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The U.S. Integrated Ocean Observing System (IOOS): A Prototype User Valuation

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The U.S. Integrated Ocean Observing System (IOOS)

A Prototype User Valuation

Prepared for:
The IOOS Association
By
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Middlebury Institute *of*
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Executive Summary

Regional ocean and coastal observing systems have become a large and important investment in understanding oceanic and atmospheric conditions and processes with a particular emphasis on supporting decisions on everything from whether to take a boat trip on the Great Lakes to timing the arrival of cargo ships at ports in the Gulf of Mexico. The U.S. has made a substantial investment in the platforms, monitoring instrumentation, data communication, analytical tools, models and data distribution components of its regional observing systems. A question that has been consistently asked over the past decades is "what is the value of this investment in ocean observing"?

There is no single answer to this question, because ocean observation data is used directly by some to support decisions while others use the observing data to create more elaborate and sophisticated information services. Observations from the Regional Associations (Ras) supply both final demand and intermediate demand. Goods and services produced from observations data such as weather forecasts create additional value from ocean observations which is likely substantially larger for the final users. This study focuses only on the value only of the data and information provided by the RA's primarily through their websites.

These data are distributed without charge to the user, and special methods are needed to assess its value. The approach taken here is to consider the data as a public good and to use a valuation method called contingent valuation. A survey was used to identify the characteristics of the data users and to elicit estimates of their values. Respondents were recruited from the RA websites on a voluntary basis.

The results of the analysis showed that the 1.22 million users of RA data and information (defined as individual IP addresses from which data was accessed) placed an estimated value of **$156.81 million per year for data accessed for organizational (employment) purposes and $41 million per year for data accessed for personal use; a total estimated value of $198.01 million per year**. Survey respondents totaled 3,631, meaning these results are valid plus or minus 1.6%.

These estimates are likely *under*estimates of the value of RA data for several reasons.

- Two RA's did not participate in the survey project.
- A key group of users, those who only access data only through direct computer connections, were not surveyed.
- Ocean observing data is used both directly to help make decisions (such as planning a boating trip) and to create more complex data and information products (such as weather forecasts). The former are called end-user values and the latter intermediate user values This study included values for both types of data but did not include the likely much larger values from end-users of the array of information services products that incorporate observing data provided by RAs.

The values of different types and uses of data were also estimated. Of the types of data and information used, current ocean conditions had the lowest annual average value (for all respondents) of $110.63 and data and information on administrative information (such as marine protected area boundaries) had the highest at $189.78 per year. For employee-related uses, the lowest value was for education related uses at $273.86 per year while data and information being used for the creation of value added services had the highest annual value at $466.60. Individual users valued "general information" highest at $99.28.

The surveys were collected very unevenly from the nine participating Regional Associations. Over half of the survey respondents came from only three of the RA's (PacIOOS, GLOS and SECOORA), so there may be some biases of unknown size in the results. These are likely underestimates of total national values since there are two RAs not included in the results and some employees were not surveyed in this project. Values for all RAs were calculated, but the sample size varied significantly between RAs. Only GLOS and SECOORA had responses that met standard tests of statistical significance.

This was a prototype study to learn the best way to use contingent valuation surveys to measure ocean observing values. This prototype study has demonstrated that using such surveys to elicit estimates of the sum users might be willing to pay for IOOS ocean/Great Lakes data and information is feasible and produces valid results. Replication of this study is recommended for those RAs that did not respond or where the number of respondents were too few to yield a

statistically significant result. The full study should be replicated about every five years or soon after any major changes in the scope, quantity and/or quality of observing data being made available to users. In either case, the first priority in future studies is to ensure sufficient responses that each RA in order to deliver statistically significant results. The more extensive economic benefits of the various information products and services that incorporate ocean observing data should also be measured in future studies, though this will require more extensive and complex studies than the present one.

1. Introduction

Ocean observations and measurements have been taking place since the first records of tides. The 20th century revolution in sensor, information and communications technologies (ICT) combined with the development of new platforms such as satellites and autonomous vehicles have greatly expanded the types, geographic scope, and frequency of ocean observations and measurements. Making use of the ability to distribute data and information at very low cost through the internet, the entire range of ocean observations is increasingly available in near real-time throughout the world.

The collection, management, and distribution of ocean observing data and information varies from country to country. In the United States, coastal ocean observing is primarily a partnership between the federal government, represented by the Integrated Ocean Observing System (IOOS) Program Office housed at the National Oceanic and Atmospheric Administration (NOAA) and eleven Regional Associations (RAs) that design, operate and maintain regional coastal observing systems with governmental and nongovernmental partners. The eleven RAs cover all the United States coastal waters and Exclusive Economic Zone, including the Great Lakes, and serve as aggregators, managers, and distributors of coastal observing data and information collected from a variety of sources.

The earliest studies of economic value were conducted before most of the current ocean observing networks or regional associations were formed. (Dumas & Whitehead, 2008; Kite-Powell et al., 2003; Kite-Powell & Colgan, 2001) These studies identified a number of pathways by which economic value could be created and provided very approximate estimates of what the values might be. Other early studies used more formal modeling approaches to arrive at estimates of possible benefits for both commercial (Wellman & Hartley, 2008) and recreational fishing (Wieand, 2008).

These studies were very helpful in identifying the possible economic value of ocean observing data and information, but they were not grounded in the observations of actual behavior that is required for more accurate measurement. There have, in fact, been very few studies in the years between those early estimates and the present. This study is one of the first to explore the valuation of the data and information from ocean observing systems as defined by users willingness to pay, and to estimate these values on a national scale.

This is a prototype study. Its primary purpose is to develop and test a measurement approach using surveys of the users data and information distributed through the websites of the RAs. The study arrives at useful, but sometimes statistically limited, estimates of the current values. These are reported in the section below on the findings from the survey, which follows a brief introduction to the concept of economic value and the approach taken here. A third section evaluates the methodological test including its strengths and weaknesses and makes recommendations for future uses of this approach to valuation.

2. The Economic Value of Ocean Observing: An Introduction

A starting point for defining and measuring the economic value of ocean observing is to determine levels of investment in the technology to undertake ocean observations and the value of commercial revenues from the sale of ocean information services based in whole or in part on ocean data.. *The Ocean Enterprise* studies conducted by NOAA IOOS focus on valuing U.S. business activity in these two areas. (NOAA, 2017; NOAA, 2021) (Figure 1) These studies surveyed businesses in the United States identified as either providers of ocean observing technology or as intermediate developers of information services that added value to ocean observations and measurements tailoring them to deliver benefit to a specific end-use segment or end-user group. The 2016 study found that together these businesses generated $7 billion in direct revenue of which $1.4 billion was in exports from the U.S in 2015. Total employment by these businesses was estimated at between 223,000 and 268,000. The 2021 study found that output from businesses in this ocean observing-related cluster had grown by $1.0 billion to $8.0 billion, and added around 100,000 employees.

Figure 1 The Ocean Enterprise

This view of the value of the ocean observing system is familiar to many because it is grounded in the "technology-based" or "innovation economy" ideas that have been dominant in discussions of economic development for several decades. (Hotaling & Spinrad, 2021; OECD, 2019; Spinrad, 2016) The study provides solid evidence that ocean observing-related data and technologies are a substantial economic enterprise and that there are distinct clusters of such activity in areas such as San Diego, eastern Massachusetts, and Seattle. This approach implies

that with such a significant generation of revenue (gross output) and support for a number of private sector businesses, the ultimate products of information about the ocean must be highly valued, but the approach does not say anything specific about what those ultimate values actually are. Nor, more importantly, does it say anything about values that are not reflected in the sales of the surveyed businesses.

The Ocean Enterprise tells an important but incomplete story since it includes only commercial sales of ocean information services and places no value on ocean data and information made available at no cost as a public good by organizations such as IOOS. In this study a value is placed on use of the freely available IOOS data and information through determining what users might be willing to pay for it. The concept of "economic surplus" is key here. Surplus is simply a way of recognizing that the price paid does not equal the value of the good or service. The assumption is that the price is the *smallest* measure of value. If the value is less than the price, there would be no purchase. But if the value is greater than the price the surplus, the difference between what one is willing to pay and the price is the surplus value. In the case of something acquired for free, as with IOOS ocean observation data, surplus is the total value, and the measurement of willingness to pay the necessary step in quantifying it.

Figure 2 Value Flows from Ocean Observing Data

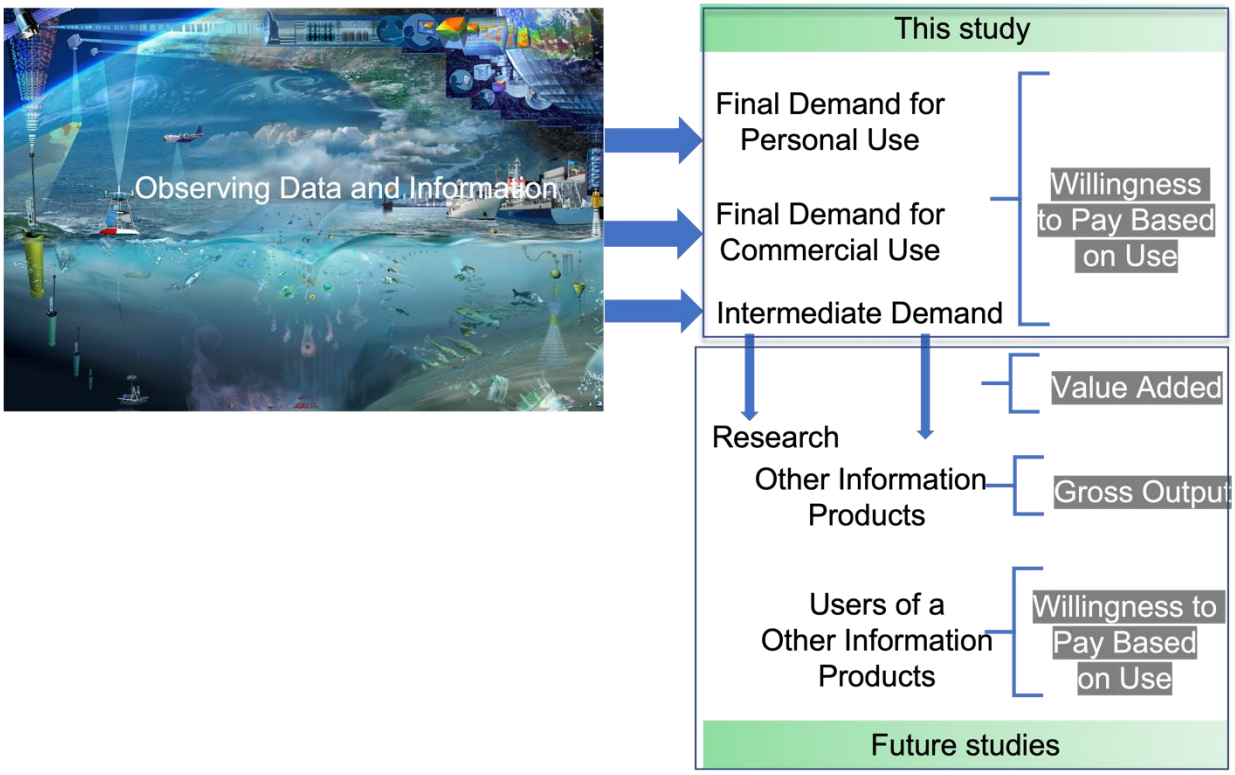


Figure 2 picks up the values story where the Ocean Enterprise leaves off The network of ocean observations data transmits data through the websites and direct computer to computer

connection to users. Some may use the data for personal reasons such as checking the wind speed in advance of a boating trip. Some may use the data for employment related reasons such as checking sea conditions for a commercial fishing trip. In these cases, the value is determined by these final users. Others access the data to produce more elaborate and complex ocean information or knowledge. One example is scientific research. Another is using observing data as raw material for the creation of more sophisticated information services such as forecasts of ocean conditions which are then sold to subscribers.

The final component of value is the value of the benefits derived by the ultimate users of the information services which use ocean observing data as an input. Some of this value is realized through use of ocean research outputs, though the economic value of scientific research is very difficult to determine. Further value is manifested in efficiency, safety and regulatory compliance benefits arising from use of information services. This value can also be measured as surplus. In some cases, the surplus can be inferred from measuring some of these efficiencies. For example, it has been estimated that optimized ship routing made possible by models developed from ocean observations has saved the commercial shipping industry $16 billion per year. This efficiency gain is not paid for by shipping companies since the costs of the forecasts are considerably less than the value of the benefits derived but does represent a portion of the surplus value of the observing systems and its products to the final users.

A concrete example is an app called Predict Wind. (Figure 3) This app shows the direction and speed of the wind for almost any part of the ocean. The particular screen shot shows a nowcast of the wind off the west coast of the U.S. The exact conditions at a point in Monterey Bay are also shown. The user can call up the data for any point on the screen (land or sea). The user can also see forecasts up to 7 days ahead and can also choose from nine different global weather models for the forecast.

Figure 3 The Predict Wind App

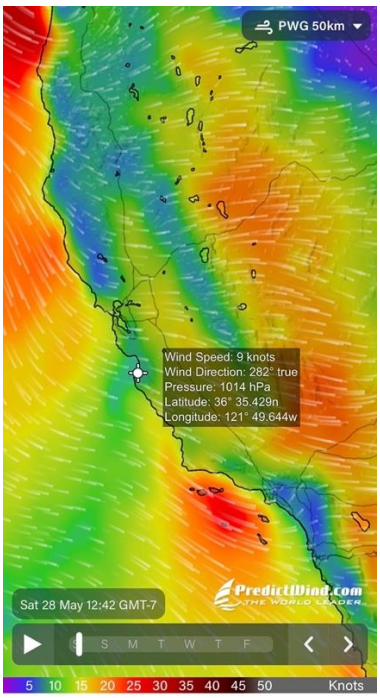
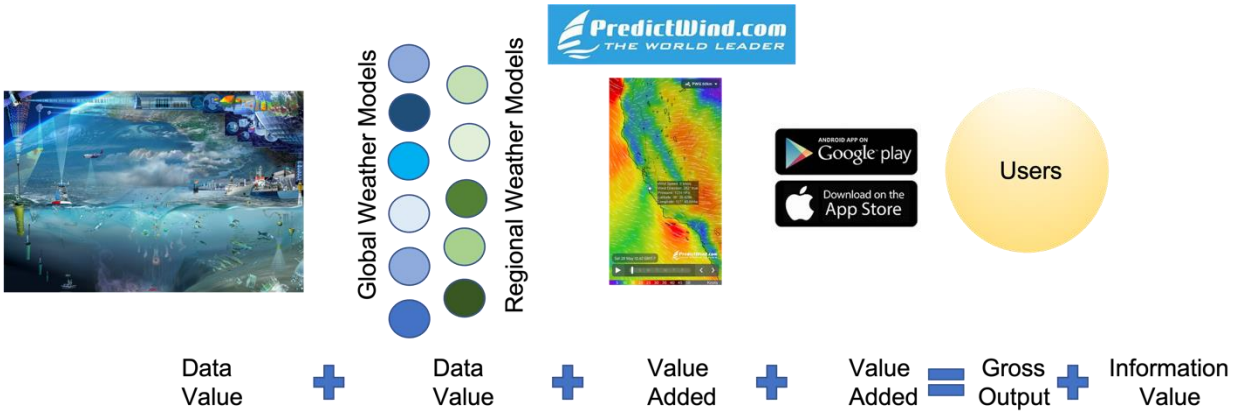


Figure 4 The Predict Wind Value Chain



The ocean observing data is fed into the organizations producing the nine different global and regional weather models from which Predict Wind then draws data from seven of the models and adds the results of two forecast models to create the app that can show each model's results using a selection of graphics and time period. Predict Wind then develops versions of the model to deliver the results to different platforms including computers and mobile devices. The Apple Store and Google Play distribute the program for mobile devices (taking a fee on each download). Users can access a limited features version free or pay for more features and options. Some users will access Predict Wind for personal reasons or as direct inputs to commercial uses

such as fishing. Others will pay for the advanced feature versions that include wind and weather forecasts and optimized ship routing. The ultimate benefits to the users will be measured in part by what they pay for their subscription and in part by the benefits greater than what they paid (their surplus).

In this example, the value of the data (based on willingness to pay for public goods data) is added in the various models which are then distributed to Predict Wind, who add value to the models, distribute through the app stores who also add value). The sum of this stream of value added is gross output (sales) summed across all firms in the industry. Beyond that gross output, users add more value by using the information. Figure 2 and Figure 4 show how ocean observations have their own value (even if the data is not sold), and how those observations enable the creation of much larger values.

This study looks at the final value for personal uses, some commercial users (most commonly people in the fishing industry) and as the value as the input to the creation of other products for observation data accessed from the RAs. Future studies will have to measure the final value of those information products to which observations are an input. These will need to include the economic values reflected in commercial goods and services as well as in ecosystem services. These future studies will help spell out the full value of ocean observations, but the values in the current study cover the only measures of some parts of the value (such as personal uses) and an important part of the other values since they are the only measures of the public goods value of the observation inputs.

With this background on the definition and structure of economic values of ocean observations and associated products, it is possible to turn to the specific measurements in this study.

3. The IOOS Regional Association Survey

Overview

The economic value of public goods with no prices can be measured several ways which basically come down to revealed preference methods (statistically imputing the public goods value from observed sales of related goods) or stated preference measures that ask users to place a value on the good as if a price existed. This latter approach is called contingent valuation and is widely used for valuation of environmental and other types of goods with no market prices. (Mitchell & Carson, 1989)

The basic tools are well-known but their application to the specific field of ocean observing values is still quite new and all estimating processes are at this stage somewhat experimental, which is the reason this is a prototype study. The objective is to test out procedures for data collection and analysis for a contingent valuation study of data provided by the regional organization of ocean observing in the U.S. and to set an initial estimate of the value of ocean observing to users in the U.S. From this test recommendations are made about the next steps in estimating values and the continuing update of value studies.

A survey of RA data users was conducted using an "opt in" link on the appropriate home page of each of the participating RA websites. Users were provided a box or similar graphic inviting them to provide information about their willingness to pay for the data they were accessing. The method of asking about willingness to pay is called a referendum format. Survey respondents are asked if they would pay a specified amount for a year's subscription to the data. The amount specified is randomly assigned to each respondent from a preset range of amounts from low to high. The economic value is statistically inferred from all respondents choices of yes or no to pay the proposed amounts. More details are provided below.

