenario reflects the following assumptions, each of which will be varied in the sensitivity analysis below.

1. Time and temperature controls are enforced by boat day. In other words, a harvesting boat either harvests ISSC matrix-compliant oysters or spends the day harvesting oysters noncompliant with the ISSC matrix, but not both. For modeling purposes, this daily decision is applied for the entire season.
2. Noncompliant oysters can only be sold on the shucked market, while compliant oysters can be sold on the halfshell market.
3. The ISSC level in place for the month is based on average daily morning temperature.
4. Harvest boats do not respond by installing on-board refrigeration.
5. There are no limitations on the ability of Alabama summer-harvested oysters to serve the halfshell market.

Table 4-3 displays the results of this simulation. The market reacts to the ISSC restriction by placing a premium of $0.20 per pound of meat on oysters suitable for in-shell consumption. Because harvesting activity in Florida and Alabama is not substantially affected by the 6-hour limit, harvesters there are projected to specialize in halfshell oysters to take advantage of the price premium. However, harvesters in Louisiana and Texas who are strongly affected by the 6-hour limit find it too costly to supply halfshell oysters under these conditions. Therefore, the harvesters in Texas and those in Louisiana that harvest from distant beds will be better-off specializing in the shucked market with no time-temperature restrictions, despite the lower price for shucked meats. In essence, these

Table 4-3. ISSC "Standard" Scenario: Time and Temperature Control Applied to Halfshell Oysters Only
Impacts are lower under ISSC time and temperature controls than with the in-shell marketing restriction because harvesting of in-shell oysters is allowed subject to handling restrictions.

	Gulf		Florida		Alabama		Lousiana		Texas	
	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact
Quantity of Oysters Harvested	7,376,185	–2.0%	1,185,092	+3.6%	503,384	+110.4%	4,966,950	–8.0%	720,760	–3.5%
Quantity Sold as Halfshell	4,003,472	–6.1%	1,185,092	+15.2%	503,384	+952.2%	2,314,996	–14.2%	0	–100.0%
Quantity Sold as Shucked	3,372,713	+3.3%	0	–100.0%	0	–100.0%	2,651,953	–1.7%	720,760	+175.7%
Price of In-shell Meat	$2.55	+5.6%	$2.76	+5.2%	$1.54	+9.7%	$2.54	+5.7%	$2.77	+5.2%
Price of Shucked Meat	$2.35	–2.7%	$2.56	–2.5%	$1.34	–4.7%	$2.34	–2.7%	$2.57	–2.5%
Value of Harvested Oysters	$17,969,196	–1.6%	$3,271,203	+9.0%	$775,537	+130.9%	$12,068,310	–6.9%	$1,854,145	–5.9%
Number of FTE Tong Boats	306	+23.1%	220	+6.0%	86	+110.4%	0	+0.0%	0	+0.0%
Number of FTE Dredge Boats	219	–4.5%	0	+0.0%	0	+0.0%	200	–4.6%	19	–3.5%
Income per Harvester[a]	$16,203	–5.6%	$11,837	+3.6%	$6,038	+15.3%	$19,088	–3.1%	$21,179	–2.8%
Number of FTE Processing Workers	896	–0.4%	194	+2.2%	233	+4.5%	375	–4.4%	93	–0.4%
Number of FTE Harvesters	930	+3.3%	220	+6.0%	86	+110.4%	547	–4.4%	77	–3.5%
Number of Other FTE Workers Dependent on Oyster Industry	1,298	–0.5%	349	+2.2%	276	+4.5%	555	–4.4%	119	–0.4%
Total Employment Dependent on Oyster Industry	3,124	+0.6%	763	+3.3%	594	+12.7%	1,477	–4.4%	289	–1.2%

Note: FTE = Full-time equivalent.

[a]Income includes profits to boat owners.

results imply that the ISSC restriction would cause an income transfer from Louisiana and Texas harvesters to Florida and Alabama harvesters.

The aggregate economic impact Gulfwide is not nearly as large under the ISSC plan as it would be under the marketing restriction. The quantity of oysters harvested falls by about 2 percent, but the number of harvesters actually increases by 3.2 percent because more labor-productive dredging in Louisiana and Texas is replaced by less labor-productive tonging in Florida and Alabama. Total Gulf employment is projected to actually increase very slightly (0.6 percent) because of this regional shift in production. This employment increase, though, does not raise aggregate income Gulfwide because the increased harvest activity in Florida and Alabama is at a lower wage than the reduced harvesting activity in Louisiana and Texas.

4.1.4 Sensitivity Analysis

The impact of the ISSC controls vary with the nature and scope of the restrictions. In this section, we alter the model conditions to allow for more and less restrictive assumptions. Combined with the standard scenario, this approach generates a range of potential outcomes under the ISSC controls. In Tables 4-4 through 4-7 we present impacts of various extensions of the standard ISSC control plan that was presented in Table 4-3. We briefly describe each scenario but leave it to the reader to review each set of results. The caption of each table presents the key points of each scenario.

Expanded Harvesting Enforcement

Because it could be difficult for enforcement officials to monitor which oysters are harvested under the time and temperature controls and which are not, we consider a scenario in which the ISSC controls would be imposed on all harvesting activity, not just oysters bound for in-shell consumption. Table 4-4 presents the results of that model scenario.

On-boat Refrigeration

We initially assumed that harvesters will not install refrigeration units on their boats as an alternative form of compliance. However, our site visits indicated that this option may be feasible in some cases, because some boats already have these units installed. The simulation in Table 4-5 allows large Louisiana boats to adopt on-boat refrigeration, thereby

Table 4-4. ISSC Time and Temperature Control Applied to All Oyster Harvesting
If the 6-hour limit was applied to all harvesting, the impact of the control is greater in Louisiana and Texas where the 6-hour limit is binding. These impacts are partially offset by gains in Florida and Alabama.

	Gulf		Florida		Alabama		Lousiana		Texas	
	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact
Quantity of Oysters Harvested	6,795,035	–9.7%	1,267,440	+10.8%	686,823	+187.1%	4,264,282	–21.0%	576,490	–22.8%
Quantity Sold as Halfshell	3,784,920	–11.2%	1,140,696	+10.8%	137,365	+187.1%	2,132,141	–21.0%	374,718	–22.8%
Quantity Sold as Shucked	3,010,115	–7.8%	126,744	+10.8%	549,459	+187.1%	2,132,141	–21.0%	201,771	–22.8%
Price of In-shell Meat	$2.64	+9.6%	$2.85	+8.8%	$1.64	+16.4%	$2.63	+9.6%	$2.87	+8.7%
Price of Shucked Meat	$2.64	+9.6%	$2.85	+8.8%	$1.64	+16.4%	$2.63	+9.6%	$2.87	+8.7%
Value of Harvested Oysters	$17,618,260	–3.6%	$3,618,350	+20.6%	$1,123,093	+234.3%	$11,223,105	–13.4%	$1,653,712	–16.1%
Number of FTE Tong Boats	352	+41.8%	235	+13.3%	117	+187.1%	0	+0.0%	0	+0.0%
Number of FTE Dredge Boats	218	–5.0%	0	+0.0%	0	+0.0%	200	–4.5%	18	–9.8%
Income per Harvester[a]	$15,343	–10.6%	$12,346	+8.1%	$6,594	+25.9%	$18,168	–7.7%	$20,074	–7.9%
Number of FTE Processing Workers	809	–10.0%	188	–1.1%	208	–6.9%	333	–15.1%	80	–14.1%
Number of FTE Harvesters	955	+6.1%	235	+13.3%	117	+187.1%	531	–7.1%	72	–9.8%
Number of Other FTE Workers Dependent on Oyster Industry	1,178	–9.7%	338	–1.1%	246	–6.9%	493	–15.1%	102	–14.1%
Total Employment Dependent on Oyster Industry	2,943	–5.2%	761	+3.0%	570	+8.1%	1,357	–12.2%	255	–13.0%

Note: FTE = Full-time equivalent.

[a]Income includes profits to boat owners.

Table 4-5. On-Boat Refrigeration in Louisiana

If large boats in Louisiana invested in on-boat refrigeration, they would take advantage of the in-shell price premium and specialize in supplying the in-shell market. The overall impact is positive because producers in the in-shell market are more price responsive than those specializing in the shucked market.

	Gulf		Florida		Alabama		Lousiana		Texas	
	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact
Quantity of Oysters Harvested	7,533,621	+0.1%	1,126,033	–1.5%	371,825	+55.4%	5,325,003	–1.4%	710,760	–4.8%
Quantity Sold as Halfshell	4,119,564	–3.3%	1,126,033	+9.4%	371,825	+677.2%	2,621,705	–2.9%	0	–100.0%
Quantity Sold as Shucked	3,414,058	+4.5%	0	–100.0%	0	+0.0%	2,703,298	+0.2%	710,760	+171.9%
Price of In-shell Meat	$2.48	+2.8%	$2.69	+2.6%	$1.47	+4.9%	$2.47	+2.8%	$2.71	+2.6%
Price of Shucked Meat	$2.32	–3.7%	$2.53	–3.4%	$1.31	–6.4%	$2.31	–3.8%	$2.55	–3.4%
Value of Harvested Oysters	$18,111,080	–0.9%	$3,031,826	+1.0%	$547,638	+63.0%	$12,720,993	–1.9%	$1,810,623	–8.1%
Number of FTE Tong Boats	221	–3.6%	0	+0.0%	0	+0.0%	202	–3.5%	19	–4.8%
Number of FTE Dredge Boats	272	+9.7%	209	+0.7%	63	+55.4%	0	+0.0%	0	+0.0%
Income per Harvester[a]	$16,804	-2.1%	$11,472	+0.4%	$5,639	+7.7%	$19,744	+0.3%	$20,944	-3.9%
Number of FTE Processing Workers	913	+1.5%	192	+1.3%	234	+5.0%	393	+0.0%	94	+0.1%
Number of FTE Harvesters	908	+0.9%	209	+0.7%	63	+55.4%	560	–2.1%	76	–4.8%
Number of Other FTE Workers Dependent on Oyster Industry	1,323	+1.4%	346	+1.3%	277	+5.0%	581	+0.0%	119	+0.1%
Total Employment Dependent on Oyster Industry	3,144	+1.3%	747	+1.1%	575	+8.9%	1,533	–0.8%	289	–1.3%

Note: FTE = Full-time equivalent.

[a]Income includes profits to boat owners.

meeting the harvest time/temperature restriction by incurring the capital and operating costs of on-board refrigeration.

Refrigerated "Mother Boat"

Our site visit interviews revealed that one possible response was the introduction of a so-called "mother boat" (or "buy boat") in Texas. This boat would pick up oysters from harvesters on the water and take the oysters bound for the halfshell market back to dock, allowing Texas harvesters to harvest less impeded by time restriction. This scenario is presented in Table 4-6.

No Expansion in Alabama Harvests

Finally, we note that our "standard" results for the ISSC control plan indicate a substantial increase (over 100 percent) in oyster harvests from Alabama. Although the projected level of output is still within levels achieved in Alabama waters in the last 10 years, certain market and institutional factors may make such an expansion of Alabama harvests infeasible. To account for this possibility in the extreme, we modeled the case where Alabama is unable to expand (or contract) their output in the in-shell and shucked markets. Table 4-7 presents these results.

Recent Developments

As indicated above, we initially assumed that time and temperature controls must be met on a boat-day basis. In other words, all harvested oysters on an ISSC-compliant boat must be under ambient temperature control within the designated time limit. Recently however, a less restrictive enforcement plan for the ISSC controls was introduced. Under the new plan, harvesters can tag bags of oysters harvested within 6 hours of refrigeration as ISSC-compliant; any remaining oysters in the boat are noncompliant. This plan will enable the harvesters to stay on the water as long as they want with the restriction that they can only sell oysters harvested within 6 hours of return to refrigeration on the in-shell market. In contrast, the previous interpretation was that all daily harvesting activity had to be conducted within the time and temperature restrictions for any oysters on a boat to comply, thus shortening the length of a boat day (and daily catch) for most harvesters.

The change in enforcement scope from boat days to bags also brings with it the possibility of a change in the way monthly water temperatures used to designate the ISSC restriction level will be computed. As indicated

Table 4-6. Refrigerated "Mother Boat" in Texas

If we allow a refrigerated boat (mother boat) in Texas to pick up oysters from dredge boats while they are on the water, the impact of the control is not as great. The impacts are not as dramatic because Texas harvesters can harvest unimpeded by the time restrictions.

	Gulf		Florida		Alabama		Lousiana		Texas	
	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact
Quantity of Oysters Harvested	7,417,152	–1.5%	1,170,067	+2.3%	469,915	+96.5%	4,982,805	–7.7%	794,366	+6.4%
Quantity Sold as Halfshell	4,024,786	–5.6%	1,170,067	+13.7%	469,915	+882.3%	1,590,438	–41.1%	794,366	+63.6%
Quantity Sold as Shucked	3,392,367	+3.9%	0	–100.0%	0	–100.0%	3,392,367	+25.7%	0	-100%
Price of In-shell Meat	$2.53	+4.9%	$2.74	+4.5%	$1.52	+8.5%	$2.52	+5.0%	$2.76	+4.5%
Price of Shucked Meat	$2.33	–3.2%	$2.55	–2.9%	$1.33	–5.5%	$2.32	–3.2%	$2.56	–2.9%
Value of Harvested Oysters	$18,006,797	–1.4%	$3,209,545	+7.0%	$715,866	+113.1%	$11,891,492	–8.3%	$2,189,894	+11.2%
Number of FTE Tong Boats	297	+19.7%	217	+4.6%	80	+96.5%	0	+0.0%	0	+0.0%
Number of FTE Dredge Boats	219	–4.5%	0	+0.0%	0	+0.0%	198	–5.6%	21	+6.4%
Income per Harvester[a]	$15,281	–7.0%	$11,744	+2.8%	$5,937	+13.4%	$18,975	–3.6%	$22,906	+5.1%
Number of FTE Processing Workers	901	+0.2%	194	+2.0%	234	+4.9%	376	–4.2%	97	+3.5%
Number of FTE Harvesters	924	+2.6%	217	+4.6%	80	+96.5%	542	–5.3%	85	+6.4%
Number of Other FTE Workers Dependent on Oyster Industry	1,305	0.0%	348	+2.0%	277	+4.9%	556	–4.2%	123	+3.5%
Total Employment Dependent on Oyster Industry	3,129	+0.8%	759	+2.7%	591	+12.0%	1,474	–4.6%	305	+4.3%

Note: FTE = Full-time equivalent.

