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PREFERENCES AND VALUES FOR THE GULF COAST OCEAN OBSERVING SYSTEM

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University
and Agricultural and Mechanical College
in partial fulfillment of
the requirements for the degree of
Masters of Science

in

The Department of Agriculture Economics
and Agribusiness

by
Cody Lynn Plummer
B.S., Louisiana State University, 2015
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I would like to dedicate this research to my parents, Lynn and Mike Plummer. Without you guys none of this would have been possible. I am forever grateful for your support.

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ABSTRACT

Integrated Ocean Observing Systems (IOOS) provide real time oceanic data and sea state forecasting information that is utilized by numerous public and private sectors engaging in maritime activities. The U.S. Gulf Coast constituent of this system (GCOOS) consists of 321 platforms, buoys, and sensors that provide measurements of wind speed, wave height, water quality, and other parameters. Government entities have proposed an expansion of this infrastructure by 40% at an estimated cost of $35 million for installation and $33 million annually for maintenance. As part of a larger project commissioned to estimate monetized benefits of this expansion, this study applied contingent valuation (CVM) methodology in a survey of avid IOOS users located in the Gulf and Atlantic regions of the United States (N=18,000; n=484). The objective was to estimate general preferences for IOOS data and specific values for the proposed GCOOS expansion. A probit model was used to examine factors associated with a respondent's likelihood to support the expansion under a public referendum. Responses were solicited via six randomized treatments containing varying tax levels. A majority of respondents (74%) indicated support for the measure, with imputed willingness-to-pay (WTP) estimates ranging from $14.11 and $36.47 annually. Consistent with economic theory, the dollar amount of the tax was significant and negatively associated with referendum support. Proxies for avidity; however, proved either irrelevant or contrary to hypothesized effects. Vessel ownership, vessel size, distance traveled, and hours per trip were non-factors while the number of trips taken proved to be a significant, but negative predictor of referendum outcome. Alternatively, Gulf respondents engaged in fishing and fee-based services were more likely to support the measure indicating that proximity could be a

more influential driver than avidity. Interpretation of these results is limited by the relatively small population queried. A broader depiction will emerge parallel versions of this survey are completed with larger populations. Taken together, these studies should prove valuable in characterizing preferences for IOOS data, assessing the economic merit of GCOOS expansion, and demonstrating the potential for non-market approaches in the valuation of publically-funded information systems.

CHAPTER 1: INTRODUCTION

The Gulf Coast Ocean Observing System (GCOOS) is the Gulf of Mexico constituent of a larger infrastructure of coastal and marine data collection in the U.S. called the Integrated Ocean Observing System (IOOS). Founded in January 2009 (PL 111-11 2009), IOOS is the umbrella term for the network of buoys, station, gauges, sensors, and systems that collect and report coastal and oceanic data and information. These data provide improved understanding and prediction of near-term maritime events such as tides, wave heights, and storms and help track more long-term processes such as sea level change. The infrastructure of GCOOS is managed by a regional advisory council of local, state, and federal institutions working with academia and the private sector in the Gulf of Mexico region. The primary goal of this network is to provide an assortment of environmental intelligence products to an even larger group of stakeholders that depend on this information for Gulf-related navigation, commerce, research, recreation, and other purposes. Sullivan (2016) defines this type of "environmental intelligence" as being timely, actionable, reliable information obtained from authoritative science sources that provides foresight about current and future conditions and informed decision-making.

This environmental information arises from physical and biological data collected from 321 stations and sensors located throughout the U.S. Gulf of Mexico (Figure 1.1). Some of the organizations that rely on the information GCOOS provides include: the military, recreational and commercial fishing, oil and natural gas, shipping, beachgoers, and coastal and beach communities. For example, GCOOS provides commercial and recreational fishing sectors with a variety of information related to water temperature, salinity, currents, and weather conditions that can ultimately influence planning and operations. Similarly, beach and coastal communities rely on GCOOS information for short-term observations and forecasts related to water quality and quantity (tidal and surge flooding) and more long-term predictions of coastal change.

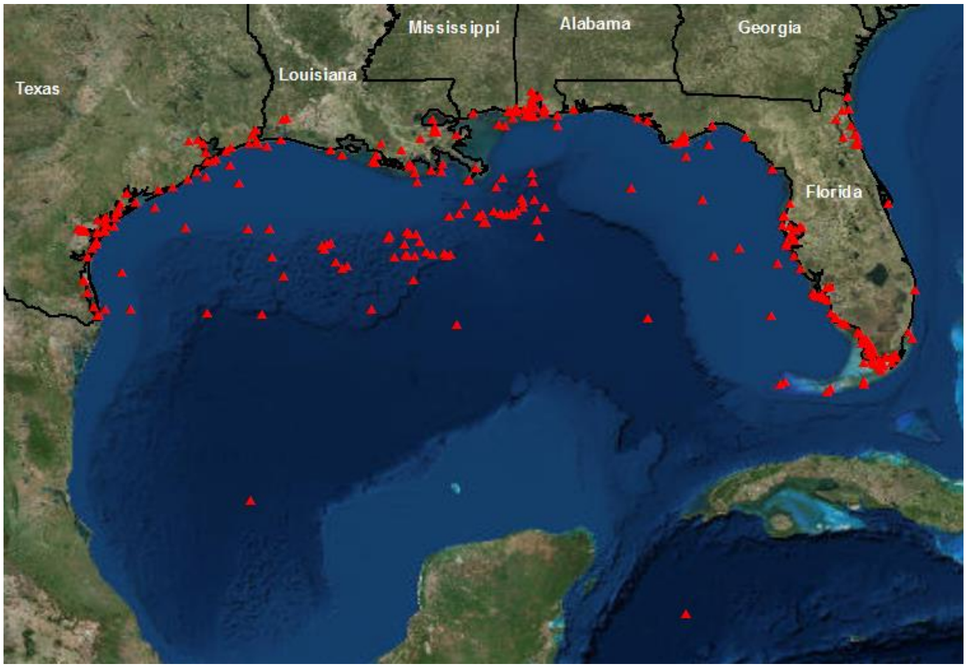


Figure 1.1 Geographic location of the current GCOOS stations and monitors in the Gulf of Mexico (n=321).

In the coming years, the GCOOS network is planning to expand the number of data collection platforms, stations, sensors and buoys in the Gulf of Mexico (GoM). As part of this planning, the network is currently examining the benefits and costs of this build-out and exploring ways to gauge the perceived value of GCOOS amongst the public. The GCOOS budget comes primarily from government sources, which means the taxpayers would be responsible for funding any expansion of the existing system.

1.1 Project Overview

In the spring of 2013 the GCOOS advisory council approached the Louisiana State University Coastal Marine Institute (CMI) to commission a project to value the information GCOOS currently provides and to examine support for expanding GCOOS data and products. The original project was sponsored by the Bureau of Ocean Energy Management (BOEM) through a CMI proposal containing four major objectives: 1) identify target audiences of GCOOS services and identify how they access primary and secondary information; 2) survey a range of users to estimate preference structure and valuations for GCOOS information; 3) compare and contrast user preferences within and across public and private sectors; and, 4) provide a baseline of data for eventual comparison to a follow up survey of registered vessel in the Northern Gulf of Mexico.

The original project aimed to utilize surveys to gauge public preferences for and valuation of GCOOS based information. By spring 2014, LSU and its coordinating partners at BOEM had agreed to assess three different facets of data in order to obtain estimates of GCOOS value. These facets included: 1) hurricane monitoring and relief services, 2) beach conditions, and 3) data and observations of value to coastal marine vessel owners and users. Given that a previous study (Lazo et al. 2010) addressed public valuation of hurricane resources, the BOEM-supported project evolved into a focus on two basic user groups: terrestrial users and aquatic users. Separate survey instruments would be needed to target these two broad groups.

1.1.1 Targeted Surveys

A questionnaire targeting the terrestrial users of GCOOS (i.e. beachgoers) was developed for distribution to a random sample of coastal residents in the five states of the U.S. Gulf region (Texas, Louisiana, Mississippi, Alabama, and Florida). Understanding the preferences and values of boaters, however, requires some assumption regarding vessel use. Thus, the coastal-marine vessel survey (aquatic access survey) was a developed as a questionnaire targeting registered vessel owners in the Gulf of Mexico region. Questionnaires targeting these two groups were drafted in late 2015 with the intent of measuring the monetary value of environmental information collected by GCOOS in the U.S. Gulf of Mexico.

1.1.2 The Coastal Marine Vessel Survey

Economic and attitudinal surveys of vessel owners and operators in coastal marine environments have established long-proven methods for the collection of data at the vessel, trip, and effort level. Decadal surveys of the recreational for hire (RFH) sector in the U.S. GoM were conducted in 1987, 1997, and 2009 by researchers at Texas A&M, University of Florida, and Louisiana State University; respectively (Loomis and Ditton 1988; Holland et al. 2000; Savolainen et al. 2010). These studies provide a structural framework for data collection via the aforementioned categories that can be used to develop the aquatic access survey. And while the studies did collect some data on information use and preferences, they fail to address how operators value maritime information in operations.

Manfredo (1989) sought to determine if those operators interested in seeking information about maritime information for recreational experiences have strong interests in data but might be limited in the amount of information provided. By using a survey, the author was able to determine that there was a need for developing more efficient mass communication efforts of maritime information. Studies like Manfredo (1989) suggest that there could be a lack of information provided to an exceptionally large population of vessel owners in United States. Little et al. (2003) conducted a study that attempted to show the comparison of the fishing industry made up of those fishermen who share information amongst each other and those who work independently. By exploring this environment with shared information, the author was able to show the effects that such information flow can have on resources. Although neither of these articles specifically address the IOOS systems, they both show a lack of shared information amongst vessel owners and operators. This is where the need to survey vessel owners is created. The goal of the vessel survey is to determine the usable characteristics of IOOS and value the information provided in the eyes of the vessel owners. To accomplish this goal in concert with the terrestrial survey requires some understanding of the relevant population.

According to Isaacs (2010), there are an estimated 12,696,183 registered vessel owners in the United States. Table 1.1 shows the five Gulf States populations with their corresponding number of registered vessels.

Table 1.1 GoM Population V. Registered Vessel Owners

State	Population		Registered Vessel Owners	
	Count	Percentage	Count	Percentage
Alabama	4,677,464	8.5%	272,558	11.7%
Florida	18,423,878	33.6%	974,553	41.9%
Louisiana	4,451,513	8.1%	316,593	13.6%
Mississippi	2,940,212	5.4%	191,312	8.2%
Texas	24,304,290	44.4%	597,428	25.7%
Total	54,797,357	100%	2,352,444	100%

Just in the Gulf alone, there are an estimated 2,352,444 registered vessels. The coastal marine vessel survey is targeted to this particular audience in order to gauge the use and preferences of IOOS and valuation of the GCOOS network and a potential buildout situation. In the process, it was determined that a parallel survey could be implemented to investigate the difference in preferences in vessel owners who might be labeled as more avid users of the GCOOS network. In determining a population for these "avid" users, it was believed that patrons who currently pay for subscription based services for information that GCOOS provides might be an acceptable population for the coastal marine vessel sub-survey. At the time of this writing, the Coastal Marine Vessel Survey is under review by the Office of Management and Budget (OMB).

1.1.2.1 The Coastal Marine Vessel Sub-Survey

During the process of finalizing the BOEM funded surveys, an opportunity emerged for parallel data collection by using the aquatic survey with a smaller, more specialized population of information users. This sub-survey would be identical to the broader coastal marine vessel survey under review by OMB; but not affiliated with

BOEM or the CMI project.[1] The rationale for a nested survey was predicated on the opportunity to address avidity issues in the use and valuation of IOOS data and information. Avidity issues in survey participation and response can influence results in numerous ways. Avid users may be more likely to self-select into a given survey, and could hold significantly different preferences than those of the general population (Thompson 1991; Whitehead et al. 2007). Indeed, a number of commercial websites have emerged in recent years that provide easy access and value-added services to government based IOOS data. Subscribes to these third party repackaging sites pay a wide range of fees for these services, and are thus theoretically different from non-paying users of IOOS based information.

It is hypothesized that the general population of vessel owners (to be targeted in the GCOOS aquatic survey currently in review at OMB) likely consists of a larger portion of participants that are unfamiliar with the vessels they were on and the information needed for any aquatic activities they participated in. Surveying a subpopulation of subscribers from a third party, data-repacking service might allow for the collection and analysis of preferences and values from a potentially more avid subset of users.

1.2 Problem Statement

Demand for esoteric types of coastal and marine observing system's data is likely to be highly concentrated. Specific subpopulations could have preferences and valuations that are substantially different from the broader population. With that in mind,

[1] Funding for the sub survey was provided by an LSU AgCenter Fellowship and by omnibus-based marine extension funds from the Louisiana Sea Grant College Program.

there exists the opportunity to engage a more sophisticated subset of IOOS and GCOOS users. Although studies have been conducted to attempt to value the current GCOOS and IOOS systems, little is known about the potential valuation of the buildout plan. There exists an opportunity to investigate and engage the public to find their preferences and willingness-to-pay for information provided from the GCOOS network. With this information, this thesis aims to utilize the feedback and determine the value of the overall network, determine if the benefits of the buildout will outweigh the costs to implement it, and estimate a total valuation of the worth of the information provided.

1.3 Project Objectives

This project engages a subset of information users to collect general preferences for IOOS data and obtain economic valuations related to the GCOOS expansion. The specific objectives include:

1. Develop a coastal marine vessel survey to gauge preferences and values for IOOS provided maritime information and data amongst sub-sector user groups.

2. Implement the survey within a sub population of IOOS users, and gauge specific preferences and welfare estimates (WTP) for a GCOOS build out.

3. Analyze data to compare and contrast user values and preferences within and across respondent categories.

4. Determine important characteristics from the data and use empirical evaluation (probit model) to identify factors affecting the valuation of the buildout.

5. Establish a baseline of information for eventual comparison to a broader application of the survey targeting registered vessel in the Northern GoM.

1.4 Rationale

The GCOOS system, and its counterparts in the greater IOOS network, consist of a publicly-subsidized infrastructure of stations and sensors maintained primarily by government entities and academic institutions operating at taxpayer expense. These entities are currently promoting an expansion of GCOOS budgeted at $35 million for capital equipment and $33 million annually for maintenance. This build-out would add an additional 129 stations to the GoM, expanding the current infrastructure by approximately 40% (GCOOS 2014).

As with any public expenditure, it is important to examine the costs of the GCOOS buildout against estimated benefits to be derived. While costs are relatively easy to estimate, the benefits of environmental projects (and especially environmental information monitoring) are more difficult to quantify. To date, the GCOOS buildout has been predicated on a list of qualitative benefits (e.g. improving public health and safety; maintaining healthy ecosystems; mitigating of coastal hazards; ensuring safe and efficient marine operations; and monitoring long-term variability of ocean change (GCOOS 2014)). Attempts to quantify these benefits; however, have not yet been undertaken. Indeed, quantified measurements of the value of environmental information have not been well documented beyond a handful of studies, and even fewer have attempted to monetize such benefits.

The aquatic survey currently being pursued under the LSU-BOEM CMI project will engage a broad population of Gulf of Mexico vessel owners in an effort to quantify general preferences for IOOS information and derive monetize estimates of GCOOS system benefits using the contingent valuation method. By implementing a version of this survey amongst a more avid sub-population, this thesis will establish a subset of nested data and analyses that could prove useful for understanding how technically-inclined individuals access, use, and value this information while providing a parallel data set for comparison to the preferences and valuations estimated by the broader survey.

The thesis is arranged into five chapters. Chapters 1 and 2 outline the background, objectives and rational for the project, a comprehensive review of the literature on information valuation, and the theoretical foundation for a contingent valuation survey. Chapters 3 provides a detailed overview of the questionnaire design, testing, and implementation. Chapter 4 provides descriptive information on respondents by type, location, and avidity and details the results of a statistical model used to predict support for the buildout and monetize estimates of GCOOS value amongst the sub population. Finally, Chapter 5 concludes with a summary and discussion of research findings, an overview of limitations, and suggestions for additional analysis to be conducted in connection with the broader survey of aquatic users.

CHAPTER 2: LITERATURE REVIEW AND VALUATION APPROACH

In any decision making process it is critical to have readily available information that is accurate and reliable. One would believe that more information would be favored to less, but access to additional information typically comes at a higher cost. In order for the acquisition of large amounts of information to be cost-effective, the benefits provided would have to outweigh the cost of collection. This is especially true for large-scale information-seeking initiatives whose budgets rely on public support - like the Gulf Coast Ocean Observing System (GCOOS). A review of previous research indicates there is not a substantial amount of literature that documents the value of these types of information providing systems. This lack of information tends to be caused by the nature of the good, which does not possess the characteristics of a physical good (Rötheli 2001, Sakalaki and Kazi 2007). We tend to see the valuation of information come from methods that lack in proven quantitative analysis, even though the accurate calculation of information is critical to determining whether investments in information resources are justified.