Survey Participation

Participation in the survey by RAs varied. Two RAs, (NANOOS in the Pacific Northwest and MARACOOS in the Mid-Atlantic region) choose not to distribute the survey to avoid confusion for their users who might have seen the study as being connected to a desire to charge for access to their data and information. MARACOOS was conducting a user survey of their own at the time of this project. The participating associations were:

AOOS- Alaska Ocean Observing System
CARICOOS- Caribbean Coastal Ocean Observing System
CeNCOOS- Central and Northern California Ocean Observing System
GCOOS- Gulf of Mexico Coastal Ocean Observing System
GLOS- Great Lakes Observing System
NERACOOS- Northeastern Regional Association of Coastal Ocean Observing Systems
PacIOOS- Pacific Islands Ocean Observing System

SCCOOS- Southern California Coastal Ocean Observing System
SECOORA- Southeast Coastal Ocean Observing Regional Association

Three of the RAs supplemented the web access to the survey with an email invitation to those who had signed up to receive the RA newsletter.

Data from the RAs can be accessed either from the website or by direct computer-to-computer connections. Users of large amounts of data are most likely to access data through direct connections. Because this survey was distributed primarily through the website, those users who access only through computer connections were not included in the sample. However, those who used both the website and computer connections were included in the sample; the number varied by RA as noted below.

The RAs participated for varying lengths of time between May 12, 2019 to October 3, 2021 (Table 1). Dates in Table 1 are identified by the earliest and latest recorded dates for surveys. On average, the survey was available for 496 days across all RAs, with a range of 183 days for GLOS to 827 days for CeNCOOS. The variance depended on the rate of response in the different regions. In some RAs (e.g., GLOS), a large number of respondents responded to the survey in a very short time. With other websites such as that of CeNCOOS, a number of respondents answered quickly and then response rates slowed considerably.

RA	Earliest Survey	Latest Survey
AOOS	9/18/20	9/9/21
CARICOO	3/11/20	10/3/21
CeNCOOS	6/19/19	9/24/21
GCOOS	2/3/20	3/10/21
GLOS	3/25/20	9/24/20
NERACOO	7/29/19	8/30/21
PacIOOS	3/25/20	8/2/21
SCCOOS	2/19/20	9/19/21
SECOORA	6/26/19	4/16/20
All RA's	6/19/19	10/3/21

Table 1 Response Dates by RA

Error! Reference source not found. shows the number of respondents to the survey overall and by RA. All together there were over 3,600 respondents, but the distribution among the regional associations was very uneven ranging from 88 at SCCOOS to 1,626 at GLOS. Four of the RAs (GLOS, PacIOOS, NERACOOS and SECOORA) accounted for four fifths of all responses.

	Number of Respondents	Percent of Respondents	Confidence Interval
AOOS	153	4.2%	0.079
CARICOOS	206	5.7%	0.068
CeNCOOS	212	5.8%	0.067
GCOOS	88	2.4%	0.105
GLOS	1626	44.8%	0.024
NERACOOS	333	9.2%	0.054
PacIOOS	383	10.5%	0.050
SCCOOS	91	2.5%	0.102
SECOORA	541	14.9%	0.042
TOTAL SAMPLE	3633	100.0%	0.016

Table 2 Number of Respondents and Standard Errors

These uneven responses rates have implications for the interpretation of the data. Survey respondents are, ideally, drawn from a random sample of the population as a whole so that the sample may be said to fairly represent the entire population. The ability of a survey to represent the population depends on the randomness with which the sample is chosen and the size of the sample. Randomness means that ideally every member of the population of interest (all users of the RAs) has an equal chance of being in the surveyed sample. In practice, this is difficult to achieve with volunteer respondents in this study. In this case, randomness is somewhat compromised by the self-selection process that recruited participants. Each respondent had to opt in by clicking the appropriate link on the website or e-mail. Randomness can be approximated with sufficient sample size so the total number of respondents matters. With a large enough sample, the effects of any bias in the sample from lack of randomness (called survey bias) can be substantially reduced.

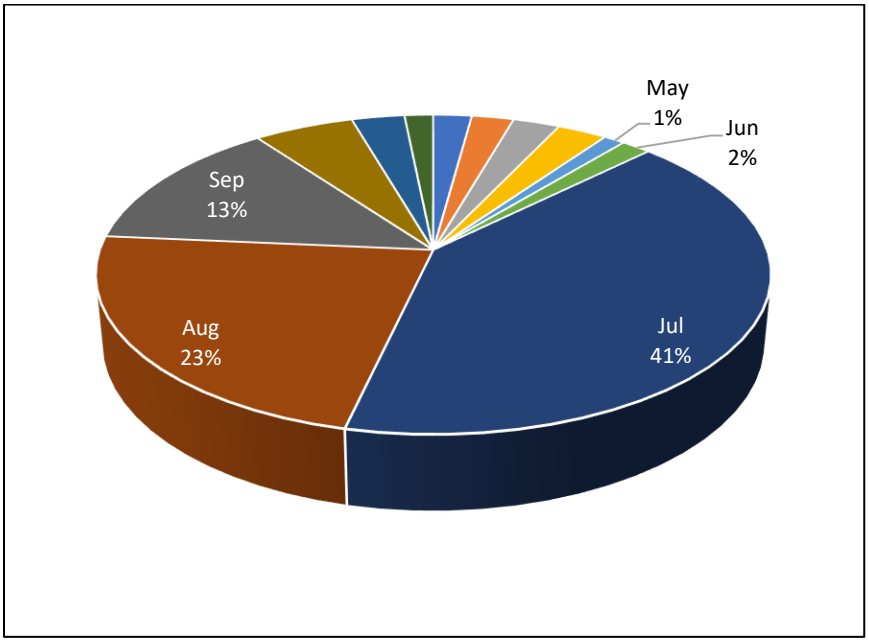
The size of a sample is a function of the chances of a difference between the characteristics of the population and the characteristics of the sample. Samples are generally drawn so that there is 95% chance that the sample's responses will be within ±5% of the actual population's responses to a question. The ±5% figure is known as the standard error of the sample. A standard error of 5% (0.05) is generally considered the *minimum* sample size to interpret the survey results as a valid representation of the population.

Standard errors for the number of responses of the various regional associations and for the sample as a whole are also shown in **Error! Reference source not found.**. Since the standard error is a measure of the difference between the sample and the population, the *smaller* the standard error, the *smaller* the difference between sample and population and thus the more accurately the survey represents the population. Three of the RA samples (GLOS, PacIOOS, and SECOOORA) meet the .05 test. At .054 NERACOOS does not meet the test, but is close enough to the threshold that the sample could be considered a fair representation. The total of

3,633 responses has an estimated standard error of 0.016 (1.6%), meaning that there are likely small differences between population and sample. But all other samples fall below the threshold and so, while the results for each RA are shown in the discussion below, the results of all RAs *except* GLOS, SECOORA, PacIOOS and NERACOOS will have a substantial amount of uncertainty. The implications of the representativeness of the samples are discussed when the values of the data are calculated.

Although the pooled responses sample meets the criterion for adequate sample size, indeed exceeds it by a comfortable margin, care should still be taken in interpreting the results from the entire sample since because five of the regional associations make up such a large portion of the responses. As will be seen from the discussion below, there are many similarities among the responses from the different associations which means a pooled sample relying on only three of the associations is probably reasonably representative of the entire population of observing systems users. But there are other examples of large differences among the associations so care must be taken in interpreting results. These differences may arise solely because of small sample sizes; larger sample sizes for all associations might reduce or eliminate differences, but this cannot be known from the existing data.

Figure 5 Distribution of Survey Responses by Month



The timing of responses is an indicator of the types and purposes of data retrieved through the websites. Figure 5 shows the distribution of survey responses for all RAs by month. The summer months of July, August and September were the periods when most (75%) of the survey responses were received; if October is included the total goes to 81%. These overall patterns were dominated by the response patterns from GLOS, where nearly all responses came in July and August. The monthly distribution of responses was more even year round for all associations when viewed on an individual basis. (Table 3)

Table 3 Distribution of Survey Responses by Regional Association

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	% of Responses
AOOS							80	68	5				153	4.2%
							52.3%	44.4%	3.3%					
CARICOOS	1		1				123	39	33	7		2	206	5.6%
	0.5%		0.5%				59.7%	18.9%	16.0%	3.4%		1.0%		
CenCOOS	1	8	39	31			105		2	16	10		212	5.8%
	0.5%	3.8%	18.4%	14.6%			49.5%		0.9%	7.5%	4.7%			
GCOOS				4	2	27	11	30	9		5		88	2.4%
				4.5%	2.3%	30.7%	12.5%	34.1%	10.2%		5.7%			
GLOS	51	62	33	53	33	14	411	367	335	160	81	42	1642	45.0%
	3.1%	3.8%	2.0%	3.2%	2.0%	0.9%	25.0%	22.4%	20.4%	9.7%	4.9%	2.6%		
NERACOOS	1			10	3	13	233	42	19		4	8	333	9.1%
	0.3%			3.0%	0.9%	3.9%	70.0%	12.6%	5.7%		1.2%	2.4%		
PacIOOS	24	2	1				311	20	18		5	2	383	10.5%
	6.3%	0.5%	0.3%				81.2%	5.2%	4.7%		1.3%	0.5%		
SCCOOS		1	5				60	2	19			4	91	2.5%
		1.1%	5.5%				65.9%	2.2%	20.9%			4.4%		
SECOORA		12	16	3	5	6	161	264	53	20	2		542	14.8%
		2.2%	3.0%	0.6%	0.9%	1.1%	29.7%	48.7%	9.8%	3.7%	0.4%			
Total	78	85	95	101	43	60	1495	832	493	203	107	58	3650	
	2.1%	2.3%	2.6%	2.8%	1.2%	1.6%	41.0%	22.8%	13.5%	5.6%	2.9%	1.6%		

Characteristics of Respondents

This section examines who the respondents to the survey, including how they access data, the purposes for which they access observing data, the types of data they access and frequency of use.

Accessing the Data

As noted, users of RA data may access the data by downloading through the website, by using API's[1] or similar connections to transfer data between servers, or both. As shown in Table 4, the majority of survey respondents accessed the data exclusively through the website (82%), and this did not vary significantly among the RAs which ranged from SECOORA at 74% to PacIOOS at 85%. The number of users accessing only through the servers was quite low and most of those who access data through the servers also used the websites. This is not surprising given that the access point to the survey was the website.

Number/ Percent of RA	Website Only	Server Only	Both	Total
AOOS	102	2	21	125
	81.6%	1.6%	16.8%	
CARICOOS	144	2	37	183
	78.7%	1.1%	20.2%	
CenCOOS	134	4	21	159
	84.3%	2.5%	13.2%	
GCOOS	58	3	9	70
	82.9%	4.3%	12.9%	
GLOS	1217	37	201	1455
	83.6%	2.5%	13.8%	
NERACOOS	238	4	46	288
	82.6%	1.4%	16.0%	
PacIOOS	305	7	46	358
	85.2%	2.0%	12.9%	
SCCOOS	44	1	20	65
	67.7%	1.5%	30.8%	
SECOORA	237	13	72	322
	73.6%	4.0%	22.4%	
Total	2479	73	473	3025
	82.0%	2.4%	15.6%	

Table 4 Point of Access to RA Data

[1] Automated Program Interfaces

Types of Respondents

The use of the data, whether for reasons related to their employment or for personal uses, or both, is important to understand the value. Table 5 shows the majority of respondents accessed the data only as an individual. Again, the large proportion of GLOS respondents biases the results. While 91% of GLOS respondents did so for individual use purposes, the distribution between personal uses and employment use differed among the other RA respondents. Remove the GLOS responses from the analysis, and the result is that 23% of respondents accessed data only for employment, 55% as individuals, and 27% as both.

Number/ Percent of RA	Employment	Individual	Both	Total
AOOS	40	40	38	118
	33.9%	33.9%	32.2%	
CARICOOS	16	102	62	180
	8.9%	56.7%	34.4%	
CenCOOS	61	62	32	155
	39.4%	40.0%	20.7%	
GCOOS	14	35	17	66
	21.2%	53.0%	25.8%	
GLOS	23	1325	97	1445
	1.6%	91.7%	6.7%	
NERACOOS	83	97	104	284
	29.2%	34.2%	36.6%	
PacIOOS	23	253	80	356
	6.5%	71.1%	22.5%	
SCCOOS	30	15	19	64
	46.88	23.44	29.69	
SECOORA	79	158	48	285
	27.7%	55.4%	16.8%	
Total	369	2087	497	2953
	12.5%	70.7%	16.8%	

Table 5 Reason for Accessing Observing Data

Those accessing the regional observing data for their employment come from an array of organizations. (Figure 6) The major employment sectors are government, private companies, and academic institutions, together comprising over three quarters (77%) of the organizations represented in the survey.

Figure 6 Distribution of Organization Types by Respondent

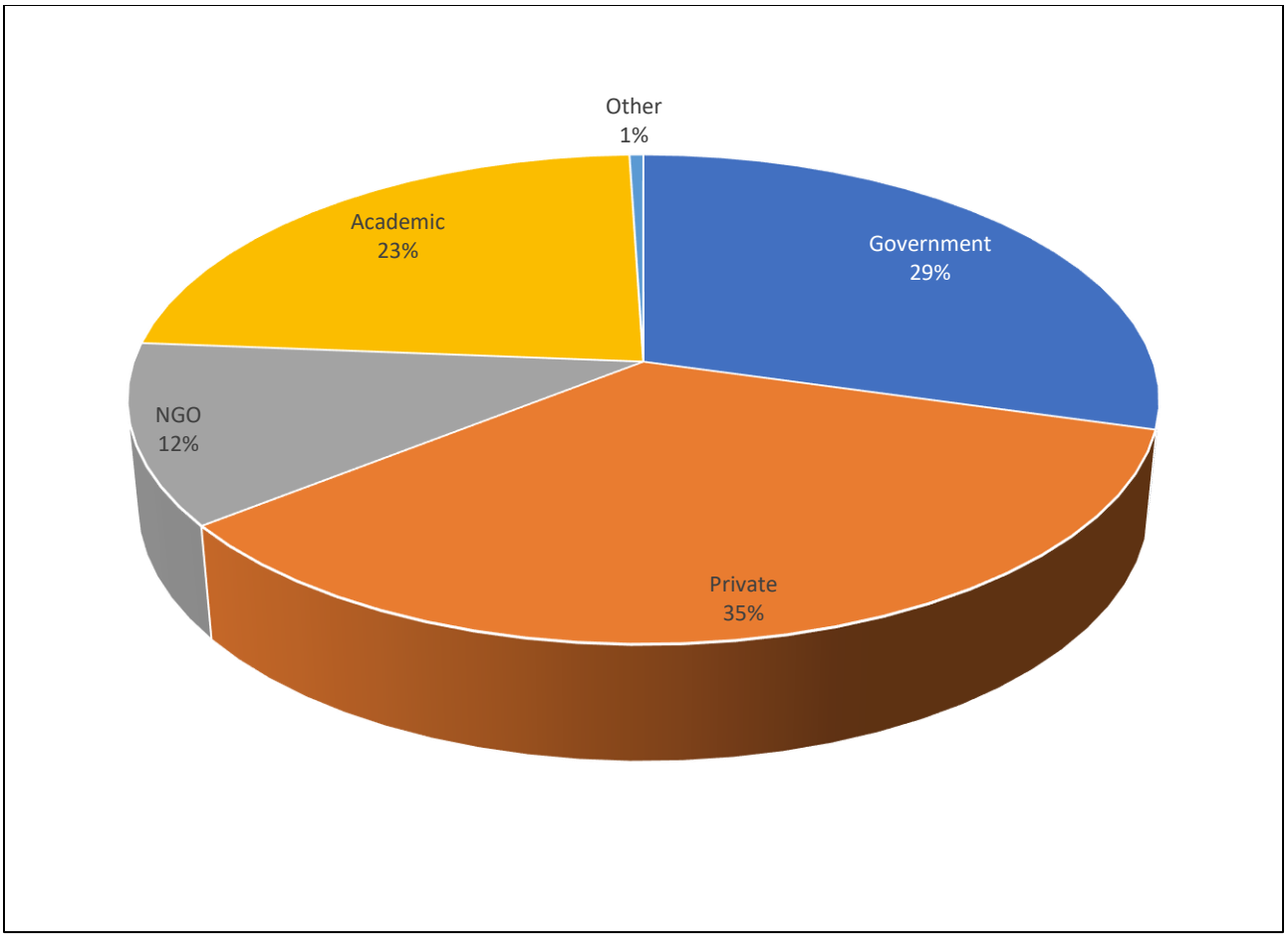


Table 6 shows some variation among the types of organizations whose employees use observing data. Overall, the largest share of employer organizations are those in the private sector. Academic users are the largest users of GCOOS, SECOORA and CenCOOS. Private organizations are the largest users of data from GLOS and CARICOOS, while government organizations are home to the largest percent of users for AOOS, NERACOOS, PacIOOS, and SCCOOS. Academic organization users are the largest share of employee users for CenCOOS, GCOOS, and SECOORA. It is important to note that the number of responses to this question in each RA is relatively small; differences between organization shares of less than 10% are not reliable.

	Government	Private company	NGO	Academic	Other	Total
AOOS	24	14	22	10	4	74
	32.4%	18.9%	29.7%	13.5%	5.4%	
CARICOOS	22	26	10	10	6	74
	29.7%	35.1%	13.5%	13.5%	8.1%	
CenCOOS	26	12	10	33	5	86
	30.2%	14.0%	11.6%	38.4%	5.8%	
GCOOS	3	4	7	11	0	25
	12.0%	16.0%	28.0%	44.0%	0.0%	
GLOS	18	62	7	10	20	117
	15.4%	53.0%	6.0%	8.6%	17.1%	
NERACOOS	52	45	16	26	34	173
	30.1%	26.0%	9.3%	15.0%	19.7%	
PacIOOS	33	28	6	21	10	98
	33.7%	28.6%	6.1%	21.4%	10.2%	
SCCOOS	23	4	7	12	2	48
	47.9%	8.3%	14.6%	25.0%	4.2%	
SECOORA	27	14	7	52	7	107
	25.2%	13.1%	6.5%	48.6%	6.5%	
Total*	234	278	95	185	4	802
	29.2%	34.7%	11.8%	23.1%	0.5%	

*Includes recoded "other" responses

Table 6 Employer Organizations by Regional Association

The types of governmental organizations of users are shown in

Figure 7. The largest group are involved in resource management (e.g., fisheries or coastal management). Environmental management (e.g., water quality monitoring) is the next most common government organization type. Public safety and weather/climate related organizations were next most common, although many respondents identified themselves as "other organizations." These data probably do not adequately represent governmental users since organizations such as the National Weather Service and the Coast Guard access data through direct connections to the RA servers and were not captured in the website-based surveys.