[a]Income includes profits to boat owners.

Table 4-7. Alabama Harvest Quantities Are Fixed
The impact is slightly greater if we do not allow Alabama to take advantage of the in-shell price premium.

	Gulf		Florida		Alabama		Lousiana		Texas	
	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact	Post-Control	Percentage Impact
Quantity of Oysters Harvested	7,260,147	–3.6%	1,237,707	+8.2%	239,199	+0.0%	5,059,085	–6.3%	724,155	–3.0%
Quantity Sold as Halfshell	3,904,891	–8.4%	1,237,707	+20.3%	47,840	+0.0%	2,619,344	–2.9%	0	–100%
Quantity Sold as Shucked	3,355,256	+2.7%	0	–100.0%	191,359	+0.0%	2,439,742	–9.6%	724,155	+177.0%
Price of In-shell Meat	$2.61	+8.2%	$2.82	+7.5%	$1.60	+14.0%	$2.60	+8.2%	$2.83	+7.5%
Price of Shucked Meat	$2.35	–2.4%	$2.57	–2.2%	$1.35	–4.0%	$2.34	–2.4%	$2.58	–2.2%
Value of Harvested Oysters	$18,218,564	–0.3%	$3,491,211	+16.3%	$334,470	–0.4%	$12,523,846	–3.4%	$1,869,037	–5.1%
Number of FTE Tong Boats	271	+8.9%	230	+10.7%	41	+0.0%	0	+0.0%	0	+0.0%
Number of FTE Dredge Boats	226	–1.8%	0	+0.0%	0	+0.0%	206	–1.7%	19	–3.0%
Income per Harvester[a]	$16,480	–4.0%	$12,162	+6.5%	$6,393	+22.1%	$19,352	–1.7%	$21,258	–2.4%
Number of FTE Processing Workers	886	–1.5%	194	+2.2%	229	+2.5%	371	–5.5%	92	–1.8%
Number of FTE Harvesters	909	+1.0%	230	+10.7%	41	+0.0%	561	–1.9%	77	–3.0%
Number of Other FTE Workers Dependent on Oyster Industry	1,285	–1.5%	349	+2.2%	270	+2.5%	549	–5.5%	117	–1.8%
Total Employment Dependent on Oyster Industry	3,080	–0.8%	773	+4.6%	540	+2.3%	1,481	–4.2%	286	–2.1%

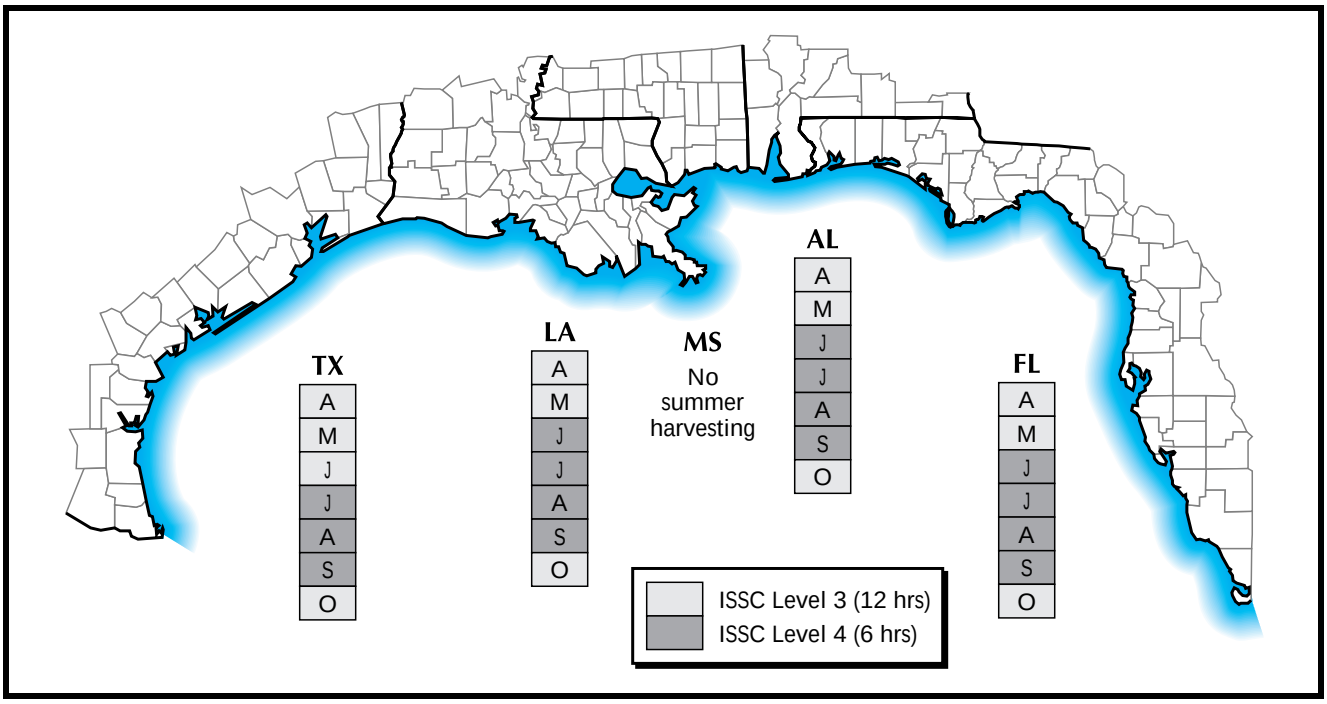
Note: FTE = Full-time equivalent.

[a]Income includes profits to boat owners.

above, the initial water temperature calculation method was based on the average morning temperature with the presumption that under boat-day enforcement of the ISSC controls, most harvesting would be done in the morning. However, with the revised enforcement plan using bags, the rationale for using morning temperatures no longer applies, because boat days are not restricted by a clock rule.

If, as a consequence, monthly water temperature calculations are based on average daily temperatures, rather than average morning temperatures, the more restrictive levels will apply for more months of the year, as illustrated by comparing Figure 4-2 to Figure 4-1.

Figure 4-2. ISSC Restriction Levels — Average Daily Basis
When water temperatures are based on daily averages, Louisiana summers have four Level-4 months.



Unfortunately, because of the late date at which the new enforcement information was received, we were not able to explicitly model the effects of the new enforcement option. However, we can provide a qualitative sense of the impacts. Overall, the new method of enforcement would be expected to reduce the absolute size of the impacts reported in Table 4-3. The distribution of impacts would also be less extreme; the loss in Louisiana and Texas would be less dramatic and the gains in Florida and Alabama lower.

If the level of the ISSC control were based on average daily water temperature rather than average morning water temperature, there would be more months under the 6-hour limit. With more months subject to the strictest controls, the impact of the control option is enlarged. However, the effects would vary less by state, because the difference across states in the number of months designated as Level 4 is less dramatic.

Because one aspect of the new enforcement conditions reduces impacts (the switch to tag enforcement), while the other aspect raises impacts (the increase in months designated as Level 4), it is not possible to, even directionally, determine the net effect of the recent enforcement developments relative to the results reported in Table 4-3.

4.2 DISPLACEMENT EFFECTS

We reported the direct and indirect effects including the number of FTE jobs and the amount of earnings losses from control changes in Section 4.1. We cannot precisely estimate the number of people who will remain jobless nor the number of those who will enjoy or suffer quality-of-life changes. Therefore, in this section, we characterize the possible qualitative consequences of labor displacement. To examine impacts on people who would be displaced from the oyster industry, we consider the economic and health effects of worker displacement. Our model of worker displacement examines the possible consequences to workers of losing their employment.

Generally, worker displacement may result in workers finding similar jobs in other industries, changing occupations altogether, experiencing a period of unemployment, or suffering extended joblessness. The nonearnings costs of worker displacement may include loss of health insurance, increased stress, and stress-related health problems. As discussed in Chapter 3, these effects of worker displacement may be significant depending on the economic conditions for the individuals and their communities.

Primarily, two disciplines examine the costs of worker displacement: health care and economics. Typically, health researchers, such as physicians and psychologists, are concerned about the mental and physical health of individuals who suffer from economic insecurity or the loss of their jobs. Economists, in general, concern themselves with studying the permanent income losses that result from worker

displacement. Some health economists and policy analysts also investigate the health impacts of income losses.

4.2.1 Results

We present research in several fields of study to characterize the potential worker displacement effects of control changes for the Gulf oyster industry. First, we show the current earnings and employment conditions for Gulf oyster industry labor. Then, we describe the workers' most likely alternative employment or next-best opportunities.

Current Employment and Earnings

To bring oysters to consumers, the oyster industry must complete several activities. A list of oyster industry job descriptions includes fishermen, boat captains, boat owners, leaseholders, plant owners, and plant employees. Table 4-8 describes the age, education, and annual earnings for these typical oyster industry jobs. As reported in Chapter 2 of this report, boat and plant owners generally hire employees as deck hands or shuckers on an "as-needed" basis.

Table 4-8. Descriptions of Typical Oyster Industry Labor
Many persons employed in the oyster industry have less than a high school education.

Job Type	Age	Education	Annual Earnings
Fishermen	20 – 50	10 years	$20,000 – 40,000
Boat Captains	30 – 50	10 years	$35,000 – 60,000
Boat Owners	30 – 60	10 – 12 years	$35,000 – 100,000
Leaseholders	40 – 60	10 – 12 years	Depends on acreage
Plant Owners	40 – 60	10 – 13 years	$100,000 – 200,000
Plant Employees	20 – 50	10 years	$20,000 – 30,000

These earnings figures are typical for people who work full-time and year-round in the oyster industry.

Next-Best Employment and Earnings Opportunities

During interviews with individuals in the oyster industry, universities, and government, we discussed likely employment alternatives for oyster industry workers. According to respondents, in many harvesting and processing operations in the Gulf, the labor force is predominantly a minority mixture (e.g., black, Vietnamese, Croatian) with little or no

education. Even in operations with a majority of American white workers, few have completed 12 years of school. Harvesting workers receive a day wage (e.g., $100 per day) or receive a piece rate ($1.00 to $1.50 per bag) depending on the number of bags harvested. The majority of processing workers are currently employed at a piece rate ($5.00 to $6.50 per gallon of shucked meats) that approaches $10 to $12 an hour for skilled shuckers.

Oyster processing and harvesting workers have few other employment opportunities according to key informants. Representatives from industry trade groups expect these workers would either take jobs making minimum wage (i.e., $4.25 per hour) or go on public assistance to have health insurance for their children.

Table 4-9 shows potential employment alternatives for different labor categories according to industry representatives. The next-best alternative employment for many fisherman and processing employees may be manual labor in construction or minimum wage employment because they have less than a high school education and few skills other than oystering. During interviews, industry representatives reported that harvesters who have left oystering have taken jobs working as prison guards, construction workers, truck drivers, or restaurant workers.

Table 4-9. Alternatives According to Respondents
Many of the next-best employment opportunities for displaced oyster industry workers would pay near minimum-wage.

Job Type	Alternative Employment
Fisherman	Other fishing; manual labor
Boat Captains	Other fishing; manual labor
Boat Owners	Other fishing; sell and reinvest
Leaseholders	Sell and reinvest
Plant Owners	Other species; restaurant; sell and reinvest
Plant Employees	Manual labor; minimum wage employment

Oyster industry workers have opportunities commensurate with their skills and education. Some employment opportunities may require further training such as trucking, construction, or service occupations.

Although we cannot precisely estimate the duration of unemployment, displaced oyster workers would likely not find immediate re-employment and would experience some period of joblessness. The nature of their

employment (e.g., self-employed, temporary) means that most oyster workers do not meet the definition of "displaced worker" used in national surveys. Thus, results from these national surveys are not directly generalizable to the oyster industry.

Nonetheless, national surveys do indicate general trends that may be applicable for some oyster workers. According to the Current Population Survey (CPS) data, Gardner (1993) reports that 8.3 weeks without work (e.g., joblessness) was the median period of joblessness for those who were re-employed after being displaced.[3] She reports that two-thirds of people who were displaced between 1987 and 1991 had been re-employed by January 1992; however, half were positioned in lower paying jobs. For 60 percent of those with lower paying jobs, earnings losses were greater than 20 percent (Gardner, 1993). Blacks are less likely to find re-employment in the time period analyzed than whites (i.e., 9.5 percent less likely) and experienced lengthier joblessness (i.e., 13.5 median weeks without work) (Kletzer, 1991). However, these statistics reflect the experience of mostly union labor in manufacturing plants located in urban areas who meet the definition of "displaced worker." Thus, these results are not statistically generalizable to the oyster industry. These statistics do suggest that displaced oyster workers may experience a period of joblessness before finding re-employment and that their re-employment may be at reduced wages.

4.3 SUMMARY

In this chapter we presented the estimated economic impacts of alternative remedies for controlling *Vibrio vulnificus*-related illnesses. The in-shell marketing restriction, once recommended to the ISSC by FDA but then superseded by the ISSC time and temperature controls, might have imposed relatively large economic impacts on the Gulf oyster industry and other related sectors of the economy. The effects would be felt across all states in the Gulf, though the increased shucking activity would mitigate losses in some states more than others.

The ISSC time and temperature controls would likely have much smaller aggregate economic impacts than the marketing restriction option. However, distributional effects of this policy should be considered. This

[3] Younger workers (under 35 years of age) had the shortest unemployment spell (6.2 weeks), and older workers had longer unemployment spells (10.4 weeks for over 55 years; 9.3 weeks for ages between 45 and 54).

policy is likely to cause economic losses in Louisiana and Texas but economic gains in Florida and Alabama. This transfer effect occurs because tonging activity, which predominates in Florida and Alabama, is less heavily affected by the time controls than dredging activity, which predominates in Louisiana and Texas.

