# Memorandum

**Date:** April 16, 2010

**To:** Bobbi Hudson, Pacific Shellfish Institute

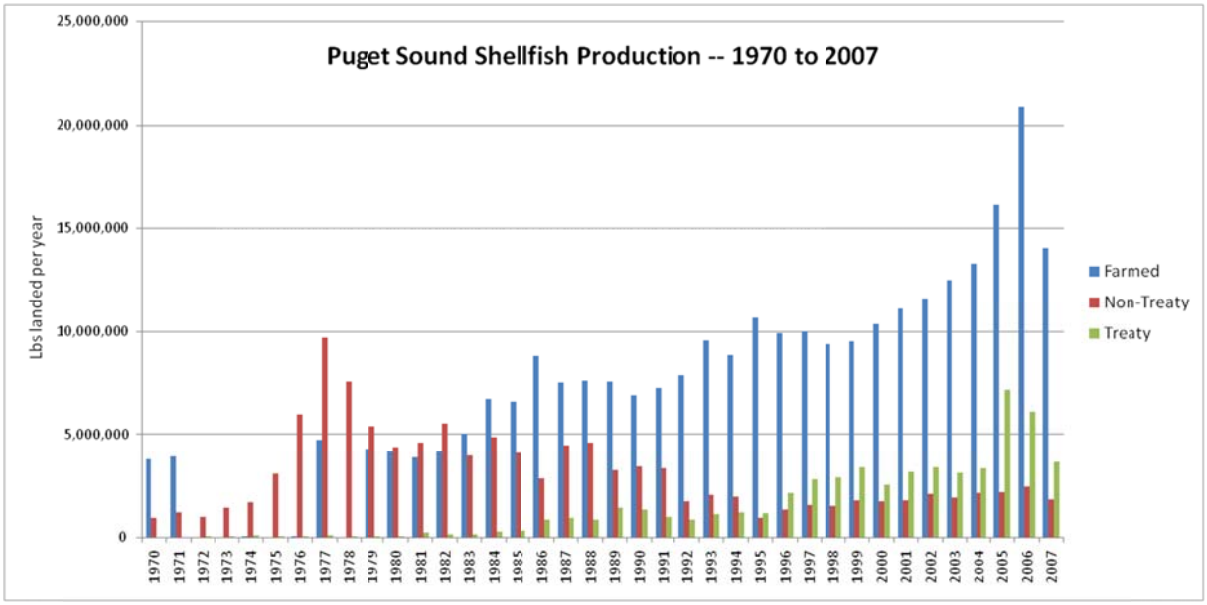
**From:** Katharine Wellman

**Re:** NOAA PSI Grant: Puget Sound Shellfish Revenue and Expenditure Survey

## 1 Introduction

One of the most readily understood ecosystem service benefits provided by shellfish is the commercial production of shellfish as a food source. Puget Sound is one of the largest shellfish producing regions in the United States.

**Figure 1. Puget Sound Shellfish Production**




Source: Washington Department Fish and Wildlife, 2009

Shellfish production provides revenues, jobs and income to local and regional economic systems. As illustrated in Figure 1, according to Washington Department of Fish and Wildlife (WDFW, 2009), Puget Sound farmed shellfish (clams, mussel, geoduck, oyster, and scallops) harvest has ranged from 3.8 million pounds in 1970 to 11.4 million pounds in 2008. All Washington farmed shellfish harvest (Puget Sound and Coastal Washington) has ranged from 7.6 million pounds in

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1970 to 5.6 million in 2008 with an estimated 2006 ex vessel value of $107 million. The WDFW shellfish database is the best that exists. However, the database has some significant limitations. Until recently, production reporting was voluntary. In addition, the value of production appears to be a combination of reported price and a WDFW calculated price. Assumptions for how value is derived are not clear. Clearly, no cost or expenditure data are collected. More than two decades ago, Bonacker and Cheney (1988) described the state of knowledge of Washington's shellfish industry as follows: "We are weakest in the area of economics." The state of the availability of economic data clearly has changed little in the intervening years.