Figure 7 Types of Governmental Organizations of Users

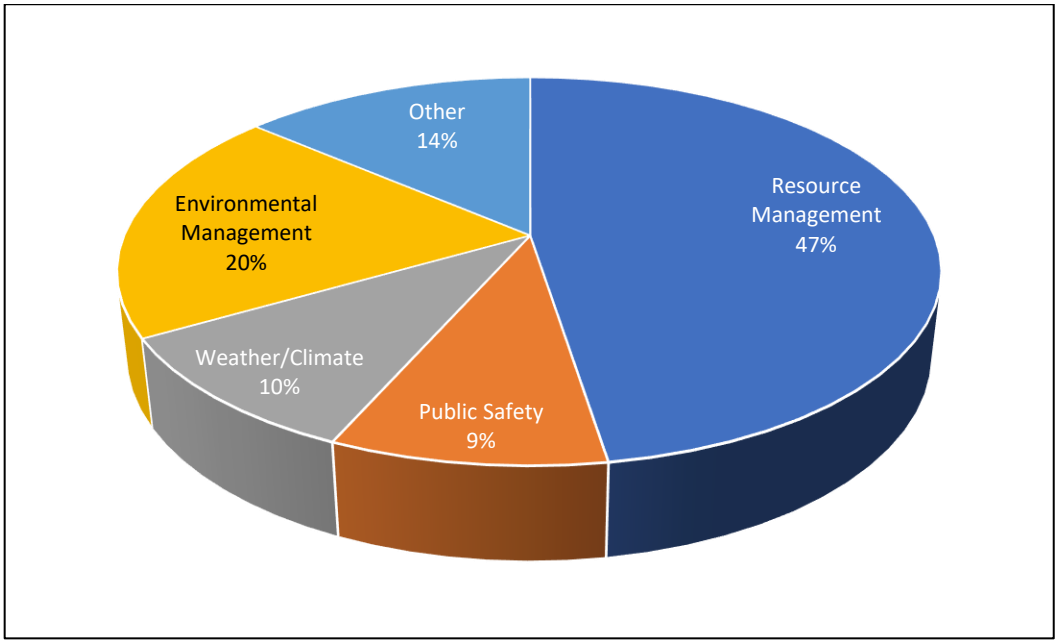


Figure 8 Private Sector Organizations of Users

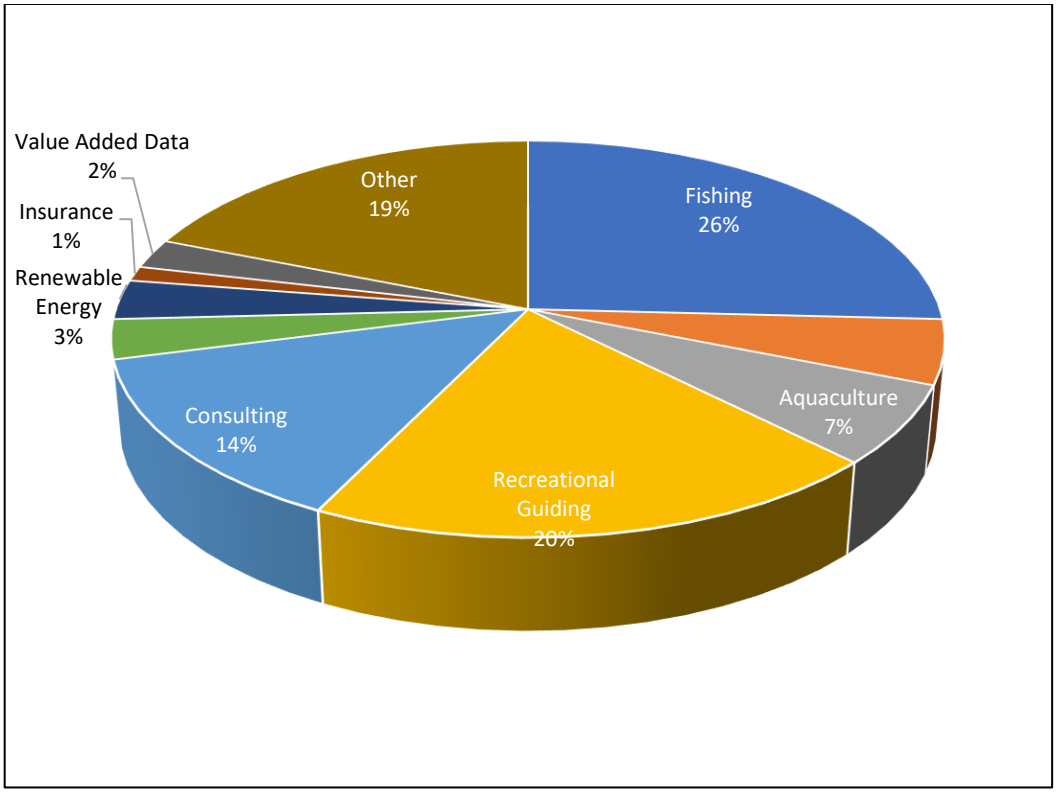


Figure 8 shows the a diversity of organizational types for private sector employees. The fishing industry represents the largest group followed by recreational charter boats. Oil and gas company employees outnumber renewable energy employees, though this may change in the future. Value-added data providers and shipping companies together make up only 10% of users. This group may be accessing data directly.

The distribution of private sector organization types by RA is shown in Table 7. The largest group in each RA is noted by showing the percent in bold. Fishing industry employees were the largest group for AOOS and NERACOOS, while recreational guides were the largest for respondents from CARICOOS and GLOS. "Other" was the most common group in CenCOOS and PacIOOS. Across all RA's this category reflected a variety of firms radio stations, construction workers commuting to islands, and harbor pilots.

The survey asked about the type of data users accessed and for what purpose the data were being used. Since each user could want several different types of data and use it for different purposes, the survey asked about the percent of their inquiries by type of data and purpose of data and multiple responses were allowed.

Users of the RA websites access the data on a consistent basis. (Table 8) Employees accessed data over 100 times in the previous year at NERACOOS (the most used), GLOS and SECOORA. However, GLOS and PacIOOS had the largest average access levels by user. A high average user number of accesses reflects a relatively large number of individual users who check data such as sea conditions very frequently for recreational purposes. Note that the survey asked respondents to indicate a range of number of access events and the results in Table 8 were computed from the mid-point of the ranges chosen.

Table 7 Private Sector Organizations by Regional Association

	Fishing	Shipping	Aquaculture	Recreational Guiding	Consulting	Oil and Gas	Renewable Energy	Insurance	Value Added Data	Other	Total
AOOS	7	1	0	1	3	2	0	0	0	0	14
	50.0%	7.1%	0.0%	7.1%	21.4%	14.3%	0.0%	0.0%	0.0%	0.0%	
CARICOOS	1	2	0	10	4	0	2	2	0	5	26
	3.9%	7.7%	0.0%	**38.5%**	15.4%	0.0%	7.7%	7.7%	0.0%	19.2%	
CenCOOS	1	0	1	1	2	1	1	0	1	4	12
	8.3%	0.0%	8.3%	8.3%	16.7%	8.3%	8.3%	0.0%	8.3%	**33.3%**	
GCOOS	0	0	0	1	1	0	0	0	0	2	4
	0.0%	0.0%	0.0%	25.0%	25.0%	0.0%	0.0%	0.0%	0.0%	50.0%	
GLOS	3	4	3	22	6	2	2	1	0	17	60
	5.0%	6.7%	5.0%	**36.7%**	10.0%	3.3%	3.3%	1.7%	0.0%	28.3%	
NERACOOS	16	3	3	7	4	1	0	0	4	7	45
	35.6%	6.7%	6.7%	15.6%	8.9%	2.2%	0.0%	0.0%	8.9%	15.6%	
PacIOOS	2	2	0	7	6	1	2	0	0	8	28
	7.1%	7.1%	0.0%	25.0%	21.4%	3.6%	7.1%	0.0%	0.0%	**28.6%**	
SCCOOS	1	0	0	0	2	1	0	0	0	0	4
	25.0%	0.0%	0.0%	0.0%	50.0%	25.0%	0.0%	0.0%	0.0%	0.0%	
SECOORA	0	1	1	0	6	0	1	0	1	4	14
	0.0%	7.1%	7.1%	0.0%	42.9%	0.0%	7.1%	0.0%	7.1%	28.6%	
Total*	64	13	16	49	34	8	8	3	6	47	207
	30.9%	6.3%	7.7%	23.7%	16.4%	3.9%	3.9%	1.4%	2.9%	22.7%	

Table 8 Average Annual Number of Access Events by RA

	As an employee		As a private individual	
RA	N	Mean	N	Mean
AOOS	78	6.8	76	6.2
CARICOOS	76	10.0	163	11.0
CenCOOS	87	7.3	91	6.4
GCOOS	27	6.7	47	5.6
GLOS	108	10.0	1201	10.3
NERACOOS	178	9.4	193	9.3
PacIOOS	99	10.7	326	12.5
SCCOOS	48	7.4	33	7.4
SECOORA	114	6.4	186	5.6
All Ra's		8.6		9.8

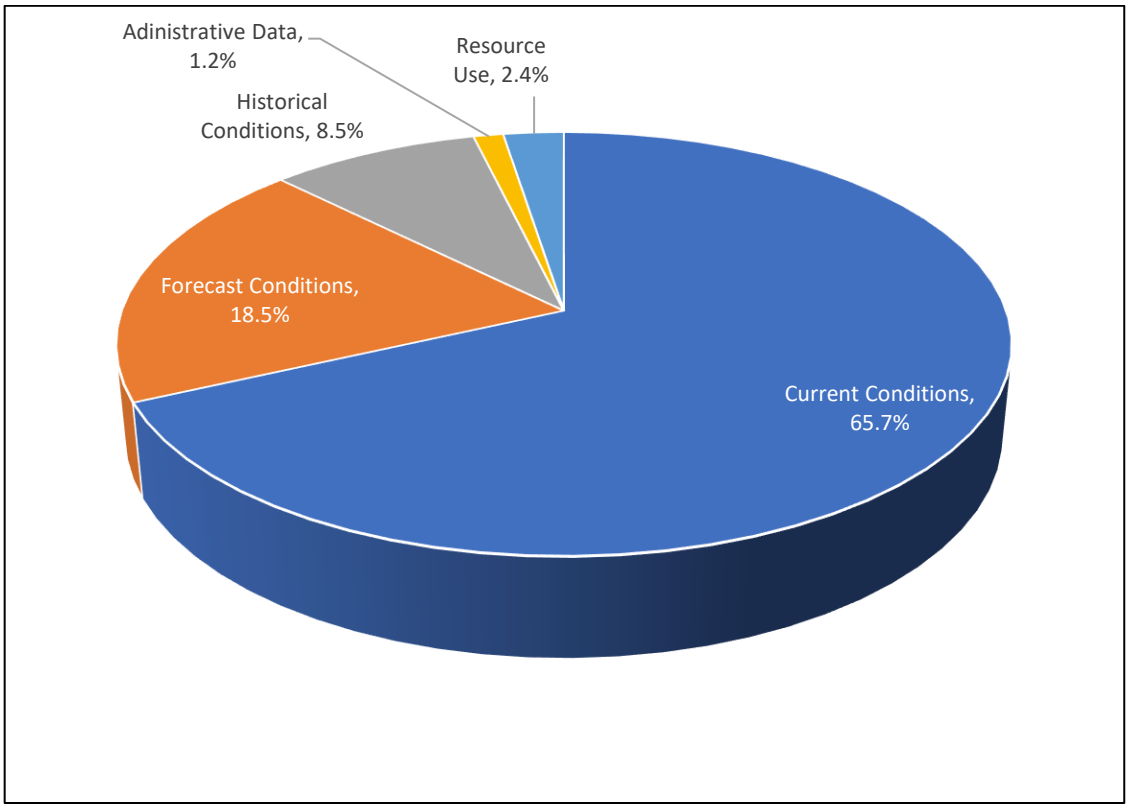


Figure 9 Types of Data Accessed

Data Types

Almost two thirds of data downloads are for data describing current conditions. These real-time data and the forecast conditions account for over 80% of data used. Current conditions are the majority of data downloads in most RAs. For GLOS, three quarters of data downloads are for current oceanographic and weather conditions, consistent with the high proportion of individual users in the summer in this region. (Since the Great Lakes freeze over in the winter, the GLOS system largely shuts down from November to April, so Forecasts were most frequently downloaded in CARICOOS and PacIOOS. AOOS users were interested in both current and historical conditions

In Table 9 data on current oceanographic and weather conditions are the most common type of data in all RA's, accounting for 64% for all RAs and 75% of access events in GLOS with its concentration of individual and summer users noted above. Current conditions data is the majority of data accessed in PacIOOS, NERACOOS, CARICOOS, and GLOS. Forecasts are second most common for data from PacIOOS and CARICOOS.

	Current Conditions	Forecast Conditions	Historical Data	Administrative Information	Resource Use
AOOS	37.6	15.1	28.2	3.4	8.7
CARICOOS	51.5	32.2	7.4	2.9	3.1
CenCOOS	49.5	15.9	19.5	3.6	2.0
GCOOS	47.2	12.5	18.0	6.7	4.8
GLOS	75.3	15.6	4.0	0.7	1.8
NERACOOS	59.1	16.1	20.2	0.8	1.9
PacIOOS	56.6	33.2	6.8	0.9	1.0
SCCOOS	41.2	15.4	30.0	2.3	4.8
SECOORA	44.7	15.1	20.7	3.5	4.9
All RAs	64.3	9.5	18.8	1.4	2.3

Table 9 Types of Data Accessed
(Mean Number of Times RA Data Accessed Past Year

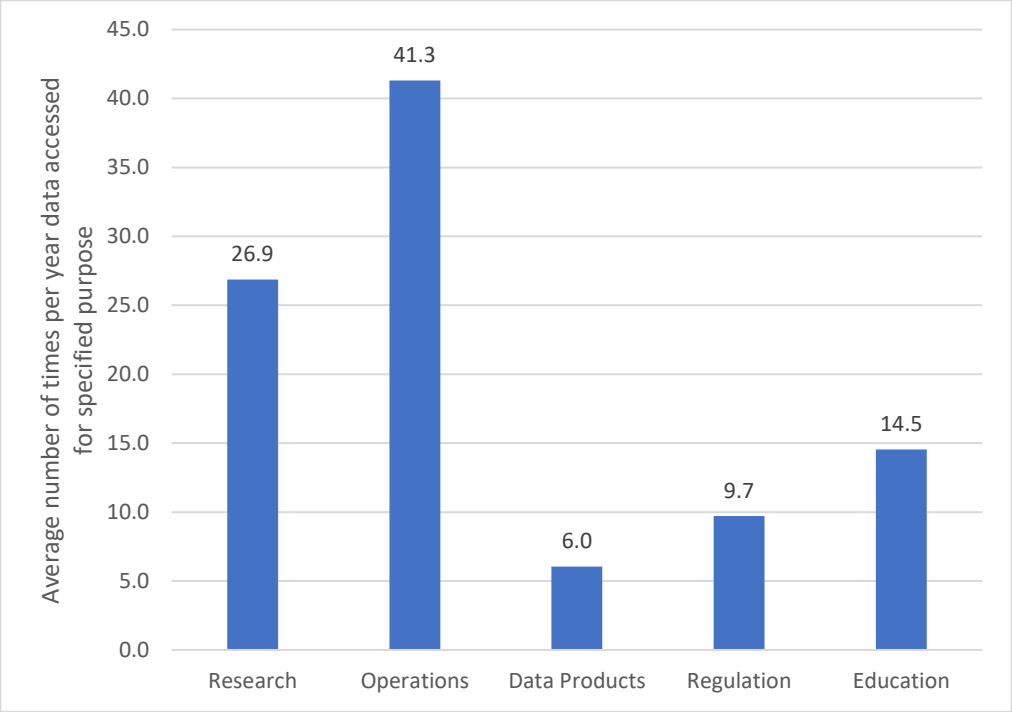
Purposes of Using Data

The purposes for which data was used by employee users are shown in

Figure 10 for the sample as a whole and Table 10 by RA. Data was primarily used to support operational decisions by employees; this was consistent with the predominance of current and forecast data accessed noted above. Operations support is the primary purpose at GLOS, again reflecting the seasonal nature of the GLOS observations. Research is the second most common purpose, particular in SCCOOS where it was the major use of data (although this is a small number of responses), and for NERACOOS where is the second use of data.

The number of data access events for educational purposes was largest for data from SECOORA, followed closely by AOOS. SCCOOS and CARICOOS had the most frequent users of data for regulatory purposes. Data for value-added products was relatively infrequently accessed. This could be because data is being accessed by direct computer to computer connections.

Figure 10 Purposes of Data Accessed by Employee Users



RA	Research	Operational Information	Inputs to Value added other data products	In support of Regulation	Educational Purposes
AOOS	32.2	24.2	6.2	8.4	21.8
CARICOOS	15.7	51.6	4.7	12.8	12.4
CenCOOS	32.5	22.5	9.0	9.3	19.1
GCOOS	38.2	5.5	17.1	8.2	31.1
GLOS	10.7	61.5	5.4	6.1	7.1
NERACOOS	25.4	57.9	6.4	9.5	10.9
PacIOOS	18.2	49.2	2.4	9.6	12.4
SCCOOS	60.5	13.3	7.4	24.8	14.0
SECOORA	41.9	15.9	5.2	5.6	22.8
All RA's	26.9	41.3	6.0	9.7	14.5

Table 10 Purposes of Data Accessed by Employee Users
(Mean Number of Times RA Data Accessed Past Year)

Figure 11 shows the use of data for individual users. The most common purpose indicated was for recreational purposes (two thirds of respondents), with most of the remainder accessing weather data . These categories may overlap as recreational users would be interest in weather and sea state conditions for trip planning.