The ISSC impacts are sensitive to specific assumptions about enforcement of the rule and the types of responses engendered by the regulated entities. As part of our evaluation, we varied these assumptions to create alternative scenarios for the model. The size and distribution of impacts are found to vary appreciably depending on the scope of enforcement; the adoption of different refrigeration technologies; and the ability of relatively unconstrained producers, such as those in Alabama, to make up for the expected production shortfall from the more heavily restricted states (Louisiana and Texas).

Although the economic models can estimate job "losses" and "gains," assigning meaning to these results without a full understanding of alternative opportunities for displaced labor is difficult. In this chapter we provide some evidence of the alternative sources of employment for displaced labor and discuss the implications in a qualitative manner. Many of the laborers potentially affected by these control options earn more in the oyster industry than they are likely to immediately earn outside of the industry. Thus, the impact of job displacement for those individuals will depend on the length of their unemployment period, other opportunities that exist with their current set of skills, and adjustments they can make (e.g., retraining, relocation) to improve their employment prospects outside of the oyster industry.

References

Addison, John T., Douglas A. Fox, and Christopher J. Ruhm. 1995. "Trade and Displacement in Manufacturing." *Monthly Labor Review* April:58-67.

Berrigan, M., T. Candies, J. Cirino, R. Dugas, C. Dyer, J. Gray, T. Herrington, W. Keithly, R. Leard, J.R. Nelson, and M. Van Hoose. March 1991. *The Oyster Fishery of the Gulf of Mexico, United States: A Regional Management Plan.* Ocean Springs, MS: Gulf States Marine Fisheries Commission. Number 24.

Bjorkland, Anders. 1985. "Unemployment and Mental Health: Some Evidence from Panel Data." *Journal of Human Resources* 20(4):469-83.

Brucker, Sharon M., Steven E. Hastings, and William R. Latham III. 1990. "The Variation of Estimated Impacts from Five Regional Input-Output Models." *International Regional Science Review* 13(1):119-139.

Bureau of Economic Analysis (BEA), U.S. Department of Commerce. 1992. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II).* Washington, DC: U.S. Government Printing Office.

Carrington, William J. 1993. "Wage Losses for Displace Workers: Is It Really the Firm that Matters?" *Journal of Human Resources* 28(3):435-462.

Carrington, William J., and Asad Zaman. 1994. "Interindustry Variation in the Costs of Job Displacement." *Journal of Labor Economics* 12(2):243-275.

Catalano, Ralph. 1991. "The Health Effects of Economic Insecurity." *American Journal of Public Health* 81(9):1148-52.

Chapman, Kenneth S., and Govind Hariharan. 1994. "Controlling for Causality in the Link from Income to Mortality." *Journal of Risk and Uncertainty* 8(1):85-93.

Cheng, Hsiang-tai and Oral Capps, Jr. 1988. "Demand Analysis of Fresh and Frozen Finfish and Shellfish in the United States." *American Journal of Agricultural Economics* 70(3):533-542.

Clark, Andrew E., and Andrew J. Oswald. 1994. "Unhappiness and Unemployment." *The Economic Journal* 104(May):648-659.

Coughlin, Cletus C., and Thomas B. Mandelbaum. 1991. "A Consumers Guide to Regional Economic Multipliers." *Federal Reserve Bank of St. Louis Review* January/February:19-32.

Dooley, David, and Ralph Catalano. 1980. "Economic Changes As a Cause of Behavioral Disorder." *Psychological Bulletin* 87(3):450-468.

Duleep, Harriet Orcutt. 1989. "Measuring Socioeconomic Mortality Differentials Over Time." *Demography* 26(2):345-351.

Dunning, R.D., and C.M. Adams. February 1995. "Economic Analysis of the Potential for Oyster and Hard Clam Depuration in Dixie and Levy Counties, Florida." Staff paper series SP95-1. Prepared by the Food and Resource Economics Department, Institute of Food and Agricultural Sciences. Gainesville, FL: University of Florida.

Evans, David S., and Linda S. Leighton. 1995. "Retrospective Bias in the Displaced Worker Surveys." *The Journal of Human Resources* 30(2):386-396.

Fallick, Bruce Chelimsky. 1993. "The Industrial Mobility of Displaced Workers." *Journal of Labor Economics* 11(2):302-323.

Farber, Henry S. 1993. "The Incidence and Costs of Job Loss: 1982-91." *Brookings Papers: Microeconomics* pp. 73-132.

Fenwick, Rudy, and Mark Tausig. 1994. "The Macroeconomic Context of Job Stress." *Journal of Health and Social Behavior* 35(3):266-82.

French, M.T., and L.J. Dunlap. 1995. "Compensating Wage Differentials for Job Stress" Unpublished manuscript.

Gardner, Jennifer M. 1993. "Recession Swells Count of Displaced Workers." *Monthly Labor Review* June:14-23.

Graham, John D., Bei-Hung Chang, and John S. Evans. 1992. "Poorer Is Riskier." *Risk Analysis* 12(3):333-337.

Gruber, Jonathan, and Brigit Madrian. 1995. "Nonemployment and Health Insurance Coverage." mimeo.

Hamermesh, Daniel S. 1989. "What Do We Know About Worker Displacement in the U.S.?" *Industrial Relations* 28(1):51-59.

Hamilton, Joel R., M. Henry Robison, Norman K. Whittlesey, and John Ellis. 1994. "Interregional Spillovers in Regional Impact Assessment: New Mexico, Texas, and the Supreme Court." *Growth and Change* 25(Winter):75-89.

Hamilton, Joel R., Norman K. Whittlesey, M. Henry Robison, and John Ellis. 1991. "Economic Impacts, Value Added, and Benefits in Regional Project Analysis." *American Journal of Agricultural Economics* 73(2) May:334-344.

Heikkinen, Martti E., Erkki T. Isometsä, Hillevi M. Aro, Seppo J. Sarna, and Jouko K. Lönnqvist. 1995. "Age-Related Variation in Recent Life Events Preceding Suicide." *The Journal of Nervous and Mental Disease* 183(5):325-331.

Horvath, Francis W. 1987. "The Pulse of Economic Change: Displaced Workers of 1981-85." *Monthly Labor Review* 110(6):3-12.

Interstate Shellfish Sanitation Conference (ISSC). 1995. *Draft Interstate Shellfish Sanitation Conference Summary of Actions: Thirteenth Annual Meeting*. Columbia, SC. August.

Jacobson, Louis S., Robert J. LaLonde, and Daniel G. Sullivan. 1993. "Earnings Losses of Displaced Workers." *American Economics Review* 83(4):685-709.

Jin, Robert L., Chandrakant P. Shah, and Tomislav J. Svoboda. 1995. "The Impact of Unemployment on Health: A Review of the Evidence." *Canadian Medical Association Journal* 153(5):529-540.

Johnson, Kenneth P. 1995. "Redefinition of the BEA Economic Areas" *Survey of Current Business (*February):75-81.

Kearney, A.T. 1993. "National Marine Fisheries Service—Contemporary Economic Issues in the Valuation of Commercial and Recreational Fisheries." SK Grant NA89AA-H-SK-65. June. Prepared for the National Marine Fisheries Service, Silver Springs, Maryland.

Keeney, Ralph L., and Detlof von Winterfeldt. 1986. "Why Indirect Health Risks of Regulations Should Be Examined." *Interfaces* 16(6):13-27.

Keithly, Walter R., and Kenneth J. Roberts. 1988. "The Louisiana Oyster Industry: Economic Status and Expansion Prospects." *Journal of Shellfish Research* 7(3):515-525.

Kletzer, Lori. 1991. "Earnings after Job Displacement." in Job Displacement: Consequences and Implications for Policy. John Addison, ed. Wayne State University Press, 1991.

Kletzer, Lori. 1992. "Industry Wage Differentials and Wait Unemployment." *Industrial Relations* 31(2):250-269.

Kottage, B.E. 1992. "Stress in the Workplace." *Professional Safety* 37:24-26.

Lipton, Douglas, and James Kirkley (eds.). February 1994. *A Profile of the Oyster Industry: Northeastern United States.* Gloucester Point, VA: Maryland and Virginia Sea Grant Marine Advisory Programs.

Lutter, Randall, and John F. Morrall III. 1994. "Health-Health Analysis: A New Way to Evaluate Health and Safety Regulation." *Journal of Risk and Uncertainty* 8(1):43-66.

Malik, M.S. 1993. "All Stressed Up and No Place to Go?" *Modern Office Technology* 38(2). pages?????

Marshall, Alfred. 1890. *Principles of Economics*, 1st Edition. London: Publishers.

Melancon, Earl J., Jr., and Richard Condrey. 1992. "Economics of a Louisiana Oyster Seed Bedding Fishery and Influence of Lease Yield on Expenses to Operate." *Journal of Shellfish Research* 11(1):143-147.

Podgursky, Michael, and Paul Swaim. 1987. "Job Displacement and Earnings Loss: Evidence from the Displaced Worker Survey." *Industrial and Labor Relations Review* 41(1):17-29.

Prochaska, Fred J., and Walter R. Keithly. July 1986. "Production Costs and Revenues in the Florida Oyster Industry." Florida Sea Grant College Program, report number 87.

Robinson, Lance, Page Campbell, and Linda Butler. 1994. *Trends in Texas Commercial Fishery Landing, 1972-1993.* Management Data Series No 111. Austin, TX: Texas Parks and Wildlife Department, Fisheries and Wildlife Division.

Ruhm, Christopher J. 1991a. "Are Workers Permanently Scarred by Job Displacement?" *The American Economic Review* March:319-324.

Ruhm, Christopher J. 1991b. "Displacement Induced Joblessness." *The Review of Economics and Statistics* 73(3):517-522.

Ruhm, Christopher J. 1995. "Economic Conditions and Alcohol Problems." *Journal of Health Economics* 14:583-603.

Schapiro, Morton Owen, and Dennis A. Ahlburg. 1982-1983. "Suicide: The Ultimate Cost of Unemployment." *Journal of Post Keynesian Economics* 5(2):276-280.

Sheeran, Pascal, Dominic Abrams, and Sheina Orbell. 1995. "Unemployment, Self-Esteem, and Depression: A Social Comparison Theory Approach." *Basic and Applied Social Psychology* 17(1&2):65-82.

Spulber, D.F. 1989. *Regulations and Markets*. Cambridge, MA: MIT Press.

Thurman, Walter N., and J.E. Easley, Jr. 1992. "Valuing Changes in Commercial Fishery Harvests: A General Equilibrium Derived Demand Analysis." *Journal of Environmental Economics and Management* 22:226-240.

U.S. Department of Commerce, Bureau of Economic Analysis. 1992. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMSII)*. Washington, DC: U.S. Government Printing Office.

U.S. Food and Drug Administration (FDA). April 1, 1995a. *Interstate Certified Shellfish Shippers List*. Washington, DC: U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration.

U.S. Food and Drug Administration (FDA). September 21, 1995b. "ISSC Vibrio Vulnificus Control Plan for Oysters." FDA Talk Paper (T95-50). Rockville, MD: U.S. Department of Health and Human Services.

U.S. Public Health Service. 1990. *Healthy People 2000: National Health Promotion and Disease Prevention Objectives.* Washington, DC: Department of Health and Human Services. DHHS Publication No. (PHS) 91-50213.

van Raaij, W. Fred, and Gerrit Antonides. 1991. "Costs and Benefits of Unemployment and Employment." *Journal of Economic Psychology* 12:667-687.

Viscusi, W. Kip. 1994. "Mortality Effects of Regulatory Costs and Policy Evaluation Criteria." *RAND Journal of Economics* 25(1):94-109.

Wildavsky, A. 1979. "Richer is Safer." *The Public Interest*. 60(summer):23-29.

Yang, Bijou. 1992. "The Economy and Suicide: A Time-Series Study of the USA." *American Journal of Economics and Sociology* 51(1):87-99.

Zemke, R. 1991. "Workplace Stress Revisited." *Training* 28(11):35-39.

Appendix A
Site Visit Reports

ALABAMA SITE VISIT REPORT

On October 13 and 18, RTI staff visited Alabama to interview oyster processors, and state regulators regarding the potential economic impacts and other relevant aspects of the ISSC interim control plan agreement made in August 1995. The control plan addresses mortality and morbidity associated with *Vibrio vulnificus* (ISSC summary of actions, 1995). RTI staff members Jackqueline L. Teague and Donald W. Anderson interviewed representatives from two oyster processing firms. RTI also interviewed two representatives from the Alabama Department of Health and the Alabama Department of Conservation. This report summarizes the information reported by respondents. RTI staff will analyze the information, cross-check it with published sources when feasible, and conduct other internal and external consistency checks before incorporating quantitative estimates provided by respondents into our database.

The interviews with oyster processors were conducted in Bayou Le Batre and Bon Secour, Alabama. The regulatory personnel interviews were conducted in Mobile, Alabama.

HARVESTING SECTOR

Current Status

Alabama oyster harvesters use tongs. Although dredging is permitted, even those with riparian oyster rights along the boundary of their property usually use tongs. According to respondents, public sentiment is strongly opposed to dredges in Alabama because dredging is considered too damaging to the oyster habitat. There are 712 licensed oyster harvesters and 400 to 500 oyster tong boats in Alabama; however, only 100 to 150 are harvesting every day with up to 200 on the water on a given day. Respondents reported that at least 60 oyster harvesters relied on the summer harvests for their living.

Harvesters are usually males between the ages of 20 and 50 who have been oystering their entire adult life and who do not have a high-school diploma. Almost all harvesters own their own boats. Usually only one person is tonging on a boat although occasionally two people will work together. Basic harvesting activities include transporting the boat to a put-in location, traveling by boat to the oyster bed, working the bed with tongs to extract the oysters, culling the oysters according to regulatory limits and product quality constraints, traveling back to the put-in location,

and hauling the shellstock in the harvester's truck to the processing plant. The oyster beds are 5 to 25 minutes from shore; the remotest beds are accessible within 30 minutes.

Harvesters typically deal with one processor and negotiate a prearranged price per 70-pound bag (per bushel). In Alabama, many harvesters tong in the morning and shuck their oysters at the processor's plant in the afternoon. According to respondents, Alabama processors sell only 17 percent of their oysters for half-shell consumption; the remaining oysters are shucked. This high shucking rate may be strongly influenced by the shucking agreements with harvesters or by the lack of contractual contacts with those dealers that order half-shellstock.