There is literature across various disciplines that investigates the nature and value of information used in decision-making, but few of these methods attempt to determine the monetized value of information. The literature review addresses this challenge in more detail, but the main goal is to provide the reader with a baseline from which he or she can further investigate the economic value of information generated from data providing systems like GCOOS.

2.1 Valuing Information

As stated earlier, one of the main uses of information is to aid in the process of decision-making. Without a strong source of information, the chances of making errors increases. With that being said, there is a well-known need for information but no consistent method to put a numerical value to what it is worth. Typically, the motivation for valuing information is related to the inputs needed to generate it. This includes the infrastructure and maintenance investment that will generate the final product for the consumer. This introduces the need for benefit-cost calculations (Nelson and Winter 1964).

Arrow (1996) conducted a study that critically analyzed characteristics of information and discussed the impacts of these characteristics on the ability to view information as an economic commodity. The author stated that information is often valuable and costly, similar to an economic good and considered information as a variable in a benefit-cost analysis by weighing the cost of its acquisition to the amount of return given in various payoffs. His results showed that information is a relatively scarce commodity. Since there is no practical method of defining units of information, economic decisions themselves can alter the benefit of information (Arrow 1996). The author also concluded that additional units of identical information provided no added economic value.

Sakalaki and Smaragda (2007) conducted an experiment that examined the difference in value between material good and information and found that people tend to undervalue information due to its intangible and paradoxical nature. To test their hypothesis, subjects were presented with one combination of three types of products (material, non-expert information, and expert information) and two levels of investments (low and high). Using a chi-square analysis and a two-way ANOVA test, they were able to demonstrate how material goods were more valued than non-expert and expert informational goods. The authors also showed that expert informational goods were only valued higher than non-expert informational goods when investment levels were low; non-expert information had higher value when investment levels were high.

2.2 Valuing Information-Providing Systems

There are several studies more closely related to valuing information systems that require a large sum of capital used for developing infrastructure and maintenance. Brathwaite and Saleh (2009, 2013) conducted several studies that attempt to value environmental information provided from communication satellites. They addressed the large investment needed for design and implementation of commercial satellites and the ongoing costs of maintenance. The information generated by these systems was described as valuable to stakeholders because it can update their beliefs and facilitate choices with higher expected pay-offs than would occur without information (Brathwaite and Saleh 2009). The authors evaluated the value of spacecraft and satellites, viewing these spacecraft as sources of information for stakeholders. Information is viewed as valuable to stakeholders because it can update their beliefs and facilitate choices with higher expected pay-offs than would occur without information. These satellites and space monitoring systems are then used in the process of forecasting and valuing weather in markets such as agriculture.

Babcock (1990) showed how monitoring and forecasting weather could influence agriculture productivity. With the amount of uncertainty in weather prediction, it is important for farmers to know about these weather trends in order to make an economic profit and protect themselves if bad weather leads to yield loss. The author examined how the economic value of weather-related information changed with improvements in forecast accuracy in a competitive market environment. He created a model to characterize the relationships between crop yield, weather, and the level of farmer cooperation. The model simulated farmer decisions under different levels of forecast quality, including perfect forecasts. From the information provided by the model, the author was able to determine the value of forecast information for both elastic and inelastic demand curves. The results, however, were somewhat counterintuitive. Babcock found that the value of weather information declines as the information becomes more accurate. Each individual farmer gets value from weather information, but it seems that the total industry may suffer as weather-based farming decisions can negatively affect price (Babcock 1990).

Macauley (2006) conducted a similar study which measured the contribution space-derived earth science has on natural resource management. She utilized a “standard valuation framework” using an agricultural example in which a farmer’s decisions depended on whether heavy rain was in the forecast. The dependent variables used in this example were the risk awareness of the farmer, the cost of implementing a defensive mechanism, the outcome of such a mechanism, and the uncertainty of the information. The independent variable was the application of earth science data. Output was compared between model simulations with and without the earth science data. The simulated probability rain and the farmer's risk preference give the information its value. Results from the first example concluded that the value of information was low when the beliefs of individuals were close to the extremes, when making the wrong decision had low cost, and when there were no actions to take even after obtaining the data. Factors that increased the value of information included: when the decision maker was indifferent about his/her alternatives, when making the wrong decision had a high cost, and when the actions that could be taken were more responsive.

Miller (2016) recently conducted a survey study to identify the users and uses of Landsat satellite imagery for consumers in Colorado. The main objectives of this study were to characterize the various Landsat user groups, identify the differences among the groups, measure the importance of the imaging and satisfaction levels, and identify any challenges in using Landsat images. The study was conducted through an online survey in which various user groups were identified based on their response to specific images and the key characteristics of importance when using these images. The author documented a high level of satisfaction with the Landsat services and concluded that (since the satellites where U.S. owned and operated) there was a significant difference in the opinions from U.S. and non-U.S. users.

2.3 Valuing Ocean Observing Systems

Continuing on studies that attempt to value information of specific areas of weather forecasting, there have been some attempts to value the information provided by Integrated Ocean Observing Systems. There have been a variety of estimating tools including simulation models, multidisciplinary value-centric modules, several surveying techniques, and benefit-cost analysis that have attempted to monetize the value of information. Although results of these studies are informative, some of their findings may have been overreaching based on the available, secondary data.

Studies conducted by Kite-Powel (2005 a&b, 2007) estimated the economic benefits from installing more NOAA PORTS® and the information they provide. NOAA Physical Oceanographic Real-Time Systems (PORTS®) are near-shore ocean observing systems that provide real-time information on water level and current. Some PORTS® stations also measure wind, salinity, and water temperature, and other sensors at these stations measure visibility and wave height. The data provided by these PORTS® are used by decision-makers and therefore have economic value (Kite-Powell 2005a). They help reduce uncertainty in economic decision making by providing real time information. The author provides a methodology to quantify the economic benefits from PORTS® and the costs associated with the data collection process and maintenance based on a Bayesian approach in which the expected net benefit was estimated as an integral of the product of the net benefit and probability of a state of nature. The value of the systems will change when new information is provided depending on the reliability of the new information.

A variety of approaches were used to value this information including maritime shipping, recreational boaters and anglers, and environmental managers. No economic results were presented in the paper, instead the authors merely speculated on possible reasons that would support or explain the outcomes of the study. The ultimate goal of these methodologies were to allow the reader to apply the formulas in their individual assessments of the PORTS® data. Kite-Powell recommended applying a 1% proxy rule to the metrics following (Nordhaus 1986) whereby the value of weather information is nearly 1% of the value generated by the activity.

Furthermore, specific case studies were conducted in unison with the overall valuation study of the NOAA PORTS® in 2005 and 2007. The study specifically concentrated on the PORTS® in the Tampa Bay and Houston/Galveston areas. Using the same approach as the larger study, Kite-Powell was able to show the estimated benefits of the NOAA PORTS® and the information they provide for the respected areas of business. As stated earlier, the uses of information from the PORTS® included the prevention of grounding vessels, commercial and recreational fishing, and coastal forecasting of weather. The author was able to determine that data the NOAA PORTS® provided did in fact lead to significantly less grounding of vessels, an increase in efficiency for cargo transportation, and led to an increase in annual economic benefit from several recreational avenues such as boating, fishing, and beach going. On the other hand, the scientific methods behind these conclusions were questionable. The data used to draw conclusions was collected from secondary sources, and the author appeared to rely on simple assumptions to draw conclusions. One such example follows: Assuming 50% of grounding preventions were due to PORTS® data, the author estimated internal and external costs associated with groundings, based on the approach found in the Coast Guard’s Port Needs Study (1991). Coast Guard data were used to quantify recreational boating accidents in the Galveston Bay area; it was assumed that 10% of benefits can be attributed to PORTS® data.

These types of assumptions were made across all of the results provided in the case study. The ultimate conclusion of the studies provided an ambiguous valuation of the NOAA PORTS® and the information they provide. The arbitrary nature of these assumptions call into question the linkages between information and activity. It is difficult to state, in the absence of direct observational data, how commercial activity would be affected by increases or decreases in government-funded information.

Similar approaches have been used by other studies attempting to justify a maintenance and expansion of IOOS networks. Kaiser and Pulsipher (2004, 2006) attempted to measure the value of an expanded Gulf of Mexico Ocean Observing System (GCOOS). In the late 1990's a need developed for an information system to collect data on weather patterns throughout the GoM. Instead of relying on the current makeshift methods of data collection, an expansion of the whole network was being considered. This would be extremely expensive to establish and maintain, but it was thought that an integrated ocean system could yield a substantial economic benefit. Due to uncertainty in quantifying the benefits in the current integrated system, estimating the added benefits from an improved system would be very difficult. The goal of the study was to: "describe the ocean observing system that currently exists in the Gulf of Mexico, and to identify and quantify the expected economic benefits that may result from the implementation of an integrated regional network" (Kaiser and Pulsipher 2004). The authors asserted that weather events can impact a wide variety of human activities ranging from offshore drilling to the fishing industry to the transportation industry. It was hypothesized that an improved ocean observing system would improve weather forecasting for the region, although no attempt was made to identify how that improvement would be manifested. Instead, an approach was used similar to that of Kite-Powell, in which benefits derived from an improved ocean observing system would be assumed as a fraction of the economic activities of various sectors. They assumed that the benefit of an improved observation system could be expressed by a small factor (usually 1%), allowing them to compute the expected benefit from an improved observation system. Some of the groups used in the study include: marine transportation, commercial and recreational fishing, oil spill response and energy drilling, development and production activities. After multiplying the assumed savings offered to each industry observed by the one percent margin, the authors proceeded to sum these amounts into an aggregate value estimate for the entire GCOOS.

Gouldman et al. (2016) conducted a survey to determine the extent of the use of IOOS information in the private sector, in commercial activity supporting oceanic measurements, and the economic and environmental benefits associated with the reporting and repackaging of oceanic information. The authors sought to raise awareness of the importance of IOOS and determine the degree of engagement with NOAA and IOOS programs alike. After providing a background on the IOOS network and the industry associated with it, the authors spent time determining a list of organizations who were potentially engaged in what they refer to as the Ocean Enterprise economy. They employed a multi-method approach to collect quantitative and qualitative data from various sectors.

Although the authors did not seek to economically monetize IOOS, they accounted for a broad range of industry that could rely on the IOOS network, including commercial fishing, oil and gas, research, navigation, and commerce. Respondents were differentiated in the study by additional categories related to location dynamics, revenue and employment estimates, foreign markets, and business dynamics. The authors listed some possible barriers limiting the knowledge of and use of IOOS, including: inadequate data coverage, limited knowledge, local regulations, and limited access. They stress the importance of the network, call for an expansion of IOOS infrastructure, and present their results as potentially useful as a baseline for conducting a more in-depth economic impact study. While the study does provide detailed feedback from IOOS users, use of their findings is constrained by the method in which data was collected. The lack of a distinct population and the use of self-selected, snowball sampling could introduce an element of bias and limit the extrapolation of results.

2.4 Contingent Valuation Method

An alternative approach to help eliminate some of these issues involves using stated preferences (SP) through the contingent valuation method (CVM), a more commonly recognized method for assessing the value of public goods. The Contingent Valuation Method is used to value systems that are not captured by the open market, like environmental ecosystems (Johnston et al. 2017). In the context of a GCOOS expansion, application of the CVM would involve asking a respondent whether they would vote for a proposed change at some specific cost. This introduces the idea of willingness-to-pay (WTP), which has become the preferred method of CVM due to the fact that it is not incentive based as is the case with a willingness-to-accept (WTA) approach in which there is some incentive for individuals to reveal their true preferences (Johnston et al. 2017).

There have been thousands of studies conducted utilizing the CVM; however, few have been as informative as the applications and guidance stemming from the *Exxon Valdez* oil spill disaster. The National Oceanic and Atmospheric Administration (NOAA) assembled a panel of six high-profile economists and survey researchers to determine if the CVM truly captured the economic losses of those affected by the oil spill. This panel became known as the “NOAA Blue Ribbon Panel.” Led by economist Kenneth Arrow, the NOAA panel was presented with the task of reviewing CVM and determining if it was a credible compensation method (Arrow 1993). The NOAA panel agreed that the CVM method could be useful, but certain steps should be taken to produce reliable willingness-to-pay values. Their recommendations include six general guidelines for a successful CVM study: defining the market scenario, choosing the elicitation method, designing the market administration, sample design, designing the experiment, and estimating the WTP function (Arrow 1993). While these standards have been embraced by most CVM practitioners, critics of the method point out that considerable issues remain unsolved. These critics cite problems such as hypothetical bias, scope effects and embeddedness and assert that monetizing non-market benefits via this method may be net detrimental (Hausman 2012). Conversely, other economists refute this position, stating that CVM as a decision-support tool is net positive, and provides useful, monetized estimates as a starting point for discussion - especially in the area of environmental policy making (Haab et al. 2013).

The majority of CVM applications have historically centered on valuation of environmental amenities. Petrolia and Kim (2009) used CVM to estimate the value of barrier islands along the Mississippi Gulf Coast. After several natural disasters including Hurricanes Katrina and Rita in 2005, there became a need to assess the economic value the barrier islands provide in damage relief off the coast of Mississippi. The authors acknowledged that the maintenance and rebuilding of these barrier islands come at no small cost from the government. The goals in this study were to gather information on the key motivation factors on why the public supports the restoration of the barrier islands including storm protection, recreational aspects, environmental, and business impacts (Petrolia and Kim 2009). The authors measured the non-market value for the islands through discrete-response, probit model approach and aggregated responses to aggregate societal WTP at the population level. Their results found that the public did in fact have some degree of support for the barrier islands. Through their survey method, the authors were also able to determine some of the main reasons for the support of the barrier islands including hurricane protection.

Additional applications of CVM have focused on benefits of interest to recreational boaters. The CVM method was also used to estimate the changes in value of recreational boating with a dredging program off of the coast of North Carolina. Whitehead et al. (2007) used a survey to gauge respondents WTP to maintain the Atlantic Intercostal Waterway (AIWW). The authors hypothesized that a respondents WTP should increase with the quantity and quality of the dredging. The survey included instruments that were designed to elicit responses from both transient and local recreational boaters. By presenting a hypothetical program to maintain the depth of the AIWW with the associated costs randomly assigned to each individual respondent, the authors were able to value the cost of maintenance of dredging and describe the added benefits the dredging would provide for the residents.

Lazo et al. (2010) conducted a CVM survey to gather data on the fundamental aspects of households' perception of hurricane forecasting information and their potential use and values for improving these forecasting systems. The authors study was designed to explore evacuation decision making and elicit values (WTP) for improved hurricane forecasting information. The survey was used to collect data on aspects that affect people's stated likelihoods of evacuation including intensity of the hurricane, access to information prior to the hurricane, and reasons why participants might not choose to evacuate. Based off these characteristics, the authors were able to build a statistical model explaining why different populations might choose or not choose to evacuate for a hurricane. Regarding the valuation of hurricane information, the authors presented the respondents with a set of alternatives and asked to choose their preferred alternative. By associating prices with the different alternatives, the authors were able to extrapolate the population's WTP for hurricane information.

Unlike other valuation methods that consider only market values, CVM can also account for non-market values (Perman 2003). The method has been applied in hundreds of studies; including valuations of ecosystem services, recreation from public infrastructure, and weather information systems. In the case of the GCOOS, the application of CVM within a dichotomous choice construct appears to be the most preferable approach for gauging preferences and values for an expanded system. The theoretical and statistical framework for this approach is discussed in the following section.

2.5 Theoretical Framework

Stated preference methods are the only known direct approach to estimate nonuse values such as those associated with the GCOOS network (Johnston et al. 2017). The Hicksian demand generates a curve that keeps utility constant as the price of the good changes by adjusting income so that the consumer might stay on the same indifference curve through compensation. Individual utility can be expressed via indifference curves in which an individual's maximum utility is a function of income and the quantity of a particular good (Figure 2.1).