Figure 11 Mean Number of Times Data Accessed Per Year for Indicated Purpose

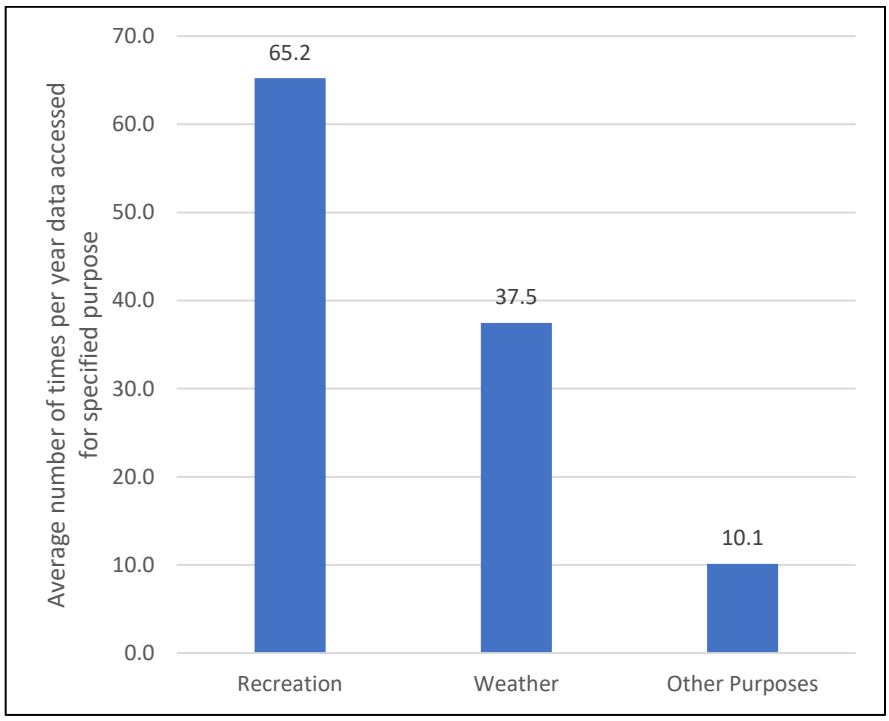


Table 11 shows the purposes for which individual users accessed data as measured by the average number of access events over the past year. Recreation related data was the primary purpose (more than 50% of access events) at CARICOOS, GLOS, and PacIOOS.

	N Respondents	Support Recreation Activities	Weather	Other
AOOS	34	35.4%	52.5%	6.2%
CARICOOS	67	56.2%	38.4%	2.4%
CenCOOS	63	45.0%	39.8%	11.8%
GCOOS	30	40.8%	38.0%	15.2%
GLOS	1310	73.0%	32.1%	3.9%
NERACOOS	153	49.2%	44.9%	5.9%
PacIOOS	284	75.5%	20.8%	3.3%
SCCOOS	13	34.8%	44.5%	13.1%
SECOORA	93	40.9%	45.4%	9.5%
Total	2047	67.4%	33.0%	4.7%

Table 11 Purposes of Data Accessed by Individual Users by Regional Association
(Mean Number of Times RA Data Accessed Past Year)

Value Estimates

The economic values of the IOOS RA data examined here are the estimates placed on the data by those who are users of the data and who responded to the survey. These values were developed from a survey process because no price is charged for the data. The information shares many of the characteristics of environmental goods and services that are also valuable but have no prices, and for which the use of surveys has been standard for process for degerming valuation for many years. (Freeman et al., 2014; Mitchell & Carson, 1989)

The surveys utilize an estimation method called "contingent valuation." The basic approach is simple: if we do not know what people *do* pay, we ask what they *would* pay if required. Substantial research has shown that it is best to ask this question in a specific format, called a referendum format. The survey presents a description of a specific good or service to be valued, posits a mechanism by which a payment would be made (called a payment vehicle) and then asks each respondent if they would pay a specified amount of not. The respondent need only respond yes or no to the proposed amount. Since there are only two choices, this is also called a dichotomous choice approach. An extension of this idea is to ask about the acceptability of a second amount depending on the response to the first amount posed. If the first amount is approved a higher amount is proposed in the next question; if the first amount is rejected a lower amount is proposed. In this case the method is called a double bid dichotomous choice method. The valuation process requires each respondent to only answer two questions and is thus simple and quick to answer, though some time may be spent describing the good to be valued and the payment vehicle.

As with all purchasing decisions, more people will be willing to pay lower amounts than higher amounts. The variance in the number of people paying different prices is the key to estimating a willingness to pay for the population as a whole. This variance is created by asking a range of prices randomly across the entire population of respondents. The prices offered in each individual survey are randomly selected from a specified range. When the survey process is complete, the distribution of prices across the respondents should be determined by the number of possible prices offered. Thus if there are five options from low to high, then the final survey sample should have about 20% of the sample being asked about willingness to pay at each price.

For the valuation portion of this survey, the following question introduced the topic. "RA" was substituted for the name of the respective regional association in each survey. The questions were reviewed and amended based on input from the RAs.

> *In this section you will be asked whether you would continue to use the data from RA if you were asked to pay an annual subscription. Depending on your earlier response, we will ask about whether you would pay the price as an employee, as a private individual, or both.*
>
> *Please note that while we are asking what you would pay for data from RA this is only to learn about the value of the data. RA has no intention of charging users for its data.*
>
> *We will present you with a possible subscription fee and ask if you would agree to pay it*

or not. If you agree to pay the presented fee, we will ask if you would pay a somewhat higher fee. If you do not agree to pay the presented fee we will ask if you would pay a somewhat lower fee.

If the respondent had indicated in an earlier question that they used the data as an employee (or both) they were then asked:

*In terms of the data you use **as an employee**, please indicate whether you think an annual subscription fee of **$100** would be acceptable.*

In making your decision, assume that there are no significant budget constraints on your organization. The indicated amount could be paid by your organization. Therefore your answer is based on your best professional judgment about the value of the data you use from SECOORA.

- ○ *I would pay this fee (1)*
- ○ *I would NOT pay this fee (2)*

If the answer is that they would pay this fee, the respondent is asked:
*As an employee would you still pay the indicated fee if it were **$200**?*

- ○ *I would pay the higher fee (1)*
- ○ *I would NOT pay the higher fee (2)*

If the answer is that they would not pay this fee, the respondent is asked:
*As an employee would you still pay the indicated fee if it were **$50**?*

- ○ *I would pay the lower fee (1)*
- ○ *I would NOT pay the lower fee (2)*

Similar questions were asked of people about use of the data as an individual. The amounts that were randomly posed to the survey respondents are shown in Table 12

Table 12 Bid Amounts for Double Bid Valuation

INITIAL BID	IF YES	IF NO
$100	$200	$50
$200	$400	$100
$300	$600	$150
$400	$800	$200
$500	$1,000	$250

The estimation of the values based on the answers to the questions requires a statistical analysis of the results using a technique called logistic regression, which is a way of estimating the *probability* that someone would choose "yes" to the proposed amount. The probability of choosing yes can be determined solely by the amount offered (the bid) or could be determined by a combination of the bid and other factors such as the type of data or the frequency of use. A number of computer programs can make the necessary calculations. The calculations for this study were made using programs in R developed by Aizaki et al. (2015). These programs estimate the statistical probability that each amount will be chosen by the respondents and then, based on the amounts of the prices offered (bids), what the average amount people would be willing to pay. This average must then be adjusted for the margin of error determined by the number of respondents to identify a range of possible values.

There are several different ways in which logistic regression can be done to calculate economic values. For the analysis in this report, several different strategies were examined. The choice of approach is shaped by the extent to which different formulations of the regression produce statistically significant results. That is the observed relationships in the model are unlikely to have occurred by random chance. Regressions were tested using double bids and single bids (the results of the first choice offered only) and values were related to various attributes of the users including the types of organizations for which they worked, the types of data used, and the purposes for which data was used. In general these models did not work well statistically, so a simpler approach was chosen. This approach is called a nonparametric analysis because no characteristics of the respondent (parameters) are used.

The results of the estimation of annual values per user are shown in Table 13. The estimated values can be interpreted as the mean willingness to pay a subscription fee for access to the data for the employee and individual respondents. The results using all respondents are in the first row and show an employee average value of $298.30 and an individual average value of $55.20. Table 13 also shows the number of respondents on which the estimate is based. Not everyone who responded to the survey answered the valuation questions. This was particularly the case with employee respondents.

Table 13 Estimates of Annual Average Information Value by Regional Association

	Estimated Annual Average Values		Number of Survey Responses	
	Employee	Individual	Employee	Individual
All Responses	$298.30	$55.20	588	1919
AOOS	$273.34	$59.80	65	61
CARICOOS	$195.42	$62.06	60	134
CenCOOS	$351.29	$62.17	60	63
GCOOS	$369.50	$44.53	16	28
GLOS	$300.16	$63.52	89	1100
NERACOOS	$360.63	$67.86	147	161

	Estimated Annual Average Values		Number of Survey Responses	
	Employee	Individual	Employee	Individual
PacIOOS	$96.85	$70.59	54	258
SCCOOS	$289.63	$95.51	38	26
SECOORA	$215.53	$51.53	59	88

The amount that people indicated as a value for employment-related data ranged from $369.50 to $96.85 per year .. For individuals, the value ranged from $95.51 to $44.53. Table 14 shows the calculated sample error for all respondents to the value questions and for each of the RAs, along with the high and low estimates based on the standard error and the mean value.

Table 14 Average Annual Values Adjusted for Sample Error by RA

	Sample Error (Plus or Minus)		Employee		Individual	
	Employee	Individual	Low Estimate	High Estimate	Low Estimate	High Estimate
All Responses	0.046	0.022	$284.58	$312.02	$53.99	$56.41
AOOS	0.120	0.125	$240.54	$306.14	$52.33	$67.28
CARICOOS	0.125	0.085	$170.99	$219.85	$56.78	$67.34
CenCOOS	0.125	0.122	$307.38	$395.20	$54.59	$69.75
GCOOS	0.240	0.185	$280.82	$458.18	$33.84	$52.77
GLOS	0.103	0.023	$269.24	$331.08	$62.06	$64.98
NERACOOS	0.080	0.076	$331.78	$389.48	$62.70	$73.02
PacIOOS	0.130	0.061	$84.26	$109.44	$66.28	$74.90
SCCOOS	0.160	0.185	$243.29	$335.97	$77.84	$113.18
SECOORA	0.128	0.103	$187.94	$243.12	$46.22	$56.84

The sample error shows the range within which there is a 95% probability that the surveyed populations values represent the entire population's values. Thus for all employee respondents, the standard error was .04 or 4%, meaning that there is a 95% probability that the population average value lies between $174.10 and $188.42, with a mean (from Table 13) of $181.26. Since .04 is less than the standard of .05, this result is said to be *statistically significant*. On the other hand, the sample error for the SCCOOS employee respondents was 0.18 (18.5%) which is well below the standard of .05. For SCCOOS, the estimated annual average values for employees range from $243.29 to $334.97 and for individuals between $77.84 and $113.18. Both results are equally likely. That is, it is not possible to tell the average values are at either end of the range or anywhere in between.

Figure 12 Estimated Employee Values Adjusted for Sample Error

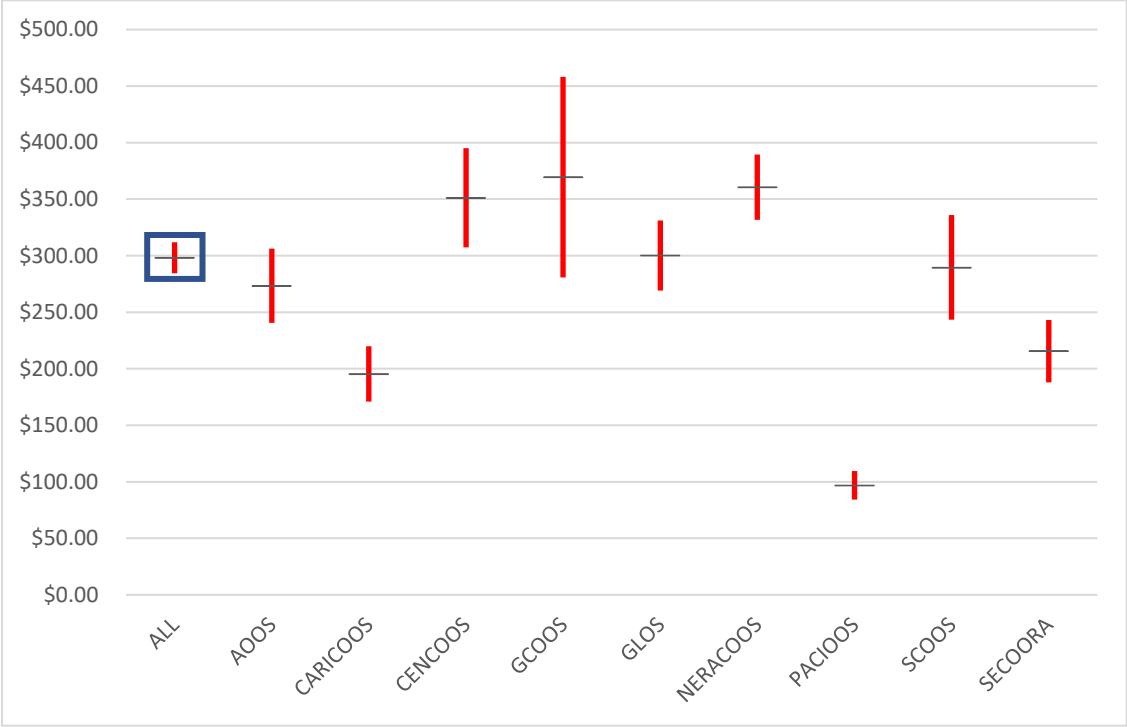


Figure 13 Estimated Individual Values Adjusted for Sample Error

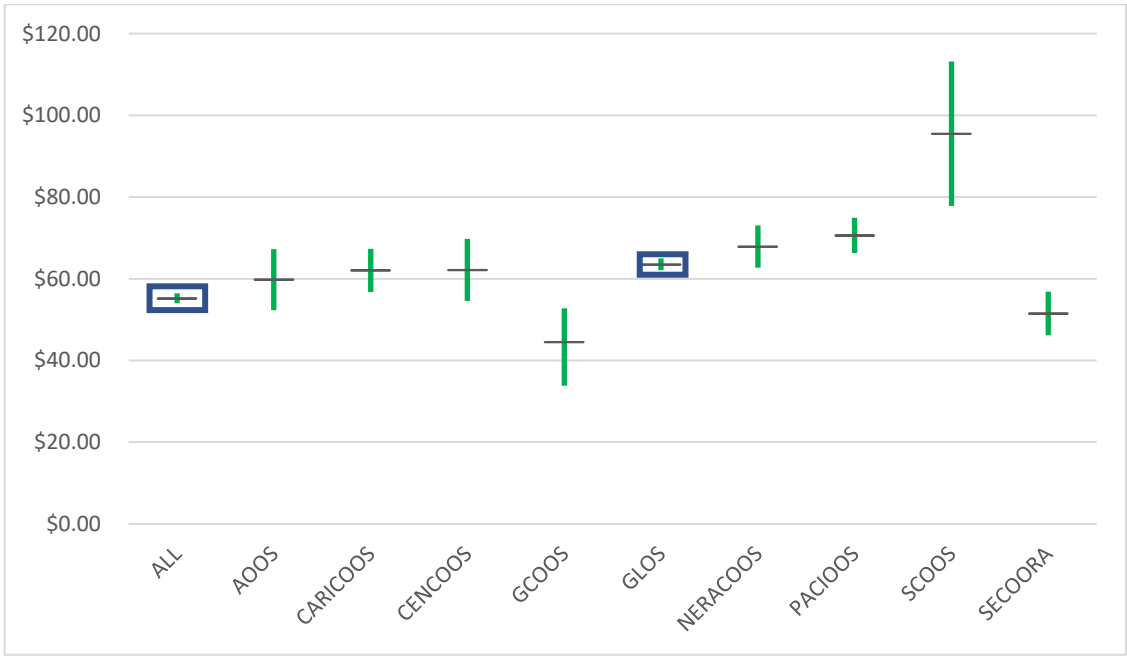


Figure 12 and Figure 13 illustrate the importance of sample size to the reliability of results. The appropriate sample size in any survey is a function of several factors but the

generally accepted standard is that the sample estimate should not differ from what the true population value would be by more than plus or minus 5%.[2] by showing that a large enough sample minimizes the possible difference between the sample's responses to the survey and a small sample increases the range of statistically valid estimates.

Another way to understand the importance of sample size and thus sample error is shown in Figure 12 for employee use values and Figure 13 for individual use values which show the mean estimated value (horizontal lines) and the range of estimates determined by the sample error (the vertical lines). Those results that are statistically significant levels of sample errors are surrounded by a box. It will be noted from Table 14 and Figure 12 that no RA had sufficient employee responses but that the combination of all employee responses is at a statistically significant level. This is a function of fewer employee respondents and a smaller proportion of those respondents answering the value questions. There were sufficient individual respondents for GLOS and PacIOOS to provide statistically significant results.

The discussions of statistical significance are all premised on margins of errors calculated separately for employee and individual users, and the totals are then based on the proportions of total users of each user type. But the proportions of user types are themselves a function of the survey with, in some cases, high overall margins of error. Establishing the proportions of user type is thus critical to all estimates of values. This can be done by using a simple gateway question in which the user responds with their self-designated user type (employee, individual, or both). Collecting this data for each visitor and each visit would provide a much more accurate measure of this critical variable.

The question of whether there are differences in values based on the type of data used or based on the purposes for which data is used. Unfortunately, the small samples in most of the RAs means that the subpopulations of different data users are too small to conduct useful analysis, so these estimates are for the sample as a whole. Table 15 shows the results.

Table 15 Economic Values of Types of Data and Purpose For Which Data is Used

		Average Annual Value	N of observations	Statistical Significance
Type of Data Used (both individual and employee users)	Current Conditions	$110.63	2,147	0.01
	Forecasts	$119.49	1,293	>.05
	Historical Conditions	$167.96	928	>.05
	Administrative Information	$189.78	207	>.05
	Resource Management	$159.38	261	>.05
	Research	$368.94	322	>.05
	Operations	$287.99	384	>.05

[2] Statisticians refer to a sample as being "statistically significant" if the standard error, or margin of error is .05 or smaller.

