Cost of and Approaches to HACCP Implementation: An Oyster Industry Example

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As the result of highly visible events that involve food safety (some involving oyster consumption), HACCP programs have been developed to help assure safety. A protocol for seafood products, developed cooperatively by regulators and industry, is in place. The cost of such programs has not been documented. This research used the case-study approach to identify alternative HACCP systems and to estimate the implementation and operating costs of those systems in the oyster-processing industry.

Food safety has been and remains an important concern of U.S. consumers. Concern is heightened when food-borne illness outbreaks occur and when attendant publicity keeps these events in the public mind. Recent examples of events that received wide publicity include hamburgers and melons. The concerns have been reflected in regulatory action to reduce the number and severity of outbreaks.

Most bacterial sources of contamination pose little danger to consumers if food is properly cooked. Products consumed in the raw form carry a higher risk. Among these foods are oysters, particularly the raw halfshell form popular with many consumers. The United States Food and Drug Administration (FDA) estimated that about 20 million Americans eat raw oysters at least once every year. Industry concern about contamination increased when a growing number of illnesses spurred FDA to require warning labels on all oysters harvested from southern waters. Gulf states harvested about 2/3 of the total U.S. oyster supply from 1982 to 2001 (NMFS 2003); Louisiana contributed about 60% of that total. A significant proportion of that production moved into interstate commerce.

Two of the leading sources of illness from oysters are *E. coli* and *V. vulnificus*. *E. coli* results from naturally occurring populations and from various discharges (examples include municipal system overflows, and fishing and other vessels). Contamination is more likely if the harvest is from polluted waters. *V. vulnificus* is the more serious bacterial threat to human health. It occurs naturally, is common in Gulf of Mexico waters, its incidence is not related to pollutant sources, and concentrations increase with higher temperatures. Contamination from either source varies significantly by geographic location, harvesting season, and storage conditions of the harvested shellstock.

While most consumers suffer no ill effects from *V. vulnificus*, a small number of serious illnesses and deaths are reported annually. The overall illness rate is approximately 0.5 per 1,000,000 in the Gulf Coast population (Park et al. 1997). From 1989 to 2000, the U.S. Food and Drug Administration (FDA) recorded 282 serious illnesses associated with consumption of raw oysters and clams containing *V. vulnificus*. While illnesses are infrequent, about half of those reported (149) resulted in death (NATAP 2002). However, incidence is believed to be under-reported (CDC 2000).

Seafood safety has long been a concern. Beginning in 1925, the National Shellfish Sanitation Program (NSSP) evolved over time into a 3-way partnership between the U.S. Public Health Service (now Food and Drug Administration), state public-health officials, and the shellfish industry. These entities worked cooperatively to develop safety protocols. The Interstate Shellfish Sanitation Conference (ISSC) developed and published safety procedures which were formally revised as necessary. An ISSC goal has been the adoption of a Model Ordinance containing uniform regulations across state boundaries and embodying appropriate safety principles.

Over the past two decades, the FDA evaluated a regulatory structure based on the Hazard Analysis and Critical Control Point (HACCP) concept. HACCP as adopted by the seafood industry follows guidelines from the National Advisory Committee on Microbiological Criteria for Foods with approval by various food-processing trade associations and

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advisory groups. A Model Seafood Surveillance Project (MSSP) created a new inspection system to provide "reasonable" consumer protection.

These two approaches to seafood safety were reconciled when the ISSC recognized an Interstate Shellfish Sanitation Program (ISSP) and its Model Ordinance (containing HACCP regulations) as the effective set of rules governing participation in the ISSC. Mandatory compliance with the Model Ordinance, or an approved substitute, was effective on December 18, 1997.

In general, the Model Ordinance consists of Critical Control Points (CCP) at receiving, raw-product storage, processing, finished-product cold storage, and shipping points. At receiving, verification of harvest from government-approved waters occurs before acceptance for processing, lowering the probability of contamination. The raw-product storage CCP requires proper cold storage within two hours and monitoring by time-temperature recorders to verify continuous compliance. Processing activities such as washing and grading occur in warmer temperatures outside the cooler where bacteria growth occurs more rapidly, but the CCP governs these times. Additional CCPs assure that the packaged product is stored at proper temperatures prior to and during shipment. Individual firms are affected, because these regulations may impose additional costs. In addition to the ISSP model, individual processors may develop HACCP protocols (which must be approved) that meet firm and safety goals. This paper identifies and summarizes costs of HACCP systems being used by Louisiana raw-oyster processors and evaluates the impact of these costs in terms of expected behaviors of the firm.