Regulators in Alabama report that check-point data indicate that the harvester catch rate is about 1.4 to 1.6 sacks an hour per person. Alabama has restricted summer harvesting to a 6-hour day during the summer (June 1 to October 1) for the past 3 years. On a typical 6-hour day, harvesters usually bring in 8 to 10 sacks according to regulatory respondents. Alabama has a harvesting limit of 12 sacks per person and 24 sacks per boat. The 70-pound sack of shellstock usually yields 6 to 7 pounds of meat.

Required capital equipment is similar to Florida tonging, which includes a boat, an engine, tongs, a pick-up truck, and a trailer. Nondurable goods and materials include gloves, boots, fuel and oil, licenses, and permits.

Traditionally, harvesters also generate some income from fishing for other seafood such as shrimp and fish. Currently, few laws limit entry into other seafood fishing according to Alabama regulatory representatives. For example, net-fish licenses are limited to only those harvesters who can show previous income from net-fishing (i.e., at least 50 percent of income during 2 of the previous 5 years). Oystering has been the traditional last resort for fisherman who could find nothing else. If other fishing was unsuccessful, fisherman counted on the oysters as a resource.

Potential Effects of ISSC Interim Control Plan According to Respondents

1. Water temperature action levels. Regulators report that preliminary water temperature data suggest that June through September may require a Level 4 action with 6 hours time to refrigeration required. However, Alabama limited harvesting from 6 a.m. to noon during these months for the past 3 years. Action Level 3 with 12 hours time to refrigeration probably will not require any change because Alabama already limits the harvest day to 10 hours from October 1 to June 1, according to regulatory officials.

2. Refrigeration on board and shading. Respondents report that refrigeration on board tong boats in Alabama is impossible: there is no room on the small skiff. Tongers in Alabama have not shaded their oysters, so shading will require some innovation.

3. Reduced length of harvesting day. Alabama harvesters have already accommodated the 6-hour limited day. Alabama has required a 6-hour harvest day from June 1 to October 1 since 1993.

4. Other State Shellfish Control Authority (SSCA) options. Few enforcement options are recommended among industry and regulatory representatives in response to the ISSC interim control plan action level 4 (6-hour limits) because Alabama has enforced a 6-hour harvest day during the potential Level 4 months of June through September. The only issues discussed for potential changes are how best to design shading that will not heat the oysters or whether the harvesters may be required to leave the water any sooner to ensure that oysters will be under refrigeration.

   Respondents in Alabama consider the primary impacts of the ISSC interim control plan to be on the processors, and not on the harvesters.

PROCESSING SECTOR

Current Status

During the October interview, regulatory respondents stated that there were 53 certified processing firms in Alabama. The ISSC Interstate Shellfish Shippers' List (November 1995) reports 43 oyster processors in Alabama. The list indicates there are 39 shucker-packers, 1 shellstock shipper, 3 repackers, and no reshippers for a total of 43 oyster processors in Alabama. Certificates expire September 30 each year; the September 1995 ISSC Interstate Shellfish Shippers' List reported 66 oyster processors in Alabama. The September 1995 list indicated there were 48 shucker-packers, 10 shellstock shippers, 3 repackers, and 5 reshippers for a total of 66 oyster processors in Alabama. Although only 43 certificates have been issued, others may be added throughout the year. According to respondents, 30 to 40 processors are located in the Bayou Le Batre and Coden area. Respondents report that 20 of those processors are year-round shucking plants, but about 20 are seasonal and only operate during the peak winter demand for shucked oysters.

Typically, the processing firms are owner-operated by an individual or a husband and wife. Shellstock shippers sometimes have no permanent plant; instead they have only a refrigerated truck to pick up and deliver oysters. Respondents report that the majority of shucker-packers (about 15) are medium-sized plants with about 10 shuckers. Large plants have 30 to 35 shuckers and small plants have only 3 to 6 shuckers. There are about 15 small plants and 9 large plants. These shucker-packers ship 80 percent or more of their oysters as shucked product with only about 17 percent shipped as shellstock for half-shell consumption, according to an informal survey of processors conducted by respondents. Those interviewed stated that the largest oyster processor in Alabama processes more half-shell product than shucked product, but this is not representative of most plants in Alabama. Processors in Alabama report that although shucking is less profitable

during the summer months, they continue to shuck in order to retain their customers and employees.

Although Alabama oysterers harvest in the summer, processors rely heavily on Louisiana for oysters during the summer season. Respondents estimated that 95 percent of the oysters processed in Alabama come from out of state; 70 to 75 percent come from Louisiana and the other 20 percent come from Texas. This implies that Alabama landings provide 5 to 10 percent of the total oysters processed in Alabama during the summer. One processor remarked, "Louisiana is the market in the summer." Processors report sending their own refrigerated trucks that can carry 400 sacks to Louisiana to pick up oysters at the Louisiana shellstock shipper's dock. They report that using their own truck allows them to ensure the proper temperature control for the product.

Most of the half-shell product is sold in the Southeast, where little half-shell product from other regions is sold. Some Gulf shellstock is shipped to other regions (e.g., Chesapeake) for shucking, but this is uncommon. Usually, processors directly contract with grocery stores and restaurants and transport the product themselves. Processors report that the majority of half-shell oysters are served raw in restaurants.

Processors report that dealers sell oysters for between $14 and $15 per sack with $11 or $12 per sack going to the harvesters. They report that freight adds approximately $1 per sack ; thus, the processor pays about $15 per sack of oysters in 1995. Although half-shell oysters sell for around $30 per 30-pound box to restaurants, shucked product sells for around $32 per gallon of meat. A gallon is about 8 pounds of meat and processors pay shuckers about $6.50 per gallon. During the summer, 30 pounds of shellstock only yields about 3 pounds of meat; therefore, 30 pounds of shellstock can either be washed and boxed to be sold for $30 or can be shucked and sold for $12. Smaller cup-shaped single oysters are preferred for half-shell consumption. Larger oysters are preferred for shucking, but clumped or elongated oysters are shucked as well.

Processing-plant employees include shuckers, packers, truckers, clerical/administrative personnel, and salespeople. Shuckers are paid by the piece (i.e., $6.50 per gallon of shucked meat) and can make between $300 and $600 per week. Many work year-round, but some shuckers voluntarily take time off in the summer when meat yields per oyster shucked are smaller. Shuckers are provided with mandated benefits (Social Security and Workers Compensation) but seldom have health insurance. Some of the other plant workers do receive health benefits. Shuckers typically have less than a high-school education and their specialized skills are not easily transferable to other professions in the region. Other manual laborers, such as loaders and packers, also typically have no high-school education but their skills do no appear to be quite as specialized. In Alabama, the majority of shuckers are Asian immigrants or African-Americans. Both men and women work as shuckers.

Potential Effects of ISSC Interim Control Plan According to Respondents

1. Water temperature action levels. Although Action Level 4 appears to be a minimal change for Alabama harvesters, Alabama processors receive 70 to 75 percent of their product from Louisiana.

2. Refrigeration on board and shading. According to respondents, it would cost $1 million to build a refrigerated warehouse boat to collect oysters off-shore to eliminate the return trip for remote oyster beds. Processors in Alabama are uncertain that the investment would pay off given the interim nature of the ISSC control plan and the questionable change in consumer confidence. They also questioned whether oysters would open to feed during temperature fluctuations (e.g., unloading/loading at docks, trucks, storage units, and washing and boxing), which could shorten their shelf-life and increase the possibility of cross-contamination.

3. Reduced length of harvesting day. Although Action Level 4 appears to be a minimal change for Alabama harvesters, Alabama processors receive 70 to 75 percent of their product from Louisiana. Respondents report that they expect Louisiana will ship little if any product out of state for processing during Action Level 4 months in Louisiana. Some Alabama processors predict that they will be forced to leave oystering

4. Other State Shellfish Control Authority (SSCA) options. Respondents consider the primary impacts of the ISSC interim control plan on the processors to be under the jurisdiction of Louisiana and beyond Alabama's control.

SUGGESTED SOLUTIONS/CONSEQUENCES

1. At-risk consumer education is essential. Educating consumers about *Vibrio* was unanimously selected by all parties interviewed as the preferred approach to reducing the number of *Vibrio*-related illnesses. Respondents strongly believe that the ISSC interim control plan will not make oysters safer for the at-risk group because the infectious dose in unknown. They suggested that labeling the product and distributing the information in schools would be useful educational campaigns.

2. Good operating practices should be further encouraged. According to respondents, industry and regulators must work together to produce a better product. They suggested that washing the oysters prior to refrigeration would produce a better product because washing them after refrigeration made them more likely to open and spoil.

3. Perform more research on factors/methods that affect *Vibrio* incidence. Respondents said that refrigeration should not be required if it is not proven to reduce *Vibrio* illness incidence. They mentioned that cool pasteurization and hybrid transogenic oysters resistant to Vibrio infestation should be considered.

4. Require official state docks Respondents questioned whether enforcing the refrigeration requirement for half-shell shellstock would be possible without official state docks or inspectors. Repeatedly, industry questioned the ability to enforce the separation of half-shell and shucked shellstock. Alabama processors lamented that they would be dependent on the knowledge and integrity of Louisiana harvesters and dealers. "There's no way to enforce it," respondents repeated.

FLORIDA SITE VISIT REPORT

On May 17 and 18, RTI staff visited the upper Gulf Coast of Florida to interview oyster harvesters and processors, trade-group representatives, and state regulators regarding the potential economic impacts and other relevant aspects of options addressing mortality and morbidity associated with *Vibrio vulnificus*. RTI staff members Jackqueline L. Teague and Brian C. Murray interviewed five oyster harvesters and five representatives from two oyster processing firms, as well as a representative of the Southeastern Fisheries Association. RTI also interviewed three representatives from the Florida Bureau of Marine Resource Regulation and Development. This report summarizes the information reported by respondents. RTI staff will analyze the information, cross-check it with published sources when feasible, and conduct other internal and external consistency checks before incorporating quantitative estimates provided by respondents into our database.

The interviews with oyster harvesters and processors were conducted in Apalachicola, Florida, where 85 to 90 percent of the state's oyster industry is located. The regulatory personnel and trade group interviews were conducted in Tallahassee, Florida.

HARVESTING SECTOR

Current Status

Florida requires oyster harvesters to use tongs except on the few remaining oyster leases in Apalachicola Bay. There are 742 registered oyster harvesters in Franklin County, where Apalachicola Bay is located, but the actual number working the water for a primary living is substantially less—perhaps less than one-half (i.e., 150 to 350 harvesters on the water on any given day). Harvesters are usually males between the ages of 20 and 50 who have been oystering their entire adult life and who do not have a high-school diploma. The high-school dropout rate is considered high in Franklin County, partly because oyster harvesting and processing has traditionally presented a relatively high earning potential to pregraduation teenagers.

Gross annual income for an Apalachicola Bay oysterer ranges from $25,000 to $35,000; expenses range from $4,000 to $10,000. The typical harvester is male, white, 35 to 40 years old, has a tenth-grade education, and 20 years of experience oystering. Almost all (i.e., 98 percent) harvesters own their own boat; very few rent. Harvesting typically is a "one-man" or a husband-and-wife operation. Basic harvesting activities include transporting the boat to a put-in location, traveling by boat to the oyster bed, working the bed with tongs to extract the oysters, culling the

oysters according to regulatory limits and product quality constraints, traveling back to the put-in location, and hauling the shellstock in the harvester's truck to the processing plant.

Harvesters typically deal with one or two processors and negotiate a prearranged price per 60-pound bag (per bushel) for shellstock harvested from certain beds. Shellstock bound for the half-shell market typically is more profitable for processors and they may pay more for a bag that contains more half-shell ("cup") oysters, which have been harvested from a particular bed. However, the harvester will not receive a different price for each bag based on the half-shell content. If the harvester brings in substandard shellstock, his relationship with the processor is jeopardized. The allowable harvest area is significantly smaller in the summer, which sometimes causes processors with private oyster leases to contract with other harvesters to harvest from those leases in the summer.

Required capital equipment includes a boat, an engine, tongs, a pick-up truck, and a trailer. This total capital value is approximately $10,000 for "as-is" equipment. Nondurable goods and materials include gloves, boots, fuel and oil, licenses, and permits. A new boat costs approximately $2,500 and lasts 8 to 12 years. A new engine costs from $3,000 to $5,500 and lasts about 4 years. Many harvesters buy used engines every year or two with financing. Tongs last about a year and cost $200. Only 10 out of 400 harvesters have any boat insurance.

Traditionally, about one-half of oyster harvesters also generate income from fishing for other seafood such as mullet, shrimp, and crab. However, about 90 percent of harvesting income is typically from oystering. Other income-generating activities for harvesters include "relaying," where shellstock is moved from one bed to another to cleanse the oysters of impurities from the first bed. Payment for relaying is drawn from a fund comprising state trust fund moneys and local license fees. The harvesters we interviewed indicated that they typically generate little nonfishing income.

Potential Effects of Options According to Respondents

1. Harvesting restriction. The harvesters we interviewed indicated that they would leave oystering altogether if they were forbidden to harvest during the 7-month period from April 1 to October 31. They posited that some harvesting would take place during the other 5 months, but that so many harvesters would leave oystering altogether due to this restriction that harvest levels would plummet. Some thought they could accept a 3-month ban (e.g., May through August). However, some harvesters projected that, given the water-quality closures during January and February, even a 3-month summer closing would force them to leave oystering.

2. Marketing restriction. Currently, nearly all of the shellstock harvested in the summer from Apalachicola Bay is bound for the half-shell market; therefore, harvesters feel that the half-shell marketing restriction is tantamount to a summer ban. Local processors get most of their product for shucking from Louisiana and Texas.

3. Time controls. Recently, Florida imposed a daily 12-hour harvest limit, which appears to have had little effect on harvesters; however, it is difficult to translate this experience to the Agency-recommended 8- and 10-hour limits. Harvesters said the problem is not that they want to spend that much time on the water—it is difficult to spend much more than 8 hours in the summer sun of Florida. They said the problem arises in that enforcement requires a clock deadline. So, if a harvester has engine trouble and can't get onto the water until noon and must be off the water by, say, 4:30 to get the product to the processor by 6:00, he has a very short and unproductive day.