		Average Annual Value	N of observations	Statistical Significance
Purpose of Data Use Employees	Development of New Data Products	$466.60	124	0.01
	Regulatory Support	$371.56	161	>.05
	Education	$273.86	246	>.05
Purpose of Data Use Individual	Recreation	$84.01	1,709	0.05
	General Information	$99.28	1,442	>.05

The types of data used were common between individual and employee users and so estimated values lie between the lower individual and higher employee values. The most valuable information used is "Administrative Information" at a mean of $189.78. The lowest valued is current condition information at $110.63, but this figure is affected by the large number of individual users in the GLOS sample. Notably the Current Conditions information value is also the only type with a statistically significant result in a logistic regression using each information type as an explanatory variable of the value. Again, this is likely related to the large number of individual respondents in the Great Lakes who use GLOS for boating information. This is reinforced in the relatively high value for recreation information among individual users, which is also statistically significant.

Among data purposes for employee users, the highest value is data used for the development of new data products. The annual average value of $466.90 is also statistically significant at the .01 level (standard error of plus or minus 1%). The lowest value is for educational purposes at $273.86. These values are consistent with what might be expected. The high value for RA data as an input for data products is likely associated with the clear value chain in this use. Organizations know what the ultimate data product will be, and in many cases what can be charged for it. On the other hand, the ultimate value of data used in education products is likely set by employees of academic organizations with smaller budget and less known about ultimate values.

The final calculation estimates the total economic value of ocean observing as represented by the survey sample. Since the average willingness to pay has been calculated, the total values can be estimated by multiplying the average by the total number of users. For this purpose, each RA was asked for the total number of individual users of the website in 2020. The number of users was estimated from the web site analytic services employed by each of the RAs. The total users were divided into employee and individual users based on the proportions reported in the survey; those who reported using the website for both purposes were counted as employees. The results of multiplying the average economic value by the total number of users of each type are shown in Table 16.

Table 16 shows, for each RA the total estimated value derived by multiplying the regional mean value (in millions of dollars) from Table 13 by the number of users of each RA in 2020.

The results show a mean for all survey respondents of $160.637 million per year for employee users $41.557 million per for individual users. The resulting total value to users of ocean observing systems is estimated as $202.193 million.

Table 16 Total Economic Values for Observing Systems Data (Millions of Dollars per year

RA	Data	Employee	Individual	Total
AOOS	Users	20,223	10,371	30,594
	Regional Mean Value	$273.34	$59.80	
	Total Value @ Region Mean $M	$5.53	$0.62	$6.15
	Total Value @ All Sample Mean $M	$6.03	$0.57	$6.61
CARICOOS	Users	47,115	61,613	108,728
	Regional Mean Value	$195.42	$62.06	
	Total Value @ Region Mean $M	$9.21	$3.82	$13.03
	Total Value @ All Sample Mean $M	$14.05	$3.40	$17.46
CenCOOS	Users	33,611	22,408	56,019
	Regional Mean Value	$351.29	$62.17	
	Total Value @ Region Mean $M	$11.81	$1.39	$13.20
	Total Value @ All Sample Mean $M	$10.03	$1.24	$11.26
GCOOS	Users	70,115	79,163	149,278
	Regional Mean Value	$369.50	$44.53	
	Total Value @ Region Mean $M	$25.91	$3.53	$29.43
	Total Value @ All Sample Mean $M	$20.92	$4.37	$25.29
GLOS	Users	19,871	219,407	239,278
	Regional Mean Value	$300.16	$63.52	
	Total Value @ Region Mean $M	$5.96	$13.94	$19.90
	Total Value @ All Sample Mean $M	$5.93	$12.11	$18.04
NERACOOS	Users	36,886	19,133	56,019
	Regional Mean Value	$360.63	$67.86	
	Total Value @ Region Mean $M	$13.30	$1.30	$14.60
	Total Value @ All Sample Mean $M	$11.00	$1.06	$12.06
PacIOOS	Users	88,981	225,219	314,200
	Regional Mean Value	$96.85	$70.59	
	Total Value @ Region Mean $M	$8.62	$15.90	$24.52
	Total Value @ All Sample Mean $M	$26.54	$12.43	$38.98
SCCOOS	Users	160,395	49,100	209,495

RA	Data	Employee	Individual	Total
	Regional Mean Value	$289.63	$95.51	
	Total Value @ Region Mean $M	$46.46	$4.69	$51.14
	Total Value @ All Sample Mean $M	$47.85	$2.71	$50.56
SECOORA	Users	48,482	59,847	108,329
	Regional Mean Value	$215.53	$51.53	
	Total Value @ Region Mean $M	$10.45	$3.08	$13.53
	Total Value @ All Sample Mean $M	$14.46	$3.30	$17.77
TOTAL ALL RA's	Users	525,680	746,260	1,122,662
	All RA Value	$298.30	$55.20	
	Total Value @ All Respondents Value $M	**$156.810**	**$41.194**	**$198.004**

These are statistically significant results, with a standard error 4.6% for employee values and 2.2% for individual values (Table 14). Using these standard errors, there is a 95% chance that the total value lies between $188.896 and $228.845 million. (Table 18)

Table 17 Total Economic Value Adjusted for Sample Error

Employee	
Low	High
$149.597	$164.024
Individual	
Low	High
$39.299	$64.822
Total	
Low	High
$188.896	$228.845

Estimating the values for each RA is more difficult because of the large variance in the number of responses to the valuation questions among the RAs. There are two ways to address this problem in small-response RAs. The first is to use the all-sample estimated values for the region's values. The second is to calculate the range of possible values using the standard error.

The first approach is shown in Table 18. For each of the RAs, the total value is calculated two ways. The first is to use the mean values estimated for each RA and the second is to estimate using the sample-wide result. As noted, the small number of respondents in several RAs raises a question of whether the resulting value should be used and the results from all RAs used. Table 18 compares the total values estimated using the regional value and the all sample value by

calculating the ratio between the two (expressed as a percent). Regional values smaller than the all-sample values are negative numbers and shown in red.

Employee-user values calculated using the regional means are half above and half below the all-sample-based estimates, while individual user values are mostly higher using the regional sample than the all-sample based estimated values. For RAs where the differences are small such as GLOS and SECOORA employee values, the regional value or all-sample value can be used with some confidence. For regions where the differences are quite large, such as PacIOOS for employees and SCCOOS for individuals, a total value using the regional mean should probably not be reported. In this case the range of estimated values as determined by the standard error as shown below should be used.

Total value at regional mean value as percent of value at sample value		
	Employee	Individual
AOOS	-8.4%	8.3%
CARICOOS	-34.5%	12.4%
CenCOOS	17.8%	12.6%
GCOOS	23.9%	-19.3%
GLOS	0.6%	15.1%
NERACOOS	20.9%	22.9%
PacIOOS	-67.5%	27.9%
SCCOOS	-2.9%	73.0%
SECOORA	-27.7%	-6.6%

Table 18 Comparison of Total Values Using Regional and All-Sample Means

The total values for each RA adjusted for sample error based on the number of respondents to the valuation questions are shown in Table 19. There are two ways to use this table. One is to report that for a specific RA the total user value has a 95% chance of being between the low estimate and the high estimate. For example, for AOOS, it can be reported that "there is a 95% chance that the value of services is between $8.84 million and $11.26 million." The alternative is to report the low estimate only and denote it as a "conservative" estimate. For example, "a conservative estimate of the value of AOOS ocean observations is $8.84 million per year".

Table 19 Total Economic Values by RA Adjusted for Sample Error

	Employee		Individual		Total		Margin of Error	
	Low	High	Low	High	Low	High	Employee	Individual
AOOS	$7.95	$10.12	$0.89	$1.14	$8.84	$11.26	0.120	0.125
CARICOOS	$8.06	$10.36	$3.50	$4.15	$11.56	$14.51	0.125	0.085

	Employee		Individual		Total		Margin of Error	
	Low	High	Low	High	Low	High	Employee	Individual
CenCOOS	$10.33	$13.28	$1.22	$1.56	$11.55	$14.85	0.125	0.122
GCOOS	$19.69	$32.13	$2.87	$4.18	$22.56	$36.30	0.240	0.185
GLOS	$5.35	$6.58	$13.62	$14.26	$18.97	$20.84	0.103	0.023
NERACOOS	$10.12	$11.88	$0.98	$1.14	$11.10	$13.02	0.080	0.076
PacIOOS	$7.50	$9.74	$14.93	$16.87	$22.43	$26.61	0.130	0.061
SCCOOS	$8.78	$12.12	$2.51	$3.65	$11.29	$15.78	0.160	0.185
SECOORA	$12.61	$16.31	$2.96	$3.64	$15.57	$19.96	0.128	0.103

The next section summarizes all the findings from this section by regional association and for all regional associations, providing options for how data can be presented and described.

Summary of Findings by Regional Association

Estimating economic values using surveys always raises a number of issues about the methods used and their influence on the results. For this study values were estimated using a simple statistical technique so the major issues regarding the results arise from issues of sampling design and adequacy of sample sizes. As the preceding discussion makes clear, sample size was generally inadequate to yield margin of errors at levels that are small enough that there is high confidence that the estimated results are not simply the product of random chance. This does not mean that the results, even with large margins of error, are without meaning. But it means that with high margins of error the range of possible values may be quite large and the results not terribly useful.

But ultimate this is a matter of interpretation of the results and the context in which they are used. Therefore the alternative interpretations of the findings that are laid out in the previous section should be presented so that those using the results of this study can make their own decisions about what to report. All of the data in the sections below have been presented in tables in the preceding section, but in that section they have been presented to describe the flow of the analysis process. They are reassembled here to make clear the alternative interpretations of the findings and to set out clear verbal statements of how the findings can be interpreted. Each of the RA's findings are presented in table format and then summary statements are provided for the table. Column and Row identifiers are provided in brackets for reference to the table.

Good practice would be to report the total sample size and the sample size of respondents to the valuation question and then report the average and total values, noting the lack of statistical significance in the results. Additional detail concerning employee and individual values if the context requires this information. Finally, one of two approaches could be taken to reporting alternative values, one using the entire sample average values, and one using high and low estimates computed using the RA margins of error. If the higher value is reported, it should also be reported accompanied by noting the lower value and that is not statistically possible to say which is more likely to be correct.

The context in which these results are used cannot be accurately forecast, but two examples can be given. If it is desired to put out a press release or a report in a newsletter of the values, then using the mean per user, total number of users, and total values at either the RA or all-survey can be used, noting the statistical significance of whichever result is chosen. If the intention is to compare the values to users with the costs of RA operations (however defined), then the comparison should be made with both the total values using the RA estimates and the all-survey estimates. Additionally, the low and high range values calculated using the margin of error should be used. If costs exceed any of the estimated values, it would be appropriate to redo and refine the survey to make sure that the costs do not exceed the values to users.

AOOS

	A	B	C	D	E	F	G
1		Users			Total Responses to Survey		
2		Employee	Individual	Total	Employee	Individual	Total
3		20,223	10,371	30,594	101	52	153
4		Responses to Valuation Questions			Average Value per User		
5		Employee	Individual	Total	Employee	Individual	Weighted Average
6		65	61	126	$273.34	$59.80	$200.95
7		Total for RA @ Regional Mean $Millions			Total for RA @ All RA Mean $ Millions		
8	AOOS	Employee	Individual	Total	Employee	Individual	Total
9		$5.53	$0.62	$6.15	$6.03	$0.57	$6.61
10		Margin of Error		Total Value for Employees		Total Value for Individuals	
11		Employee	Individual	Low	High	Low	High
12		12.0%	12.5%	$10.33	$13.28	$0.54	$0.70
13		Total for RA @ Regional Mean Adjusted by Margin of Error					
14		Low	High				
15		$11.55	$14.85				

- AOOS reports 30,594 users [D3] of which 20,223 [B3] are estimated to have accessed data for purposes related to their employment and 10,371 [C3] are estimated to have accessed for individual reasons.

- A total of 153 [G3] website visitors responded to the AOOS survey, of which 101 [E3] responded as employee users (or combined employee and individual users) and 52 [F2] responded as individual users.

- The average annual value per user was estimated at $273.34 [E6] for employees and $59.80 [F6]for individuals.

- The total annual value of the data services at AOOS is estimated to be $6.15 million [D9]. Of this $5.53 [B9] million is estimated as the value to employee users and $.062 million [C9] to individual users.

- Of the 153 [G3] respondents to the survey, 126 [D6] responded to the questions regarding valuation of services, 65 [B6] of which were for employment purposes and 61 [C6] for individual purposes. This meant a margin of error of 12.0% [B12] for value estimates of employees and 12.5% [C12] for value estimates of individuals. Neither of these margins or error met standard tests to distinguish results from random chance.

- There are two ways in which results can be adjusted for this high margin of error. The first way is to value AOOS services at the same average values for employees and individuals as the sample of all respondents across all RA's. In this case, the AOOS total value is estimated at $6.61 million [G9]. Employee total values would be $6.03 million [E9] and total individual values would be $0.57 million [F9].

- Alternatively, the margin of error from the AOOS sample can be used. In this case the total value of the AOOS services would lie between $11.55 million [B15] and $14.85 million. [C15]. It is not statistically possible to distinguish between these two results.

- Using the margin of error, employee values lie between $10.33 [D12] million and $13.28 [E12] million and individual values between $0.52 [F12] and $0.70 million. [G12]

CARICOOS

	A	B	C	D	E	F	G
1		Users			Total Responses to Survey		
2		Employee	Individual	Total	Employee	Individual	Total
3		47,115	61,613	108,728	89	117	206
4		Number of Responses to Valuation Questions			Average Value per User		
5		Employee	Individual	Total	Employee	Individual	Weighted Average
6		60	134	194	$195.42	$62.06	$119.85
7		Total for RA @ Regional Mean $Millions			Total for RA @ All RA Mean $ Millions		
8	CARICOOS	Employee	Individual	Total	Employee	Individual	Total
9		$11.81	$1.39	$13.20	$10.03	$1.24	$11.26
10		Margin of Error		Total Value for Employees		Total Value for Individuals	
11		Employee	Individual	Low	High	Low	High
12		12.5%	8.5%	$8.06	$10.36	$3.50	$4.15
13		Total for RA @ Regional Mean Adjusted by Margin of Error					
14		Low	High				
15		$11.56	$13.86				

- CARICOOS reports 108,728 users [D3] of which 47,115 [B3] are estimated to have accessed data for purposes related to their employment and 61,613 [C3] are estimated to have accessed for individual reasons.

- A total of 206 [G3] website visitors responded to the RA survey, of which 89 [E3] responded as employee users (or combined employee and individual users) and 117 [F2] responded as individual users.

- The average annual value per user was estimated at $195.42 [E6] for employees and $62.06 [F6]for individuals.

- The total annual value of the data services at CARICOOS is estimated to be $13.20 million [D9]. Of this $11.81 million [B9] is estimated as the value to employee users and $1.39 million [C9] to individual users.

- Of the 206 [G3] respondents to the survey, 194 [D6] responded to the questions regarding valuation of services, 60 [B6] of which were for employment purposes and 134 [C6] for individual purposes. This meant a margin of error of 12.5% [B12] for value estimates of employees and 8.5% [C12] for value estimates of individuals. Neither of these margins or error met standard tests to distinguish results from random chance.

- There are two ways in which results can be adjusted for this high margin of error. The first way is to value CARICOOS services at the same average values for employees and individuals as the sample of all respondents across all RA's. In this case, the CARICOOS total value is estimated at $11.26 million [G9]. Employee total values would be $10.03 million [E9] and total individual values would be $1.24 million [F9].

- Alternatively, the margin of error from the CARICOOS sample can be used. In this case the total value of the RA services would lie between $11.56 million [B15] and $13.86 million. [C15]. It is not statistically possible to distinguish between these two results.

- Using the margin of error, employee values lie between $8.06 million [D12] and $10.36 million [E12] and individual values between $3.50 million [F12] and $4.15 million. [G12]

CenCOOS

	A	B	C	D	E	F	G
1	CenCOOS	Users			Total Responses to Survey		
2		Employee	Individual	Total	Employee	Individual	Total
3		33,611	22,408	56,019	127	85	212
4		Responses to Valuation Questions			Average Value per User		
5		Employee	Individual	Total	Employee	Individual	Weighted Average
6		60	63	123	$351.29	$62.17	$235.64
7		Total for RA @ Regional Mean $Millions			Total for RA @ All RA Mean $ Millons		
8		Employee	Individual	Total	Employee	Individual	Total
9		$11.81	$1.39	$13.20	$10.03	$1.24	$11.26
10		Margin of Error		Total Value for Employees		Total Value for Individuals	
11		Employee	Individual	Low	High	Low	High
12		12.5%	12.2%	$10.33	$13.28	$1.22	$1.56
13		Total for RA @ Regional Mean Adjusted by Margin of Error					
14		Low	High				
15		$11.55	$14.85				

- CenCOOS reports 56,019 users [D3] of which 33,611 [B3] are estimated to have accessed data for purposes related to their employment and 22,408 [C3] are estimated to have accessed for individual reasons.

- A total of 212 [G3] website visitors responded to the CenCOOS survey, of which 127 [E3] responded as employee users (or combined employee and individual users) and 85 [F2] responded as individual users.

- The average annual value per user was estimated at $351.29 [E6] for employees and $62.17 [F6] for individuals.

- The total annual value of the data services at CenCOOS is estimated to be $13.20 [D9]. Of this $11.81 million [B9] is estimated as the value to employee users and $1.39 million [C9] to individual users.

- Of the 212 [G3] respondents to the survey, 123 [D6] responded to the questions regarding valuation of services, 60 [B6] of which were for employment purposes and 63 [C6] for individual purposes. This meant a margin of error of 12.5% [B12] for value estimates of employees and 12.2% [C12] for value estimates of individuals. Neither of these margins or error met standard tests to distinguish results from random chance.

- There are two ways in which results can be adjusted for this high margin of error. The first way is to value RA services at the same average values for employees and individuals as the sample of all respondents across all RA's. In this case, the RA total value is estimated at $11.26 million [G9]. Employee total values would be $10.03 million [E9] and total individual values would be $1.24 million [F9].