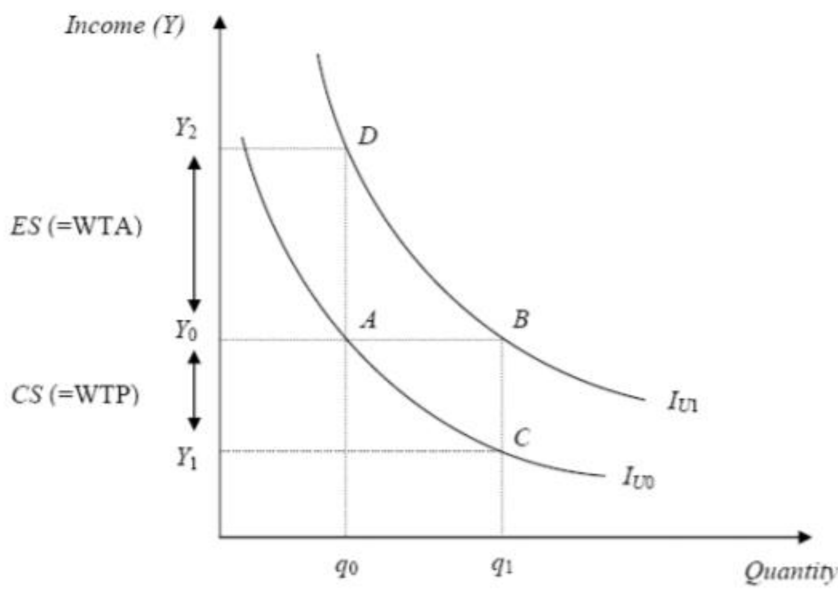


Figure 2.1 Equivalent Surplus or Willingness-to-Pay (adopted from Hwang 2013)

Indifference curves are a series of different combinations between two different economic goods in which theoretically, a consumer would be indifferent of which particular combination he or she would receive (Perman, 2003). Figure 2.1 measures quantity of the good on the x-axis and income on the y-axis and shows different levels of consumption to maximize utility at various points shown on the two indifference curves I_{u0} and I_{u1}. Compensating surplus (CS) is the amount of money needed for the person to stay at the same utility level with the given change. If I_{u0} is the initial indifference curve with utility u_0, and I_{u1} is the new indifference curve with utility u_1. The change in income from Y_0 to Y_1 represents the amount the consumer would be willing-to-pay to increase consumption of good q_0 to q_1 where *C* is the final point of consumption. This represents the WTP. The equivalent surplus (ES) is the amount of money that allows the person to move to a different utility level without the given changes. The ES is represented by the changes in income levels Y_0 to Y_2. This represents the monetary value q needed for the individual to move to u_1 without the change in quantity where D is the final consumption point. This represents the alternative approach, Willingness-to-Accept (WTA).

2.5.1 Random Utility Model

Following methods provided in Haab and McConnell (2002) the contingent valuation method is based on maximizing an individual's utility within stated conditions. When faced with a valuation question, the participant is given the opportunity to accept a proposed tax and receive the stated improvements of a good or reject it all together. This leads to the evaluation of two separate utility functions generated from the accepting or rejecting the changes. The respondent's utility can therefore be described as a function of these choices:

$$u_{ij} = u_i(y_j, z_j, \varepsilon_{ij}) \quad (2.1)$$

In the context of the GCOOS buildout, $i = 1$ would reflect an individual's utility with the buildout implemented and $i = 0$ would be the status quo. The other determining factors of utility are represented by y_j with j^{th} representing the respondent's discretionary income, and z_j representing other household characteristics of the corresponding choice including the unobservable individual characteristics represented by ε_{ij}.

Based on these assumptions, if the respondent says yes to the GCOOS buildout, a required payment t_j, representing the cost to the taxpayer if the referendum passes, will be subtracted from the income (Haab and McConnell 2002).

$$u_1(y_j - t_j, z_j, \varepsilon_{1j}) > u_0(y_j, z_j, \varepsilon_{0j}) \quad (2.2)$$

The probability of a yes response means the participant believes he or she will be better off with the GCOOS buildout $u_1 > u_0$.

$$\Pr(yes_j) = \Pr(u_1(y_j - t_j, z_j, \varepsilon_{1j}) > u_0(y_j, z_j, \varepsilon_{0j})) \quad (2.3)$$

The determined utility for the hypothetical CVM scenario is represented by

$$v_{1j}(y_j - t_j) = \alpha_1 z_j + \beta_1(y_j - t_j) \quad (2.4)$$

Where t_j is the price offered to the j^{th} respondent. The corresponding status quo utility is

$$v_{0j}(y_j) = \alpha_0 z_j + \beta_0(y_j) \quad (2.5)$$

The change in the deterministic utility is

$$v_{1j} - v_{0j} = (\alpha_1 - \alpha_0)z_j + \beta_1(y_j - t_j) - \beta_0(y_j) \quad (2.6)$$

Let's assume that the marginal utility of income is constant between the two CVM states, i.e., that $\beta_1 = \beta_0$ and the difference in utility becomes

$$v_{1j} - v_{0j} = \alpha z_j - \beta t_j \quad (2.7)$$

The corresponding probability of saying yes becomes

$$\Pr(yes_j) = \Pr(\ \alpha z_j - \beta t_j + \varepsilon_j > 0) \quad (2.8)$$

Where $\varepsilon_j \equiv \varepsilon_{1j} - \varepsilon_{0j}$ defined above.

It is necessary to specify the nature of the random terms (Haab and McConnell 2002). It is assumed that ε_j are independently and identically distributed with the mean zero describes the distribution. If ε_1 and ε_0 are independent normal, then $\varepsilon = \varepsilon_1 - \varepsilon_0$. The logistic can be derived as the difference between the extremes making the probability for a yes respondent at j estimated as

$$\Pr(\alpha z_j - \beta t_j + \varepsilon_j > 0) = \Pr(-(\alpha z_j - \beta t_j) < \varepsilon_j$$

$$= 1 - \Pr(-(\alpha z_j - \beta t_j) > \varepsilon_j$$

$$= \Pr(\varepsilon_j < \alpha z_j - \beta t_j) \quad (2.9)$$

The last equation discusses the symmetry of the distribution. For a symmetric distribution $F(x) = 1 - F(-x)$, then convert $\varepsilon \sim N(0, \sigma^2)$ to a standard normal variable. If $\theta = \varepsilon/\sigma$ then $\theta \sim N(0,1)$ and

$$\Pr(\varepsilon_j < \alpha z_j - \beta t_j) = \Pr(\theta < \frac{\alpha z_j}{\sigma} - \frac{\beta}{\sigma} t_j)$$

$$= \Phi(\frac{\alpha z_j}{\sigma} - \frac{\beta}{\sigma} t_j) \quad (2.10)$$

where $\Phi(x)$ is the cumulative standard normal (Haab and McConnell 2002).

The calculation of the WTP is derived by replacing *t* with WTP in equation (2.6) as follows:

$$\alpha_1 z_j + \beta(y_j - WTP_j) + \varepsilon_{j1} = \alpha_0 z_j + \beta y_j + \varepsilon_{j0} \quad (2.11)$$

Solving for WTP yields:

$$WTP_j = \alpha z_j/\beta + \varepsilon_j/\beta \quad (2.12)$$

2.6 Statistical Model

After considering several different models, the dichotomous choice probit model was determined to be the best approach for developing a statistical assessment of stated preference data. Given that the dependent variable, y, is a binary variable, it takes on the value of 0 or 1.

$$\mathrm{y_n} = \begin{matrix} 1 \\ 0 \end{matrix} \qquad (2.13)$$

If $\mathrm{P_n}$ is the probability that the n[th] person does not pay the tax, then $0 < \mathrm{P_n} < 1$. This probability will be affected by some other independent variables. An example of an independent variable could be a participant's education level, denoted by $\mathrm{X_n}$. The probability of default is expressed as a function of education. The set of parameters that could change the value of y are denoted by β, P stands for probability.

$$\mathrm{P_n} = \mathrm{E}(\mathrm{y_n}|\mathrm{X_n}) = F(\alpha + X_n\beta) \qquad (2.14)$$

Where

$$F(\alpha + X_n\beta) = \int_{-\infty}^{\alpha + X_n\beta} f(t)dt \qquad (2.15)$$

is the cumulative standard normal distribution function and

$$f(t) = [\frac{1}{2\pi}]^{1/2}\exp(-\frac{z^2}{2}) \qquad (2.16)$$

is the normal density function. The default is determined by the *probit probability model.*

2.6.1 Maximum Likelihood Estimation

When estimating binary choice, the models are typically based on the method of maximum likelihood. The probit model with a successful probability $\Phi(\mathrm{X_n}\beta)$ and n independent variables leads to a joint probability or the likelihood function:

$$P(Y_1 = y_1, Y_2 = y_2, \dots, Y_n = y_n) = \mathrm{L} = \prod_{i=1}^{N} [\Phi(\mathrm{X_n}\beta)]^{y_i} \left[\left(1 - \Phi(\mathrm{X_n}\beta)\right)\right]^{1-y_i} \qquad (2.17)$$

Let us denote $\Phi(\mathrm{X_n}\beta) = \Phi_i$. Log-likelihood function is

$$\ln L(\beta) = \sum_i y_i \ln\Phi_i + (1 - y_i)\ln(1 - \Phi_i) \qquad (2.18)$$

With the first-order conditions to maximize L are

$$\frac{\partial \ln L}{\partial \beta} = \sum_{y_i=0} \frac{-\Phi_i}{1 - \Phi_i} x_i + \sum_{y_i=1} \frac{\Phi_i}{\Phi_i} x_i \qquad (2.19)$$

This log-likelihood function is globally concave in β, and therefore standard numerical algorithms for optimization will converge rapidly to the unique maximum.

2.6.2 Marginal Effects

The probit model is a simple regression. The function $\Phi(.)$ is a commonly used notation for standard normal distribution, and $\Phi(.)$ is the corresponding density function.

$$E(y|x) = 0 * [1 - \Phi(x'\beta)] + 1 * \Phi(x'\beta) = \Phi(x'\beta) \qquad (2.20)$$

The marginal effects of a continuous independent variable would be:

$$\frac{\partial E(y|x)}{\partial x} = \left\{\frac{d\Phi(x'\beta)}{dx}\right\} * \beta = \Phi(x'\beta) * \beta \qquad (2.21)$$

The marginal effect values will typically vary with the value of x. When we interpret the estimated model, it is useful to calculate this value at the mean of the independent variables. In our particular model, we will calculate the marginal effect at the means of the independent variables.

Since the marginal effect is used to calculate the results of a small change in an independent variable, the formula above would not be useful in calculating the marginal effect for the change in any dummy (binary) variable with a value of 0 or 1. We must adjust the formula in that instance to work with the binary independent variable represented by a:

$$M.E. = P(Y = 1|\bar{x}_a, a = 1) - P(Y = 1|\bar{x}_a, a = 0) \quad (2.22)$$

Where $\bar{x}_a$ denotes the means of all the other variables in the model.

Based on this foundation, data can be collected to help identify the value of GCOOS information and the determinants of that value. The model framework provides a foundation for gauging an individual's decision on whether or support the existing and expanded GCOOS network via some type of dichotomous choice (e.g. referendum). It is expected that several factors could be key determinants of such a decision, but a survey is required collect this information.

CHAPTER 3: SURVEY DESIGN AND IMPLEMENTATION

Subscribers to a commercial ocean monitoring and forecasting service were used as the subpopulation of the aquatic survey (coastal marine vessel survey). As previously stated, the aquatic survey was designed to gather information on a participant's use and preferences of IOOS and valuation of the GCOOS network. This chapter will describe the process of developing and implementing the sub-survey following the suggestions given from the Arrow (1993) NOAA panel and Johnston et al. (2017) in Chapter 2. A summary of the data and results is presented in Chapter 4.

3.1 Survey Design

A draft questionnaire targeting coastal marine vessel owners and users was developed in Spring 2016 following Arrow (1993) techniques. The survey, originally developed in Microsoft Word 2013, was programmed into an identical online survey platform using Qualtrics™ and contained a total of 32 possible questions (Appendix A). After the questionnaire was completed, it was tested among a review panel made up of approximately 75 people with backgrounds in academia, recreational fishing, and people with an extensive knowledge of maritime information. The target audience consisted of users of a third party, IOOS information and data repackaging service known as Roffers Offshore Fishing Forecast Service (ROFFS). This subpopulation contains a wide range of users from private and public sectors engaged in recreational and commercial fishing, marine research, law enforcement, and commerce. In summer

2016, proprietor Mitchell Roffer agreed to send the survey to his entire registry of subscribers.

The survey was divided into three main sections to help gather information and understand background information of the participants.

3.1.1 Descriptive Data

The first part of the survey included basic questions on a respondent's coastal and marine boating history in the last 12 months. These questions were designed to differentiate the more avid boaters from those who might not use GCOOS information as much. This was done so by collecting specific information at the vessel and trip level related to the type and duration of coastal marine activities (e.g. fishing, sailing, research, etc.) and the length of the actual vessel. By providing information on the distance traveled offshore and length of the participant's trips, the data could be used to examine any relationship between boater avidity and the likelihood of supporting the tax. To avoid extreme outliers, limitations were set on the ranges for each individual question that called for a continuous answer at the boating level. By instilling maximum and minimum limits for each question, the amount of outliers presented was significantly less.

3.1.2 Contingent Valuation Scenario

The second part of the survey sought to determine how often the respondents accessed online information from networks like GCOOS. Questions then gauged respondent's use of specific types of ocean monitoring information (e.g. current observations and forecasted conditions) and their preference for general categories of IOOS-based information. The valuation exercise included informative slides displayed to educate the participant on the current extent of the network (Figure 3.1) and the types of information typically provided by GCOOS stations (Figure 3.2) (Mitchell and Carson 1989).