4. Temperature controls. Apalachicola Bay harvesters said that they have "one-man" boats that are too small to accommodate any onboard refrigeration unit. Moreover, any refrigeration unit would require a fixed capital investment that most harvesters said they could not afford. One harvester suggested that placing the oysters on an elevated pallet in a shaded area of the boat would keep the product much cooler once it is taken out of the water. Several harvesters questioned whether *Vibrio* counts would be substantially reduced by refrigeration. State regulators said research results generally show small decreases in the *Vibrio* growth rate, but not enough to motivate rulemaking.

PROCESSING SECTOR

Current Status

Respondents estimated that there are approximately 20 to 40 processing firms in the Apalachicola region. Sales for these plants range from $0.5 to $5 million. Typically, the processing firms are owner-operated by an individual or a husband and wife. One of the respondents has joined with a partner to help establish himself in the shrimp-processing business, which requires more capital than oyster processing. Most processors rely on oysters for 85 to 90 percent of their business, although one processor received 80 percent of his total revenue from shrimp.

One processor estimated the replacement value of his plant assets to be $3 million, but his plant was relatively large with approximately $5 million in annual sales. Another processor gave a current appraised value estimate of $1.2 million, but that figure was largely related to shrimp processing. The owner's assets are collateralized. A few large processors also own some private oyster leases. The state attempted to confiscate the few remaining Apalachicola Bay leases several years ago but lost in a legal challenge. The value of the leases was not determined.

A typical plant owner is a male in his late forties or early fifties who has a high-school diploma and occasionally some college. Work experience typically is entirely in the seafood

industry. Owner income from operations ranges from $100,000 to $200,000, with $100,000 to $150,000 common among larger processors.

Typically, half-shell product comprises over half of the processors' revenues, with one processor indicating that half-shell product accounts for 75 percent of his revenue. Most of the half-shell product is sold in the Southeast, where little half-shell product from other regions is sold. The shucked product is sold nationally and shucked product from other regions (e.g., the pacific Northwest) can be found in Gulf states grocery stores, especially in the summer. Some Gulf shellstock is shipped to other regions (e.g., Chesapeake) for shucking but this is uncommon. Usually, processors directly contract with grocery store and restaurant chains and transport the product themselves.

Processors typically have slightly less business in summer than in winter, accounting for 35 to 40 percent of annual revenue. Processors indicated that both half-shell and shucked product exhibit summer declines of similar proportion. This is contrary to information we received from other states, indicating that the half-shell market dominates in the summer and shucked product dominates in the winter.

Processing-plant employees include shuckers, packers, truckers, clerical/administrative personnel, and salespeople. Shuckers are paid by the piece (i.e., $5.50 per gallon of shucked meats) and can make between $300 and $600 per week. They typically work year-round, but some shuckers voluntarily take off in the summer when meat yields per oyster shucked are smaller. Shuckers are provided with mandated benefits (Social Security and Workers Compensation) but seldom have health insurance. Some of the other plant workers do receive health benefits. Shuckers typically have less than a high-school education and their specialized skills are not easily transferable to other professions in the region. Other manual laborers, such as loaders and packers, also typically have no high-school education but their skills do no appear to be quite as specialized.

Potential Effects of Options According to Respondents

1. Harvesting restriction. Processors indicated that they could not generate enough revenue in 5 months to maintain their oyster processing operation. They did not view importing shellstock from other regions as economically feasible. One processor indicated that there would be a negative effect on his shrimp processing business because his trucks leave the plant with both shrimp and oyster products. He would have to reduce the number of runs he makes, and perhaps the number of trucks he operates, in order to generate full truckloads of shrimp. Another potential problem is the effect of a temporarily discontinued supply on processors' ability to retain a customer base if those customers can obtain steady supplies of product from other regions in the interim.

2. Marketing restriction. One processor indicated that it would be economically impossible for his company to operate solely on shucked product in the summer, when half-shell product usually accounts for 75 percent of his business. He said that the industry would have to initiate a marketing campaign to increase shucked product consumption in the summer. He jokingly suggested that having Christmas in July would help. He also posited that few processors would remain in business and that those who did would have market power and be able to suppress the shellstock price even further. Another processor commented that this alternative was "not as bad as a total ban, but I don't think we could make it."

3. Time controls. Processors generally did not have strong opinions about how this option would affect them.

4. Temperature controls. Generally, processors had no strong opinions about onboard refrigeration. Some thought this, along with other improved operating practices, would help improve the integrity of the product.

SUGGESTED SOLUTIONS/CONSEQUENCES

1. At-risk consumer information is pivotal. Informing consumers about *Vibrio* was unanimously selected by all parties interviewed as the preferred approach to reducing the number of *Vibrio*-related illnesses. Florida currently requires warning labels on the product and requires restaurants to have a warning on menus. Respondents suggested requiring this type of consumer information on a national level. They thought that more interaction with the medical profession was necessary to communicate information to certain high-risk populations.

2. Good operating practices should be further encouraged. Options aimed at improving harvesters' and processors' operating practices and protecting the integrity of the product were seen in a more positive light than absolute restrictions. Some harvesters suggested onboard shading as a workable cooling alternative to refrigeration for Florida harvesters.

3. Perform more research on factors/methods that affect *Vibrio* incidence. Harvesters said that, for example, refrigeration should not be required if it is not proven to reduce *Vibrio* illness incidence. Previous depuration experiments were seen as a failure. Some respondents mentioned that more research on irradiation should be considered. Experimental methods such as in-shore farming were mentioned, as was the name of one Florida researcher who is experimenting with these methods.

4. Do what Florida is doing now, no more. Opinion seemed strong that FDA should not consider *Vibrio* an adulterant. Currently, Florida requires warnings on product sold at retail establishments and restaurants, refrigeration within 30 minutes of delivery to a certified dealer, and 14-day pull dates.

5. Put Gulf oysters on a level playing field with other food products. Most respondents thought the perceived risk from Gulf oyster consumption is disproportionate to the actual risk relative to oysters from other regions and to other food products. Some respondents also questioned the logic of treating half-shell product differently from shucked product.

GULF INDUSTRY COUNCIL SITE VISIT REPORT

On April 19, RTI staff attended a meeting of the Gulf Industry Council to interview oyster harvesters, processors, and leaseholders regarding the potential economic impacts and other relevant aspects of options to address mortality and morbidity associated with *Vibrio vulnificus*. RTI associate economist Jackqueline L. Teague interviewed four representatives from three states: two from Louisiana, and one each from Alabama and Mississippi. Separately, RTI interviewed regulatory staff from Louisiana by telephone. This report summarizes the information reported by respondents. RTI staff will analyze the information, cross-check it with published sources when feasible, and conduct other internal and external consistency checks before incorporating quantitative estimates provided by respondents into our database.

The interviews were conducted in New Orleans, Louisiana, between meetings of the Shellfish Workshop I sponsored by the Gulf of Mexico Program.

HARVESTING SECTOR

Current Status

The Council reported that the Gulf oyster industry is valued at $200 million per year. Council representatives reported that the acres of oyster leases off the Louisiana coast are worth millions of dollars. These leases are mortgagable and inheritable.

Respondents reported that there are approximately 1,700 oyster harvesters in Louisiana, including public and private harvesters. Harvesters are typically males between the ages of 15 to 70 who have been oystering their entire adult life and who do not have a high-school diploma. Basic harvesting activities include traveling by boat to the oyster bed, working the bed with dredges by swinging the boat in a circle to extract the oysters, culling the oysters according to regulatory limits and product quality constraints, sacking the oysters, traveling back to the dock, and unloading the sacks at the dealers.

The typical dredge boat captain is a male of foreign descent (e.g., Yugoslavian, Hispanic) who is 35 to 40 years old; some have a high-school education or GED. Most captains in Louisiana own their boat. A captain with two boats can make $100,000 a year but most make between $35,000 and $40,000. Typically, harvesting requires a three- to four-man crew. Gross annual income for a Louisiana deckhand ranges from $15,000 to $25,000 (i.e., $50 to $75 to $100 to

$120 per day, depending on the day's catch) with half of that income resulting from summer harvesting. The typical deckhand is a male of foreign descent who is 20 to 30 years old and who has less than a high-school education. Experienced deckhands can become boat captains.

Harvesters typically deliver product to one dealer or leaseholder and receive $10 to $12 per sack for shellstock. A sack yields approximately 4 to 5 pounds of shucked meats during the summer and 8 to 10 pounds in the winter.

There are approximately 300 to 400 resident dredge boats licensed in Louisiana. An additional 900 licenses are issued to nonresident dredge boats whose owners travel to Louisiana waters. Two types of boats are used for oystering in Louisiana. Large luggers accommodate overnight trips to remote areas and few have refrigeration on board; few harvesters own luggers. Most oyster boats are 40- to 50-foot dredge boats with a cabin on the stern. These boats are valued at between $80,000 and $100,000 each.

The processors, harvesters, and leaseholders we spoke with indicated that harvesters typically generate little in the way of nonfishing income.

Leases are currently selling for between $100 and $6,000 per acre, depending on the quality of the cultch (i.e., the layers of shell that create a foundation for oyster production); $1,000 an acre is typical in Louisiana. One leaseholder reported owning 18,000 acres worth approximately $3 million (i.e., $166 per acre average market value). There are approximately 360,000 leased acres in Louisiana waters.

Potential Effects of Options According to Respondents

1. Harvesting restriction. Representatives that we interviewed indicated that harvesters would leave oystering altogether if they were forbidden to harvest for the 7-month period from April 1 to October 31. Whole families (i.e., several generations) are involved in the oyster business and representatives reported that it hurt to even think about such severe changes. They posited that some harvesting would take place during the other 5 months, but that so many harvesters would leave oystering altogether that harvest levels would plummet. According to respondents, there are few alternatives for oysterers. Oyster boats cannot easily be converted to shrimp boats because the cabin is on the stern rather than on the bow. One harvester we met in Texas had been a harvester in Louisiana 3 years previously in 1992 when the oysters had died. He converted two boats to shrimping at a cost of $15,000 but found that shrimping was not viable and returned to oystering. Respondents believed that oysterers forced to seek reemployment at minimum wage might have to move out of the area to find work. They also said that leaseholders would lose much of the value of their leases with a 7-month closure.

2. Marketing restriction. About 50 to 70 percent of the shellstock harvested in the summer from the Gulf is currently bound for the half-shell market; therefore,

respondents thought that the marketing restriction would be tantamount to a summer ban. Demand for summertime shucked product is low and unprofitable because the oyster meat yields are smaller in the summer.

3. Time controls. Respondents reported that problems with this restriction arise in that enforcement requires a clock deadline. Some Louisiana harvesting areas are so remote that luggers travel overnight; these boats sometimes have refrigeration on board. However, other areas are accessible after only 4 hours; for these remote locations, it takes about 8 hours to travel out and back round-trip. Harvesters said that they sometimes spend 3 to 4 hours looking for oysters, which would make even the 14-hour harvest day restrictive in Louisiana (whereas Texas and Florida could accommodate a 12-hour limit). These remote locations are inaccessible and are often closed due to pollution and bad weather during the shorter days in winter (i.e., up to 75 percent closures).

4. Temperature controls. Industry representatives reported that most Louisiana harvesters' boats would have difficulty accommodating any on-board refrigeration unit. Because oyster dredge boats are designed to displace only 3.5 feet of water with the bow drawing only 1 foot, a refrigeration unit would increase the draft and preclude harvesting in 4-foot waters. They thought that adding a refrigeration unit to hold the day's harvest would make the boat top heavy and more likely to capsize and that carrying ice would not be feasible, either, because of limited space. Furthermore, representatives reported that ice spoils the oysters because they open to feed in the heavy mist and the fresh-water mist or melted-ice water kills them or ruins their salinity. Only a few boats, such as the large luggers, have refrigeration units on board for extended overnight excursions.

PROCESSING SECTOR

Current Status

There are approximately 225 oysters processors in Louisiana, Mississippi, and Alabama. Louisiana Seafood Promotion Board records indicate there are approximately 56 certified dealers, 42 shucker-packers, 4 repackers, and 37 reshippers for a total of 139 oyster processors in Louisiana. The ISSC Interstate Shellfish Shippers' List reports 146 oyster processors in Louisiana, 24 in Mississippi, and 59 in Alabama.

Most processing facilities are owner-operated by an individual or a husband and wife. A typical plant owner is in his late 40s or early 50s and has a high-school diploma and occasionally some college. Typically, his work experience is entirely in the seafood industry. The majority of owners have only one plant. Two of the oyster representatives that we interviewed were 100 percent oyster processors and two were 40 percent and 70 percent oyster processors who handled shrimp, crab, or other species as well. The oyster processors who processed other species were larger operations with 75 full-time oyster employees among 180 to 275 total employees.

Several owners have a variety of assets including the processing plant. One processor reported recently constructing a processing plant. A new plant costs about $250,000. Larger processors also own two or three semi-tractor-trailer trucks and three or four boats, as well as private oyster leases.

The half-shell market dominates in the summer and shucked product dominates in the winter in Louisiana, Mississippi, and Alabama. In Louisiana, half-shell product typically comprises 70 percent of processors' summer revenues. Most of the half-shell product is sold outside Louisiana in a national market including the Southeast, Northeast, Midwest, and Canada. Some in-shell product from other Gulf states is sold in Louisiana. The shucked product is sold nationally and shucked products from other regions, (e.g., the Pacific Northwest) can be found in Gulf states grocery stores, especially in the summer. Processors often contract directly with grocery store and restaurant chains and transport the products themselves.

Processors employ from 30 to 100 people, though smaller plants are common. Processing plant employees include shuckers, packers, truckers, clerical/administrative, and salespeople. Typically, a processor has 30 to 35 employees who are primarily shuckers. Shuckers earn approximately $11 per hour doing "piecework." Shuckers seldom have health insurance. Typically, they work year-round but some voluntarily take off in the summer when meat yields per oyster shucked are smaller. Shuckers in Louisiana typically are minority women who have less than a high-school education; their specialized skills are not easily transferable to other professions in the region.