- Alternatively, the margin of error from the CenCOOS sample can be used. In this case the total value of the CenCOOS services would lie between $11.55 million [B15] and $14.85 million. [C15]. It is not statistically possible to distinguish between these two results.

- Using the margin of error, employee values lie between $10.33 million [D12] and $13.28 million [E12]and individual values between $1.22 million [F12] and $1.56 million. [G12]

GCOOS

	A	B	C	D	E	F	G
1	GCOOS	Users			Total Responses to Survey		
2		Employee	Individual	Total	Employee	Individual	Total
3		70,115	79,163	149,278	41	47	88
4		Responses to Valuation Questions			Average Value per User		
5		Employee	Individual	Total	Employee	Individual	Weighted Average
6		16	28	44	$369.50	$44.53	$197.17
7		Total for RA @ Regional Mean $Millions			Total for RA @ All RA Mean $ Millions		
8		Employee	Individual	Total	Employee	Individual	Total
9		$25.91	$3.53	$29.43	$10.03	$1.24	$11.26
10		Margin of Error		Total Value for Employees		Total Value for Individuals	
11		Employee	Individual	Low	High	Low	High
12		24.0%	18.5%	$19.69	$32.13	$2.87	$4.18
13		Total for RA @ Regional Mean Adjusted by Margin of Error					
14		Low	High				
15		$22.56	$36.30				

- GCOOS reports 149,278 users [D3] of which 70,115 [B3] are estimated to have accessed data for purposes related to their employment and 79,163 [C3] are estimated to have accessed for individual reasons.

- A total of 88 [G3] website visitors responded to the RA survey, of which 41 [E3] responded as employee users (or combined employee and individual users) and 47 [F2] responded as individual users.

- The average annual value per user was estimated at $369.50 [E6] for employees and $44.53 [F6] for individuals.

- The total annual value of the data services at GCOOS is estimated to be $29.43 million [D9]. Of this $25.91 million [B9] is estimated as the value to employee users and $3.53 million [C9] to individual users.

- Of the 88 [G3] respondents to the survey, 44 [D6] responded to the questions regarding valuation of services, 16 [B6] of which were for employment purposes and 28 [C6] for individual purposes. This meant a margin of error of 24.0% [B12] for value estimates of employees and 18.5% [C12] for value estimates of individuals. Neither of these margins or error met standard tests to distinguish results from random chance.

- There are two ways in which results can be adjusted for this high margin of error. The first way is to value GCOOS services at the same average values for employees and individuals as the sample of all respondents across all RA's. In this case, the RA total value is estimated at $11.26 million [G9]. Employee total values would be $10.03 million [E9] and total individual values would be $1.24 million [F9].

- Alternatively, the margin of error from the RA sample can be used. In this case the total value of the RA services would lie between $22.56 million [B15] and $36.30 million. [C15]. It is not statistically possible to distinguish between these two results.

- Using the margin of error, employee values lie between $19.69 million [D12] and $32.13 million [E12] and individual values between $2.87 million [F12] and $4.18 million. [G12]

GLOS

	A	B	C	D	E	F	G
1		Users			Total Responses to Survey		
2		Employee	Individual	Total	Employee	Individual	Total
3		19,871	219,407	239,278	135	1,491	1626
4		Responses to Valuation Questions			Average Value per User		
5		Employee	Individual	Total	Employee	Individual	Weighted Average
6		89	1100	1189	$300.16	$63.52	$83.17
7		Total for RA @ Regional Mean $Millions			Total for RA @ All RA Mean $ Millions		
8	GLOS	Employee	Individual	Total	Employee	Individual	Total
9		$5.96	$13.94	$19.90	$5.93	$12.11	$18.04
10		Margin of Error		Total Value for Employees		Total Value for Individuals	
11		Employee	Individual	Low	High	Low	High
12		10.3%	2.3%	$5.35	$6.58	$13.62	$14.26
13		Total for RA @ Regional Mean Adjusted by Margin of Error					
14		Low	High				
15		$18.97	$20.84				

- GLOS reports 239.278 users [D3] of which 19,871 [B3] are estimated to have accessed data for purposes related to their employment and 219,407 [C3] are estimated to have accessed for individual reasons.

- A total of 1,626 [G3] website visitors responded to the GLOS survey, of which 135 [E3] responded as employee users (or combined employee and individual users) and 1,491 [F2] responded as individual users.

- The average annual value per user was estimated at $300.16 [E6] for employees and $63.52 [F6] for individuals.

- The total annual value of the data services at GLOS is estimated to be $19.90 [D9]. Of this $5.966 million [B9] is estimated as the value to employee users and $13.94 million [C9] to individual users.

- Of the 1,626 [G3] respondents to the survey, 1,189 [D6] responded to the questions regarding valuation of services, 89 [B6] of which were for employment purposes and 1,100 [C6] for individual purposes. This meant a margin of error of 10.3% [B12] for value estimates of employees and 2.3% [C12] for value estimates of individuals. The employee value estimates are *not* statistically significant, but the individual estimates are statistically significant.

- There are two ways in which results can be adjusted for this high margin of error. The first way is to value GLOS services at the same average values for employees and individuals as the sample of all respondents across all RA's. In this case, the RA total value is estimated at $18.04 million [G9]. Employee total values would be $5.93 million [E9] and total individual values would be $12.11 million [F9].

- Alternatively, the margin of error from the RA sample can be used. In this case the total value of the RA services would lie between $18.97 million [B15] and $20.04 million. [C15]. It is not statistically possible to distinguish between these two results.

- Using the margin of error, employee values lie between $5.35 million [D12] and $6.58 million [E12] and individual values between $13.62 million [F12] and $14.68 million. [G12]

NERACOOS

	A	B	C	D	E	F	G
1		Users			Total Responses to Survey		
2		Employee	Individual	Total	Employee	Individual	Total
3		36,886	19,133	56,019	219	114	333
4		Responses to Valuation Questions			Average Value per User		
5		Employee	Individual	Total	Employee	Individual	Weighted Average
6		147	161	308	$360.63	$67.86	$260.63
7		Total for RA @ Regional Mean $Millions			Total for RA @ All RA Mean $ Millons		
8	NERACOOS	Employee	Individual	Total	Employee	Individual	Total
9		$13.30	$1.30	$14.60	$11.00	$1.06	$12.06
10		Margin of Error		Total Value for Employees		Total Value for Individuals	
11		Employee	Individual	Low	High	Low	High
12		8.0%	7.6%	$10.12	$11.88	$0.98	$1.14
13		Total for RA @ Regional Mean Adjusted by Margin of Error					
14		Low	High				
15		$11.10	$13.02				

- NERACOOS reports 56,019 users [D3] of which 36,886 [B3] are estimated to have accessed data for purposes related to their employment and 19,133 [C3] are estimated to have accessed for individual reasons.

- A total of 333 [G3] website visitors responded to the RA survey, of which 219 [E3] responded as employee users (or combined employee and individual users) and 114 [F2] responded as individual users.

- The average annual value per user was estimated at $360.63 [E6] for employees and $67.86 [F6]for individuals.

- The total annual value of the data services at NERACOOS is estimated to be $14.60 million [D9]. Of this $13.30 million [B9] is estimated as the value to employee users and $1.30 million [C9] to individual users.

- Of the 333 [G3] respondents to the survey, 308 [D6] responded to the questions regarding valuation of services, 147 [B6] of which were for employment purposes and 161 [C6] for individual purposes. This meant a margin of error of 8.0% [B12] for value estimates of employees and 7.6% [C12] for value estimates of individuals. Neither of these margins or error met standard tests to distinguish results from random chance.

- There are two ways in which results can be adjusted for this high margin of error. The first way is to value NERACOOS services at the same average values for employees and individuals as the sample of all respondents across all RA's. In this case, the NERACOOS total value is estimated at $12.06 million [G9]. Employee total values would be $11.0 million [E9] and total individual values would be $1.06 million [F9].

- Alternatively, the margin of error from the RA sample can be used. In this case the total value of the RA services would lie between $11.10 million [B15] and $13.02 million. [C15]. It is not statistically possible to distinguish between these two results.

- Using the margin of error, employee values lie between $10.12 million [D12] and $11.88 million [E12] and individual values between $0.98 million [F12] and $1.14 million. [G12]

PacIOOS

	A	B	C	D	E	F	G
1		Users			Total Responses to Survey		
2		Employee	Individual	Total	Employee	Individual	Total
3		88,981	225,219	314,200	108	275	383
4		Responses to Valuation Questions			Average Value per User		
5		Employee	Individual	Total	Employee	Individual	Weighted Average
6		147	161	308	$96.85	$70.59	$78.03
7		Total for RA @ Regional Mean $Millions			Total for RA @ All RA Mean $ Millions		
8	PacIOOS	Employee	Individual	Total	Employee	Individual	Total
9		$8.62	$15.90	$24.52	$26.54	$12.43	$38.98
10		Margin of Error		Total Value for Employees		Total Value for Individuals	
11		Employee	Individual	Low	High	Low	High
12		13.0%	6.1%	$7.50	$9.74	$14.93	$16.87
13		Total for RA @ Regional Mean Adjusted by Margin of Error					
14		Low	High				
15		$22.43	$26.61				

- PacIOOS reports 314,200 users [D3] of which 88,,981 [B3] are estimated to have accessed data for purposes related to their employment and 225,219 [C3] are estimated to have accessed for individual reasons.

- A total of 383 [G3] website visitors responded to the PacIOOS survey, of which 108 [E3] responded as employee users (or combined employee and individual users) and 275 [F2] responded as individual users.

- The average annual value per user was estimated at $96.85 [E6] for employees and $70.59 [F6]for individuals.

- The total annual value of the data services at PacIOOS is estimated to be $24.52 million [D9]. Of this $8.62 million [B9] is estimated as the value to employee users and $15.90 million [C9] to individual users.

- Of the 383 [G3] respondents to the survey, 308 [D6] responded to the questions regarding valuation of services, 147 [B6] of which were for employment purposes and 161 [C6] for individual purposes. This meant a margin of error of 13.0% [B12] for value estimates of employees and 6.1% [C12] for value estimates of individuals. Neither of these margins or error met standard tests to distinguish results from random chance.

- There are two ways in which results can be adjusted for this high margin of error. The first way is to value PacIOOS services at the same average values for employees and individuals as the sample of all respondents across all RA's. In this case, the RA total value is estimated at $38.98 million [G9]. Employee total values would be $26.54 million [E9] and total individual values would be $12.43 million [F9].

- Alternatively, the margin of error from the RA sample can be used. In this case the total value of the RA services would lie between $22.43 million [B15] and $26.61 million. [C15]. It is not statistically possible to distinguish between these two results.

- Using the margin of error, employee values lie between $7.50 million [D12] and $9.74 million [E12] and individual values between $14.93 million [F12] and $16.87 million. [G12]

SCCOOS

	A	B	C	D	E	F	G
1		Users			Total Responses to Survey		
2		Employee	Individual	Total	Employee	Individual	Total
3		160,395	49,100	209,495	70	21	91
4		Responses to Valuation Questions			Average Value per User		
5		Employee	Individual	Total	Employee	Individual	Weighted Average
6		38	26	64	$289.63	$95.51	$244.13
7		Total for RA @ Regional Mean $Millions			Total for RA @ All RA Mean $ Millions		
8	SCCOS	Employee	Individual	Total	Employee	Individual	Total
9		$46.46	$4.69	$51.14	$47.85	$2.71	$50.56
10		Margin of Error		Total Value for Employees		Total Value for Individuals	
11		Employee	Individual	Low	High	Low	High
12		16.0%	18.5%	$8.78	$12.12	$2.51	$3.65
13		Total for RA @ Regional Mean Adjusted by Margin of Error					
14		Low	High				
15		$11.29	$15.78				

- SCCOOS reports 209,485 users [D3] of which 160,395 [B3] are estimated to have accessed data for purposes related to their employment and 49,100 [C3] are estimated to have accessed for individual reasons.

- A total of 91 [G3] website visitors responded to the SCCOOS survey, of which 70 [E3] responded as employee users (or combined employee and individual users) and 21 [F2] responded as individual users.

- The average annual value per user was estimated at $289.63 [E6] for employees and $95.51 [F6]for individuals.

- The total annual value of the data services at SCCOOS is estimated to be $51.14 [D9]. Of this $46.46 million [B9] is estimated as the value to employee users and $4.69 million [C9] to individual users.

- Of the 91 [G3] respondents to the survey, 64 [D6] responded to the questions regarding valuation of services, 38 [B6] of which were for employment purposes and 24 [C6] for individual purposes. This meant a margin of error of 16.0% [B12] for value estimates of employees and 18.5% [C12] for value estimates of individuals. Neither of these margins or error met standard tests to distinguish results from random chance.

- There are two ways in which results can be adjusted for this high margin of error. The first way is to value SCCOOS services at the same average values for employees and individuals as the sample of all respondents across all RA's. In this case, the RA total value is estimated at $50.56 million [G9]. Employee total values would be $47.85 million [E9] and total individual values would be $2.71 million [F9].

- Alternatively, the margin of error from the RA sample can be used. In this case the total value of the RA services would lie between $11.29 million [B15] and $15.78 million. [C15]. It is not statistically possible to distinguish between these two results.

- Using the margin of error, employee values lie between $8.78 million [D12] and $12.12 million [E12]and individual values between $2.51 million [F12] and $3.65 million. [G12]

SECOORA

	A	B	C	D	E	F	G
1		Users			Total Responses to Survey		
2		Employee	Individual	Total	Employee	Individual	Total
3		48,482	59,847	108,329	242	299	541
4		Responses to Valuation Questions			Average Value per User		
5		Employee	Individual	Total	Employee	Individual	Weighted Average
6		59	88	147	$215.53	$51.53	$124.93
7		Total for RA @ Regional Mean $Millions			Total for RA @ All RA Mean $ Millions		
8	SECOORA	Employee	Individual	Total	Employee	Individual	Total
9		$10.45	$3.08	$13.53	$14.46	$3.30	$17.77
10		Margin of Error		Total Value for Employees		Total Value for Individuals	
11		Employee	Individual	Low	High	Low	High
12		12.8%	10.3%	$12.61	$16.31	$2.96	$3.64
13		Total for RA @ Regional Mean Adjusted by Margin of Error					
14		Low	High				
15		$15.57	$19.96				

- SECOORA reports 108,329 users [D3] of which 48,482 [B3] are estimated to have accessed data for purposes related to their employment and 59,487 [C3] are estimated to have accessed for individual reasons.

- A total of 541 [G3] website visitors responded to the RA survey, of which 242 [E3] responded as employee users (or combined employee and individual users) and 299 [F2] responded as individual users.

- The average annual value per user was estimated at $215.53 [E6] for employees and $51.53 [F6]for individuals.

- The total annual value of the data services at RA is estimated to be $13.53 million [D9]. Of this $10.445 million [B9] is estimated as the value to employee users and $3.08 million [C9] to individual users.

- Of the 541 [G3] respondents to the survey, 147 [D6] responded to the questions regarding valuation of services, 59 [B6] of which were for employment purposes and 88 [C6] for individual purposes. This meant a margin of error of 12.8% [B12] for value estimates of employees and 10.3% [C12] for value estimates of individuals. Neither of these margins or error met standard tests to distinguish results from random chance.

- There are two ways in which results can be adjusted for this high margin of error. The first way is to value SECOORA services at the same average values for employees and individuals as the sample of all respondents across all RA's. In this case, the SECOORA total value is estimated at $17.77 million [G9]. Employee total values would be $14.46 million [E9] and total individual values would be $3.30 million [F9].

- Alternatively, the margin of error from the RA sample can be used. In this case the total value of the RA services would lie between $15.57 million [B15] and $19.96 million. [C15]. It is not statistically possible to distinguish between these two results.

- Using the margin of error, employee values lie between $12.61 million [D12] and $16.31 million [E12] and individual values between $2.96 million [F12] and $3.64 million. [G12]

	A	B	C	D	E	F	G
1	ALL REGIONAL ASSOCIATIONS	Users			Total Responses to Survey		
2		Employee	Individual	Total	Employee	Individual	Total
3		525,680	746,260	1,271,940	1,133	2,500	3,633
4		Responses to Valuation Questions			Average Value per User		
5		Employee	Individual	Total	Employee	Individual	Weighted Average
6		588	1919	2507	$298.30	$55.20	$155.67
7		Total for RA @ Regional Mean $Millions			Total for RA @ All RA Mean $ Millions		
8		Employee	Individual	Total	Employee	Individual	Total
9		N/A	N/A	N/A	$156.81	$41.19	$198.00
10		Margin of Error		Total Value for Employees		Total Value for Individuals	
11		Employee	Individual	Low	High	Low	High
12		4.5%	2.2%	$149.75	$163.87	$42.70	$43.65
13		Total for RA @ Regional Mean Adjusted by Margin of Error					
14		Low	High				
15		$192.45	$207.52				

- Overall the nine RAs that participated in the survey reported 1,271,940 users [D3] of which 525,680 [B3] are estimated to have accessed data for purposes related to their employment and 746,620 [C3] are estimated to have accessed for individual reasons.

- A total of 3,633 [G3] website visitors responded to the survey, of which 1,133 [E3] responded as employee users (or combined employee and individual users) and 2,500 responded as individual users.

- The average value per users was estimated at $298.30 [E6] for employees and $55.20 [F6] for individuals.

- The total annual value of the data services at the nine RAs is estimated to be $198.0 million [G9]. Of this $156.81 [E9] million is estimated as the value to employee users and $41.19 million [F9] to individual users.

- Of the 3,633 [G3] respondents to the survey, 2,507 [D6] responded to the questions regarding valuation of services, 588 [B6] of which were for employment purposes and 1,919 [C6] for individual purposes. This meant a margin of error of 4.5% [B12] for value estimates of employees and 2.2% [C12] for value estimates of individuals. Both of these margins or error meet standard tests to distinguish results from random chance.

- If a range of results is needed, the total value of the RA services would lie between $192.45 million [B15] and $207.52 million. [C15]. It is not statistically possible to distinguish between these two results.