Northern Economics, Inc. (NEI) has attempted to address this data gap by conducting a preliminary revenue and expenditure analysis of commercial shellfish farms in Little Skookum (Manila clams) and Totten Inlet (mussels and oysters) in South Puget Sound. This analysis is a step toward developing a more comprehensive cross-sectional economic survey of shellfish growers. The findings of such a survey can be used to estimate a production function and build an input-output model for the Washington shellfish industry as well as provide a basis for estimating the producer surplus generated by the industry. NEI has worked closely with the Pacific Shellfish Institute (PSI) and Little Skookum Shellfish Growers (LSSG) in designing a test survey, conducting a preliminary survey of three South Sound shellfish growers, and analyzing the information collected to assess necessary changes to ensure the effectiveness of a full survey in collecting relevant and robust data. Our goal is to acquire additional resources in order to conduct a more comprehensive survey of shellfish growers throughout Washington State. With this data we intend to generate an industry production function and related Input-Output model.

The following section describes production functions, input-output models, and tools used by economists to measure producer surpluses. This section also outlines how information generated from these models could be used by fishery managers and the industry. Section 3 describes our survey design, data collection and implementation processes while Sections 4 and 5 present the study's analytical results and recommendations for future industry-wide survey design.

# 2 Economic Models

## Production Function

As with any other industry, the output (i.e., harvest) of a shellfish farming operation is a function of many variable and fixed inputs applied in the production process. Production output is dependent upon biological and environmental factors, as well as on capital, labor, management skills and the technology used (Coffen and Charles 1991). The relationship between inputs and output is referred to as the production function.

It is anticipated that for the purpose of applying production function methodology to demonstrate relationships between inputs and output in Washington's shellfish industry, the industry will be divided into different farm types or sectors. Differentiation of sectors may be based on species raised and/or farming techniques. A production function will be created for each sector. Each production function is considered an average representation of the sector, based on information provided by an economic survey administered to growers within the sector.

The estimated production functions could help 1) explain the variation in production output observed for each species from one farm to the next, and hence determine which economic inputs are significant in explaining production variation of aquaculture operations; 2) determine whether there are economies of scale in aquaculture production (e.g., if inputs are doubled, to what extent will output change?); and 3) analyze the economic efficiency of inputs in existing aquaculture operations (Coffen and Charles 1991).

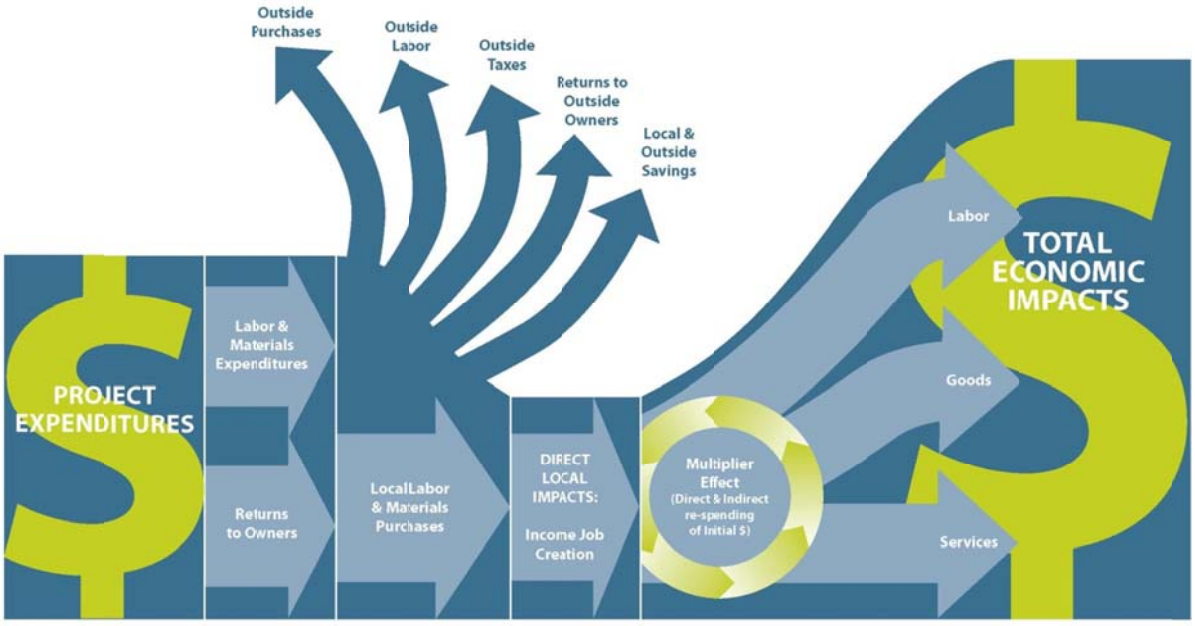
The results may provide some guidance both to the shellfish aquaculture industry and to policy-makers regarding the productivity of key economic inputs. Furthermore, individual shellfish growers can utilize average results by modifying them to reflect the specific differences on their farms (Coffen and Charles 1991). In addition, the sensitivity of costs, returns, and other performance measures to changes in key parameters provides prospective shellfish growers with a basis for developing expectations on debt requirements, production costs, and the profit potential of the business (Adams, Holiman et al. 1993).