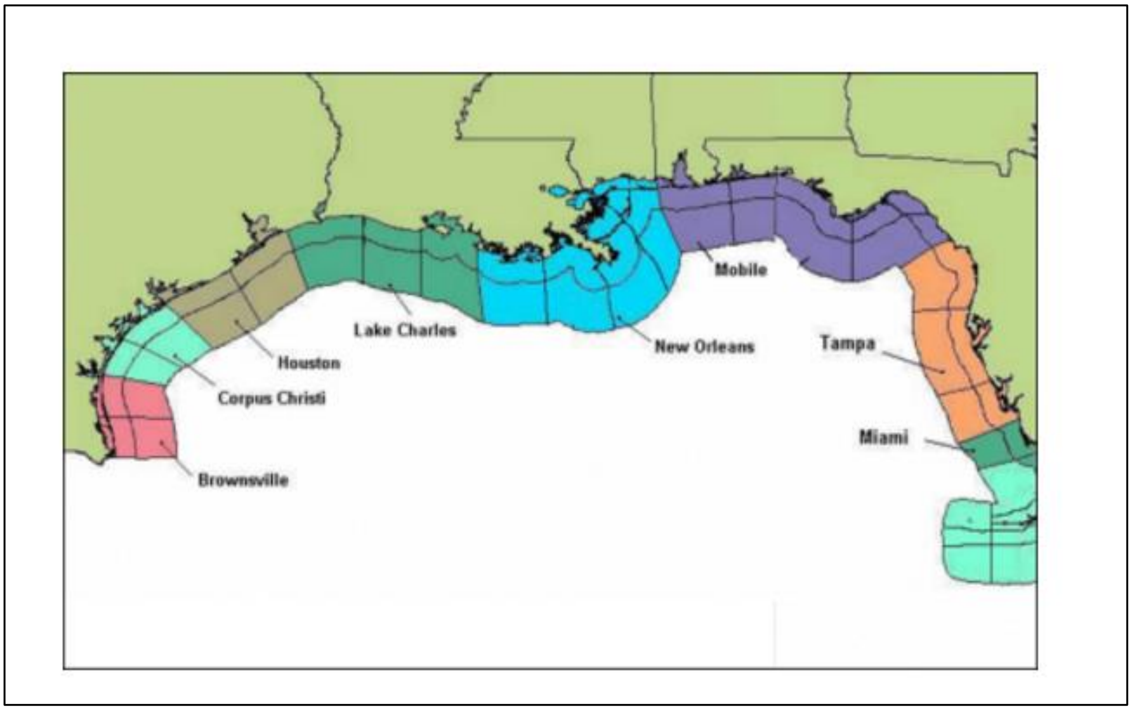


Figure 3.1 Screenshot of NOAA coastal-marine website with forecast zones

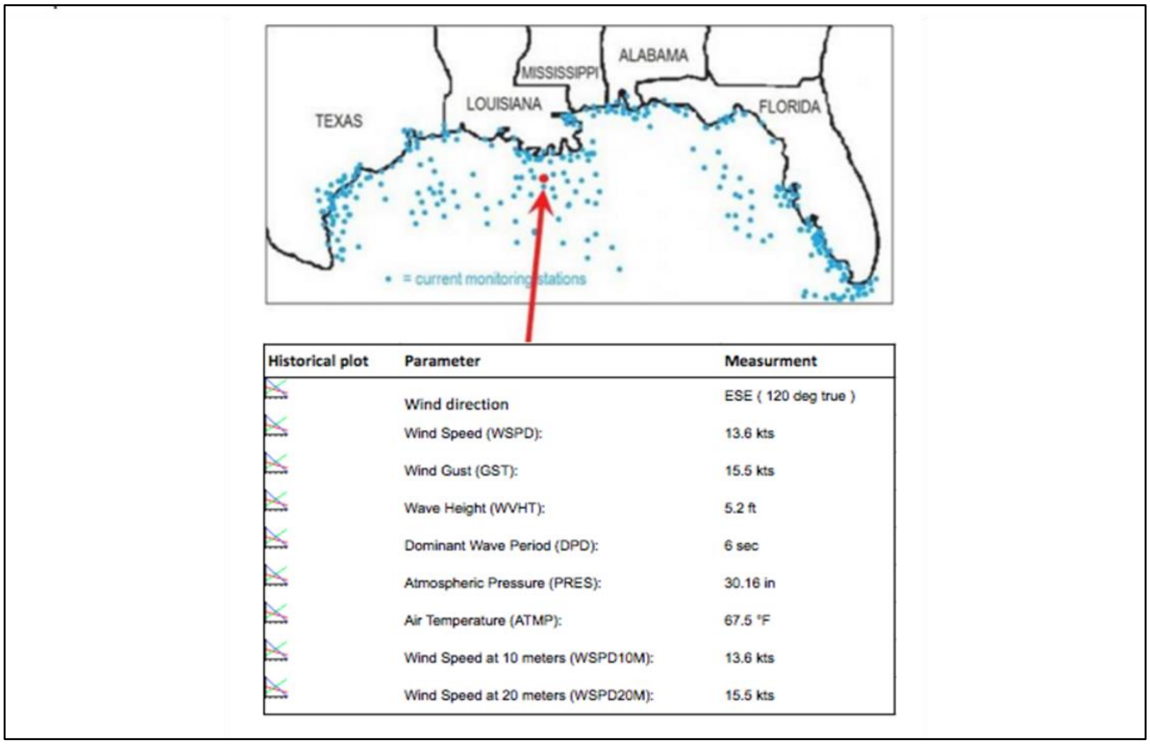


Figure 3.2 Representation of how GCOOS provides data to users

A follow-up scenario is then proposed for hypothetical expansion in which the existing GCOOS infrastructure would be expanded by 40% (Figure 3.3). Following the introduction of the expansion, individuals were asked whether they would be willing to support the proposed expansion via referendum. The question included randomly-assigned amounts of money that would be imposed as an annual sum per household paid via the federal income tax return. This approach is recommended by Johnston et al. (2017) and has been utilized in related studies (Petrolia and Kim 2009; Whitehead 2007; Lazo et al. 2010). Ideally, the range of values used in hypothetical referenda would be obtained from iterative panel testing and previous research. In this case, the range derives from previous experience in CVM studies from the research team (Petrolia and Kim 2009; Whitehead 2007) and beta testing of the survey with 75 respondents. Based on this approach, the possible tax amounts included a onetime $1, $2, $4, $6, and $10 annually (Figure 3.4).

It has been determined that using a binary dependent variable of accepting or rejecting the tax is the preferred construct for CVM. According to Johnston et al. (2017), the use of open-ended questions allows respondents to provide either unrealistically high or zero WTP responses. Moreover, this method is described as being more valid than a Willingness-to-accept (WTA) approach. The authors also assert that WTA responses tend to be higher than WTP due to human nature. People are more likely to ask for more money for compensation than pay to keep something at the status quo. Other models such as the double hurdle model use open ended approaches which values individual's choices to support or not support a proposal separately from the actual valuation (Martinez 2006).

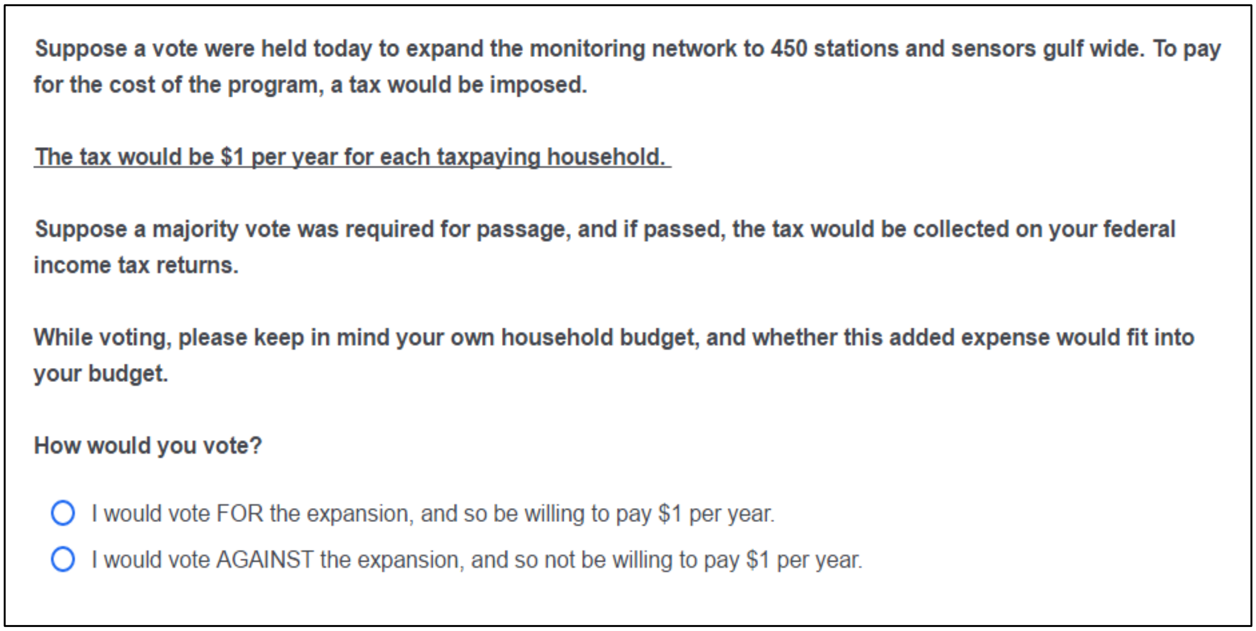
Under current funding, there are 321 stations and sensors monitoring coastal-marine conditions throughout the U.S. Gulf of Mexico. There is a proposal to expand this network by an additional 129 stations, a 40% expansion, for a total 450 stations and sensors Gulf-wide.

While specific benefits of this build-out will vary by location and user need, the expansion has the overall potential for:

- improved accuracy of real-time weather and sea-state observations
- improved accuracy of coastal marine forecasts
- more advanced notification of hazardous weather
- expanded monitoring of atmospheric and water data

This expansion of the network would not be free. It would require additional funds, at taxpayer expense, to purchase the needed monitoring equipment, to hire additional personnel, and maintain the system.

Figure 3.3 Proposed expansion and benefit of buildout



Suppose a vote were held today to expand the monitoring network to 450 stations and sensors gulf wide. To pay for the cost of the program, a tax would be imposed.

The tax would be $1 per year for each taxpaying household.

Suppose a majority vote was required for passage, and if passed, the tax would be collected on your federal income tax returns.

While voting, please keep in mind your own household budget, and whether this added expense would fit into your budget.

How would you vote?

- I would vote FOR the expansion, and so be willing to pay $1 per year.
- I would vote AGAINST the expansion, and so not be willing to pay $1 per year.

Figure 3.4 Example referendum question with one of five randomly assigned tax amounts

3.1.3 Demographic Information

The third and final section of the questionnaire collected basic demographic information on survey participants. These questions included information on the age, gender, ethnicity, income, occupation, and education. These characteristics were collected based on previous research and literature documenting the importance of demographics in decision-making.

3.2 Survey Administration

A draft survey was initially sent to the Louisiana State University Institutional Review Board for approval of the project in 2015, it was determined at that time that the questionnaire would be exempt from the university's Human Subjects Review process (Cadarette 2015). In early August of 2016, a test version of the survey was sent out to a group of 75 participants. Based on the results and feedback from this test, some changes were made and the finalized survey was produced. The survey was sent out as a census to all ROFFS subscribers (n≈18,000) with reminders at two week intervals during the survey period following established survey techniques, an invitation to participate (Roffer 2016; Dillman 2007).

An initial call for participation was sent out via the ROFFS Fishy Times Newsletter™ on September 7, 2016 (Appendix B). This invitation included a brief description of the IOOS and GCOOS networks and provided some insight to the purpose of the survey. It was explained that the survey responses would be used as an early baseline of information in a larger study to be conducted by Louisiana State University in the coming year. Following the informative call for participation, three rounds of direct emails were sent to the subscriber population encouraging them to participate and also providing a link to the survey.

The first round of surveys was posted via direct email to ROFFS subscribers on September 15, 2016 and resulted in a total of 143 responses. A second round of survey reminders was sent out on September 29, 2016 and resulted in an additional 186 respondents. A third and final round was sent out October 13, 2016 with an additional 155 responses collected. The process resulted in a total of 484 respondents, or a response rate of ~ 2% of the estimated subscriber population.

Dillman (2007) provides guidance for minimum sample sizes required for variously sized populations, response expectations, and sampling errors seen in:

$$N_s = \frac{N_p p(1-p)}{\left(N_p - 1\right)(B/C)^2 + p(1-p)} \tag{3.1}$$

Where N_s is the completed sample size needed for the corresponding desired level of error. N_p is the size of the population (≈18,000), B is the acceptable amount of sampling error (we assume 5%), C is the Z-statistic associated with the level of confidence (in this case 1.96), and p is the proportion of population expected to choose one of the two response categories to the valuation question of yes or no, assumed to be 0.5 according to the author. The N_s with this particular set of parameters is 376.

Based on this calculation, the 484 responses obtained are above the 5% margin of sampling error. Table 3.1 is from Dillman (2007) and Salant and Dillman (1994), and lists sample sizes needed to estimate population percentages for various population sizes and their corresponding levels of sampling error. Coded responses from Qualtrics were downloaded initially into Microsoft Excel for data cleaning. Partial responses were salvaged or discarded depending on the level of completeness. The final number of useable responses (n=379) is just above the necessary number of total responses (n=376) as seen below.

Table 3.1 Minimum Sample Sizes for Various Populations, Response Expectations, and Sampling Errors (Dillman 2007)

Sample Size for the 95% confidence level						
Population	± 3% sampling error		± 5% sampling error		± 10% sampling error	
	50/50 split	80/20 split	50/50 split	80/20 split	50/50 split	80/20 split
100	92	87	80	71	49	38
200	169	155	132	111	65	47
600	384	320	234	175	83	56
1,000	517	406	278	198	88	58
4,000	843	584	351	232	94	61
8,000	942	629	367	239	95	61
18,000	1,007	658	376	242	95	61
100,000	1,056	679	383	245	95	61

CHAPTER 4: RESULTS

4.1 Descriptive Analysis

In order to develop a comprehensive economic evaluation of support for the GCOOS buildout, it is necessary to understand the general demographics of the respondents from the survey. As mentioned in Chapter 3, the population of this sub-survey primarily consists of subscribers to a third party data repackaging company that provides enhanced information and services not otherwise available from public IOOS networks.

Table 4.1 shows the general demographics of respondents to the survey. A majority of the respondents were white (95%) male (96%) respondents. When asked about education and income levels, a majority of the respondents indicated they had completed their bachelor's degree or attended some college (70%) and had a household incomes greater than $150,000 per year (55%). Finally, nearly all of the responses collected came from two respondent groups that focus their boating activity in one of two geographic areas - the U.S. Gulf of Mexico (23.6%) and the U.S. Atlantic coast (75.7%). Since such a large portion of responses came from the Atlantic region, corresponding tables and models were divided into three different groups: Aggregate, Atlantic, and Gulf. It was hypothesized that by doing this, differences amongst the three groups might be captured.

Table 4.1 Basic Demographics of Survey Respondents

Respondents Demographics	Count	Percentage
Gender		
Male	366	95.56%
Female	17	4.44%
Ethnicity		
White	357	94.95%
Black or African American	0	0%
American Indian or Alaskan Native	5	1.33%
Other	10	2.66%
Education		
High School or less than High School	32	8.37%
College Degree or Some College	269	70.42%
Post Graduate Degree	81	21.21%
Employment		
Employed full or part time	310	80.31%
Unemployed	3	0.78%
Retired, homemaker, or student	73	18.91%
Income		
< $59,999	33	9.88%
$60,000 - $149,000	122	35.47%
> $150,000	188	54.65%
Location		
Combined	407	100%
Gulf	96	23.59%
Atlantic	308	75.68%

4.1.1 Vessel Level

Previous studies have shown the importance of collecting boater information specifically at the level of a “primary vessel” (Savolainen et al. 2010; Miller and Isaacs

2011; Holland et al. 2012). This convention allows respondents to reply to specific questions about vessel size and length that can be examined as an indicator of a wide range of other factors related to income and risk. In this application, it is hypothesized that vessel characteristics could be an indicator of how participants value and use specific types of coastal and marine data and forecasting for their aquatic activities. Table 4.2 provides a general overview of the respondents boating information for the primary vessel.

Table 4.2 Vessel Characteristics

	Aggregate		Atlantic		Gulf	
	Count	Percentage	Count	Percentage	Count	Percentage
Owner of Boat						
Yes	298	73.9%	212	77.1%	58	63.1%
Length of Boat						
< 25 ft. (1)	74	18.3%	53	19.3%	15	17.4%
26-40 ft. (2)	234	57.8%	166	60.4%	48	52.2%
> 41 ft. (3)	97	23.9%	56	20.3%	28	30.4%
Purpose of Boating						
Recreational fishing	327	81.1%	229	83.3%	70	76.1%
Charter fishing	31	7.7%	21	7.6%	8	8.7%
Commercial fishing	9	2.2%	3	1.1%	5	5.4%
Sailing	2	0.5%	2	0.7%	0	0%
Tourism	9	2.2%	5	1.8%	0	0%
Maritime T&C	1	0.2%	0	0%	1	1.1%
Oil & Gas Service	2	0.5%	1	0.4%	1	1.1%
Research	15	3.7%	10	3.6%	4	4.4%
Other	7	1.7%	4	1.4%	3	3.3%

For all respondents (aggregate), a majority indicated they are the vessel owner (74%). The length of vessels was categorized into three different groups: small, medium, and large, with more than half falling in the medium size category of 26-40 feet (58%). Furthermore, the participants were asked to state their main purpose of being on the vessel with the majority falling into the recreational fishing category (81%).

Results for the other two categories follow similar patterns with the combined group. For the Atlantic and Gulf groups respectively, a majority of the participants were vessel owners (77% and 63%); had vessels that primarily fell into the medium range category (60% and 52%); and said the main purpose of their boating was primarily for recreational fishing (83% and 76%).

4.1.2 Trip Level

Data gathered at the trip level was also collected based on approaches from previous studies. By collecting data on the amount of time spent on the primary vessel and the distances traveled for each trip, respondents could further be categorized into a range of users based on avidity. Table 4.3 provides summary statistics for all of the respondents at the trip level divided into the three different groups. The average range of responses for each of the individual groups stated they were on their primary vessel approximately 41-44 times in the last year. The trips taken had an average length ranging from 10-15 hours which would be considered around a full day on the water. The average maximum amount of time on the water was approximately 30-38 hours which would mean the participants stayed on their boat overnight. The average distance of the trips was around 22-35 miles from shore with the maximum trip distance from shore being around 80-107 miles.

All of the averages were compared to results given in other studies to confirm the avidity claim. According to a survey done by the Fisheries on the United States (2016) the average angler stated he or she took an average of 6.3 to 7.6 trips per year. This is much smaller than the average 41.2 trips per year from this population. Furthermore, data collected from Savolainen et al. (2011) gave an average time of trips at 8.3 hours and a distance of trip at 22.7 miles. These results are also much smaller than those collected from this particular population. Finally, a study done by the US Fisheries and Wildlife Services deemed any person that takes more than 22 trips per year for hunting or fishing purposes was an avid participant.

As stated earlier, vessel length was used to separate responses into three categories: small, medium, and large. Group one is responses from those who indicated a primary vessel under 25 ft., group 2 are vessels ranging from 26-40 ft., and group three is respondents indicating a primary vessel above 40 ft. Generally speaking, larger boats are hypothesized to travel distances further from shore and spend longer periods of time on the water due to larger fuel capacities and greater seaworthiness. Table 4.4 provides the average and maximum distance and time offshore for these three vessel categories. Assumptions about boat size and avidity (average distance and time spent on board) are confirmed. The mean number of times on board, average and maximum time spent on the vessel, and average and maximum distance traveled all increase with vessel size.