- Using the margin of error, employee values lie between $149.75 [D12] million and $163.87 [E12] million and individual values between $42.70 million [F12] and $43.65 million. [G12]

Conclusions

Since the emergence of IOOS regional observing systems in the 1990s, there have been questions about the economic value of the large amount of data that has become available. This is a difficult problem because the data provided by the RAs are made available without charge through downloads from the websites in accordance with the purpose of the program. These data have the characteristics of an unpriced public good and can be valued using valuation methods similar to other public goods, such as the environmental services, through the use of user surveys of willingness to pay for data.

This project was a test of a prototype approach to valuing the data and information provided by coastal observing systems in the U.S. The results showed that 1.22 million users of RA data had a total value estimates of $156.81 million per year for the who access data as for organizational (employment) purposes and $41.19 million per year for individual users, giving a total value of $198.01 million per year. Survey respondents totaled 3,631, of which 2,507 answered valuation questions meaning these results are valid plus or minus 1.6%. However, over half of the survey respondents came from only three of the RA's (PacIOOS, GLOS and SECOORA), so there may be some biases of unknown size in the results.

There was significant variation in the number of responses among the RAs. The number of responses to the valuation questions ranged from a low of 44 (GCOOS) to a high of 1,189 (GLOS). These lower number of responses meant margins of errors ranging from a low of 2.3% for individual respondents from GLOS to a high of 24% for employee respondents of GCOOS. For all but three (GLOS, SECOORA, and PacIOOS, the value estimates were not statistically significant, meaning the results could not be distinguished from answers that were randomly selected.

Respondents were asked about whether they used data as employees of an organization or as individuals or both. They were asked about the types of data they used and the purposes for which the data was used. About three quarters of the respondents used data for individual purposes, mostly monitoring real-time conditions for recreational purposes. Employment-related users were primarily from private companies, government, and academic organizations. Private sector users were primarily from fishing, recreational guiding, and consulting fields.

The values of different types and uses of data were also estimated. Of the types of data used, information on current ocean conditions had the lowest annual average value (for all respondents) of $110 63 and data on administrative information had the highest at $189.78. For employee-related uses, the lowest value was for education related uses at $273.86 per year while data being used for other data products had the highest value at $466.60. Individual users valued general information highest at $99.28. But of these values only that for current conditions and the development of new products were statistically significant.

Data acquired for the development of new data products had the highest value and the strongest statistical significance among employee-related uses, while data for recreation-related information had the strongest significance for individual uses.

Several major observations can be made from the processes used:

1. The website is a useful portal to the survey, but the wide variance in the number of responses across the RA indicates future replications of the study should consider a different approach to recruiting respondents, starting with RA email/contact lists and then supplementing these with access through the website.

2. The range of values for hypothetical annual subscriptions to the data needs to be refined. For this study, the same values were proposed to both employee and individual respondents, but the range ($50 to $1000) was clearly too high for individual respondents. A lower range of values should be used , for example from $50 to $250 ; this may result in somewhat lower value estimates, but this will likely be offset by increased confidence in the results.

3. This survey used very general descriptions of the types of data and purposes for which it is used. Additional detail on types and purposes could be provided in future surveys.

4. Given the relatively high values indicated by employee users, it is important to include those who directly access the observing data from computer connections in the valuation process. The process for doing this is likely to be unique to each RA, but including computer-connected only users will likely increase the estimated average and total values.

5. Employee user values are more than five times the values of individuals. This is logical, but it means that accurately reflecting the proportion each type in the population of users in the survey respondents is important to the final value estimates. In this study the proportion of the population users was derived from the survey since that is the only data available. Future iterations of the survey should be preceded by studies of the user population that measure the proportion of each type of user so that samples and totals can be improved.

4. Future Measurements of User Values

This was a prototype study designed to test the data collection methods and the usefulness of treating the value of ocean observing systems in a public goods, or willingness to pay format. An evaluation of the test valuation shows both positive outcomes and some issues that must be changed going forward. The study demonstrated that a survey of ocean observation data using a willingness to pay format can produce results that are consistent with economic principles and with the requirements of survey research. But weaknesses in the approach used have been identified and future replication of the study needs to address these.

The total and per respondent values estimated here may be considered stable for the next several years for the national ocean observations population and for those portions of the sample where statistically significant results are available. Updates to national total and regional values can be made by updating the number of users of each RA and recalculating the totals. However, replication of this study is recommended in a shorter time frame than five years, perhaps in 2023 for those RA's for which the number of respondents in this study were too few for a statistically significant result.

RAs wishing to update the study by increasing the number of respondents can continue to survey users using either email samples or website access. Collection of additional responses is likely to take some time as the pace of responses slows dramatically within a few weeks of the initial invitation being made (whether by email or by a link on the website). For this reason it is recommended that surveys be undertaken in waves lasting about a month and being repeated no more often than quarterly.

RAs wising to add to the existing pool of respondents should be sure to use the same survey instrument as used in the initial study. If a decision is made to alter the survey instrument as suggested below, then any responses using the new instrument should be considered a new sample and current responses not used. If a new survey instrument is to be used, it is strongly recommended that a new instrument be designed for use by all RAs in subsequent studies in order to assure consistency of data across all RAs that can be used to calculate national totals.

The technical requirements for collecting and analyzing the survey are simple and can be met with any combination of software tools. This project was accomplished using Qualtrics survey software to collect data. Analysis of all parts of the survey except for valuation was done using SAS software. The valuation analysis was done using the DCchoice module in R. Alternatives to this software include Survey Monkey or SNAP as survey software, SPSS or R for data analysis, and SAS or EViews for valuation estimates. Minimum qualifications for personnel replicating the survey are knowledge of basic statistics, linear and logistic regression and familiarity with at least one statistical program. A basic knowledge of economics is helpful.

The most important consideration in any future addition to or updating the value estimation is increasing the number of respondents, not only to the overall study but to the

valuation questions. This has to be approached in several ways, including the subpopulations of users to be targeted, the ways in which respondents are recruited, and the survey instrument itself.

The use of the website as a contact point provides a convenient means of recruiting survey respondents, but it can omit those who access observing system data through direct computer collections. This can be quite a sizable number of users. PacIOOS reports a total of 548,000 individual users, 42% of which access by server-to-server connections. This population was not included in the estimates of total values since they were not part of the surveyed population, except to the extent they were also website users and chose to participate in the survey.

To reach the server-connection only population will require that RA's identify those users and contact them by email. The survey may require some modifications as to the types of data used (not all data from an RA may be available through server connections) but the current survey should be adequate for valuation. These users would then be contacted by email and invited to respond to the survey. A link in the email would connect the user to the survey.

Another consideration in using the website as the recruitment method is that the website clearly has limitations in reaching the general population of users. The contact point on the website may be more or less visible; the number of people who opt to do the survey is limited and so after a certain point few additional responses are made; or people may be willing to do the survey, but get involved in downloading their data and do not return to the survey. An online survey with an email as an invitation provides a specific and targeted opportunity to respond to the survey. Most surveying software include an automatic reminder system for those who do not initially respond and automatic tracking of response rates relative to the sample.

To shift to an email-invitation surveys, associations require email contact lists from users. Compiling such lists will require different approaches at each association. Probably the easiest approach would if an RA offered any kind of push service of specific information to email or SMS addresses.

The second priority after securing additional responses is accurately distinguishing between employee and personal uses. This is partly because the margins of errors can be noticeably different between the two subpopulations and partly because the differences in estimated values and partly because the differences in per user values are so large. Getting the number of employee users wrong by 20% can mean well more than a 20% increase in final values. To provide a more accurate count of the user types, a regular identification question could be set up as a gateway question between the home page and the data delivery page.

It is estimated that over half the people who respond to surveys do so on portable devices, primarily phones. It is critical, therefore that the survey be provided in a format suitable for such devices; this requires using what is called responsive programming that automatically formats for whatever device is being used. Most survey software, such as Qualtrics used in the prototype

study, automatically do this. If SMS addresses are used, a URL link to the survey can be included in the SMS and the survey taken on the mobile device.

If values are to be re-estimated there are several options for measuring the values that should at least be reviewed before launching a new valuation project. These options include:

- Change the values in the double bid format. If the initial bid is accepted the second bid is set a double the initial bid; if the initial bid is rejected the second bid is half the first.

- The resulting estimates of willingness to pay tended towards the lower end of the range of possible prices, which suggests few accepted the higher bids. It may be possible to increment the bids by fixed amounts (say $100) rather than proportional amounts.

- Reduce the range of bids for individuals from $50 to $1000 (currently the same as for employees) to a lower range, for example: This is highly recommended for use in a new valuation process that replaces the prototype process.

Initial Amount	Bid 1	Bid 2
$50	$100	$25
$100	$50	$150
$150	$200	$100
$200	$150	$250
$250	$200	$150

- Reusing the double bid valuation process in the current survey. This is recommended if additional responses are to be added to data collected from the prototype survey data.

- Change to a single-bid dichotomous choice survey. A single bid survey omits the second subsequent bid and just focuses on one bid. Considerations of the time respondents spend on the survey may play a role in the choice and double bids do offer the opportunity explore responses to higher values. But the literature on dichotomous choice surveys does not offer clear cut evidence of the superiority of single v. double bid approaches, though single bid surveys are becoming more common.

- Choice of estimating models. The estimating model (the specific relationship between the decision to accept or reject a bid and the factors affecting that decision) used in this study related the decision solely to the size of the bid. It is possible to test for other factors that might affect the bid. In the analysis for this study, a number of variables were tested as possible influences, primarily for the type of data or purpose of data

use. None proved to provide statistically significant influence on the decision and so none were used in the final analysis. But other variables could be tested such as the type of organization or other user characteristics might prove useful.

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Appendix A: Survey Instrument

IOOS DBDC

Q1.1
Center for the Blue Economy Survey on the Economic Value of Ocean Observing Systems

Introduction

Thank you for your interest in providing information about the value of the data that you have accessed from the RA. This study is being conducted on behalf of RA and the Integrated Ocean Observing System Association by the Center for the Blue Economy of the Middlebury Institute of International Studies at Monterey. Your assistance with the survey will help RA and the IOOS Association to better understand the value of the data that they deliver and to plan for improved services in the future.

Your responses are entirely voluntary, and you may refuse to complete any part or all of this survey. Your responses will be anonymous. By completing and submitting the survey, you affirm that you are at least 18 years old and that you give your consent for the Center for the Blue Economy to use your answers in this research.

If you have any questions about this research before or after you complete the survey, please contact Dr. Charles Colgan at ccolgan@middlebury.edu. If you have any concerns or questions about your rights as a participant in this research, please contact the Chair of the Middlebury College Institutional Review Board at irb@middlebury.edu.

Please indicate if you agree to continue the survey:

- ○ I agree to continue (4)
- ○ No thanks. Take me to the exit (5)

Skip To: End of Survey If Center for the Blue Economy Survey on the Economic Value of Ocean Observing Systems Introducti... = No thanks. Take me to the exit

End of Block: Introduction

Start of Block: User Characteristics

Q2.1 This section asks about you as a user of data from SECOORA. Do you access the data through the website or do you directly access data through server to server connections or both?

- ○ Website only (1)
- ○ Server to Server connections only (2)
- ○ Both (3)

Q2.2
Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment, as a private individual, or both?

- ○ As part of my employment (1)
- ○ As a private individual (2)
- ○ Both (3)
- ○

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As part of my employment

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q2.3 About how many times did you access the SECOORA data over the past 12 months **as an employee?** Your best guess will do. This should include both accessing data from the website and through direct server connections.

- ○ <10 (4)
- ○ 10-19 (7)
- ○ 20-29 (8)
- ○ 30-39 (9)
- ○ 40-49 (10)
- ○ 50-74 (11)
- ○ 75-99 (12)

- ○ 100-149 (13)
- ○ 150-199 (14)
- ○ >200 (15)
- ○

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As a private individual

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q2.4 About how many times did you access the SECORRA website over the past 12 months **as a private individual?** Your best guess will do.

- ○ <10 (4)
- ○ 10-19 (7)
- ○ 20-29 (8)
- ○ 30-39 (9)
- ○ 40-49 (10)
- ○ 50-74 (11)
- ○ 75-99 (12)
- ○ 100-149 (13)
- ○ 150-199 (14)
- ○ >200 (15)

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As part of my employment

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q2.5 If you accessed the SECOORA website over the past 12 months as part of your employment, which of the following best describes the organization for which you accessed the data. If more than one applies, indicate the organization type for which you worked a majority of time.

- ○ Government or Native American agencies (including contractors) (1)
- ○ Private company (2)
- ○ Nongovernmental Organization (3)
- ○ Academic Institution (4)
- ○ Other (please describe) (5) _____

Skip To: Q2.6 If If you accessed the SECOORA website over the past 12 months as part of your employment, which of... = Government or Native American agencies (including contractors)

Skip To: Q2.7 If If you accessed the SECOORA website over the past 12 months as part of your employment, which of... = Private company

Skip To: End of Block If If you accessed the SECOORA website over the past 12 months as part of your employment, which of... = Nongovernmental Organization

Skip To: End of Block If If you accessed the SECOORA website over the past 12 months as part of your employment, which of... = Academic Institution

Skip To: End of Block If If you accessed the SECOORA website over the past 12 months as part of your employment, which of... = Other (please describe)

Display This Question:

If If you accessed the SECOORA website over the past 12 months as part of your employment, which of... = Government or Native American agencies (including contractors)

Q2.6 Please indicate the type of governmental organization for which you work. Your selection should be based on the specific part of the organization in which you work.

- ○ Resource management (such as fisheries or land use) (1)
- ○ Public safety/law enforcement (2)
- ○ Weather/Climate (3)
- ○ Environmental Management (such as pollution control) (4)
- ○ Other (please describe) (5) _____

Display This Question:

If If you accessed the SECOORA website over the past 12 months as part of your employment, which of... = Private company

Q2.7 Please indicate the type of private company (or the part of the company) on whose behalf you access data. Pick the one that is closest to your work.

- ○ Commercial Fishing (1)
- ○ Commercial Shipping (2)
- ○ Aquaculture (3)
- ○ Recreational Guiding/Tours (4)
- ○ Consulting (5)
- ○ Oil and Gas (6)
- ○ Renewable Energy (7)
- ○ Insurance/Reinsurance (8)
- ○ Value Added Data Provider (9)
- ○ Other (please describe) (10) _____

Q3.1 *How you use observing data*

Thinking of all the times over the past 12 month you accessed data from SECOORA, please provide **your best estimate** of the percent of each type of data that you used. Please enter whole numbers, without punctuation or decimals. (i.e., enter 50, NOT 50% or 0.5) The entries should sum to 100.

Data on current (real time) conditions : _____ (1)
Data from models or forecasts of conditions : _____ (2)
Historical data : _____ (3)
Administrative data (boundaries, management areas, etc. : _____ (4)
Resource utilization data (e.g. fisheries landings) : _____ (5)
Other (please describe) : _____ (6)
Total : _____

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As part of my employment

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q3.2 Thinking of all the times you accessed data from SECOORA over the past 12 months **for your employmen**t, please provide your best estimate of the proportion of each of the following data types that you accessed. Please enter whole numbers, without punctuation or decimals. (e.g., enter 50, NOT 50% or 0.5) The entries should sum to 100.

Basic or applied research : _____ (1)
To support operational decisions : _____ (2)
To develop new data products : _____ (3)
To inform regulatory-related activities : _____ (4)
Education-related purposes : _____ (5)
Other : _____ (6)
Total : _____

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As a private individual

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q3.3 Thinking of all the times you accessed data from SECOORA over the past 12 months **as a private individua**l, please provide your best estimate of the proportion of each of the following

data types that you accessed. Please enter whole numbers without decimals. The entries should sum to 100.
Information to help decide about recreational uses of the ocean : _____ (1)
General information about weather/sea conditions : _____ (2)
Other (please describe) : _____ (3)
Total : _____

Q4.1
Your estimation of the value of the data

In this section you will be asked whether you would continue to use the data from SECOORA if you were asked to pay an annual subscription. Depending on your earlier response, we will ask about whether you would pay the price as an employee, as a private individual, or both.

Please note that while we are asking what you would pay for data from SECOORA this is only to learn about the value of the data. SECOORA has no intention of charging users for its data.

We will present you with a possible subscription fee and ask if you would agree to pay it or not. If you agree to pay the presented fee, we will ask if you would pay a somewhat higher fee. If you do not agree to pay the presented fee we will ask if you would pay a somewhat lower fee.

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As part of my employment

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q5.1 In terms of the data you use **as an employee**, please indicate whether you think an annual subscription fee of **$100** would be acceptable.

In making your decision, assume that there are no significant budget constraints on your organization. The indicated amount could be paid by your organization. Therefore your answer is based on your best professional judgment about the value of the data you use from SECOORA.

- ○ I would pay this fee (1)
- ○ I would NOT pay this fee (2)

Display This Question:

If In terms of the data you use as an employee, please indicate whether you think an annual subscrip... = I would pay this fee

Q5.2 As an employee would you still pay the indicated fee if it were **$200**?

- I would pay the higher fee (1)
- I would NOT pay the higher fee (2)
- Display This Question:

If In terms of the data you use as an employee, please indicate whether you think an annual subscrip... = I would NOT pay this fee

Q5.3 As an employee would you pay the fee if it were $**50**?

- I would pay the lower fee (1)
- I would NOT pay the lower fee (2)

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As a private individual

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q5.4 In terms of the data you use **a private individual**, please indicate whether you think an annual subscription fee of $100 *dollars* would be acceptable.

- I would pay this fee (1)
- I would NOT pay this fee (2)

Display This Question:

If In terms of the data you use a private individual, please indicate whether you think an annual su... = I would pay this fee

Q5.5 As a private individual would you still pay the indicated fee if it were **$200**?

- I would pay the higher fee (1)
- I would NOT pay the higher fee (2)

Display This Question:

If In terms of the data you use a private individual, please indicate whether you think an annual su... = I would NOT pay this fee

Q5.6 As a private individual would you pay the fee if it were **$50**?

- I would pay the lower fee (1)
- I would NOT pay the lower fee (2)

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As part of my employment

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q6.1 In terms of the data you use **as an employee**, please indicate whether you think an annual subscription fee of **$200** would be acceptable.

In making your decision, assume that there are no significant budget constraints on your organization. The indicated amount could be paid by your organization. Therefore your answer is based on your best professional judgment about the value of the data you use from SECOORA.

- I would pay this fee (1)
- I would NOT pay this fee (2)
-

Display This Question:

If In terms of the data you use as an employee, please indicate whether you think an annual subscrip... = I would pay this fee

Q6.2 As an employee would you still pay the indicated fee if it were **$400**?