## Input-Output Model

An input-output (I/O) model depicts inter-industry relations of a regional economy. It shows how the output of one industry is an input to each other industry. Analysts frequently conduct Input-Output analyses using the IMPLAN® system developed by MIG, Inc. There are two components to the IMPLAN® system. The database provides economic and socio-demographic descriptions for all United States counties across over 500 industry sectors. The software component of the IMPLAN® modeling system calculates, for a pre-defined study area, multipliers to assess economic impacts to the state. These multipliers are for economic output, total value added, employment, employee compensation, personal income, other proprietary income, and indirect business taxes. Multipliers are provided for direct, indirect, and induced impact effects.

While the IMPLAN® system (See Figure 2) includes a commercial fisheries sector, it does not fully represent the characteristics of Washington's shellfish industry. Therefore, the analysis would have to adjust the model to reflect the specific production characteristics of shellfish cultivation operations in selected counties in Washington based upon information collected in an economic survey of shellfish growers. Once output (direct sales value) and expenditure figures are entered for each shellfish sector, the analysis will rely on IMPLAN®'s input-output model of the Washington economy to track the circulation of money and estimate indirect and induced impacts.

**Figure 2. Measuring Economic Impacts: IMPLAN**




Source: ©Northern Economics, Inc.

Once the analyst quantifies from which industries Washington shellfish growers purchase their production inputs, the I/O model is able to predict how these expenditures will flow through the economy. Economists refer to this flow through the economy as the industry's multiplier effect. The multiplier effect is a numerical representation of how many times a dollar spent by industry flows through the economy before savings rates, taxes, and expenditures made outside the local economy reduce the effect of the dollar to zero.[1] The input-output model uses these multipliers to predict the countywide (or statewide) estimates of employment and income. The models also allow for the analysis to estimate the effects of a unit change in direct or initial spending in each sector of the shellfish industry, including indirect effects (businesses buying and selling to each other) and induced effects (household spending based on the income earned from the direct and indirect effects).

## Producer Surplus

The producer surplus earned by a shellfish farm is the difference between the total revenue earned through the production of shellfish and the total opportunity costs (including costs of entrepreneurs' skills, labor, capital, and ownership of natural resources) of growing, harvesting, and processing the shellfish and delivering them to the point of first sale. The term "opportunity costs" refers to foregone economic value when a resource, such as labor, capital, or land, is used to produce one good or service instead of something else. The data required for estimating

[1] Economists refer to these outflows as "leakages" from the local economy.

producer surplus include detailed costs and earnings for an average shellfish farm. Such information could be obtained from an economic survey of shellfish growers.

A strong analysis will account for a producer surplus. First, the market price of an input or output may diverge from its opportunity cost or "true economic value." In general, however, the best approximation of the opportunity cost of a good or service that is fairly widely bought and sold is its market price (Gittinger 1982). A second consideration is that labor costs must consider the opportunity cost of labor—that is, what an individual could have earned if they had not spent that time shellfish fishing or farming (Lipton 2008). In general, wage rates accurately reflect the opportunity cost of hired labor. However, for a family-owned shellfish farm, the "salary" of the owner/operator (and unpaid family members) will not be included in the data collected in an economic survey (Adams, Holiman et al. 1993), and, therefore, must be imputed. The cost of family labor is what the family could earn in its next most remunerative alternative. Finally, it is important to recognize that, while producer surplus may be positive in the aggregate, it may mask what is happening at an individual farm level. For example, some growers may operate at a loss during a given year.

The producer surplus generated by farming shellfish is an important component of the economic valuation of the ecosystem services provided by the Washington shellfish industry. It represents a monetary measure of the net value received by society from growing shellfish for sale.