Table 4.3 Boating at the Trip Level

	Aggregate		Atlantic		Gulf		Baseline
	Mean (Std. Dev)	Range	Mean (Std. Dev)	Range	Mean (Std. Dev)	Range	Mean
Number of Trips	41.2 (45.09)	0 - 300	41.79 (45.58)	1 - 300	43.33 (46.78)	1 - 270	6.3 -7.6*
Average Length of Trip (hours)	10.54 (15.15)	2 - 200	9.26 (12.69)	2 - 200	15.08 (22.43)	2 - 150	8.3**
Max Length of Trip (hours)	30.12 (30.12)	1 - 200	28.84 (38.06)	2 - 200	38.75 (37.93)	1 - 200	
Average Trip Distance from Shore (miles)	29.51 (24.32)	1 - 150	27.75 (22.10)	1 - 105	35.41 (29.99)	1 - 150	22.7**
Max Trip Distance from Shore (miles)	84.52 (47.17)	1 - 200	80.06 (42.97)	1 - 200	107.12 (54.05)	1 - 200	

* Fisheries of the United States (2016)
**Savolainen et al (2011)
***USFWS Survey (Avid>22 trips per year)

Table 4.4 Vessel Length V. Trip Information

	Vessel 1 (<25') n=74		**Vessel 2 (26-40') n=234**		**Vessel 3 (>40') n=97**	
	Mean (Std. Dev)	Range	Mean (Std. Dev)	Range	Mean (Std. Dev)	Range
Number of Trips	30.16 (36.01)	0 - 225	39.42 (45.12)	3 - 300	53.69 (51.19)	1 - 200
Average Length of Trip (hours)	6.95 (2.39)	2 - 12	8.96 (6.53)	2 - 52	18.25 (30.15)	2 - 200
Max Length of Trip (hours)	16.94 (25.61)	3 - 200	29.47 (34.5)	1 - 200	47.14 (47.37)	2 - 200
Average Trip Distance from Shore (miles)	16.86 (13.94)	1 - 55	27.72 (19.6)	1 - 105	44.33 (33.14)	3 - 150
Max Trip Distance from Shore (miles)	51.09 (40.12)	1 - 200	83.94 (37.44)	3 - 200	121.01 (51.87)	6 - 200

4.1.3 Specific Information Sought

It is important to consider this particular population of avid users who currently pay for services to understand what characteristics they are looking for from networks like IOOS. Figure 4.1 shows different measurements offered by the IOOS networks ranked according to levels of importance as indicated by the frequency respondents chose the characteristic. These data can generally be described as primarily falling into two categories – parameters dealing with conditions related to wind and water. The more basic but necessary characteristics sought were chosen most frequently. These characteristics include data on wind direction and wind speed as well as wave periods, air temperatures, precipitation, visibility, and tidal information. Less commonly utilized information included the more esoteric parameters dealing with currents and water quality measurements.

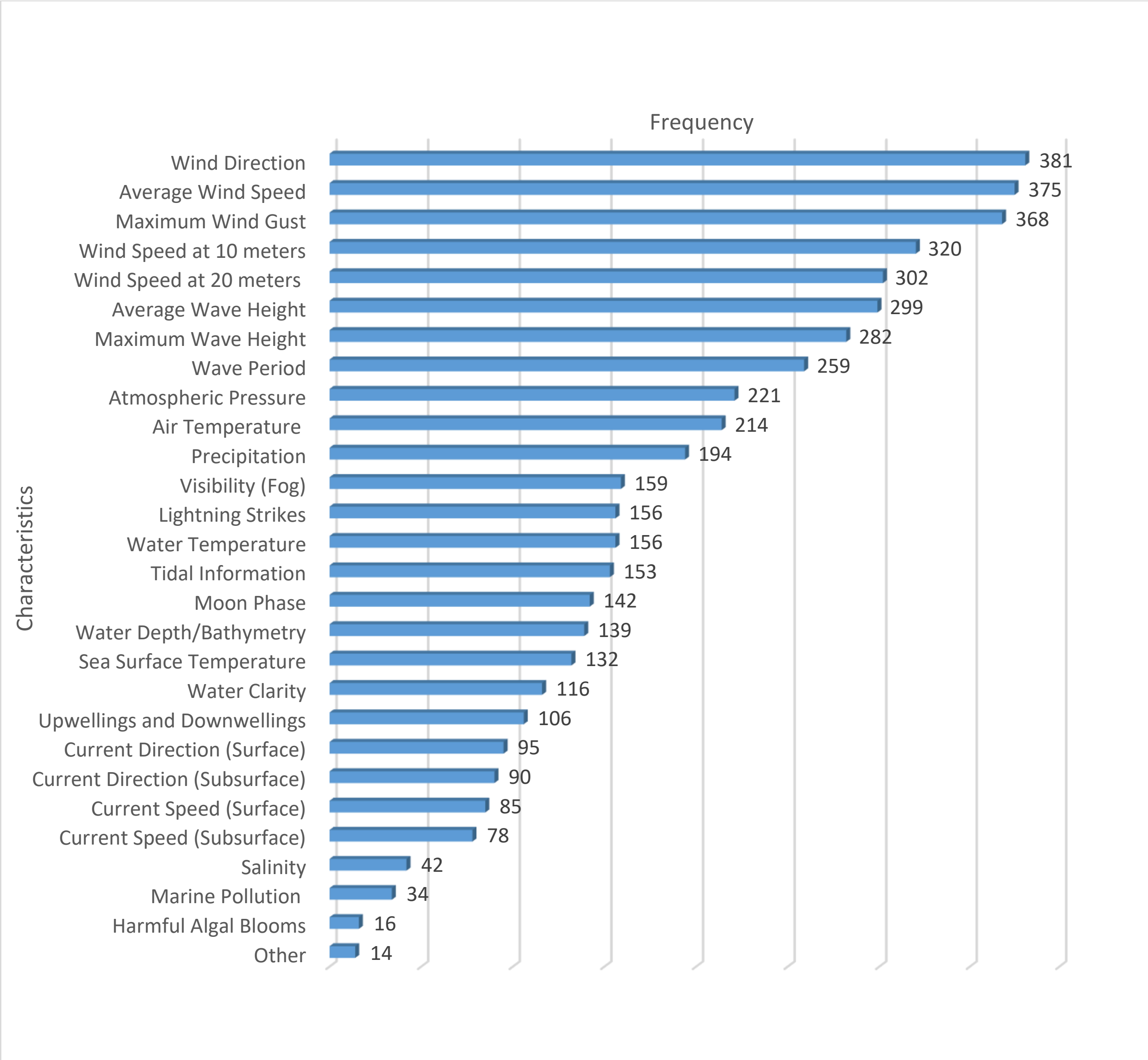


Figure 4.1 Coastal-marine information of importance to respondents

4.1.4 Current Spending on Fee-Based Services

As stated earlier, it is hypothesized that people who pay for maritime information services are more likely to be more avid users of IOOS data. The population utilized in this survey consists primarily of individuals who subscribe to a fee-based service that provides repackaged maritime information. Table 4.5 represents those respondents who currently pay for services and the reasons they are doing so. Nearly three-quarters of the population surveyed claims they pay for aftermarket services provided from companies like ROFFs (73%). The reasons they pay for the services include: access to additional services that might not be offered by IOOS networks, including: access to raw data for research purposes; advanced forecasting; more frequent observations; and customizable analyses. The mean amount of money the participants said they spend on forecasted services is around $252 annually and ranges from $1 - $4,000 a year. The mean and standard deviations of amount of money spent on services increases as the size of the vessel increases from an average $62 spent by owner of smaller boats and an average $335 spent by larger vessel owners.

Table 4.5 Respondents who Currently Pay for Data

	Count	Percentage	
Pay for Service	286	72.77%	
Do not Pay for Service	107	27.23%	
Why they pay for data			
Want additional parameters/observations	118	42.29%	
Access to raw data	70	25.09%	
Advanced modeling and forecasting	182	65.23%	
Customized analysis	167	59.86%	
More frequent observations	120	43.01%	
Other	32	11.47%	
	Mean	Std. Dev	Range ($)
Money Spent on Services			
Small vessel (n=69)	67.94	140.42	1 - 500
Medium vessel (n=216)	173.48	255.45	1 - 2,000
Large vessel (n=84)	335.52	526.71	1 - 4,000
Aggregate	251.54	361.75	1 - 4,000

4.2 Econometric Model

Data from the coastal-marine vessel survey were imported into Stata (v.12) and incorporated into a dichotomous choice model following equations 2.13 through 2.16 based on a random utility framework. The following section provides a description of specific model variables and hypothesized relationships.

4.2.1 Variable Descriptions

<u>Dependent</u>

- *Vote*: Dependent variable indicating if the participant accepted or rejected the proposed tax in the survey. This variable is the dependent variable for three different models based on the groups explained in Section 4.1.
    - *Aggregate*
    - *Atlantic*
    - *Gulf*

<u>Independent</u>

- *Tax*: A continuous variable representing the hypothetical tax values (annual per household). Values randomly assigned as: $1, $2, $4, $6, $10 amounts.

- *Age*: Year of birth, used to examine the effects of age in the model.

- *Income*: A categorical variable representing the income in dollars. *Income* is the overall reference group represented by income < $60,000, *Income2* is categorical variable for income $60,000 < x < $150,000, *Income3* is categorical variable of income above >$150,000.

- *Education*: A categorical variable representing the amount of education. *Education1* is the overall reference group represented by education of high school graduate or less, *Education2* is categorical variable for education of some college, associate degree, or bachelor's degree, *Education3* is categorical variable of education at the graduate level (Master's, Ph.D).

- *Ownership*: A binary variable, 1 if participant owns vessel and 0 if participant does not own the vessel.

- *Vessel***:** A categorical variable representing the size of the primary vessel in feet, where *Vessel1* is the overall reference group represented by vessels at or below

<= 25’, *Vessel2* is a categorical variable for vessels between 25’ < x<= 40’, *Vessel3* is a categorical variable for vessels >= 41’.

- *Trips Before*: A continuous variable representing the number of trips the respondent has taken in the past 12 months.
- *Trips After***:** A continuous variable representing the number of trips the respondent would take if the GCOOS expansion were approved.
- *Proximity:* A continuous representation of the respondent’s distance in miles from the Gulf of Mexico region.
- *Chla*: A binary variable, 1 if participant selected values data on Chlorophyll *a* and 0 if participant does not value that information.
- *Fees*: A dummy variable that represents the relationship between those who spend money on repackaging services and the likelihood of supporting the proposed tax.
- *Hours Before*: A continuous variable representing the average length of trips taken (in hours) during the past 12 months.
- *Hours After*: A continuous variable representing the average length of trips (in hours) the respondent would take if the GCOOS expansion were approved.
- *Miles Before*: A continuous variable representing the average distance of trips taken (in miles) from shore in miles the past 12 months.
- *Miles After*: A continuous variable representing the average distance of trips taken from shore (in miles) the respondent would take if the GCOOS expansion were approved.
- *Fishing*: Binary variable describing whether the purpose of the trip is related to fishing or not.

4.2.2 Expected Relationships

Table 4.7 provides several of the variables used in the model as well as their expected signs based on economic theory, previous literature, and hypothesized relationships. The sign on, *Tax* is expected to be negative based on the law of demand for consumer consumption (Perloff 2009). As price increases, the less likely the participant might be willing to pay the tax. This assertion appears to be supported by visual inspection of the data, in which share of “No” votes increases as the tax increases (Figure 4.2).

Table 4.7 Variable Description and Expected Signs

Variable Abbreviation	Variable Description	
Dependent Variable		
Vote	Accept or Reject the Proposed Referendum	
Independent Variable		Expected Sign
Tax	Continuous Representation of Tax Variable	-
Age	Age of Participant	-
Income1	Income Reference Group	
Income2	$60,000 - $149,999	+/-
Income3	>$150,000	+/-
Education1	Education Reference Group	
Education2	College Degree or Some College	+
Education3	Advanced Degree	+
Ownership	Ownership of Vessel	+
Vessel1	Vessel Size Reference Group	
Vessel2	26-40 Foot	+
Vessel3	>40 Foot	+
Trips Before	Number of Trips Taken Before Referendum	+
Trips After	Number of Trips Taken After Referendum	+
Proximity	Respondents Distance in Miles from Gulf	-
Chla	Requested data about Chlorophyll *a*	+
Fees	Money Spent on Repackaging Information	-
Hours Before	Length of trips before expansion explanation	+/-
Hours After	Length of trips after expansion explanation	+
Miles Before	Distance of trips before expansion explanation	+/-
Miles After	Distance of trips after expansion explanation	+
Fishing	Related to fishing or not related to fishing	+

The next variable, Age, has an expected negative relationship with supporting the tax. Feenberg (1987) shows an examination of the relationship of people’s age and the likeliness of supporting a tax. The authors' results show that as participants age increases, the less likely they are to support taxes.

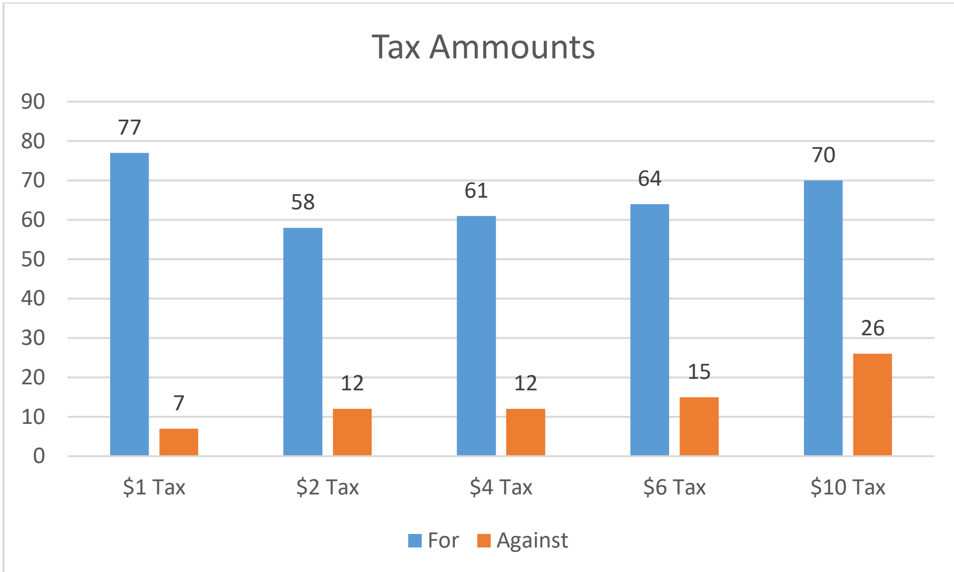


Figure 4.2 Support for GCOOS expansion at various tax levels

The expected sign on vessel length is positive for *Vessel2* and *Vessel3*, which is based on the findings of Savolainen et al. (2010). They found that larger vessels were associated with higher incomes and higher expenditures on input costs like gasoline, maintenance, etc. This leads to the assertion that the larger, more expensive boats might be more inclined to support the tax, given the larger amounts of money already invested by the participant.

In order to capture the effects of the amount of boating being done before and after implementing the expansion, *Trips Before* and *Trips After* variables were added to initial model runs. These variable represent the amount of times the participants said they were on a boat in the past 12 months. However, in order to differentiate the two variables *Trips After* was created from a question that asked if the participant would be more likely to take more trips after gaining knowledge of the tax payment and the expansion of the GCOOS network (see survey in Appendix A). It was hypothesized that those participants who are on their boat more often would be more likely to support the expansion due to the fact that they likely use the network or a similar one already. A similar assumption was made with the ownership variable, which shows if the participant owns the vessel being discussed within in the survey or not. Since these participants likely have more invested in their boating trips, it was believed that they would be more likely to support the tax.

The *Proximity* variable is a continuous representation of the respondent's location in miles from the closest area of Gulf of Mexico waters. This variable is hypothesized to have a negative coefficient. This means that as the respondents distance from the Gulf increases, the likelihood of supporting an expansion of a network in the Gulf will decrease.

The variable *Fees* was expected to have a negative relationship with supporting the tax. It is believed that those participants who currently pay for services similar to those provided by the GCOOS network would be less inclined for an expansion of data that they already pay for. Effects like these are seen in (Ladd 1982). The author states that consumers typically like to see a decrease in taxes, even if they are for personal services, and an increase in personal spending.