- ○ I would pay the higher fee (1)
- ○ I would NOT pay the higher fee (2)

Display This Question:

If In terms of the data you use as an employee, please indicate whether you think an annual subscrip... = I would NOT pay this fee

Q6.3 As an employee would you pay the fee if it were **$100**?

- ○ I would pay the lower fee (1)
- ○ I would NOT pay the lower fee (2)

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As a private individual

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q6.4 In terms of the data you use **a private individual**, please indicate whether you think an annual subscription fee of $200 *dollars* would be acceptable.

- ○ I would pay this fee (1)
- ○ I would NOT pay this fee (2)

Display This Question:

If In terms of the data you use a private individual, please indicate whether you think an annual su... = I would pay this fee

Q6.5 As a private individual would you still pay the indicated fee if it were **$400**?

- ○ I would pay the higher fee (1)
- ○ I would NOT pay the higher fee (2)

Display This Question:

If In terms of the data you use a private individual, please indicate whether you think an annual su... = I would NOT pay this fee

Q6.6 As a private individual would you pay the fee if it were **$100**?

- I would pay the lower fee (1)
- I would NOT pay the lower fee (2)

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As part of my employment

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q7.1 In terms of the data you use **as an employee**, please indicate whether you think an annual subscription fee of **$300** would be acceptable.

In making your decision, assume that there are no significant budget constraints on your organization. The indicated amount could be paid by your organization. Therefore your answer is based on your best professional judgment about the value of the data you use from SECOORA.

- I would pay this fee (1)
- I would NOT pay this fee (2)

Display This Question:

If In terms of the data you use as an employee, please indicate whether you think an annual subscrip... = I would pay this fee

Q7.2 As an employee would you still pay the indicated fee if it were **$600**?

- I would pay the higher fee (1)
- I would NOT pay the higher fee (2)

Display This Question:

If In terms of the data you use as an employee, please indicate whether you think an annual subscrip... = I would NOT pay this fee

Q7.3 As an employee would you pay the fee if it were **$150**?

- I would pay the lower fee (1)
- I would NOT pay the lower fee (2)

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As a private individual

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q7.4 In terms of the data you use **a private individual**, please indicate whether you think an annual subscription fee of $300 *dollars* would be acceptable.

- I would pay this fee (1)
- I would NOT pay this fee (2)

Display This Question:

If In terms of the data you use a private individual, please indicate whether you think an annual su... = I would pay this fee

Q7.5 As a private individual would you still pay the indicated fee if it were **$600**?

- I would pay the higher fee (1)
- I would NOT pay the higher fee (2)
-

Display This Question:

If In terms of the data you use a private individual, please indicate whether you think an annual su... = I would NOT pay this fee

Q7.6 As a private individual would you pay the fee if it were **$150**?

- I would pay the lower fee (1)
- I would NOT pay the lower fee (2) End of Block: Subscription 300

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As part of my employment

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q8.1 In terms of the data you use **as an employee**, please indicate whether you think an annual subscription fee of **$400** would be acceptable.

In making your decision, assume that there are no significant budget constraints on your organization. The indicated amount could be paid by your organization. Therefore your answer is based on your best professional judgment about the value of the data you use from SECOORA.

- ○ I would pay this fee (1)
- ○ I would NOT pay this fee (2)

Display This Question:

If In terms of the data you use as an employee, please indicate whether you think an annual subscrip... = I would pay this fee

Q8.2 As an employee would you still pay the indicated fee if it were **$800**?

- ○ I would pay the higher fee (1)
- ○ I would NOT pay the higher fee (2)

Display This Question:

If In terms of the data you use as an employee, please indicate whether you think an annual subscrip... = I would NOT pay this fee

Q8.3 As an employee would you pay the fee if it were **$200**?

- ○ I would pay the lower fee (1)
- ○ I would NOT pay the lower fee (2)

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As a private individual

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q8.4 In terms of the data you use **a private individual**, please indicate whether you think an annual subscription fee of $400 *dollars* would be acceptable.

- ○ I would pay this fee (1)
- ○ I would NOT pay this fee (2)

Display This Question:

If In terms of the data you use a private individual, please indicate whether you think an annual su... = I would pay this fee

Q8.5 As a private individual would you still pay the indicated fee if it were **$800**?

- ○ I would pay the higher fee (1)
- ○ I would NOT pay the higher fee (2)

Display This Question:

If In terms of the data you use a private individual, please indicate whether you think an annual su... = I would NOT pay this fee

Q8.6 As a private individual would you pay the fee if it were **$200**?

- I would pay the lower fee (1)
- I would NOT pay the lower fee (2) Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As part of my employment

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q9.1 In terms of the data you use **as an employee**, please indicate whether you think an annual subscription fee of **$500** would be acceptable.

In making your decision, assume that there are no significant budget constraints on your organization. The indicated amount could be paid by your organization. Therefore your answer is based on your best professional judgment about the value of the data you use from SECOORA.

- I would pay this fee (1)
- I would NOT pay this fee (2)

Display This Question:

If In terms of the data you use as an employee, please indicate whether you think an annual subscrip... = I would pay this fee

Q9.2 As an employee would you still pay the indicated fee if it were **$1000**?

- I would pay the higher fee (1)
- I would NOT pay the higher fee (2)

Display This Question:

If In terms of the data you use as an employee, please indicate whether you think an annual subscrip... = I would NOT pay this fee

Q9.3 As an employee would you pay the fee if it were **$250**?

- I would pay the lower fee (1)
- I would NOT pay the lower fee (2)
-

Display This Question:

If Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = As a private individual

Or Over the past 12 months, when you accessed SECOORA data did you do so as part of your employment,... = Both

Q9.4 In terms of the data you use **a private individual**, please indicate whether you think an annual subscription fee of $400 *dollars* would be acceptable.

- I would pay this fee (1)
- I would NOT pay this fee (2)

Display This Question:

If In terms of the data you use a private individual, please indicate whether you think an annual su... = I would pay this fee

Q9.5 As a private individual would you still pay the indicated fee if it were **$800**?

- I would pay the higher fee (1)
- I would NOT pay the higher fee (2)

Display This Question:

If In terms of the data you use a private individual, please indicate whether you think an annual su... = I would NOT pay this fee

Q9.6 As a private individual would you pay the fee if it were **$200**?

- I would pay the lower fee (1)
- I would NOT pay the lower fee (2)

Appendix B: SAS Code

1. Create format for question values (SPSS, value labels)

```
proc format;
      value       usetype
                        1='Employment'
                        2='Individual'
                        3='Both';
      value       $usetype
                        1='Employment'
                        2='Individual'
                        3='Both';

      value $frequse
                        4='<10'
                        7='10-19'
                        8='20-29'
                        9='30-39'
                        10='40-49'
                        11='50-74'
                        12='75-99'
                        13='100-149'
                        14='150-199'
                        15='>200';
      value frequse
                        4='<10'
                        7='10-19'
                        8='20-29'
                        9='30-39'
                        10='40-49'
                        11='50-74'
                        12='75-99'
                        13='100-149'
                        14='150-199'
                        15='>200';
      value  $emptype
                        1='Government'
                        2='Private company'
                        3='NGO'
                        4='Academic'
                        5='Other';
      value  emptype
                        1='Government'
                        2='Private company'
                        3='NGO'
                        4='Academic'
                        5='Other';
      value  $govtype
                        1='Resource Management'
                        2='Public Safety'
                        3='Weather/Climate'
                        4='Environmental Management'
                        5='Other';
      value  govtype
```

```
                    1='Resource Management'
                    2='Public Safety'
                    3='Weather/Climate'
                    4='Environmental Management'
                    5='Other';
    value   $pritype
                    1='Fishing'
                    2='Shipping'
                    3='Aquaculture'
                    4='Recreational Guiding'
                    5='Consulting'
                    6='Oil and Gas'
                    7='Renewable Energy'
                    8='Insurance'
                    9='Value Added Data'
                    10='Other';
    value   pritype
                    1='Fishing'
                    2='Shipping'
                    3='Aquaculture'
                    4='Recreational Guiding'
                    5='Consulting'
                    6='Oil and Gas'
                    7='Renewable Energy'
                    8='Insurance'
                    9='Value Added Data'
                    10='Other';
    value          yesno
                    0='No'
                    1='Yes';
    value           $access
                    1='Website Only'
                    2='Server Only'
                    3='Both';
    value           access
                    1='Website Only'
                    2='Server Only'
                    3='Both';
  run;
```

2. Variable Labels (SPSS Variable Labels)

```
LABEL
        Q2_1='Data Access'
      Q2_2='Access Purpose'
      Q2_3='Employee N Access'
      Q2_4='Private N Access'
      Q2_5='Org Type'
      Q2_5_5_TEXT= 'Org Other'
      Q2_6= 'Public Org Type'
      Q2_6_5_TEXT= 'Public Org Other'
      Q2_7 'Private Org Type'
      Q2_7_10_TEXT= 'Private Org Other'
      Q3_1_1='Pct Real time conditions'
      Q3_1_2='Pct Models/Forecasts'
      Q3_1_3='Pct Historical data'
      Q3_1_4='Pct Admin data'
```

```
Q3_1_5='Pct Resource use data'
Q3_1_6='Pct Other use'
Q3_1_6_TEXT= 'Other use TEXT'
Q3_2_1='Pct Use Research '
Q3_2_2='Pct Use Operational decisions '
Q3_2_3='Pct Use New data produces '
Q3_2_4='Pct Use Regulatory activities '
Q3_2_5='Pct Use Education '
Q3_2_6='Pct Use Other Purpose '
Q3_2_6_TEXT= 'Pct Use Other Purpose TEXT '
Q3_3_1='Pct Rec Use Info'
Q3_3_2='Pct Weather Info'
Q3_3_3='Pct Priv Other Use'
Q3_3_3_TEXT= 'Other purpose TEXT'
Q5_1='EMP 100 B1'
Q5_2='EMP 200 B1'
Q5_3='EMP 50 B1'
Q5_4='PI 100 B1'
Q5_5='PI 200 B1'
Q5_6='PI 50 B1'
Q6_1='EMP 200 B1'
Q6_2='EMP 300 B1'
Q6_3='EMP 100 B1'
Q6_4='PI 200 B1'
Q6_5='PI 300 B1'
Q6_6='PI 100 B1'
Q7_1='EMP 300 B1'
Q7_2='EMP 400 B1'
Q7_3='EMP 200 B1'
Q7_4='PI 300 B1'
Q7_5='PI 400 B1'
Q7_6='PI 200 B1'
Q8_1='EMP 400 B1'
Q8_2='EMP 500 B1'
Q8_3='EMP 300 B1'
Q8_4='PI 400 B1'
Q8_5='PI 500 B1'
Q8_6='PI 300 B1'
Q9_1='EMP 500 B1'
Q9_2='EMP 600 B1'
Q9_3='EMP 400 B1'
Q9_4='PI 500 B1'
Q9_5='PI 600 B1'
Q9_6='PI 400 B1';
```

EMP=Employee Response
PRI=Private Individual Response
B1 = Bid 1
Amount=Bid Amount

3. Frequencies for Descriptor Variables (using Qualtrics names) (SPSS: One Way Frequencies)

```
proc freq data=ioos;
title 'RA';
tables       q5_1d
       q5_2d
```

```
        q5_3d
        q6_1d
        q6_2d
        q6_3d
        q7_1d
        q7_2d
        q7_3d
        q8_1d
        q8_2d
        q8_3d
        q9_1d
        q9_2d
        q9_3d
        q5_4d
        q5_5d
        q5_6d
        q6_4d
        q6_5d
        q6_6d
        q7_4d
        q7_5d
        q7_6d
        q8_4d
        q8_5d
        q8_6d
        q9_4d
        q9_5d
        q9_6d;
 where RA='RA';
 run;
```

4. Frequencies by Regional Association (SPSS Crosstabs)

```
 proc freq data=ioos_oct_t5;
 tables ra;
 tables ra*access/nocol nopercent;
 tables ra*usetype/nocol nopercent;
 *tables ra*responsemonth/nocol nopercent;
 run;
 proc freq data=ioos_oct_t5;
 tables ra*emptype;
 run;
 proc freq data=ioos_oct_t5;
 tables ra*govorgtype/ nocol nopercent;
 run;
 proc freq data=ioos_oct_t5;
 tables ra*priorgtype/ nocol nopercent;
 run;
 proc sort data=ioos_oct_t5;
 by ra;
 proc means n mean std;
 var useemp_n;
 class ra;
 run;
 proc means n mean std;
 var usepri_n;
```

```
class ra;
run;
proc means data=ioos_oct_t5 mean std;
var current forecast history admindata resourceuse useother;
run;
proc means data=ioos_oct_t5 n mean std noprint;
var current forecast history admindata resourceuse useother;
class ra;
output out=datatype;
run;
proc means data=ioos_oct_t5 n mean std noprint;
var research operations dataproducts regulation education dataother;
class ra;
output out=datapurpose_emp;
run;
proc means data=ioos_oct_t5 n mean std noprint;
var recreation weather privother;
class ra;
output out=datapurpose_pri;
run;
proc means data=ioos_oct_t5;
var useemp_n usepri_n;
run;
proc means data=ioos_oct_t5 min max;
var recordeddate;
class ra;
output out=responses;
run;
```

5. Calculate Mean Duration of Survey Responses

```
data duration_all;
set
  duration_aoos
  duration_caricoos
  duration_cencoos
  duration_gcoos
  duration_glos
  duration_neracoos
  duration_pacioos
  duration_secoora;
duration_0=duration__in_seconds_;
if duration_0<718 and duration_0>22 then duration=duration_0;
else duration=.;
duration_min=duration/60;
run;
proc means data=duration_all;
var duration duration_min;
class ra;
run;
proc means data=duration_all;
var duration duration_min;
run;
```

Appendix C: R CODE

As noted earlier, the data was collected using the Qualtrics survey service. It was read and coded using an R script which transformed the raw data on the bids and their amounts into variables for a nonparametic estimation. The bids and their amounts were fed into the non-parametric estimation methods provided by the DCChoice library. The function used was a Kaplan-Meier-Turnbull non-parametric estimate. The function call follows the syntax, wtp <- turnbull.db(bid1 + bid2 ~ Amount1 + Amount2, data). In R, the tilde (~) specifies relationships between dependent and independent variables. The bids (bid1 and bid2) are represented as the numeric values of 1 or 0 indicating whether a respondent accepted the bid (1) or not (0).

The Turnbull function uses the inputs to compute a cumulative probability function showing the likelihood of a respondent accepting the bid amounts. The mean Willingness to Pay is the area under the curve. Figure 14 shows this curve. The R Code excerpt shows how Willingness to Pay was computed for a particular RA, NERACOOS. The sample was broken into two subsets, one consisting of professional users (Employees) and individuals who access the RA's data outside of work (Private Individuals). This was done because the two groups were offered different bids. The same method was used for all the Ras and the whole sample.

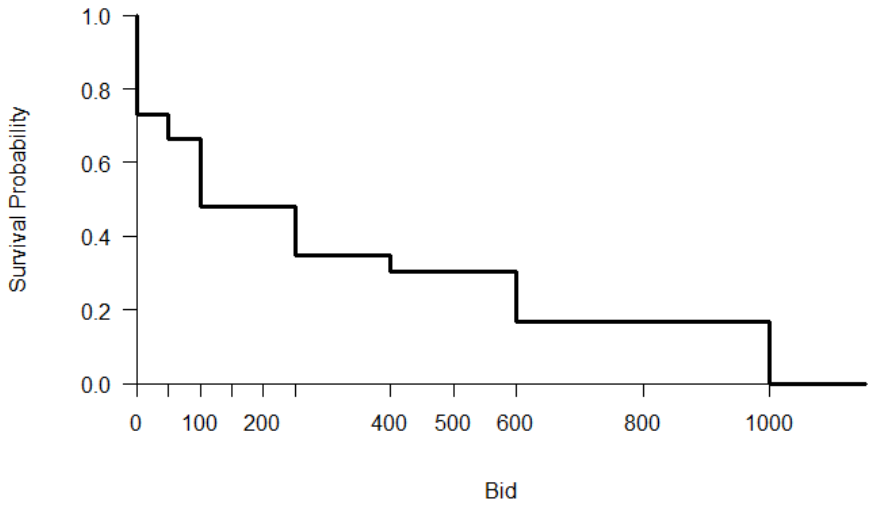

Figure 14 Turnbull Distribution of WTP Estimates

WTP Estimation for NERACOOS

Employees

```
print(paste(as.character(nrow(nera_emp_survey_df)), ' observations' ))
```

```
## [1] "147  observations"
```

```
ioos_turnbull_wtp <- turnbull.db(empbid1 + empbid2 ~ empbid1Amt + empbid2Amt, data=ne
ra_emp_survey_df)

summary(ioos_turnbull_wtp,na.rm=T)

## Survival probability:
##     Upper   Prob.
## 1       0  1.0000
## 2      50  0.7311
## 3     100  0.6639
## 4     150  0.4806
## 5     200  0.4806
## 6     250  0.4806
## 7     400  0.3465
## 8     500  0.3028
## 9     600  0.3028
## 10    800  0.1691
## 11   1000  0.1691
## 12    Inf  0.0000
##
## WTP estimates:
##  Mean: 322.038759  (Kaplan-Meier)
##  Mean: 360.633801  (Spearman-Karber)
##  Median in: [     100 ,     150 ]
```

Private Individuals

```
print(paste(as.character(nrow(nera_pri_survey_df)), ' observations' ))

## [1] "161  observations"

ioos_turnbull_wtp <- turnbull.db(pribid1 + pribid2 ~ pribid1Amt + pribid2Amt, data=ne
ra_pri_survey_df)

summary(ioos_turnbull_wtp,na.rm=T)

## Survival probability:
##     Upper    Prob.
## 1       0  1.00000
## 2      50  0.22215
## 3     100  0.17354
## 4     150  0.10536
## 5     200  0.06334
## 6     300  0.05828
## 7     400  0.02587
## 8     600  0.01119
## 9     800  0.01119
## 10    Inf  0.00000
##
## WTP estimates:
##  Mean: 41.111396  (Kaplan-Meier)
##  Mean: 67.869376  (Spearman-Karber)
##  Median in: [       0 ,      50 ]
```