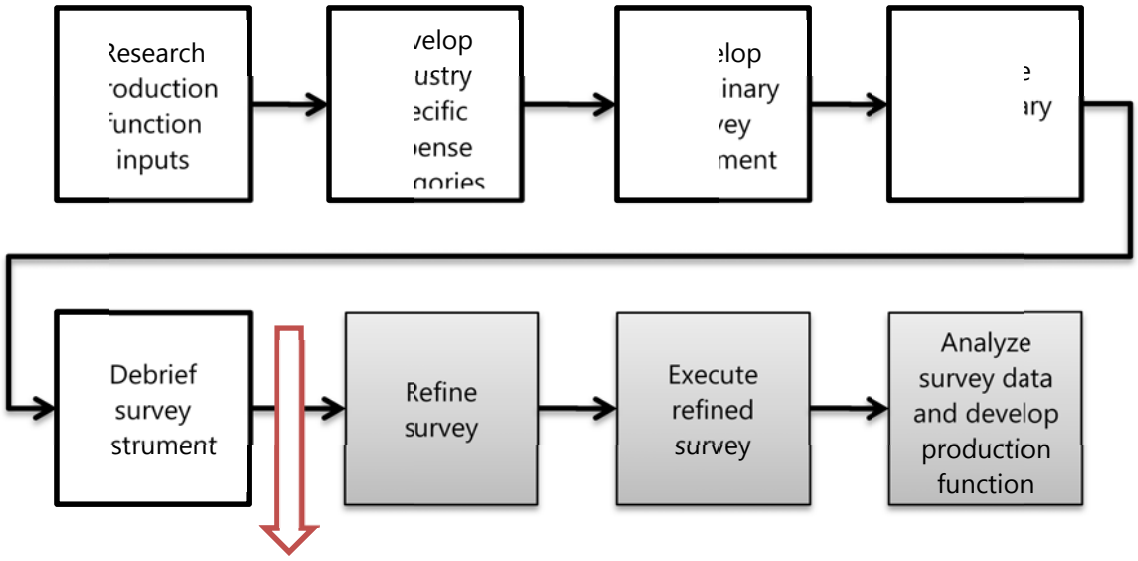
# 3 Preliminary Survey and Implementation

Determining the production function for the Washington shellfish industry is a significant undertaking, largely because so little data is currently collected or available for the industry. NEI designed a survey that explicitly queried shellfish producers about their production volumes, revenues, and expenses. This section describes the development of the survey instrument, the preliminary execution of the survey and the lessons learned.

## Survey Development

In order to develop the survey instrument, NEI gathered and studied previous survey instruments used for production function modeling. This research provided an understanding of the type of information that a robust survey instrument requires including expenditures by expense category, the amount of the expenditures and whether the expenditures occurred within the study area. In order to determine the level of producer surplus, the survey instrument also included questions about revenues generated by species type. The expenditure data were also categorized by product in order to understand whether different species and methods of shellfish production differ enough to warrant separate production functions. Figure 3 illustrates how the process is developed. Our work takes us from survey design to debrief of the survey instrument.

**Figure 3. Production Function Development Process**




Source: Northern Economics, Inc.

Northern Economics worked with Little Skookum Shellfish Growers (LSSG) to categorize their expenses from 2008 in order to determine appropriate expense categories for inclusion in the survey instrument. LSSG is a member of the study team in addition to providing data for the survey results. These expense categories formed the basis of the grower surveys. Northern Economics generalized expense categories where appropriate for all species of shellfish production. As part of the survey process, NEI solicited the survey respondents for their feedback on whether or not the categories were representative of expenses for their business.

In order to get quality responses from a small sample, NEI worked with PSI to identify growers supportive of economic research relevant to their business to respond to the test survey. In order to test the survey instrument for relevance to a variety of species, NEI identified growers of different species of shellfish. Four firms, in addition to LSSG, that best met these criteria were selected to be contacted to respond to the survey.

## Preliminary Survey Execution

Representatives of firms contacted were initially concerned about revealing sensitive financial information. In subsequent discussions, NEI was able to assure participants that the data they provided would be kept confidential and that only summarized results from the data would be made public A fourth participant never provided a reason for not participating, but did not return the survey.