Potential Effects of Options According to Respondents

1. Harvesting restriction. Processors indicated that they could not generate enough revenue in 5 months to maintain their oyster processing operation. They did not view importing shellstock from other regions as economically feasible because Connecticut oysters usually cost $80 for a 60-pound box vs. only $12 for a box of local oysters. One potential problem is the effect of a temporarily discontinued supply on processors' ability to retain a customer base if those customers can obtain steady supplies of product from other regions in the interim. Processors felt that leaseholders would lose much of the value of their leases.

2. Marketing restriction. Most processors indicated that it would be economically impossible for their companies to operate solely on shucked product in the summer, when half-shell product usually comprises 60 to 75 percent of their business. The oysters-only processors did not believe they could survive on 5 months a year. Entire families would be out of work because women who are shuckers often are married to men who are harvesters and generations are employed by the family business. The Gulf Oyster Industry Council reports that either a harvesting or marketing restriction would result in a direct economic impact of $100 million or half the total $200 million annual value.

3. Time controls. Processors generally did not have strong opinions about how this option would affect them.

4. Temperature controls. Processors generally did not have strong opinions about how this option would affect them.

SUGGESTED SOLUTIONS/CONSEQUENCES

1. At-risk consumer information is pivotal. Informing consumers about *Vibrio* was unanimously selected by all parties interviewed as the preferred approach to reducing the number of *Vibrio*-related illnesses. Representatives believed that FDA should inform *at-risk* individuals that they should thoroughly cook raw protein products instead of frightening consumers who are not at risk.

2. FDA should research and approve other technologies. Representatives thought that irradiation, plasma ionization, or freezing should be considered as possible solutions. They reported that irradiation had been shown to be effective in laboratory research but that FDA had not approved irradiation for oysters. The only irradiation plant in the Gulf region is located in Florida and cost $10 to $12 million to build. However, it was not thought to be a viable solution at this time, according to Gulf Oyster Industry Council representatives. Plasma ionization was cited as a European technique that may reduce *Vibrio*. Freezing was suggested as a possible alternative as well.

3. Put Gulf oysters on a level playing field with other food products. Most respondents felt the perceived risk from Gulf oyster consumption is disproportionate to the actual risk relative to oysters from other regions and to other food products. They thought that FDA should publicly announce that the 14-hour/14-day shelf life limits are positive and worthwhile. Respondents thought that FDA had not kept its commitment to educate *at-risk* consumers but was instead frightening all consumers unnecessarily when other food products cause far more illnesses and deaths than oysters.

LOUISIANA SITE VISIT REPORT

On October 16 and 17, RTI staff visited Louisiana to interview oyster harvesters, processors, leaseholders, and state regulators regarding the potential economic impacts and other relevant aspects of the ISSC interim control plan agreement. Made in August 1995, the agreement addresses mortality and morbidity associated with *Vibrio vulnificus* (ISSC, 1995). RTI staff members Jackqueline L. Teague and Donald W. Anderson interviewed four industry representatives. All four representatives owned oyster leases; two operated medium and large oyster processing companies; one operated three oyster boat; including one with on-board refrigeration; and one operated an oyster dock that ships only shellstock. RTI interviewed four regulatory staff from the Louisiana Department of Wildlife and the Louisiana Department of Health and Hospitals. This report summarizes the information reported by respondents. RTI staff will analyze the information, cross-check it with published sources when feasible, and conduct other internal and external consistency checks before incorporating quantitative estimates provided by respondents into our database.

The interviews were conducted in Empire, Houma, St. Bernard, and New Orleans, Louisiana.

HARVESTING SECTOR

Current Status

Louisiana regulators report that Louisiana produces 2 million sacks of oysters each year and that 50 to 60 million raw gulf oysters are consumed annually across the nation. Undoubtedly, Louisiana produces more oysters than any other state in the nation. In 1994, the state issued 360,000 acres of leases, 897 harvesting licenses, 153 tong licenses, and 1,060 dredge licenses. Landings totaled 11,327,730 pounds of meat weight valued at $20,160,789. From April 1 through October 31, 1994, Louisiana produced 6,846,900 pounds or 60 percent of its 1994 total according to preliminary data from the Louisiana Department of Wildlife and Fisheries.

In Louisiana, the public oyster season begins in September and closes in April; however, harvesting oysters on private leases is permitted all year. The regulatory representatives reported that the number of acres leased off the Louisiana coast varies from year to year. In January 1995, Louisiana leased 360,000 acres, and in 1989, 340,000 acres were leased. Leaseholders are required to pay an annual tax of $2 per acre to the state of Louisiana.

Estimates of the total value of Louisiana leases varies depending on how the value is assessed. The value of a leased acre is a subject of debate in Louisiana among regulators, leaseholders, and oil companies. Acreage is primarily leased to cultivate and harvest oysters; however, leaseholders may lease acreage for other reasons. For example, leaseholders report that they often lease acreage surrounding their productive acres to create a buffer to discourage illegal harvesting or avoid damages. The value of a lease varies depending on its highest valued use, either as an easement if purchased by oil companies, a buffer for productive oyster leases, or as an oyster-producing lease. Oyster-producing lease values vary depending on their location and productivity. Productivity varies depending on the weather, especially rainfall, and the intensity of the leaseholder's cultivation effort (i.e., laying cultch, planting or transplanting oysters).

Respondents reported the sale price of a leased acre from one leaseholder to another ranged between $100 and $6,000, depending on the quality of the cultch (the layers of shell that create a foundation for oyster production); $1,000 an acre is a typical sales value in Louisiana. Another measure of value that respondents mentioned were recent damage assessments awarded in court (e.g., leaseholders vs. oil companies). Specifically, interview respondents said that a leaseholder recently received a $1.5 million dollar damages award for 250 acres of damaged oyster leases, which implies a value of $6,000 per damaged acre. Market values, rather than damage awards, usually reflect the economic value of goods that are traded freely in a competitive market. Leaseholders reported estimated total market values and acreage for their leases that implied average values from $150 to $278 an acre. Several leaseholders considered a value of $166 per acre an appropriate working estimate for the average value of Louisiana leases, which implies a market value of approximately $60 million for the 360,000 acres of leases. However, this estimate is not based on actual sales because most leases held by respondents were inherited from parents and grandparents. According to respondents, current sales are typically near $1,000 per acre for productive acreage; however, this figure may not be representative of all acres leased from the state. Using the average value of $166 per acre to estimate the total approximate value of $60 million for the 360,000 acres of leases appears to yield a conservative estimate.

Alternatively, we may use the value of the landings as an annual monetary yield to calculate the value to the leaseholders. For example, average landings per year total 11.3 million pounds of oyster meat with an average annual value of $23 million (preliminary data for 1982, 1989, and 1994 from the Louisiana Department of Wildlife and Fisheries). Approximately 66 percent of these landings are from leases (Keithly and Roberts, 1988), therefore the approximate value of the annual monetary yield is $15.2 million. According to industry representatives, leaseholders receive about 20 percent of the landings' value (i.e., $3 million per year) with the balance going to harvesters, boat owners, and expenses. Using the $3 million as an annual

income, the net present value of the annual income stream implies a total lease value of $52 million discounted at 3 percent over 20 years, which is comparable to the value of $60 million estimated using the average per-acre value of $166.

Leaseholders report that they must plant oysters in the fall when the public season opens in September in order to be ready to harvest in April when the public season closes. Leaseholders hire a three- or four-man crew at approximately $105 per person per day to transplant oysters from public reefs. From the April public closure to the September reopening, the private leases are the only source for Louisiana oysters. Leaseholders expect to harvest up to 200 sacks of oysters per day in the spring, but the size of the catch lessens over the course of the summer season; only 50 sacks per day may be harvested by the fall.

There are about 900 licensed oyster harvesters in Louisiana, including resident and nonresident harvesters. Harvesters are typically males between the ages of 15 and 70 who have been oystering their entire adult life and who do not have a high-school diploma. Basic harvesting activities include traveling by boat to the oyster bed, working the bed with dredges by swinging the boat in a circle to extract the oysters, culling the oysters according to regulatory limits and product quality constraints, sacking the oysters, traveling back to the dock, and unloading the sacks at the dealers.

The typical dredge boat captain is a male of foreign descent (e.g., Yugoslavian, Hispanic) who is 35 to 40 years old; some have a high-school education or GED. Most captains in Louisiana own their boats. Typically, harvesting requires a three- to four-man crew, but smaller single-dredge boats may have only two men. Deckhands are paid to handle oysters on a per-sack basis unless they are transplanting or cultivating a lease, whereupon they are paid by the day. A day's wage is around $105 or $1.25 or $1.50 per sack harvested; typically a deckhand earns $125 to $150 harvesting 100 sacks in a day. The typical deckhand is a male of foreign descent who is 20 to 30 years old and who has less than a high-school education. Experienced deckhands can become boat captains.

Harvesters typically deliver product to one dealer or leaseholder and receive $10 to $12 per sack for shellstock. A sack of shellstock weighs about 104 pounds and holds approximately 15 dozen oysters. Two sacks of shellstock are equivalent to one barrel. A sack yields approximately 4 to 6 pounds of shucked meats during the summer and 8 to 10 pounds in the winter. Smaller boats harvest 40 to 50 sacks per day while larger boats bring in 75 to 100 sacks: the largest boats harvest up to 200 sacks per day.

Approximately 1,014 resident and 46 nonresident dredges are licensed in Louisiana according to preliminary 1994 data from the Department of Wildlife and Fisheries. One or two dredges are carried on each boat, representing a minimum of 530 boats. Three types of boats with dredges are used for oystering in Louisiana. Large 50- to 60-foot luggers, each worth $150,000 to $225,000, accommodate overnight trips to remote areas; few have refrigeration on board. According to industry representatives, few harvesters—perhaps only 150 to 200—own luggers. Medium-sized oyster boats are 40- to 50-foot dredge boats with a cabin on the stern. These boats are valued at between $60,000 and $100,000 each. Respondents estimate there are 100 to 150 medium-sized boats. Industry representative report the majority of oyster boats—about 300 to 400 boats—are smaller and are worth $15,000 to $20,000 each. These smaller boats are called Lafitte skiffs and accommodate a single dredge. In addition to oystering, the skiffs can be used for shrimping and other fishing. Tong boats are smaller than the dredging skiffs and are used in the Calcasieu Lake public tonging grounds. State regulators report issuing 153 tong licenses in 1994.

The processors, harvesters, and leaseholders we spoke with indicated that harvesters typically generate little nonfishing income. Oyster harvesters wait for orders from shellstock dealers before setting out to harvest. One respondent reported that some shellstock dealers rotate through a list of about 18 harvesters who operate skiffs each day. On a typical summer day, a medium-sized dealer would hire 6 to 8 of the 18 available skiffs to fill oyster orders. The dealer usually shipped orders to shucked-meat processors during the summer of 1995. Louisiana skiff harvesters usually work with a single dealer to fill orders and have enough work for 2 or 3 days a week during the summer.

PROCESSING SECTOR

Current Status

The ISSC Interstate Shellfish Shippers' List (October 1995) reports 134 oyster shippers in Louisiana. The list indicates there are 58 shellstock shippers, 45 shucker-packers, 1 repacker, and 20 reshippers for a total of 134 oyster processors in Louisiana. Companies that deal in more than one species must have separate facilities for each species. According to respondents, oysters constitute 100 percent of the sales for the majority (75 percent) of certified shippers.

Most processing facilities are owner-operated by an individual. A typical plant owner is in his late 40s or early 50s and has a high-school diploma and occasionally some college. Typically, his work experience is entirely in the seafood industry. The majority of owners have only one plant.

Several owners have a variety of assets including the processing plant. Plant owners report that an oyster plant is worth between $250,000 and $500,000 with a few larger ones worth $1 million or more. If plants could no longer be used for processing oysters, they could be converted to warehouses in Louisiana because most plants are located inland near highways. Larger processors with shucker-packer certification also own two or three semi-tractor-trailer trucks and three or four boats, as well as private oyster leases. Processors in Louisiana often send trucks to the docks to transport the oysters to their shucking plants. Respondents report that about half of the shellstock shippers do not own a permanent building but own a truck with a refrigerated trailer (i.e., a "reefer"). Reshippers also do not require a permanent building either. The other shellstock shippers usually own a dock with a refrigerated storage area to collect sacked oysters from harvesters during the day to load on refrigerated trucks as they arrive.

According to industry respondents, the half-shell market once dominated in the summer. Shucked product continues to dominate in the winter in Louisiana. In Louisiana, half-shell product used to comprise 70 percent of processors' summer revenues. During the summer of 1995, smaller processors report that the half-shell market was severely depressed. Larger processors also report that the quantity demanded decreased to around 50 percent of their sales. Smaller processors reported that now 85 percent of their oysters are shucked; however, they report that the proportions used to be reversed. The smaller dealers report that half of their shellstock is sold in Louisiana with the other half mostly going to Alabama, Florida, and Mississippi. Larger processors report about 30 percent of the their oysters are sold in Louisiana, 50 percent are sold in the Southeast (including Virginia and North Carolina), and the remaining 20 percent are sold elsewhere. Overall, most of the half-shell product is sold outside Louisiana in a national market including the Southeast, Northeast, Midwest, and sometimes California. In-shell product from other Gulf states is rarely sold in Louisiana. The shucked product is sold nationally and shucked products from other regions, (e.g., the Pacific Northwest) can be found in Gulf states grocery stores. Processors contract directly with grocery store and restaurant chains and transport the products themselves.

Processors employ from 5 to 100 people, though fewer are common among shellstock shippers who only have 1 or 2 people operating a refrigerated truck. Other shellstock shippers with a dock employ 5 to 10 people. Shucker-packer processing plant employees include shuckers, packers, truckers, clerical/administrative, and salespeople. Typically, most processing plants have 10 to 15 employees according to respondents. Shuckers are paid about $5 per sack and earn approximately $11 per hour. Shuckers seldom have health insurance. Typically, they work year-round but move among plants. For example, respondents reported that in an area with 8 shucker-packer plants, there are about 150 shuckers who move among the plants (i.e., 18 to

19 shuckers per plant). Shuckers in Louisiana typically are minority women who have less than a high-school education; their specialized skills are not easily transferable to other professions in the region. They shuck oysters from 4:30 a.m. until noon in Louisiana. Other employment opportunities include janitorial work, cane farming, or work with the oil companies. Trapping, shrimping, and crabbing are mature industries with little or no new jobs available.