Hours Before and *Miles Before* are similar to *Trips Before* and *Trips After* in the sense that they represent the average length of the trips in hours before and after the explanation of the GCOOS expansion within the survey. It is believed that these variable could have a positive or negative relationship. This is based off of the law of diminishing returns (Shephard and Färe 1974). This theory can be applied in the sense that the more time one spends on their vessel, the less return participants might get from services like GCOOS and therefore the less likely they are to support the referendum. It can be hypothesized that those who spend more time on their vessels are more likely to use data information sources like GCOOS. They might possibly find weaknesses from these services and approach third party data services as an alternative. This could in turn be the exact opposite. Since participants are spending more time on their vessel, they might be more likely to support a tax because they use the services more than others. Hours After and Miles After are both listed as positive variables due to the fact that if people are informed of where their offshore data is coming from, they might be more likely to support an expansion of that data source and quantity.

4.3 Model Specifications

When developing the model, variables were chosen using several considerations from statistical and economic methods. In order to ensure the best model fit, the individual variables were tested for potential high correlations amongst each other. If certain variables showed higher correlation between others, then they were flagged and later dropped from the probit model estimaitons. Higher correlation leads to issues with multicollinearity (Blalock 1963). A variance inflation factor test was used to also identify problems with multicollinearity. Both correlation and multicollinearity could affect the explaining power of the variables within the model. Several initial model runs were conducted testing variables with higher correlations one at a time and together to determine the effects of correlation on the model’s overall explanatory power. Once certain variables were determined to be influential, they were retained in the probit model using Stata. Using identifiers such as the log likelihood value, Likelihood Ratio chi^2, and Pseudo R^2, the final model outputs were determined for each of the individual groups mentioned earlier in Chapter 4.

After many initial model iterations, several variables began to stick out. Most of the *After* variables were dropped due to exogenaity and multicolinearity. Income was initially included as a possible variable to see if there was any influence on support for the tax, however, some respondents (7%) refused to disclose income. This decreased the sample size of the model to a level below Dillman (2007) recommendation for an appropriate sample size for a 5% sampling error. Also, economic theory states this variable should fall out the model as seen in equation (equation 2.6). After testing income in initial model runs, it was ultimately removed due to lack of significance. This is consistent with the random utility method that explains the constant marginal utility of income. Vessel size and education were insignificant possibly due to the homogeneity of the population being higher income and highly educated. The final variables chosen for the models were *Tax, Age, Ownership, Trips Before, Proximity, Fees, and Fishing.*

4.3.1 Aggregate Model

Table 4.8 represents the aggregate category of respondents from each geographic area: Atlantic and Gulf.

Table 4.8 Parameter Estimate: Aggregate Data

N=379 LR chi^2 = 15.32 Pseudo R^2 = 0.10

Variable	Coef.	Std. Err.	Marginal Effect
Tax	-0.060***	0.023	-0.013
Age	-0.008	0.007	-0.002
Ownership	-0.408**	0.202	-0.082
Trips Before	-0.007	0.002	-0.001
Proximity	-0.00005	0.0001	-0.002
Fees	0.227	0.182	0.049
Fishing	-0.203	0.322	-0.064
Constant	2.125	0.517	

*p<0.1, **p<0.05, ***p,0.01

The first variable, *Tax*, is a continuous representation of the amount of the referendum as it increases from $1 to $10 from the randomly assigned value in the survey. This variable has a negative coefficient of -0.060 which means as the price of the service increases, respondents are less likely to support the tax. *Tax* also has a p-value of 0.01 which is at the 1% significance level. This result is partially evident in the graphical representation provided in figure 4.2. The *Tax* marginal effects explain that if the amount of the tax increases by one dollar, the probability of the respondent supporting the referendum decreases by 1.3%.

The next variable, *Age* variable was coded as a continuous variable of the respondent's year they were born subtracted from the current year, 2017. It has a coefficient of -0.008 and a p-value of 0.24 which fall outside the 10% level of significance and therefore could be labeled as only insignificant. As the respondents age increases by one year, the probability for the participant to support the referendum decreases by 0.2%.

The *Ownership* variable is a binary representation corresponding to whether the respondent owns the vessel mentioned in the survey or not. The corresponding coefficient was -0.408 and a p-value of 0.044 which falls within the 5% level of significance. The negative coefficient for the variable means that those who own the vessels mentioned in the survey are less likely to support the referendum. While this result is the opposite of the expected relationship for this variable, there are some potential explanations counterintuitive results with this and other avidity-related variables that will be addressed in the following chapter. If the participant owns the vessel discussed in the survey, the probability likelihood of the respondent supporting the tax decreases by approximately 8%.

The variable *Trips Before* is insignificant with p-values of 0.664. As explained earlier, *Trips Before* is a continuous representation of the amount of trips taken by the respondent before the mentioning of the referendum has occurred. The hypothesized sign for this variable was positive; however, the coefficient for *Trips Before* is negative and insignificant. The marginal effect sign for *Trips Before* corresponds to the coefficients in the probit model. For *Trips Before*, as the amount of trips before the knowledge of the GCOOS expansion increases by one trip, the probability of the respondent supporting the tax decreases by 0.1%.

Proximity had a negative coefficient of -0.0000498 and a p-value of 0.726. The hypothesized sign was negative but the variable was highly insignificant. The marginal effect for this variable states that for every mile the distance increases from the GoM waters, the likelihood of supporting the referendum decreases by %0.2.

The final two variables, *Fees* and *Fishing*, were both insignificant. Fees was a binary representation of the respondents who currently spend money on third party repackaging services similar to those the GCOOS network provides. The variable Fishing was also a binary variable that represented those respondents whose main purpose of the offshore trips taken were for fishing purposes. The marginal effects for the last two binary variables have similar explanations. Those participants who currently spend money on forecasting services show a positive probability of supporting the tax as the number of respondents increases. Lastly, if participants said the main purpose of their trips was related to fishing, the probability of those participants supporting the referendum decreases by approximately 6%.

4.3.2 Regional Models

Results from respondents who boat most frequently in the Atlantic Ocean are shown in table 4.9.

Table 4.9 Parameter Estimate: Atlantic Data

N=275 LR chi^2 = 11.58 Pseudo R^2 = 0.05

Variable	Coef.	Std. Err.	Marginal Effect
Tax	-0.057**	0.027	-0.019
Age	-0.0005**	0.0004	-0.004
Ownership	-0.294	0.254	-0.153
Trips Before	-0.005	0.002	-0.001
Proximity	-0.00006	0.0002	-0.002
Fees	0.144	0.216	0.092
Fishing	-0.826	0.518	0.189
Constant	1.09	1.043	

*p<0.1, **p<0.05, ***p<0.01

The explanation of the variables coefficients will be comparable to those from the combined category. The variable *Age* becomes significant at the %5 confidence level with a negative coefficient of -0.0005. The rest of the variables continue to have the same coefficient as the combined category. Marginal effects resembled the marginal effects of the combined category as well.

There were several variations within the model run that looked at the Gulf respondents. Table 4.10 shows the results.

Table 4.10 Parameter Estimate: Gulf Data

N=91 LR chi^2 = 19.20 Pseudo R^2 = 0.20

Variable	Coef.	Std. Err.	Marginal Effect
Tax	-0.106*	0.056	-0.019
Age	-0.016	0.019	-0.004
Ownership	-0.835*	0.497	-0.153
Trips Before	-0.003	0.004	-0.001
Proximity	0.008*	0.004	0.002
Fees	0.506	0.413	0.092
Fishing	1.033*	0.604	0.189
Constant	1.399	1.248	

*p<0.1, **p<0.05 , ***p<0.01

Many of the variables that were not significant in the other model runs turned out to be significant in this particular model. The first variable, *Tax*, continued to be negative and significant meaning the higher the tax price the less likely the respondent would support the tax. *Age* turned out to be insignificant in the Gulf model. *Trips Before* continues to be insignificant with a corresponding negative coefficient. *Ownership* was negatively significant meaning the respondents who own their boat are less likely to support the tax. *Proximity* in the Gulf model was positive and significant. This means that as the distance from the Gulf increases, the likelihood of support for the expansion increases. This is counterintuitive to what was hypothesized earlier. Finally the *Fishing* variable was significant meaning those whose purpose for boating was related to fishing were more likely to support the tax. Marginal effects would have the same signs for the variables except for the change in signs in *Fishing* and *Proximity.* The change in the

Fishing coefficient means that those respondents who said the main purpose of the trip was for fishing would be 19% more likely to support the tax.

4.4 Valuation Estimates

The modeling of key factors influencing preferences for the referendum allows a foundation for a monetized valuation based on survey results. Given the randomly assigned values that participants were offered in the form of an annual tax ($1, $2, 4$, $6, and $10) it is possible to develop a lower, median, and upper bound valuation estimate for the GCOOS expansion. Table 4.11 contains the Aggregated, Atlantic, and Gulf responses at various bids, and indicates a general reduction in the percentage of support for the referendum as bids increased from 1$ (92%) to $10 (73%).

Table 4.11 Levels of Support for $1, $2, $4, $6, $10 Annual Tax

	Bids for expanding the network					
$WTP_{Aggregate}$	$1	$2	$4	$6	$10	Total
Yes	77 (92%)	58 (83%)	61 (84%)	64 (81%)	70 (73%)	330 (82%)

4.4.1 Mean Willingness-to-Pay

For the valuation exercise, the mean willingness-to-pay estimates will be used. The process is outlined in Haab and McConnell (2002). The unbounded probit model mean WTP is defined as:

$$M(WTP) = \frac{\alpha\bar{x}}{\beta} \tag{4.1}$$

Where α is the coefficient of each variable in the model except the bid, $\bar{x}$ is the mean of each variable, and β is the estimated bid coefficient. The coefficients come from table 4.8. The means and coefficients are provided in table 4.11 and were taken from the various tables 4.1 through 4.5 or were calculated as needed. Mean WTP estimations were calculated for all three groups.

4.4.2 The Delta Method

Confidence intervals were calculated using the Delta method, following Bliemer (2013). The first step is to calculate the variance-covariance matrix noted as $V(\beta)$ from the estimated probit model. After calculating the variance-covariance matrix, a Jacobian vector is constructed using the derivation of:

$$\overline{WTP} = \frac{\beta_1\mu_1 + \beta_2\mu_2 + \beta_3\mu_3 + \cdots + \beta_k\mu_k + \beta_0}{\beta_c} \tag{4.2}$$

where $\beta_1, \beta_2, \ldots, \beta_k$ are the coefficients on the supporting covariates, and β_0 is the coefficient on the constant.

From there, the variance of $\overline{WTP}$ is calculated as:

$$Var(\overline{WTP}) = \Delta' V \Delta \tag{4.3}$$

The standard error is then:

$$se(\overline{WTP}) = \sqrt{Var(\overline{WTP})} \tag{4.4}$$

Finally, the confidence intervals, using a 95% confidence and a critical value of $t_{0.975} = 1.96$ is written as:

$$CI(\overline{WTP}) = \overline{WTP} \pm 1.96 * se(\overline{WTP}) \tag{4.5}$$

For the Aggregate unbounded probit model, the mean WTP is $25.29 with a 95% confidence interval between $14.11 and $36.47. For the Atlantic model, the mean WTP was $21.98 with a lower bound valuation of $10.80 and an upper bound of $33.16. For the Gulf model, a mean WTP of $30.82 was calculated which is much higher than the Atlantic. The confidence interval ranges from $19.64 to $42. There are several different populations to which these estimates could be extrapolated. Table 4.12 shows the mean WTP from the Aggregate model estimations with the corresponding populations for three different potential estimations.

Table 4.12 Valuation Estimations of Potential Populations

	Survey Respondents (n = 484)	Survey Population (n = 18,000)	Total Registered Vessel Owners in the GoM (n = 2,352,444)
WTP	$12,240	$455,220	$59,493,308
C.I. WTP	$6,829 - $17,651	$253,980 - $656,460	$33,192,984 - $85,793,632

First, the amount of respondents from the survey, 484, could be used to value the GCOOS expansion. Although the valuation range would be much lower, this is the most accurate representation of the estimate for this particular survey. The mean WTP estimate for this particular survey would be $12,240. The lower end estimation from the confidence interval would be $6,829 and the upper end estimation would be $17,651. To further expand this estimation, the valuation is applied to the entire population of ROFFs subscribers (n=18,000) to which the survey was sent. This population estimation would yield a mean WTP of $455,220. The lower bound estimation for this population would be $253,980 with the upper bound estimation of $656,460. This estimation is much higher than the estimation from the actual respondents but would still not exceed cost of the actual expansion of the GCOOS network. A final valuation is derived using the entire population of registered vessel owners in the five states of the Northern U.S. GoM (Texas, Louisiana, Mississippi, Alabama, and Florida). With a population of approximately 2.35 million registered vessels, the mean WTP estimation would be $59,493,308 with the confidence interval ranging from $33,192,984 - $85,793,632 respectively.

Developing these alternative valuations allows for comparisons with future versions of this survey with larger populations. As previously stated, this questionnaire was developed as a preliminary version of a larger survey to be carried out with registered vessel owners. Baseline data from this nested survey could prove useful in understanding differences in how more general and avid users express preferences and valuations for maritime information.

CHAPTER 5: SUMMARY, CONCLUSION, AND LIMITATIONS

5.1 Summary and Conclusions

This study was prompted by a need to estimate the value of a publically-funded information network. Integrated Ocean Observing Systems (IOOS) are the regional infrastructures of stations and sensors that collect and disseminate maritime weather and sea-state data in U.S. coastal and marine waters. These systems are developed and maintained primarily by government and academic institutions operating at taxpayer expense. These institutions are currently advocating for an expansion of the Gulf Coast version of this network (GCOOS) budgeted at $35 million for capital equipment and $33 million annually for maintenance (GCOOS 2014). As with any public expenditure, it is important to examine the costs of the project against the estimated benefits to be derived. While costs are relatively easy to estimate, the benefits of such expenditures can be more difficult to quantify. Measuring these benefits requires some understanding of how users access the information for decision-making.

Studies of terrestrial (beach-based access) and aquatic (vessel-based access) information users are currently underway in an attempt to gauge preferences for the existing IOOS network and to estimate monetized benefits of the proposed GCCOS expansion. Each of these studies rely on representative sampling amongst large populations numbering in the millions. Demand for esoteric data; however, is likely to be concentrated amongst specific subpopulations of information users. Preferences for coastal and marine information could be substantially different between avid users and broader populations. With that potential difference in mind, this project was initiated as a precursor and ultimate parallel to the upcoming vessel survey. The objectives of this project were: to develop an aquatic vessel survey of preferences for integrated ocean observing system (IOOS) data and monitoring; to implement that survey within a sub population of avid IOOS users; and, to gauge specific preferences and welfare estimates for a GCOOS build out.

An extensive literature review was undertaken to characterize the extent to which previous research has delved into the topic of information valuation. This review uncovered a number of studies that could be generally categorized as information-valuation, but relatively few that addressed the value of complete information systems. Even fewer studies have attempted to quantify the value of ocean observing systems, and most of those studies lack specific linkages to user preferences. After comparing numerous methodological options for accomplishing the overall goal, it was determined that contingent valuation (CVM) would be the most suitable approach for the proposed study. While CVM does have shortcomings, it offers the most direct approach for linking and monetizing individual preferences to non-market amenities. Similar to previous CVM applications with ecosystem services, an econometric approach was developed in which random utility theory provided the theoretical basis for a probit-model based statistical assessment of GCOOS support and valuation.

Following recommendations provided by the NOAA Blue Ribbon panel (Arrow 1993), a CVM-based survey was developed and implemented with a population of subscribers to a third party information repackaging company: Roffer’s Ocean Fishing Forecasting Service (ROFFs). After gathering baseline information about the participants boating history in the past year, the survey presented a referendum-based exercise to determine whether a given respondent would be willing to support the expansion of the GCOOS network in the form of a tax. The tax was presented as an annual payment of either $1, $2, $4, $6 or $10 per household, and randomly assigned to each participant participating in the survey. Additional data on the primary vessel, trip characteristics, and demographics were also collected to provide a broader depiction of avidity, information use, and socioeconomic status. The survey was implemented as a census to all ROFFs newsletter subscribers (N=18,000), offered via a series of newsletter solicitations from August to October 2016. A total of 484 individuals responded to the survey, or about 2.5% of the known population. Data from the 44 question survey were exported into Microsoft Excel 2013 and cleaned for consistency, yielding a total of 405 useable responses for initial model runs in Stata version 12.