The survey instrument, which is shown in Attachment A, was emailed to the three survey participants as a Microsoft Word document. Two of the participants entered their responses directly into the Word document and emailed them back. One participant printed the form and wrote in their responses. Northern Economics entered the survey responses into an Excel worksheet for analysis.

# 4 Preliminary Survey Results

This section presents limited results from the preliminary survey in order to inform the survey efforts of future researchers. We limited the results in order to protect the confidentiality of the participants due to the small sample size. There is also no reason to report more data since the small sample size precludes the results from being meaningful for the industry as a whole.

The survey results include the three companies that responded to the survey in addition to the data provided by LSSG. Survey results show that revenue for the firms that participated in the survey ranged from approximately $2 million to over $4 million. The growers that responded to the survey had clams or geoducks as their main revenue source. All growers produced more than one type of shellfish including oysters, clams, and other shellfish. The differences in the types of grower's results in impressive differences across expense categories as illustrated below. Table 1 shows the percent of total revenue by product for each grower surveyed. The products represented are clams, geoducks, and oysters, but have been relabeled as products A, B, and C in no particular order for confidentiality. Of the firms surveyed, the highest revenue from the largest single product ranged from 82 to 96 percent. The growers surveyed tended to have one major product and at least one other product. One firm did have a substantial second product that accounted for 18 percent of its revenue.

**Table 1. Percent of total Revenue by Product**

| | Company | | | |
|---|---|---|---|---|
| **Product** | **1** | **2** | **3** | **4** |
| Product A | 0 | 3 | 4 | 18 |
| Product B | 4 | 5 | 96 | 82 |
| Product C | 96 | 91 | 0 | 0 |

Source: Northern Economics, Inc Grower's Survey 2009.

In terms of production costs, survey results suggest that the largest average expense was labor costs associated with growing and harvesting crews, with a range between 5 and 30 percent of total expenses. Managers and executives were the second largest expense group, with a range between 7 and 21 percent. Tideland leases were the third largest expense even though some respondents did not have any tideland lease expenses. The fourth largest expense was Growing/Harvest supervisors, ranging from 3 to 18 percent. The largest expense in general for the shellfish growers surveyed is labor.

Survey results suggest more generally that the cost structure of the participating firms is very different. Management salaries ranged from below 10 percent to over 20 percent of total costs. Tideland Lease costs also varied greatly from over 30 percent of total expense to zero. Table 2 shows the Maximum, Minimum, and Average of the largest expense categories as a percentage of the total expenses.

**Table 2. Preliminary Survey Reponses - Percent of Total Expenses**

| Expense Category | Maximum Percent | Minimum Percent | Average* |
|---|---|---|---|
| Growing/Harvest Crew | 30 | 5 | 19 |
| Managers/Executives | 21 | 7 | 12 |
| Tideland Leases | 32 | 0 | 11 |
| Growing/Harvest Supervisors | 18 | 3 | 10 |
| Amortization | 20 | 0 | 5 |
| Other Harvest | 19 | 0 | 5 |
| Depreciation Expense | 6 | 0 | 4 |
| Other Staff | 6 | 0 | 3 |
| Employee Medical | 5 | 0 | 3 |
| Capital Equipment | 6 | 0 | 2 |
| Freight | 9 | 0 | 2 |
| Processing - crew | 9 | 0 | 2 |
| Research and Development | 7 | 0 | 2 |
| Interest Expense | 4 | 0 | 2 |
| Business Taxes | 4 | 0 | 2 |
| Professional Dues and Subscriptions | 2 | 1 | 1 |
| General Liability | 2 | 1 | 1 |
| Legal and Admin | 2 | 1 | 1 |
| Repairs and Maintenance | 2 | 0 | 1 |

Source: Northern Economics, Inc Grower's Survey, 2009.

* The average presented is only for the survey results. It should not be considered representative of the industry average.

The largest expense category next to labor was medical costs for employees, which is, or course, still labor related. All other expense categories were less than three percent of total expenses. The next highest expense category was freight, even though only two firms listed freight as an expense. This raises questions about whether some firms did not include freight because their customers reimburse growers for freight or they make deliveries themselves.

Expenses as a percentage of revenue were substantially different for each grower. The profitability among the four growers did not correlate to the type of shellfish produced or total revenue. The range in profitability among such a small sample is an indicator of the diversity of shellfish growing operations and therefore the attention to detail that will be required when future researchers attempt to generate production functions for the various shellfish species.