Potential Effects of ISSC Interim Control Plan According to Respondents

1. Water Temperature Action Levels. Regulators report that preliminary water temperature data suggest that June, July, and August may require a Level 4 action level with 6 hours time to refrigeration required. Level 3 may be necessary during April, May, September, and October according to preliminary data.

2. Refrigeration onboard. Harvesters are deeply concerned about investing significant capital to meet ISSC requirements that are only interim plans. Specifically, onboard refrigeration will require costly changes in boats and equipment that could only be justified if the control plan is certain. Since the plan is merely interim, harvesters are confused about whether to encumber themselves with the debt.

   Industry representatives reported that most Louisiana harvesters' boats would have difficulty accommodating any on-board refrigeration unit. Because oyster dredge boats are designed to displace only 3.5 feet of water with the bow drawing only 1 foot, a refrigeration unit would increase the draft and preclude harvesting in 4-foot waters. They are concerned that adding a refrigeration unit to hold the day's harvest would make the boat top heavy and more likely to capsize. They are also concerned about the hazard of losing power to the refrigeration unit since the oysters in the malfunctioning unit would quickly become overheated.

   Harvesters may be able to purchase or lease small refrigeration units that use liquid carbon dioxide for temperature control. However, this new technology has not been tried for oysters on small boats, and industry representatives expressed concern that the CO_2 may harm the oysters or the bulky unit may endanger harvesters. These pallet-sized units look promising to some industry representatives. The cost may be in the range of $6,000 to 7,000 per unit, excluding the CO_2 charging equipment. Harvesters are looking to processors to help solve these challenges because many processors already send refrigerated trucks to the dock to receive oysters. Processors report estimates of around $250 per month for a harvester to lease one pallet-sized refrigeration unit that would hold 25 to 30 sacks. Respondents reported that some harvesters hope they will be allowed to refrigerate the morning catch and return to dock to refrigerate the afternoon catch in order to have shellstock under refrigeration within 6 hours of harvest.

   Only a few boats, such as the large luggers, have refrigeration units on board. Even a 57-foot lugger had difficulty accommodating an 8' x 12' x 5.5' refrigeration unit that holds 150 sacks and that may be easily removed for the winter season. Four years ago, parts alone cost $3,600 for the unit; however, one respondent estimated that purchasing a unit, including installation would be priced around $15,000. The unit reduces the captain's field of vision as well as deck space, so he removes it as soon air temperatures fall.

3. Reduced length of harvesting day. Some Louisiana harvesting areas are so remote that luggers travel overnight. However, other areas are accessible after only 4 hours; for these locations, it takes about 8 hours to travel out and back round-trip. Harvesters said that they sometimes spend 3 to 4 hours looking for oysters, which would make even the 14-hour harvest day (Level 2) restrictive in Louisiana. To enable them to travel faster, some skiff owners are considering purchasing larger engines that will travel at 30 to 35 knots rather than only 8 knots; these engines cost $18,000 to $20,000 each. Interview respondents estimated that only one-third to one-half of the oyster beds are accessible in less than 2 hours one way. These nearer beds are productive during low rainfall years. However, remote beds (approximately one-tenth of oyster beds) require more than 4 hours' travel each way and are most productive during wet years. Most oyster beds are located within 2 to 4 hours one way (approximately 40 percent to 60 percent of oyster beds) and are considered wet/dry beds that are fairly productive whether rainfall is low or high. To allow an hour for unloading, 2 hours for traveling, and 3 hours for fishing without refrigeration onboard, one may be able to harvest from only one-third or one-fourth of Louisiana's oyster beds that are nearest to the docks, according to interviewees. To reduce the unloading time, harvesters are dependent on dealers and processors to add labor, unloading equipment, and more entry ways to refrigeration units.

   In general, processors send trucks with refrigerated trailers to docks to pick up oysters from dealers or purchase oysters from shellstock shippers who are the truck owner-operators. Placing oysters under refrigeration at the dock involves moving them from the boat into a refrigerated unit. Dealers at docks in Louisiana often move oysters from the boats using a conveyor belt, stack the oysters on pallets by hand, and move the pallets onto refrigerated trucks using a forklift. Currently, they can unload/load about 20 sacks in 10 minutes or load a trailer in about 2 hours. To reduce the time spent loading, dealers or processors would have to purchase more conveyors and more forklifts that cost about $20,000 each, hire more labor, and/or add more doors to access refrigerated storage or more refrigerated trailers. Refrigerated trucks or trailers (reefers) hold from 100 to 300 sacks of oysters and cost from $40,000 to $55,000. A rig with tractor and trailer costs from $120,000 to 150,000. Respondents reported that many processors are hesitant to make these costly capital investments to satisfy an *interim* control plan.

4. Other State Shellfish Control Authority (SSCA) options. Several enforcement options are discussed among industry and regulatory representatives in response to the ISSC interim control plan Action Level 4 (6-hour limits):

   - Allow harvesters to separate the morning's harvest for shucked processing and the afternoon's harvest for half-shell sale;

   - Allow harvesters to refrigerate morning harvest using a small unit and return with unrefrigerated afternoon harvest within the 6-hour limit;

   - License processors and/or harvesters to either handle oysters for half-shell or shucked sale but not both in order to regulate and separate the shucked and half-shell products; or

   - Restrict in-shell shipping within state lines and permit only shucked product to be shipped out of state.

   Regulators stated that although the ISSC interim control plan would improve the quality of oysters, it would certainly have a horrible effect on those who depend on oysters for

their livelihood and an uncertain effect on *Vibrio*-related illnesses among the medically at-risk group who may assume that refrigeration reduces their risk.

SUGGESTED SOLUTIONS/CONSEQUENCES

1. At-risk consumer information is the real answer. Informing consumers about *Vibrio* was unanimously selected by all parties interviewed as the preferred approach to reducing the number of *Vibrio*-related illnesses. Representatives believed that FDA should inform medically at-risk individuals that they should thoroughly cook raw protein products instead of frightening consumers who are not medically at risk. Some oyster industry representatives feel that they were bullied into the ISSC conference agreement, which was not handled using standard conference procedures.

2. More scientifically based regulation. Representatives thought that irradiation, plasma ionization, pasteurization, or freezing should be considered as possible solutions to reduce *Vibrio vulnificus*. Many respondents reported that the ISSC interim control plan is considered a political solution rather than a scientific one because refrigeration inhibits growth but does not eliminate the naturally occurring *Vibrio*. Several respondents stated that *Vibrio*-related illness is a medical problem similar to an allergy and should not be regulated as an adulterant.

3. FDA public commitment to the control plan and facilitate access to financial assistance. According to respondents, the lack of commitment by the FDA and the federal government as evidenced by the title "interim control plan" has created an atmosphere of uncertainty that hinders economic investment. The investments that will be required in Louisiana to meet the interim control plan are daunting for harvesters, dealers, and processors who hope to find some economic assistance (e.g., Economic Development Administration grants).

MISSISSIPPI SITE VISIT REPORT

On October 13, RTI staff visited Biloxi, Mississippi, to interview oyster processors and state regulators regarding the potential economic impacts and other relevant aspects of the ISSC interim control plan agreement made in August 1995. The control plan addresses mortality and morbidity associated with *Vibrio vulnificus* (ISSC summary of actions, 1995). RTI staff members Jackqueline L. Teague and Donald W. Anderson interviewed representatives from one firm; however, extenuating circumstances required a telephone interview on October 30. Ms. Teague also interviewed a Mississippi processor in April during the Shellfish Workshop in New Orleans, Louisiana. RTI interviewed two regulatory staff from the Mississippi Department of Marine Resources who were previously or currently responsible for Seafood Quality Assurance. An additional regulatory official was interviewed by telephone because he could not attend the interview on the day RTI staff were in Mississippi. This report summarizes the information reported by respondents. RTI staff will analyze the information, cross-check it with published sources when feasible, and conduct other internal and external consistency checks before incorporating quantitative estimates provided by respondents into our database.

The personal interviews were conducted in Biloxi, Mississippi, and in New Orleans, Louisiana. One firm representative and one regulatory representative responded separately during telephone interviews.

HARVESTING SECTOR

Current Status

Mississippi opens oyster harvesting in mid-October and closes the season around the first of May. The exact dates of opening and closing are set depending on the size and abundance of oysters on the reefs. No harvesting is permitted from May through September. Oysterers harvest shrimp in the summer. Both tong boats and dredge boats are used to harvest oysters. Tong boats are small boats 15 to 20 feet long. The dredge boats are 30 feet long with only one nonmechanical dredge allowed in Mississippi. Although Mississippi attempted issuing private leases during the 1970s to build oyster reefs, the private leases are not productive today.

There are approximately 97 licensed oyster dredge boats and 30 to 60 tong boats in Mississippi annually. Although the harvest day during the open season is 9.5 hours (6:30 a.m. to 4:00 p.m.), harvesters usually spend only 6 to 7 hours on the water. The daily catch per person or

per boat ranges from 40 to 50 sacks. In Mississippi, shellstock quantity is measured in barrels (i.e., 5.96 cubic feet). About 3 sacks equal one barrel with a sack of shellstock weighing approximately 100 pounds. Sacks yield between 1 and 1.5 gallons of meat depending on the month. According to state officials who collect the data, Mississippi harvesters have lower catch rates than Alabama or Louisiana harvesters who harvest on Mississippi public reefs. Mississippi requires oysters to be landed at designated landings. Approximately 250,000 sacks are landed annually in Mississippi, according to regulatory respondents.

Potential Effects of ISSC Interim Control Plan According to Respondents

1. Water temperature action levels. Regulators report that preliminary water temperature data suggest that July through September would require a Action Level 4 with 6 hours time to refrigeration required; however, Mississippi reefs are closed during those months.

2. Refrigeration on board and shading. Respondents report that refrigeration on board will not be necessary during the open season from October through April.

3. Reduced length of harvesting day. Respondents report that reduced hours will not be required during the open season from October through April.

4. Other State Shellfish Control Authority (SSCA) options. Not applicable during the open season.

   Respondents consider the primary impacts of the ISSC interim control plan to be on the processors rather than on the harvesters in Mississippi.

PROCESSING SECTOR

Current Status

The ISSC Interstate Shellfish Shippers' List (October 1995) reports 29 oyster processors in Mississippi. The list indicates there are 14 shellstock shippers, 11 shucker-packers, 2 repackers, and 2 reshippers for a total of 29 oyster processors in Mississippi.

Respondents described the shellstock shippers as having certified refrigerated trucks with 1 or 2 employees. The 11 shucker-packers have permanent facilities. Respondents report that 7 or 8 of the 11 plants truly operate year-round and that 5 of them process oysters exclusively. There are approximately 3 small plants with 4 to 7 employees, approximately 3 medium plants with 10 to 18 employees, and approximately 4 large plants with 25 employees each. Thus, respondents estimate that about 175 to 200 people are employed in oyster processing and shipping.

Processors that operate year-round report they work 52 weeks a year and 5 days a week shucking oysters. Typically, annual sales now total about $3 million, although respondents report that previously sales were closer to $5 million. They attribute the decline in sales to the reduced demand for half-shell product which they say was caused by negative media coverage. In 1995, processors report that 90 percent of oysters are shucked and 10 percent are sold for half-shell consumption in-state. Mississippi processors contract with two or three dealers in Louisiana to supply their shellstock during the summer months. Processors report that virtually 100 percent of the summer oysters are shipped in from Louisiana, and that 50 percent of the winter oysters are harvested in Mississippi with the remaining 50 percent being shipped in from Louisiana.

Several owners have a variety of assets including the processing plant. One larger Mississippi processor reported recently constructing a processing plant that cost about $250,000. Larger processors also own two or three semi-tractor-trailer trucks. A typical plant owner is in his late 30s to early 50s and has a high-school diploma and occasionally some college. Work experience typically is entirely in the seafood industry. An owner and his wife will usually receive a salary of around $40,000 to $50,000 per year according to respondents.

Processing plant employees include shuckers, packers or measurers, truckers, clerical/administrative, and salespeople. Measurers earn about $300 to $400 per week. Shuckers are paid by the piece (i.e., $6.00 to $7.00 per gallon of shucked meats) and can make between $60 and $90 per day or about $250 per week. They typically work year-round. Typically, shuckers in Mississippi are Vietnamese women who have less than a high-school education. Processors report that between July and September shuckers sometimes will not come to work if they can earn more by processing shrimp. Respondents report that workers are limited to shrimp and oyster processing. Other manual laborers, such as loaders and packers, also typically have no high-school education; however, their skills are more transferable to other industries.

Potential Effects of ISSC Interim Control Plan According to Respondents

1. Water temperature action levels. Although Mississippi reefs are closed during the summer months, Mississippi processors depend on Louisiana dealers. Louisiana regulators report that preliminary water temperature data suggest that June, July, and August may require a Level 4 action with 6 hours time to refrigeration required in Louisiana. Level 3 may be necessary in Louisiana during April, May, September, and October according to preliminary data.

2. Refrigeration on board and shading. Mississippi respondents are concerned about Louisiana's ability to accommodate refrigeration on board. According to respondents, it would cost $1 million to build a refrigerated warehouse boat to collect oysters off-shore to eliminate the return trip for remote oyster beds in Louisiana. Processors in

Mississippi are hoping that Louisiana will find a solution that will permit oysters to be shipped to Mississippi for shucking.

3. Reduced length of harvesting day. Respondents report that reduced hours in Louisiana would reduce the number of oysters available and would most likely result in the oysters that are harvested remaining in Louisiana.

4. Other State Shellfish Control Authority (SSCA) options. Although the Mississippi enforcement officials do not open oyster harvesting during the summer, processors in Mississippi are concerned that Louisiana will have an almost impossible enforcement challenge. Respondents suspect that there will be a lot of illegal activity with a 6-hour limit in Louisiana for half-shell oysters. Prices for the half-shell product are expected to rise according to respondents. They noted that during a recent harvester threat to strike in Louisiana, the price of oysters jumped from the usual price of $10 to $11 per sack to $13 to $16 per sack. They expect that the difference in price between shucking oysters and half-shell oysters will create too much incentive for people to change the "tag" on the shucking oysters. If the price difference gets too high, the potential profits will increase illegal activities according to respondents.