Descriptive statistics were developed to examine basic characteristics of respondent demographics, location, activity, and information use. The majority of respondents identified themselves as white males (95%), having some level of college education (70%) and a household income greater than $150,000 a year (55%). Respondents generally hailed from one of two geographic locations, the U.S. Atlantic region (76%) and the Gulf of Mexico region (24%). The geographic location of respondents; however, appeared to produce little to no differences in response for most activity questions, with a majority of respondents stating they were the owners of a primary vessel (74%) of 26-40 feet in length (58%), with the main purpose of trips taken being recreational fishing (81%). Activity levels were assessed by examining means and standard deviations for the number of trips taken in the past year, the average and maximum length of the trips in hours, and the average and maximum distance from shore. The small and medium vessel size categories, groups 1 (<25') and group 2 (26'-40'), had similar results for number of times onboard (30-39 trips) and time on board (7-9 hours per trip), respectively. Medium sized vessels (group 2); however, ventured an average of 28 miles offshore per trip, nearly twice the distance of the smaller vessels. Moreover, approximately one quarter of respondents (24%) indicated they had utilized the largest category of vessels (>40'). These respondents reported taking an average of 54 trips in the past 12 months averaging 18 hours at an average distance of a distance of 44 miles offshore. On the surface, these observations appear to support assumptions about the relationship between vessel size and avidity, in that number of times on board, average and maximum time spent on the vessel, and average and maximum distance traveled all tended to increase with vessel size.

The type of information demanded from IOOS systems was found to be predominantly related to current and forecasted sea state conditions important for safe navigation. Amongst 28 possible IOOS parameters, those dealing with wind and water were the most frequently selected as important for trip-level decision making (60-90% preferred). On the opposite end of the spectrum, those data dealing with water quality were far less preferred – with lower degrees of importance indicated for parameters such as harmful algal blooms (4%) and marine pollution (8%). Given the population frame queried (ROFFs subscribers), it was not surprising that nearly three quarters (73%) of respondents indicated that they subscribe to one or more fee-based services - primarily for the purposes of advanced modeling (65%) and customized analyses (60%). These individuals reported paying an average of $251 annually, with even higher averages for respondents using large category vessels ($336).

Given incomplete responses and non-mandatory survey questions, applications of the probit model were limited to smaller numbers of useable observations. Three applications were developed, an Aggregate model (n=379), one consisting of only Atlantic respondents (n=275), and one for Gulf respondents (n=91). A majority of respondents in the Aggregate model (74%) indicated support for the referendum. Consistent with economic theory, the dollar amount of the *Tax* was significant and negatively associated with referendum support. This effect held true in all three models. The Atlantic dataset also depicted a significant and negative relationship with year of birth, consistent with prior expectations and previous research (Feenberg 1987). Specifically, as *Age* increases, an Atlantic respondent is less likely to support the referendum.

One of the key questions of this research was the effect of respondent avidity on support for investments in maritime data collection and dissemination. The assertion was that those individuals who are more active and more invested in maritime activity would tend to exhibit greater support for GCOOS expansion. This avidity effect proved to be either insignificant or contrary to pre-survey expectations. Avidity variables were developed based on proxies utilized in earlier studies, including size of the primary vessel, number of times onboard, average hours onboard, average length of trips, and whether or not the respondent was the owner of the primary vessel. In most models and through numerous iterations, vessel size, distance traveled, hours per trip, and ownership proved to be insignificant predictors of referendum outcome. Although it was hypothesized that more frequent trips would be associated with a higher level of dependence on the GCOOS network, the opposite proved true. One possible explanation for this result is the existence of the secondary market for maritime information repackaging. Indeed, the queried population were all subscribers to a maritime information repackaging service (ROFFs), and nearly three quarters of respondents (73%) reported paying additional *Fees* for more specialized analysis and services. While it could be possible that the effect of these payments may be negating the need for a public expansion, another factor might also be at work – namely, the proximity of respondents to the buildout.

It is important to note that, while the survey covered general preferences for IOOS nationwide, the actual valuation question centered on the expansion of infrastructure in Gulf of Mexico region only. Accordingly, the Gulf model revealed slightly different results in that *Proximity* and *Fishing* emerged as significant variables with positive relationships to the referendum. In short, the Gulf respondents whose main purpose of their trips was for *Fishing* were more likely to support the referendum. Recall that the majority of survey respondents (81%) were recreational anglers, so it is logical that Gulf fishermen would be more likely to support expansion of an information network that services their fishing areas and provides basic sea state data that underpins their use of more advanced services. *Proximity* showed a positive significant relationship with the tax variable. This means that those respondents who were further from the Gulf were more likely to support the referendum which is counterintuitive to what was hypothesized. This result indicates that proximity effects could be a stronger predictor than avidity factors when it comes to a given respondent’s WTP for information.

Mean WTP estimations were calculated to produce monetary values on the expansion of the network. The mean WTP estimation was $25.29 per household annually, which is skewed higher than the actual tax ranges provided in the survey because of the large majority support for the referendum (82%). A critical value range of higher and lower valuations was calculated using the Delta method. The WTP confidence interval estimations ranged between $14.11 and $36.47. With these estimates calculated, the overall valuation of the network expansion was conducted using three different possible populations. The first valuation was extrapolated from the 484 respondents that participated in the survey. This extrapolation would put the value of the GCOOS expansion at $12,240 annually. An expanded estimation extends these results to the population of 18,000 ROFFs subscribers. By multiplying the mean WTP by this population, the estimated value of the network expansion would be $455,220 annually. Although this number is nowhere near the estimated cost of GCOOS expansion, it is arguably the more defensible calculation from this particular study. A final extrapolation extends the results to every vessel owner in the Gulf region. Applying the mean WTP to the estimated 2.3 million registered vessel owners (Table 1.1) produces an aggregate annual welfare estimate of $59,493,308. This amount, while greater than the annual maintenance cost for the GCOOS buildout, should be interpreted with caution. At best, this value should be seen as an extreme upper-bound valuation until the results of the broader vessel survey emerge. Any differences in preferences and values between ROFFs subscribes and Gulf vessel owners is still unknown. It is likely that these differences will be influenced by demographics, avidity, and proximity.

5.2 Limitations and Additional Research

Throughout the process of this study, several limitations were discovered that should be acknowledged as limitations and/or areas of future research. First and foremost, it is important to note that interpretation and extension of the results from this particular survey are limited by the relatively small, nested population queried. By choosing a sample from one particular third party repackaging service, the conclusions can't be credibly expanded beyond that population without substantial caveats. In order to provide more diversity of IOOS users, it would be beneficial to survey subscribers to additional repackaging services to see if the results are consistent among different groups. Ultimately, the merit of this particular study lies in its role as a precursor and parallel to the larger vessel survey to be conducted later this year. The results from this study are not the best representation of the total populations of vessel owners, but should provide a strong added level of analysis for comparison among the two groups.

Little progress has been achieved in research methods for the monetization of public, non-market information. Studies conducted prior to this one have used methods such as simulation models and benefit-cost analyses that produced unreasonable results based off simple extrapolations. When deriving the demand for non-market intangible goods such as information, it is important to consider the underlying benefits that represent the true value of these systems. In the case of IOOS the only published report of monetized valuation was based on a sensitivity analysis in which small (1-2%) changes were extrapolated to reflect the aggregate value of the information to reliant commercial sectors.

Given the non-market nature of raw data produced by these networks, CVM represents a viable, though not a perfect approach. While the method has been used extensively for ecosystem service valuation, there are only a few applications of CVM for valuing information. Critics of CVM typically point to inconsistency between WTP and willingness-to-accept (WTA) estimates for the same good or service. While revealed preferences models such as hedonic or travel cost pose viable alternatives in ecosystem service valuation, they fall short mechanically when it comes to valuing web-based information. This led to the decision to apply CVM to this particular study following the best practice techniques given by the NOAA Blue Ribbon Panel and Johnston et al. (2017) to help address common issues such as hypothetical bias, embeddedness, and scope.

After implementing the survey to the small, specialized population of avid users (n = 18,000), a response rate of only 2.4% was obtained. This response rate is much smaller than expected. On top of that, a majority of the respondents hailed from the Atlantic basin, which likely introduces a geographic bias in the combined model. According to Dillman (2007) the 405 usable responses (and 379 for the combined probit) are within the acceptable sampling error of 5% for a population of this size.

One additional economic model identified during the course of this study pertains to the secondary market for IOOS data. A large portion (73%) of survey respondents indicated that they currently pay for third party data repackaging services. A preliminary regression conducted on these fees as a function of various explanatory variables indicates stronger and more intuitive relationships between demographic and avidity. While full assessment of these effects is beyond the scope of this thesis, additional analysis is warranted and could provide insight on the demand drivers of this secondary marketplace for IOOS-based information and services.

Finally, it is worth reiterating that the survey conducted through this thesis is one of three ongoing efforts to estimate preferences for IOOS data and to conduct valuations of the proposed expansion of the GCOOS network. Thus, the contributions of this project cannot be fully realized until the completion of the parallel surveys of registered vessel owners (aquatic survey) and beachgoers (terrestrial survey) in the GoM region. The aggregate valuation from these surveys will ultimately compared to the proposed budget for GCOOS expansion to help inform a build out decision with an estimated cost of $35 million in infrastructure and $33 million annually for maintenance. Estimating monetary benefits; however, are only part of the information these surveys will provide. Characterizing voter preference and political will is also a contribution of this work. If the referendum broader aquatic or terrestrial surveys were to fail (less than under 50% support), aggregate valuations could still be estimated – and might even exceed the projected costs of the build out - but some question would remain as to the political validity of moving forward in the face of a failed, albeit simulated referendum. Conversely, additional questions would emerge if the simulated referendums pass and yet the aggregate valuations from the aquatic and terrestrial surveys fail to produce valuations in excess of the estimated project cost. Ultimately, the resolution of these outcomes is beyond the scope of this thesis. As is true for any economic research project, the results of this research should be considered simply as inputs to the broader decision-making process.

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APPENDIX: SURVEY

A Survey of Preferences for
Information on Coastal-Marine Boating

Thank you very much for taking part in this survey. We would like to learn about your preferences for information and data on weather and sea-state conditions affecting coastal-marine boating operations in state and federal waters of the United States.

This survey is being conducted by the Louisiana State University Center for Natural Resource Economics and Policy and Mississippi State University, in partnership with the Gulf of Mexico Sea Grant programs and the Northern Gulf Institute.

Your input in today's survey will help guide the agencies involved in managing Integrated Ocean Observing Systems (IOOS) at the local, state, and federal level.

Your participation is voluntary and all responses will remain anonymous. Information from the questionnaire will be released as summaries only, in which an individual's answers cannot be identified.

Please **DO NOT** forward this link. A follow-up survey will be sent out to a broader population in the coming months.

This study was exempted by the Institutional Review Board at Louisiana State University:
130 David Boyd Hall, Baton Rouge, LA 70803, (225) 578-8692, irb@lsu.edu, www.lsu.edu/irb

The survey should take 10-15 minutes to complete, depending on your level of response.

We appreciate your time and help in this important study.

Questions? Please call (225) 578-2393 or email rcaffey@.lsu.edu for assistance.

When taking the survey, if you want to return to a previous page, please use the Back button found below the questions, NOT the Back button on your browser.

To start, we'd like to know more about your experience with boating in coastal–marine waters of the U.S.

During the past 12 months, have you been on a boat (vessel) of any size operated in the coastal–marine waters (state and federal) of the United States?
(Note: "Coastal-marine" pertains to saltwater boating operations – including trips to inshore or nearshore state waters or federal waters up to 200 miles offshore. It does not include trips taken on bodies of freshwater).

- Yes
- No

How many times were you on-board a vessel operated in coastal-marine waters during the past 12 months?

0 Times

In what region did your coastal-marine boating occur the *most* during the past 12 months?

- Atlantic Ocean
- Gulf of Mexico
- Pacific Ocean

Please indicate the average and maximum length of trips taken on coastal-marine waters the past 12 months.

(Note: A "trip" is any instance of traveling on a vessel, in the past 12 months. For multi-day trips, 1 day = 24 hours)

0 Average trip length (hours)

0 Maximum trip length (hours)

Please indicate the average and maximum distance from shore for trips taken on coastal-marine waters in the past 12 months.

(Note: "shore" is your point of departure from land, and could be a boat launch, dock, marina, etc.)

0 Average distance from shore (miles)

0 Maximum distance from shore (miles)

Please estimate the length of the "primary vessel" that you were on the most during this period?

(Note: the *primary vessel* is the one boat that you were on *most* of the time)

- <20 Feet
- 20-25 Feet
- 26-30 Feet
- 31-35 Feet
- 36-40 Feet
- 41-50 Feet
- 51-60 Feet
- 61-70 Feet
- 71-80 Feet
- 81-90 Feet
- 91-100 Feet
- >100 Feet

Are you the owner of the primary vessel mentioned above?

- Yes
- No

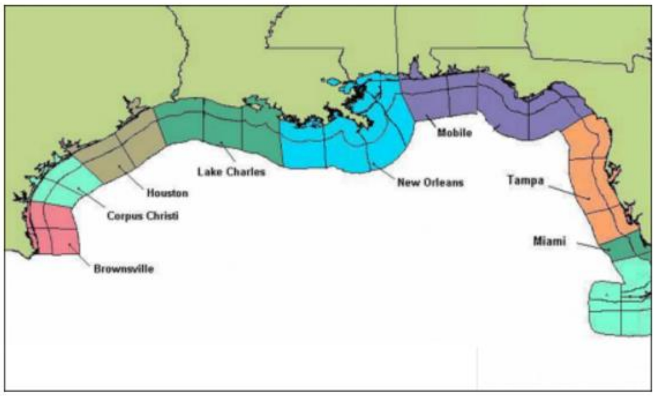
Please choose the <u>one</u> category that best describes your purpose for being on the primary vessel in coastal-marine waters during the past 12 months:

- ○ Recreational fishing
- ○ Charter boat captain
- ○ Commercial fishing
- ○ Hunting
- ○ Sailing
- ○ Tourism (diving, sightseeing, etc.)
- ○ Maritime transportation and commerce
- ○ Offshore Service Industry
- ○ Oil and Gas exploration and production
- ○ Research, Management, Monitoring
- ○ Law Enforcement
- ○ Other (please specify)

In this section, we'd like to get your preferences for specific types of coastal-marine observations and forecasts. Please read the brief overview before answering the questions.

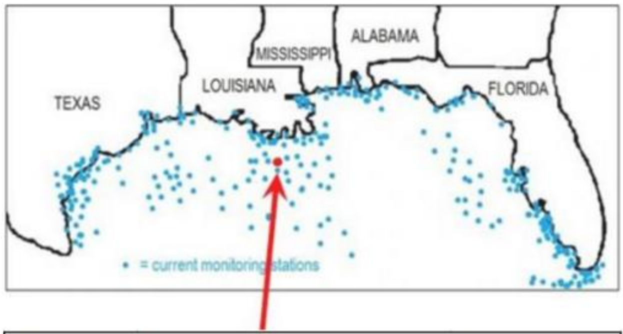
There are many factors that can affect a boating trip, such as wind speed, wave height, tides, and temperature. In some cases, a vessel operator or vessel passenger may know only *some* of these before arriving, such as temperature.

Currently, there are numerous websites that utilize public and private data to measure and predict current and forecasted conditions in coastal-marine waters. For example, below is a screen-shot of a NOAA coastal-marine website that provides forecasts for nearshore waters (0-20 miles) and offshore waters (20-60 miles) for the US. Gulf of Mexico.



These coastal-marine forecasts are informed by a network of satellites, buoys, and other monitoring equipment.

The image below provides one depiction of this network and an example of the type of data available through the National Data Buoy Center. More detailed versions of these data are available via websites maintained by the private sector.



Historical plot	Parameter	Measurment
	Wind direction	ESE (120 deg true)
	Wind Speed (WSPD):	13.6 kts
	Wind Gust (GST):	15.5 kts
	Wave Height (WVHT):	5.2 ft
	Dominant Wave Period (DPD):	6 sec
	Atmospheric Pressure (PRES):	30.16 in
	Air Temperature (ATMP):	67.5 °F
	Wind Speed at 10 meters (WSPD10M):	13.6 kts
	Wind Speed at 20 meters (WSPD20M):	15.5 kts

In the past 12 months, how often have you accessed *online* information to check conditions of coastal-marine waters?

- Daily
- Weekly
- Monthly
- Never

What type of coastal-marine information (current conditions or forecasted) is most important to you when planning a trip on the water? (Check all that apply.)