Literature Review

In a literature search, no studies were found that reported costs of HACCP implementation by oyster-processing firms, nor alternative HACCP systems other than the Model Ordinance. There were, however, studies of costs incurred in other fish/seafood industries.

HACCP system costs for breaded-fish processors were studied in Massachusetts (Colatore and Caswell 1998). Cost data were collected from eight firms through personal interviews with quality-control personnel. Costs were categorized as total costs, cost of implementing minimum requirements, and incremental costs attributable to the FDA regulation. Average costs for labor and other expenses were reported for the categories of plan design (615 hours and $19,320); training (six or seven employees per company at a cost of $865 per person); internal training costs according to whether the training occurred during or outside the regular processing schedule ($10,551); costs of control and record-keeping ($7,135); costs of monitoring, including new lab equipment ($43,975); purchases of safety-related equipment ($7,615); corrective-action costs ($24,726); new personnel costs, including training and wages ($9,507); review costs ($1,130); sanitation costs ($31,523); and validation costs (a savings of $55,495 because an FDA inspector was no longer needed).

Cost information for HACCP plans in the meat and poultry industries was reported (Roberts, Buzby, and Ollinger 1996). The measures included opportunity cost (resources reallocated if foodborne illnesses were reduced), sensitivity analysis, and economic incentives. The cost of implementing HACCP was estimated to be less than $0.20 per pound handled, and small plants appeared to have higher per-unit costs. In the pork-processing industry, costs and benefits of implementing HACCP systems were evaluated (Jensen and Unnevehr 1998). To estimate a cost function for microbial pathogen reduction, costs of individual technologies were estimated based on data from input supply firms, and estimates of pathogen reduction from selected meat-science studies were used. The resulting cost function was upward sloping, as expected. Interventions to improve safety accounted for less than 2% of total pork-processing costs.

In a study of HACCP-regulation impacts in the Mississippi catfish industry (Herrera, Herndon, and House 1999), three catfish processors were categorized by size (large, medium, and small) and by level of complexity (the number of product lines handled). Interviews with the HACCP coordinator or the plant manager provided data. Cost categories included training, record-keeping, receiving, metal detection, food-contact surfaces, hand sanitizing, and adulteration prevention. Results showed that the large processor incurred the highest total cost. By size, maximum processing capabilities were 150,000, 70,000, and 25,000 pounds per day and total costs were $413,475, $73,340, and $11,538, respectively. In this case, costs per unit of capacity were higher for larger firms in these particular cases.

Methodology

Industry Background

An expert panel composed of Agricultural Extension Service and industry sources, was assembled to assist in selection of processors, making industry contacts, and reviewing the research instrument. The relatively few firms in the industry are and have been located principally in coastal communities, though there continue to be shipments of unprocessed shellstock to more distant processing sites. Before widespread food-safety concerns, the industry operated without close scrutiny. The panel suggested that many of the smaller firms left the industry just before or upon the imposition of the Model Ordinance requirement. These firms may have chosen to forego the investments and adjustments necessary to comply with the model or to develop a protocol unique to the firm. Economic pressures in the form of increasing costs were expected. According to the panel, many of the firms that remained in the industry were always reclusive and the new regulations may have caused them to guard proprietary information more closely.

Target Firms and Selection

The target oyster processor was a firm that performed several, if not all, of the following functions: receiving, transporting to the processing area, cool storage, cleaning, size sorting, packing for halfshell market, shucking, cool-storage of packed product, and outbound shipment. Louisiana's Department of Health and Hospitals (LDHH) is responsible for maintaining the shellfish-sanitation program and for the issuance of permits to processors who are in compliance with the current shellfish sanitation program. In 1999, when data were collected, 142 firms had permits. However, the number of firms in the target population was much smaller. Many firms on the list were non-processors, such as restaurants required to have HACCP plans because of intra-firm distribution activities. Others, according to the expert panel, were fishermen only. Still others held permits but were no longer active processors. Based on its knowledge of the industry, the panel's opinion was that about 20 of these firms were oyster processors that met the research criteria, a number significantly lower than in the era when consumers seemed less concerned about food safety.