SUGGESTED SOLUTIONS/CONSEQUENCES

1. At-risk consumer information is the answer. Informing consumers about *Vibrio* was unanimously selected by all parties interviewed as the preferred approach to reducing the number of *Vibrio*-related illnesses. Several respondents suggested that medical professionals such as doctors and pharmacists should inform at-risk individuals that they should thoroughly cook raw protein products.

2. Educate retail and restaurant food handlers. Many respondents felt that improper handling was the primary problem. Respondents believed that oysters are often inappropriately refrigerated in produce units in casinos or other restaurant operations. They thought that food handlers should receive training about the proper handling of oysters.

3. The big Louisiana harvesters and processors will have to invest in refrigerated boats. Mississippi respondents suggested that the big processors will have to invest in refrigerated boats. Some respondents suggested that the primary effect of the ISSC rule would be to drive all the smaller harvesters and processors out of business: "Only the big guys will be left."

TEXAS SITE VISIT REPORT

On May 26 and 30, RTI staff visited the Galveston Bay area of Texas to interview oyster harvesters, processors, leaseholders, and state regulators regarding the potential economic impacts and other relevant aspects of options addressing mortality and morbidity associated with *Vibrio vulnificus*. RTI staff members Jackqueline L. Teague and Donald W. Anderson interviewed eight representatives from six firms: three were leaseholders who harvested and processed oysters, one was a former leaseholder who processes only, and two were oyster harvesters and leaseholders. RTI interviewed regulatory staff from Texas Parks and Wildlife who are responsible for issuing permits to boats, harvesters, and leaseholders during the leases-only summer harvest. This report summarizes the information reported by respondents. RTI staff will analyze the information, cross-check it with published sources when feasible, and conduct other internal and external consistency checks before incorporating quantitative estimates provided by respondents into our database.

The interviews were conducted in Dickinson, Seabrook, and San Leon, Texas; however, some representatives traveled from Anahuac, Texas, to participate.

HARVESTING SECTOR

Current Status

Approximately 80 to 90 percent of the total Texas harvest comes from Galveston Bay. Texas has a public season from November 1 through April 30 during which people may harvest oysters from public waters or private leases. During the summer from May 1 to November 1, public harvesting is closed throughout Texas; private leases in Galveston Bay are then the sole source for oysters. One must hold a lease or have permission from the leaseholder to obtain a license to harvest in Galveston Bay during the summer months. There are 2,322 leased acres in Galveston Bay in addition to public waters.

There are approximately 400 to 500 licensed oyster harvesters in Texas annually including public and private harvesters. About 200 are full-time oyster harvesters; the others occasionally harvest oysters. Harvesters are typically males between the ages of 20 and 50 who have been oystering their entire adult life and who do not have a high-school diploma.

Gross income for a Galveston Bay oysterer ranges from $30,000 to $40,000 with half of that income resulting from summer harvesting. Basic harvesting activities include traveling by

boat to the oyster bed, working the bed with dredges by swinging the boat in a circle to extract the oysters, culling the oysters according to regulatory limits and product quality constraints, sacking the oysters, traveling back to the dock, and unloading the sacks at the dealers.

The typical captain is a white male between the ages of 25 and 35 who has a high-school education or GED. Some captains are hired but others own their own boat. During the summer, leaseholders more often hire captains whereas perhaps 80 percent of winter captains own their own boats. The harvesting operation typically requires a three- to five-man crew. The typical deckhand is a white male 20 to 30 years old who has less than a high-school education. Experienced deckhands can become boat captains.

Harvesters typically deliver product to one dealer or leaseholder and receive a single price per 90- to 100-pound bag for shellstock harvested from leased beds. Respondents reported that Texas bags are larger than the 65- to 85-pound bags from Florida or Louisiana. According to industry representatives, the price of the larger bags from Texas processors is similar to that of the smaller bags from Florida and Louisiana to offset the additional freight costs of shipping from Texas.

There are approximately 50 full-time dredge boats operating in Galveston Bay from May through October. Two types of boats are used for oystering in Texas. One is the full-time oyster boat and the other is a shrimp boat that is occasionally used for oystering. Typically, full-time oyster boats are shallow-draft vessels 40 to 50 feet long with the cabin on the stern. These boats are valued at between $80,000 and $100,000 each. A new boat costs approximately $140,000 and lasts about 40 years with routine replacements for engines and dredges as necessary. Larger 65-foot oyster boats are valued at approximately $240,000. Shrimp boats that are occasionally converted to oystering are 45-foot shrimp boats with the cabin on the bow. These shrimp boats are valued at approximately $50,000 to $60,000 and cost $3,000 to convert for oystering (i.e., removing shrimp netting, adding dredges). For the leaseholder/boatowner, it costs about $500 a day to operate a boat (i.e., a 40- to 50-foot oyster dredge boat) with $100 a day for the captain and about $80 a day for each of the three or four deckhands.

About 90 percent of harvesting income is typically from oystering. Other income-generating activities for harvesters include “relaying,” during which shellstock is moved from one conditionally approved bed to an approved one to cleanse the oysters of impurities from the first bed. The oysters remain in the approved area for several days (typically 14 days). Leaseholders pay captains and deckhands to relay. The processors, harvesters, and leaseholders we interviewed indicated that harvesters typically generate little nonfishing income.

Potential Effects of Options According to Respondents

1. Harvesting restriction. The harvesters we interviewed indicated that they would leave oystering altogether if they were forbidden to harvest for the 7-month period from April 1 to October 31. They thought that some harvesting would take place during the other 5 months, but that many harvesters would leave oystering. According to respondents, there are few alternatives for oysterers. They thought that perhaps oysterers would be reemployed at $6 to $7 an hour but that they might have to move out of the area to find work. They reported that the Texas legislature was restricting shrimping to only those who currently own a license and that no new licenses would be issued. The boats are specifically designed for oystering (i.e., the cabin is on the stern and they displace only 1 or 2 feet of water with a shallow draft) and could not easily be converted to other uses. Shrimp boats have a 6-foot draft and the cabin is on the bow. Harvesters' boat loans usually list other collateral because banks require insurance on the boat if it is used for collateral. The insurance costs $15,000 per year, which is too expensive to maintain according to respondents. Without the income from the summer harvests, they said that they would be unable to meet these obligations. They said that the collateral for their boat loans is sometimes their family home or the home of another family member.

   Because summer harvest is permitted on leases only, respondents thought leaseholders would lose much of the value of their leases. Leases sold for $3,000 per acre a few years ago but are currently selling for as low as $700 an acre, depending on the quality of the cultch (i.e., the layers of shell that create a foundation for oyster production), with a typical lease costing $1,500 an acre. Harvesters cited the discussions of closures and the bad media regarding *Vibrio* as problems depressing current prices. During the public season in Texas from November through April, leaseholders transplant oysters to their leases but harvest only if demand/price is very high because the summer is more profitable. During the winter, they do not harvest their leases because supply is high from Texas, Louisiana, Mississippi, Alabama, and Florida, as well as from northeastern harvests, which suppresses the price. The summer season is closed to the public and open only to leaseholders who harvest while supply is lower and price is higher. Closing from April 1 to October 31 primarily impacts leaseholder/ harvesters although April is currently open for public harvest in Texas.

2. Marketing restriction. About 70 percent of the shellstock harvested in the summer from Galveston Bay is currently bound for the half-shell market; therefore, harvesters thought that the marketing restriction would be tantamount to a summer ban. Demand for summertime shucked product is low and unprofitable because the oysters are smaller in the summer.

3. Time controls. Harvesters reported that the problem with this control arises in that enforcement requires a clock deadline. So, if a harvester has engine trouble and cannot get onto the water until noon and must be off the water by 4:30 to get product to the processor by 6:00, he has a very short and unproductive day. It usually takes about 6 hours to travel round-trip. Sometimes, a harvester may spend 3 to 4 hours looking for oysters. Whereas 12 hours or more harvest time would be feasible for Texas, they said that 8 or 10 hours would severely reduce their fishing time to only 2 to 4 hours. As one respondent pointed out, "It's not like we can just go out there and pick 'em up!"

4. Temperature controls. Galveston Bay harvesters said that their boats would have difficulty accommodating any on-board refrigeration unit. Because oyster boats are designed to displace only 3.5 feet of water with the bow drawing only 1 foot, a

refrigeration unit would increase the draft and preclude harvesting in 4-foot waters. Besides, as one harvester pointed out, adding a refrigeration unit that would hold 100 sacks would make the boat top-heavy and liable to capsize. Respondents reported that ice would not be feasible, either. They said that ice spoils the oysters because they open to feed in the heavy mist, and the fresh-water mist or melted-ice water kills them or ruins their salinity.

PROCESSING SECTOR

Current Status

The ISSC Interstate Shellfish Shippers' List reports 50 certified dealers in Texas. Respondents estimated that about 30 are in the Galveston Bay area. Eight of these 30 process oysters only; the other 22 plants process other species as well. Six of the 30 plants are leaseholders. Two leaseholders are certified shellfish shippers (inshell product) only. Although leaseholders are limited to 100 acres of leases, the 2,322 acres of leases are managed by eight family heads with family members individually holding leases.

Processors employ from 5 to 100 people, though a fairly large processor has 40 to 50 employees, including 30 to 40 shuckers. Small processors who ship shellstock exclusively employ only about 5 people. Typically, sales are around $1 to $2 million although they range from $0.5 to $7 million. Processing facilities are owner-operated by an individual or a husband and wife. Only 15 to 20 percent of the owners have more than one plant.

Several owners have a variety of assets including the processing plant. Two processors reported recently renovating or constructing a processing plant. A new plant costs about $250,000 to $300,000. Larger processors also own two or three semi-tractor-trailer trucks and three or four boats, as well as private oyster leases. Several years ago, the state attempted to close summer harvest on the leases, similar to the public closure, but lost in a legal challenge.

A typical plant owner is in his late forties or early fifties and has a high-school diploma and occasionally some college. Work experience typically is entirely in the seafood industry.

Half-shell product typically comprises well over half of the processors' revenues. Most of the half-shell product is sold outside Texas in a national market including the Southeast, Northeast, and Midwest. Little in-shell product from other regions is sold in Texas. Shucked product is sold nationally and shucked products from other regions, (e.g., the Pacific Northwest) can be found in Gulf states grocery stores, especially in the summer. Processors often contract directly with grocery store and restaurant chains and transport the products themselves.

The half-shell market dominates in the summer and shucked product dominates in the winter in Texas. Summer production is exclusively in Galveston Bay from May 1 through October 31. April is the public season in Texas and respondents estimated that April accounted for 10 to 15 percent of annual revenues.

Processing plant employees include shuckers, packers, truckers, clerical/administrative, and salespeople. Shuckers are paid by the piece (i.e., $5.50 per gallon of shucked meats) and can make between $60 and $90 per day. They typically work year-round but some voluntarily take off in the summer when meat yields per oyster shucked are smaller. Shuckers are provided with mandated benefits (Social Security and Workers Compensation) but seldom with health insurance. Some of the other plant workers do receive health benefits. Typically, shuckers in Texas are men who have less than a high-school education, and their specialized skills are not easily transferable to other professions in the region. Other manual laborers, such as loaders and packers, also typically have no high-school education, but their skills do not appear to be quite as specialized.

Potential Effects of Options According to Respondents

1. Harvesting restriction. Processors indicated that they could not generate enough revenue in 5 months to maintain their oyster processing operation. Importing shellstock from other regions is not seen as economically feasible. One potential problem is the effect of a temporarily discontinued supply on processors' ability to retain a customer base if those customers can obtain steady supplies of product from other regions in the interim. As one processor put it, "How would you make it on 5 months a year?" Respondents thought that leaseholders would lose the value of their exclusive summer leasing rights.

2. Marketing restriction. Most processors indicated that it would be economically impossible for their companies to operate solely on shucked product in the summer, when half-shell product usually comprises 60 percent of their business. The oysters-only processors did not believe they could survive on 5 months a year. One processor reported that although he currently only processes oysters in the winter, he believed the consumer confidence and demand would fall drastically after a 7-month marketing restriction. This would result in many closures, including those facilities that do not currently process oysters in the summer.

3. Time controls. Processors generally did not have strong opinions about how this option would affect them.

4. Temperature controls. Processors generally did not have strong opinions about how this option would affect them except to reiterate that oyster boats would capsize or have too much draft to access the oyster beds.

SUGGESTED SOLUTIONS/CONSEQUENCES

1. At-risk consumer information is pivotal. Informing consumers about *Vibrio* was unanimously selected by all parties interviewed as the preferred approach to reducing

the number of *Vibrio*-related illnesses. Several respondents suggested placing the responsibility on medical professionals such as doctors and pharmacists to inform *at-risk* individuals that they should thoroughly cook raw protein products.

2. Educate retail and restaurant food handlers. Many respondents felt that improper handling was the primary problem. For example, they said that servers sometimes do not know that if an in-shell oyster no longer has water in it, it is bad, or that if an oyster has been harvested for more than 14 days, it should not be served. Also, they believed that oysters are often left unrefrigerated. They thought that food handlers should receive training about the proper handling of oysters, and that punitive regulations for retailers and restaurants would only drive them away from oysters. Training and education are better solutions than punitive fines, they said.

3. Perform more research on factors/methods that affect *Vibrio* incidence. Processors thought, for example, that refrigeration should not be required if it is not proven to reduce *Vibrio* illness incidence. One processor has used individually quick frozen (IQF) processing for oysters with good results. University research indicates that this process drastically reduces *Vibrio* counts. However, an IQF machine costs about $100,000, and a new IQF plant costs approximately $0.5 million, which is double the typical plant costs, according to respondents.

4. Put Gulf oysters on a level playing field with other food products. Most respondents thought the perceived risk from Gulf oyster consumption is disproportionate to the actual risk relative to oysters from other regions and to other food products. They felt that FDA should publicly announce that the 14-hour/14-day shelf life limits are positive and worthwhile. Respondents felt that FDA had not kept its commitment to educate *at-risk* consumers but was instead frightening all consumers unnecessarily when other food products cause far more illnesses and deaths than oysters.