# 5 Preliminary Survey Recommendations

In addition to the data gathered through our survey, the process of implementing and compiling survey results revealed useful information for the design and implementation of a future statewide shellfish industry survey. Several limitations to our survey and recommendations are outlined below.

- The revised survey instrument should make explicit that only non-reimbursed freight charges should be recorded.
- One respondent contracts their harvest so labor costs showed up in an "other" category. Issues such as this will need to be dealt with in final survey design. With a large enough sample, respondents that vary from the norm could be removed as outliers. If the sample size is not large enough, or just for completeness, then the survey would need to be posed to the contractor to determine their expenses.
- The expense category related to production cost needs to be better specified.
    - The survey instrument did not expressly include shellfish seed (larvae) as an expense category. A category for seed expense should be added for each species.
    - Production expenses, besides labor, were listed under supplies. Beyond seed, the materials used for production and harvest need to be better understood so they can be categorized in a manner conducive to constructing a production function. This will require further conversations with growers.
- One category of expense that was unexpected is "Product Purchased." Some shellfish growers purchase product from other shellfish growers to resell for a variety of reasons. The most common reason to purchase additional product is that their customers want more product than they are able to produce at the moment and they can still clear a profit reselling a competitor's product. This dynamic was not understood until after the survey was executed and should be made more explicit in the future.
- Medical benefits were asked for twice on the survey. There was a line item for medical benefits and "all benefits' were supposed to be included in the payroll numbers. Future revisions of the survey should ask for benefits to be included with wages and salary since there is no difference in the way that they are modeled in IMPLAN.
- Another confusing category was Gas. The expense category gas under utilities should be changed to Natural Gas. Some respondents confused natural gas with vehicle gas.
- The results of the revenue portion of the survey pose a challenge for the industry wide survey. Clearly many growers will have mixed revenue if all of the participants in this small survey do. Developing production functions for the production of each species will require that costs for each species be tied that species where possible and that other expenses be attributed based on something like the percentage of revenue.
- The subject of the survey, revenues and expenses, is sensitive by nature. The lack of response from one of the growers selected for their interest in furthering industry research is evidence of the challenge of gaining the confidence of potential respondents. In what we believe to be an effort to help protect their data confidentiality, one firm responded by rounding their costs to thousands. Requesting that firms only provide data rounded to the thousands may be a way to increase the confidence of firms responding without a meaningful loss of information. Rounding would also make data entry easier, since the numbers would be less complicated.
- Future researchers will need to be intentional in their efforts to build confidence in potential survey respondents. Asking for responses in rounded numbers is one way. For some respondents, learning that other growers intended to respond increased

confidence. Some of the growers invited to respond wanted to know more about the purpose of the survey and questioned whether the potential gain from the study justified the risk of exposing their data. Holding public meetings to explain the nature of a future survey and the reason for its importance is one way to allow potential respondents to see that others intend to respond. This could serve the dual purpose of educating potential respondents to help improve the accuracy of the responses.

- Based on the wide array of responses, it naturally raises questions about the accuracy of the response. For this preliminary survey, there was no mechanism to check the responses. When the full survey is completed, audits should be performed for responses that appear to have errors.
- The draft survey did not attempt to gather regional purchasing data. The revised version of the survey will need to make distinctions between the different regions that goods are purchased from. Since all shellfish production in the state occurs in Western Washington, the most reasonable region for analysis is the area west of the cascades. It is possible that some agricultural supplies come from the eastern part of the state, but it appears that the most important supply, seed/larvae, comes from western Washington or out of state. Of course the largest expense, labor, comes from western Washington[2].

  The ideal way to understand the regional purchasing trends is to get the zip codes of each grower's suppliers and the amount spent there. That is not feasible since it presents a further intrusion into the grower's business and a great deal of data to collect. Instead, the survey should ask what percentage of the following was purchased in western Washington and what was purchased out of the region: seed (larvae), labor, and supplies. These items are listed because they are the most likely to be purchased out of the region. A catch-all question could also be added at the end, asking if any other significant expenses occurred outside of the study region.

# 6 References

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[2] One expense item that could be problematic for calculating economic contribution is tideland leases because these payments could be going to governments or private entities. The survey should ask respondents to indicate who receives their lease payments.

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