Choice of Approach

Given these considerations and the objective of describing the HACCP-related cost structure of the industry, alternative research methodologies were considered. The panel felt that a mail survey or other self-administered data collection method would not succeed in terms of response rate and quality of information with this population. It also felt that a mail format would not capture the qualitative and case-specific nature of response to important questions. Therefore, the case approach was considered. Yin (1994) states that case-study research can be validly used to focus on problems in their real-world context. There are alternative case-study approaches, but descriptive case studies seek answers to questions such as "who" and "where" or derivatives of those terms. Considering the meager volume of HACCP-implementation studies in this industry, this approach was chosen. The panel provided guidance on firm size, processing technology, and geographic location, three criteria expected to be important bases for variation in kind of HACCP program adopted. Size categories were small, medium, and large; the panel used its industry knowledge to place each firm into a category. The technology range was believed to be small, but there are larger processors with unique technology or with safety procedures beyond the minimum HACCP requirements that operate in the industry. Finally, three production/processing zones along the Louisiana coast were identified by the panel. Respondents were to be representative across those factors, so18 case combinations were possible. Eight firms were chosen to be representative of these combinations.

The study used a multiple-case, embedded design. Multiple-case designs follow a replication logic, where each case either predicts similar results or produces contrasting results for predictable reasons. The unit of analysis, the implementation of the HACCP program, is embedded within the firm.

Case studies often use questions that guide research but may not be asked directly. The general questions were how serious the firm perceived the *V. vulnificus* problem to be, how the firm responded to this issue at the product-handling and marketing levels, and what implementation approach (Model Ordinance or unique design) was used. Hypotheses also are stated to direct attention to specific issues. These were:

- Louisiana's oyster processors adopted a uniform HACCP system,
- Larger oyster processors had lower per-unit HACCP costs than did smaller processors,
- Larger oyster processors implemented higher-technology solutions to problems posed by the food safety issues and HACCP requirements, and
- Publicity about *V. Vulnificus* stimulated firms to adopt unique and innovative technologies.

Data Collection

The 8 processors were telephoned to set up personal interviews times, but four declined to participate. The expert panel and Cooperative Extension Service agents were asked for additional suggestions and these firms were contacted. Two firms subsequently agreed to participate. However, management of these firms would not commit to appointments or broke appointments at the last minute. After this occurred repeatedly, the study was undertaken using four firms. Included were the two high-technology firms and two other firms thought to be either medium or large in size. Geographically, two firms were located in the east, and one each was in the central and western zones.

Personal-interview data collection using a structured questions procedure, as described by Yin (1994), was used. A questionnaire, based on the study questions and the panel's recommendations regarding industry terminology and type of question, was developed. The HACCP coordinator, plant manager, or other employee identified as the knowledgeable individual within the firm, was interviewed. Data on each firm's HACCP system and related costs of implementation and operation were collected. Costs accepted as HACCP-related were those additional costs incurred by processors in their efforts to comply with the regulations, above the usual costs of operation. A flexible time period was established to determine whether costs incurred would be classified as HACCP-related. Many processors, and the industry, had been involved in development of the Model Ordinance, so they were aware of changes that would be required. Some of these processors had made significant changes well in advance of the implementation date and were prepared for the December 1997 deadline. Others were becoming HACCP compliant after the deadline. So firms incurred HACCP costs at different times. The procedure attempted to capture appropriate costs over a reasonable period prior to and subsequent to the deadline, defined as the two year period prior to or one year period following the deadline.

The Cost Model

Cost information was based on the Colatore and Caswell model, shown here generally as:

> General Cost Model: Total Cost = Design + Training + Control and Record-keeping + Labor + Review + Sanitation + Validation Costs

Individual firms usually had investment and operating costs. For costs that involved labor, hours required and wage rate were collected. A short description of each kind of cost follows, and labor is a part of each:

1. Design costs—learning the model's requirements and determining their efficient integration into the operation.
2. Training costs—external training such as travel expenses, missed work, and registration fees; and internal training such as cost of stopping production for training or for training outside scheduled work.
3. Control and record-keeping costs—verifying harvest from approved waters, monitoring thermometers, verifying operation of sending devices and computers, assuring that time and temperature criteria were met, and others including corrective actions.
4. Review cost—reviewing the HACCP plan periodically.
5. Sanitation costs—determining sanitation procedures and cleaning equipment, assigning personnel.
6. Validation cost—verifying effectiveness through testing or otherwise demonstrating safe products.