- [ ] Wind Direction
- [ ] Average Wind Speed
- [ ] Maximum Wind Gust
- [ ] Wind Speed at 10 meters
- [ ] Wind Speed at 20 meters
- [ ] Average Wave Height
- [ ] Maximum Wave Height
- [ ] Wave Period (time between waves)
- [ ] Atmospheric Pressure
- [ ] Air Temperature
- [ ] Precipitation (Rain)
- [ ] Visibility (Fog)
- [ ] Lighting Strikes
- [ ] Water Temperature (Degrees)
- [ ] Tidal Information
- [ ] Moon Phase
- [ ] Water Depth/Bathymetry
- [ ] Sea Surface Temperature (Satellite imagery: Color maps)
- [ ] Water Clarity/Water Color (Satellite imagery: Chlorophyll a)
- [ ] Upwellings and Downwellings (Satellite imagery: Altimetry)
- [ ] Current Direction (Surface)
- [ ] Current Direction (Subsurface)
- [ ] Current Speed (Surface)
- [ ] Current Speed (Subsurface)
- [ ] Salinity
- [ ] Marine Pollution
- [ ] Harmful Algal Blooms
- [ ] Other (please specify)

The next section includes a valuation exercise designed to gauge your willingness to pay for an expansion of the ocean observing system in the U.S. Gulf of Mexico. This portion of the survey is open to all respondents, regardless of your location. Please read the brief introductory summary before answering the questions.

Under current funding, there are 321 stations and sensors monitoring coastal-marine conditions throughout the U.S. Gulf of Mexico. There is a proposal to expand this network by an additional 129 stations, a 40% expansion, for a total 450 stations and sensors Gulf-wide.

While specific benefits of this build-out will vary by location and user need, the expansion has the overall potential for:

- improved accuracy of real-time weather and sea-state observations
- improved accuracy of coastal marine forecasts
- more advanced notification of hazardous weather
- expanded monitoring of atmospheric and water data

This expansion of the network would not be free. It would require additional funds, at taxpayer expense, to purchase the needed monitoring equipment, to hire additional personnel, and maintain the system.

Suppose a vote were held today to expand the monitoring network to 450 stations and sensors gulf wide. To pay for the cost of the program, a tax would be imposed.

The tax would be $1 per year for each taxpaying household.

Suppose a majority vote was required for passage, and if passed, the tax would be collected on your federal income tax returns.

While voting, please keep in mind your own household budget, and whether this added expense would fit into your budget.

How would you vote?

- ○ I would vote FOR the expansion, and so be willing to pay $1 per year.
- ○ I would vote AGAINST the expansion, and so not be willing to pay $1 per year.

Suppose a vote were held today to expand the monitoring network to 450 stations and sensors gulf wide. To pay for the cost of the program, a tax would be imposed.

<u>The tax would be $2 per year for each taxpaying household.</u>

Suppose a majority vote was required for passage, and if passed, the tax would be collected on your federal income tax returns.

While voting, please keep in mind your own household budget, and whether this added expense would fit into your budget.

How would you vote?

- ○ I would vote FOR the expansion, and so be willing to pay $2 per year.
- ○ I would vote AGAINST the expansion, and so not be willing to pay $2 per year.

Suppose a vote were held today to expand the monitoring network to 450 stations and sensors gulf wide. To pay for the cost of the program, a tax would be imposed.

<u>The tax would be $4 per year for each taxpaying household.</u>

Suppose a majority vote was required for passage, and if passed, the tax would be collected on your federal income tax returns.

While voting, please keep in mind your own household budget, and whether this added expense would fit into your budget.

How would you vote?

- ○ I would vote FOR the expansion, and so be willing to pay $4 per year.
- ○ I would vote AGAINST the expansion, and so not be willing to pay $4 per year.

Suppose a vote were held today to expand the monitoring network to 450 stations and sensors gulf wide. To pay for the cost of the program, a tax would be imposed.

<u>The tax would be $6 per year for each taxpaying household.</u>

Suppose a majority vote was required for passage, and if passed, the tax would be collected on your federal income tax returns.

While voting, please keep in mind your own household budget, and whether this added expense would fit into your budget.

How would you vote?

- ○ I would vote FOR the expansion, and so be willing to pay $6 per year.
- ○ I would vote AGAINST the expansion, and so not be willing to pay $6 per year.

Suppose a vote were held today to expand the monitoring network to 450 stations and sensors gulf wide. To pay for the cost of the program, a tax would be imposed.

<u>The tax would be $10 per year for each taxpaying household.</u>

Suppose a majority vote was required for passage, and if passed, the tax would be collected on your federal income tax returns.

While voting, please keep in mind your own household budget, and whether this added expense would fit into your budget.

How would you vote?

- ○ I would vote FOR the expansion, and so be willing to pay $10 per year.
- ○ I would vote AGAINST the expansion, and so not be willing to pay $10 per year.

Please indicate the reason(s) for how you voted (Choose all that apply).

- ☐ I am satisfied with the current level of coverage.
- ☐ I was not provided sufficient details about the benefits promised by the expansion.
- ☐ I believe the tax was too high.
- ☐ I am opposed to any new taxes regardless of what the benefits may be.
- ☐ Other (please specify)

Regardless of how you voted in the previous question, how would your answers to the questions below change if the network expansion were approved?

Question:	Your previous answer:
Annual number of trips	${q://QID45/ChoiceNumericEntryValue/3} trips
Average length of trip	${q://QID116/ChoiceNumericEntryValue/1} hours
Average distance from shore	${q://QID127/ChoiceNumericEntryValue/1} miles

0 Annual number of trips (after expansion)

0 Average length of trip (after expansion)

0 Average distance from shore (after expansion)

In the past 12 months, have you subscribed to one or more web services to obtain additional information on coastal and marine based observations and forecasting?

- ○ Yes
- ○ No

In the past 12 months, how much have you spent on web services to obtain additional information on coastal and marine based observations and forecasting?

0 $

What type of additional information are you seeking from the web-based services that you subscribed to?

- ☐ Additional metrics not available elsewhere
- ☐ More frequent observations
- ☐ Access to raw data
- ☐ Advanced modeling and forecasting
- ☐ Customized analyses
- ☐ Other (please specify)

Please tell us your 5-digit zip code (for example, 70803). Note: If you are outside the U.S., please enter "00000"

Have you heard of the following organizations / agencies before today?

	Yes	No	Not Sure
National Oceanic and Atmospheric Administration (NOAA)	○	○	○
National Weather Service (NWS)	○	○	○
Integrated Ocean Observing System (IOOS)	○	○	○
Gulf of Mexico Coastal Ocean Observing System (GCOOS)	○	○	○
National Data Buoy Center (NDBC)	○	○	○

Did you or someone in your household file a federal and/or state tax return last year? (Check all that apply.)

- ☐ Federal
- ☐ State

What is your current employment status?

- Employed full-time
- Employed part-time
- Retired
- Homemaker
- Student
- Unemployed

In what sector do you currently work?

- Public sector
- Private sector

In what field of the public sector do you currently work?

- Armed Forces
- Education / Academia
- Local, state, or federal government
- Other (Please specify)

In what field of the private sector do you currently work?

- Agriculture
- Commercial and recreational fishing
- Construction
- Healthcare
- Maritime transportation and commerce
- Offshore service industry
- Oil and gas exploration and production
- Tourism
- Other (Please specify)

How many people currently live in your household (including you)?

Adults (18 years and older)	0
Children (under 18 years old)	0
Total	0

What is your gender? (Please select one)

- Male
- Female

In what year were you born?

What is your highest level of education? (Please select one)

- Less than high school
- High school graduate
- Some college
- Associate degree
- Bachelor degree
- Master's Degree
- Doctorate
- Professional degree

Please indicate the ethnicity below that best describes you.

- White
- Black or African American
- American Indian or Alaska Native
- Asian
- Native Hawaiian or Pacific Islander
- Other

Do you own or rent your home?

- Own
- Rent
- Other (please specify)

Which of the following describes your current residence?

- A single-family house
- A mobile home/trailer
- An apartment/condo/townhome
- Other (please specify)

What was your total household income in 2015 before taxes? (Please select one)

- Less than $10,000
- $10,000 - $19,999
- $20,000 - $29,999
- $30,000 - $39,999
- $40,000 - $49,999
- $50,000 - $59,999
- $60,000 - $69,999
- $70,000 - $79,999
- $80,000 - $89,999
- $90,000 - $99,999
- $100,000 - $149,999
- $150,000 - $199,999
- More than $200,000

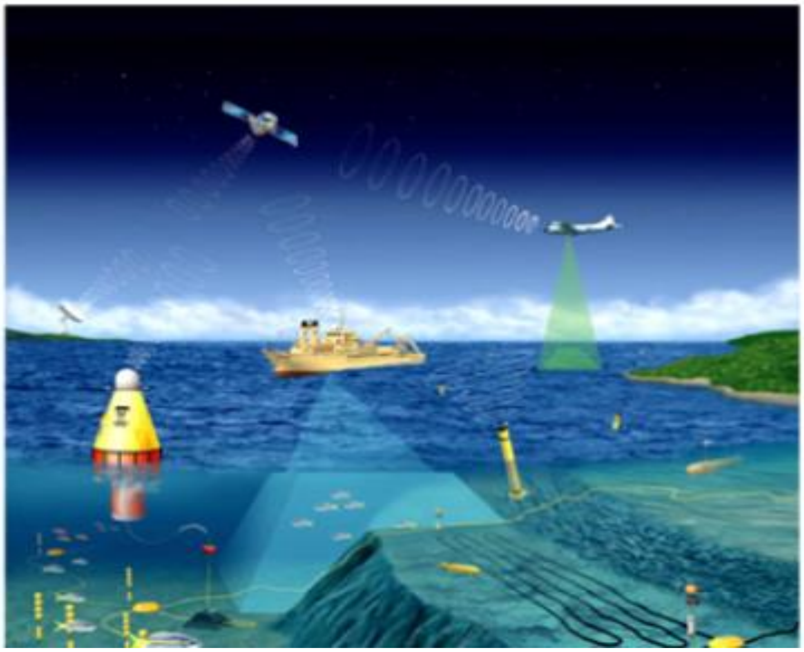
Thank you for your participation in the survey. Please share any comments in the box below.

APPENDIX: SOLICITATIONS TO PARTICIPATE

What's the value of an ocean observing system? Let us know what you think!

Natural resource economists working at Land Grant and Sea Grant institutions in the southeastern United States have initiated a multifaceted study of public preferences for integrated ocean observing systems (IOOS). This multi-year project involves numerous surveys targeting different populations in an attempt to understand how people access, use, and value specific types of IOOS-based information. One of these surveys seeks input from the owners, operators, and passengers of boats operating on coastal and marine waters of the United States. While this particular survey will eventually be sent out to a broad sample of vessel registry contacts, the team has approached ROFFSTM with a request to implement a parallel version of this study among Fishy Times subscribers. According to Rex Caffey, project team member from Louisiana State University (LSU), "the opportunity to replicate our coastal marine vessel survey within the ROFFS™ community is truly unique…we suspect it will provide input from a more advanced set of users than we expect to see in the general population."

In the coming weeks, the Coastal Marine Vessel Survey will be distributed to Fishy Times subscribers via email. Rest assured that your participation is completely voluntary and anonymous. Your participation in this brief, 10-15-minute questionnaire will provide valuable input to the agencies involved in managing these important systems at the local, state, and federal level.



Dear Fishy Times Subscriber,

As noted in our most recent newsletter, ROFFS™ has partnered with Land Grant and Sea Grant economists in the southeastern US to distribute a survey that gauges how people access, use, and value specific types of information generated by integrated ocean observing systems (IOOS). The research team is especially interested in comparing the preferences and values of more advanced IOOS users (such as you) to the input obtained from broader populations. Please consider taking a few minutes to complete this questionnaire - which focuses on information use by the owners, operators and passengers of vessels operating in coastal and marine waters.

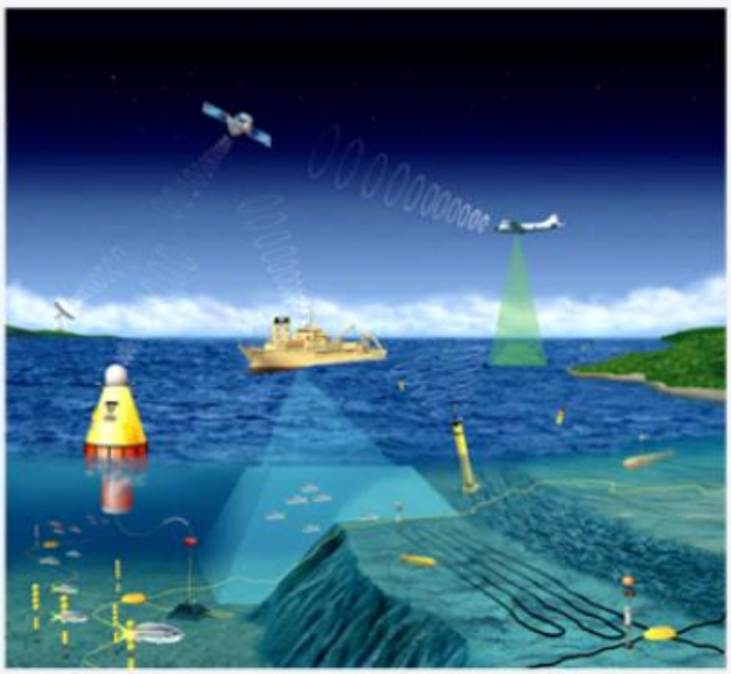
Your participation in this brief, 10-15-minute survey will provide valuable input to the agencies involved in managing these important systems at the local, state, and federal level.

Click the link below to access the survey:

Coastal Marine Vessel Survey

Thanks in advance for your consideration and time and please direct any specific questions about the project to:

Rex Caffey
LSU Center for Natural Resource Economics & Policy
rcaffey@lsu.edu
225-578-2393



NOAA Image

Dear Fishy Times Subscriber:

Thanks to those of you that have already responded to the *Coastal Marine Vessel Survey* - but we need to hear from **many** more of you!

Why is your participation in this project important?

This survey is being conducted in partnership with Land Grant and Sea Grant University researchers who are specifically targeting input from public and private sector users of the information provided by Integrated Ocean Observing Systems (IOOS). Your preferences and valuations for coastal marine forecasts and ocean monitoring data will ultimately be compared to a much broader survey the general public - but your input won't be counted if you don't respond. Information generated from this project could ultimately influence state and federal investments in ocean observing systems. We really do want to hear from you!

If you've not yet done so, please take a few minutes and make your preferences known now at the link below:

https://lsu.qualtrics.com/jfe/form/SV_9XmHdfKSrfYmsFD

Your expertise is sorely needed to provide valuable input to the agencies involved in managing this important systems at the local, state, and federal level. Thanks again for your consideration and time and please direct any specific questions about the project to: Rex Caffey, LSU Center for Natural Resource Economics & Policy, rcaffey@lsu.edu, 225-578-2393.

Dear Fishy Times Subscriber:

Over the past few weeks, nearly 300 of you have responded to the *Coastal Marine Vessel Survey.* Thank you! We'd like to hear from several more of you before we wrap up the data collection phase of this project.

Why is your participation in this research important?

This project is being conducted in partnership with Land Grant and Sea Grant University researchers who are specifically targeting input from public and private sector users of the information provided by Integrated Ocean Observing Systems (IOOS).

Your preferences and valuations for coastal marine forecasts and ocean monitoring data will ultimately be compared to a much broader survey of the general public - *but your input won't be counted if you don't respond.*

Your expertise is needed to provide valuable input to the agencies involved in managing these important systems at the local, state, and federal level.

If you've not yet done so, please take a few minutes and make your preferences known now at the link below:

https://lsu.qualtrics.com/jfe/form/SV_9XmHdfKSrfYmsFD

Thanks again for your consideration and time and please direct any specific questions about the project to:

Rex Caffey
LSU Center for Natural Resource Economics & Policy
rcaffey@lsu.edu - Ph: 225.578.2393

APPENDIX: IRB EXEMPTION

On Aug 24, 2015, at 10:44 AM, Institutional R Board <irb@lsu.edu> wrote:

Hi Michelle,
The IRB chair reviewed your application and determined IRB approval for this specific application is not needed. There is no manipulation of, nor intervention with, human subjects. Should you subsequently devise a project which does involve the use of human subjects, then IRB review and approval will be needed.
Elizabeth

VITA

Cody Lynn Plummer is originally from Bellaire, Texas. He attended Louisiana State University (2012-2015) for his undergraduate degree where he received his Bachelor's in Agriculture Business. Thereafter, he continued his education at Louisiana State University where he pursued a Master's degree in Agriculture Economics. Cody plans to return to Texas and pursue a career in the private sector.