The cost categories in this formula were descriptive but were not appropriate from an economic point of view. For that reason they were re-classified into investment-oriented costs and short-run costs, and presented as fixed and variable costs. Design and training costs comprised most of the

fixed costs because, generally, the firm underwent an initial learning phase with attendant lump-sum investment. Most other costs were variable, or were incurred during the current period and expected to recur in the next, such as wages spent on monitoring. Both kinds of costs were presented on a per-pound-of-raw-product basis. Fixed costs were not amortized.

Description of Firms

Firm A, the smallest firm in terms of oyster production, was located in a coastal southwestern regional city and was classified as a medium-sized processor by the panel. To report size and maintain confidentiality, weekly production for each firm was divided by the smallest firm's production, resulting in a ratio of 1 for firm A. Almost all oysters were harvested from Louisiana waters. The firm held leases offered by a state agency that accounted for about 65 percent of production. For a portion of output, the firm subjected oysters to a high-pressure treatment that opened the shell slightly but did not extract the oyster. With this "pre-shucked" product, retail establishments did not need the traditional "shucker" (thereby lowering costs). The product was popular with the consumer as well, and was an important item in the product line. As a multi-seafood-product firm, oyster products (pre-shucked, regular oysters for halfshell, and shucked) were a part of the firm's output.

Firm A's HACCP plan was the Model Ordinance plus the high-pressure treatment. It did not otherwise emphasize the food-safety issue in its selling activities. Firm A asserted that the pressure treatment produced a bacteria-free product but did not promote this characteristic. Beyond HACCP requirements, it demanded a high-quality raw product and sourced its product through long-term relationships with oystermen who had a reputation for product quality. Required HACCP record-keeping began in December 1997, but this firm had established a records system for that purpose in 1994.

Firm B, second-smallest among these firms, was classified as a medium-sized processor by the panel and was in urban southeast Louisiana. Its output consisted of about 75 percent shucked oysters, with the remainder going to the halfshell market. Its reported weekly average production was 2.4 times that of firm A. About 75 percent of raw product was from Louisiana waters, and it owned trucks for hauling from the dock. The firm had been in business since 1925, and said that it always had followed HACCP procedures, which were nothing more than practices that every firm should have been following. Firm B stated that to its knowledge no customer had suffered an illness related to its oysters. Its marketing effort focused on experience and quality assurance, both indicators of food safety.

Firm B's customers were loyal, and sales had been steady or growing despite reports of oyster-related illnesses. It felt that product quality was the issue, and that the minimum requirements of the model assured that quality. Given its system, only minimal change was required to become fully HACCP compliant. It officially began keeping records of its HACCP system in December 1997.

Firm C, the second-largest processor, was located in rural, non-coastal southeastern Louisiana. Firm C's size relative to Firm A was 3.5. The firm sold only oysters and a very high proportion of output was shucked product. About 80 percent of the raw product was from Louisiana waters. It felt that an important part of overall quality was the quality of raw shellstock. For shellstock, oystermen it had dealt with for at least 12 years were the source of about 80 percent of raw product.

Among the firms interviewed, Firm C had been most affected by contamination publicity. Its sales declined significantly over time as illnesses were reported. Consequently, it worked closely with institutional regulators and with other processors. It kept the regulatory agencies informed of its actions so mistakes could be corrected. It was not surprising that Firm C's system follows the Model Ordinance exactly. The firm believed that the FDA had passed down an effective safety mechanism. Its relationship with regulators was useful when interested customers (supermarkets or foodservice businesses) or consumers expressed concerns or asked questions about safety. Its HACCP plan was available, or it could request a HACCP certification letter. The firm's system was fully installed by January 1997, and record-keeping began in December 1997. These activities and other factors enabled this firm to regain lost sales.

Firm D, whose size ratio compared to firm A was 5.2, was classified as a large processor by the panel and was in a coastal southwestern regional city. This was predominantly an oyster firm, with minor sales of other products. Oyster products included both

shucked and halfshell product. About 95 percent of raw product was from Louisiana.

Firm D translated public concern about safety into a demonstrably safer product. Its marketing strategy then focused heavily on safety, and consumers were assured the product had levels of bacteria low enough to be undetectable. This claim could be made based on a mild pasteurization process developed in conjunction with researchers at a major university. Product samples were sent weekly to a third-party testing service, with consistently negative results. Pasteurization was an additional step beyond the model and part of firm D's approved HACCP plan. Investment to put this system in place was made earlier than the two-years criteria used in the study, so no inquiries about the system's cost were made. Safety, flavor, freshness, and longer shelflife were part of the promotional program. According to officers, this product was priced "a little higher" or "about 5 cents per oyster" higher than standard oysters. The pasteurized product was offered as shucked and as fresh and frozen halfshell product. Official HACCP records were initiated in December 1997, though the system had been operating since early 1997.

Results

Discussion of the hypotheses follows. In case studies, results are subjective and hypotheses are accepted or rejected based on the researcher's judgment of correspondence with expectations derived from theory or previous research.

Did all oyster processors have the same HACCP system? Added costs to develop and gain approval for alternative systems would suggest an economic incentive to adopt the Model Ordinance. Two firms had critical control points in addition to those required by the model: Firm A's pressure treatment and Firm D's mild pasteurization process. The other two firms followed the Model Ordinance. Based on these observations, all firms did not use either the model or the same plan.

Were unit HACCP costs lower for larger processors than for smaller processors? The firms reported product sales in (1) pounds of shucked oyster meat and (2) halfshell product. For consistent comparison, pounds of shucked oysters were converted to equivalent pounds of shellstock, which is the product that enters the facility. As discussed above, size is reported as a ratio based on the smallest firm (Table 1).

For variable costs, the relationship to size was mixed. As firm size increased, variable costs per pound were \$0.003, \$0.048, and \$0.024, for Firms A, C and D, respectively (Firm B declined to provide these costs). Firm A reported the lowest cost per pound, but it had non-oyster seafood product lines. It also reported early and extensive interaction with ISSC as the Model Ordinance was developed.

Table 1. Fixed and Variable Cost per Pound of Implementing HACCP Systems, by Firm.

Size ratio (largest to smallest)	Kind of cost	Cost per pound
5.2 (firm D)	fixed	\$0.013
	variable	\$0.024
	total	\$0.037
3.5 (firm C)	fixed	\$0.068
	variable	\$0.048
	total	\$0.116
2.4 (firm B)	fixed	\$0.039
	variable	*
	total	\$0.039
1.0 (firm A)	fixed	\$0.060
	variable	\$0.003
	total	\$0.063

* This firm declined to provide hours and wage rate or comparable calculation.

Firm C had experienced significant negative sales impact resulting from event publicity, and reported that it had spared no expense to become compliant, at least partly explaining its high cost.

Generally, smaller processors had higher per-unit fixed HACCP costs. These costs were $0.06, $0.039, $0.068 and $0.013, respectively, from smallest to largest. Firm C did not fit the expected pattern, but as noted above it had been substantially affected by safety issues and was very concerned that HACCP be implemented properly. Its design time was substantially longer than the other firms', and this was a large component of the higher costs. These values suggest that HACCP costs—particularly fixed costs—were lower for larger firms.

Did larger oyster processors implement higher-technology solutions to address food-safety issues and HACCP requirements? Firm D, with the mild pasteurization process, and Firm A with the pressure treatment, had implemented additional processing technology. Firm A, while smallest as measured by oyster processing, was classified by the panel as a mid-sized firm and had multiple product lines. Meanwhile, the two middle-sized firms embraced the Model Ordinance. These considerations tended toward the conclusion that high technology was associated with larger firms.

Did publicity about V. vulnificus illnesses and deaths stimulate firms to adopt unique and innovative technologies? The firms provided their perceptions about the seriousness of contamination's impacts and its attendant publicity on the industry. Firms C and D viewed this as a more serious problem. Firm D had incorporated a specific process (the mild pasteurization process) to provide a safety level beyond the model. Firm C expressed relatively more concern about industry impacts than did the others. This concern originated from the decline in sales it experienced after the requirement that warnings about the risks of raw oyster consumption be placed on oyster bags. It apparently, however, felt adequately sheltered by its strict adherence to the requirements of the Model Ordinance. Firms A and B agreed that the issue was a serious one for the industry, but their level of concern was perceived to be lower. Firm B felt that illnesses from contamination represented a problem no larger than those faced by other food products, particularly ground beef. It also expressed the opinion that the Model Ordinance was no more than the good manufacturing practices it had incorporated since its establishment. Firm A's technology, which it claimed provided a clean product (the pre-shucked oyster), appeared to be an effort at product differentiation. Overall, these considerations suggest that there were introductions of technology to address the problem.

Concluding Comments

The response by these firms to the challenge of safety issues from raw oyster consumption was diverse. They all were aware of HACCP as a regulatory initiative to improve food safety, and provided input during the development of the ordinance. The model that resulted could have been followed exactly, so no firm had to incur development costs. However, differences among the firms in terms that might have included experiences, tolerance for risk, available resource base, kind and size of markets, and other factors led to differences among the approved HACCP plans.

Discussion of Hypothesis Evaluation

Two firms added steps to the model. Firm D took a proactive approach by developing a process that verified the absence of bacterial pathogens. Firm A added a step to the ordinance in the form of the pressure treatment that (it said) resulted in a bacteria-free product, but did not periodically verify its claim or use that information in marketing. Two firms adhered to the Model Ordinance. There were multiple HACCP programs involving additional steps that appeared to be related to each firm's view of its position and opportunities in the market.

HACCP requirements added cost to the final product. Spreading these costs over more units of production appeared to lower unit cost. Costs generally behaved as expected, but the evidence was not unambiguous. For example, from statements made in the interviews, Firm C appeared to have been most affected, in terms of sales, by publicity about illnesses. As a result, its management intended to follow the model exactly, and this firm reported highest costs. Firm A had very low variable costs, probably linked to efficiencies related to costs shared with other products. Firm C argued that the Model Ordinance made compulsory processing practices that already should have been in place, practices it already used, and its costs were low.

However, the ordinance contained requirements that raised costs. It restricted harvest areas and re-

quired that oysters be cooled while on the vessel (depending on length of the fishing trip). The cooling restriction could have reduced the supply of harvested shellstock to the processor, resulting in higher prices. The ordinance contained a requirement that shellstock be refrigerated during transport to the processor. Most already was, apparently, but additional costs might have been incurred by some operations. Within the plant, additional costs might have been incurred as a result of expedited handling from the requirement that the product could not be outside the cooler for more than two hours.

As to whether firm size was positively related to technology solutions, the largest firm actively supported research into processes that would produce verifiably safe oysters. Beyond that, there seemed to be little enthusiasm for risky investment to solve this problem. More than one processor indicated customers had approached them for verification of safety procedure. Their cooperation with ISSC in testing the efficacy of the evolving ordinance had given a basis of support for their safety claims.

Illness events and the subsequent publicity was a stimulus for activity on the part of these processors. As discussed above, Firm D had actively developed technology to address the problem. The other firms had assisted with development of the model, then operated within its bounds. Firm B indicated there was no need for additional measures based on its experience, absence of feedback that its oysters had been the source of illness, and its statement of commitment to quality assurance.

Opportunity from Adversity?

Oyster sales were affected by news of events that brought their safety into question. This created a barrier for some firms, while others saw opportunity. Firm D, which had been a provider of conventional oyster products, made a substantial change. In the interview, this firm indicated that sales of conventional oyster products had been affected by illness events and that consumers seemed to avoid the products. Management perceived that the underlying popularity of the product had not disappeared as long as safety could be demonstrated, so the safety issue was perceived as a marketing opportunity. Those who no longer consumed oysters because of the safety issue could be recaptured, and a safe product might generate new or additional sales if non-consumption was the result of safety concerns. The verified clean oyster became a tool to increase sales and perhaps market share. That strategy was successful at least to some degree. A national restaurant chain that had dropped half-shell oysters from its menu subsequently re-introduced the product with Firm D as its sole source. The safety issue clearly was a powerful incentive for this risk-avoiding restaurant (as most probably are). As a footnote, Firm A kept conventional oysters in its product line, along with the pasteurized products.

Limitations and Suggestions for Further Research

The case-study approach to analysis of food-safety issues and HACCP implementation in the oyster industry provides background information about costs, industry perceptions of HACCP, and reactions of firms to these events. Little information was found in the literature review about these issues in the oyster industry, so the research provided an initial information base. The study did not provide conclusive answers to the questions posed here. Information from these firms provides a basis for further study to confirm costs and behaviors, particularly to explain choices made by the firms on the basis of firm characteristics and their financial and marketing strategies. There is potential variation in responses related to firm size, geographic location, and processing technology factors, and these are potential focuses of additional study. Information about activities of small processors would have strengthened the study.

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