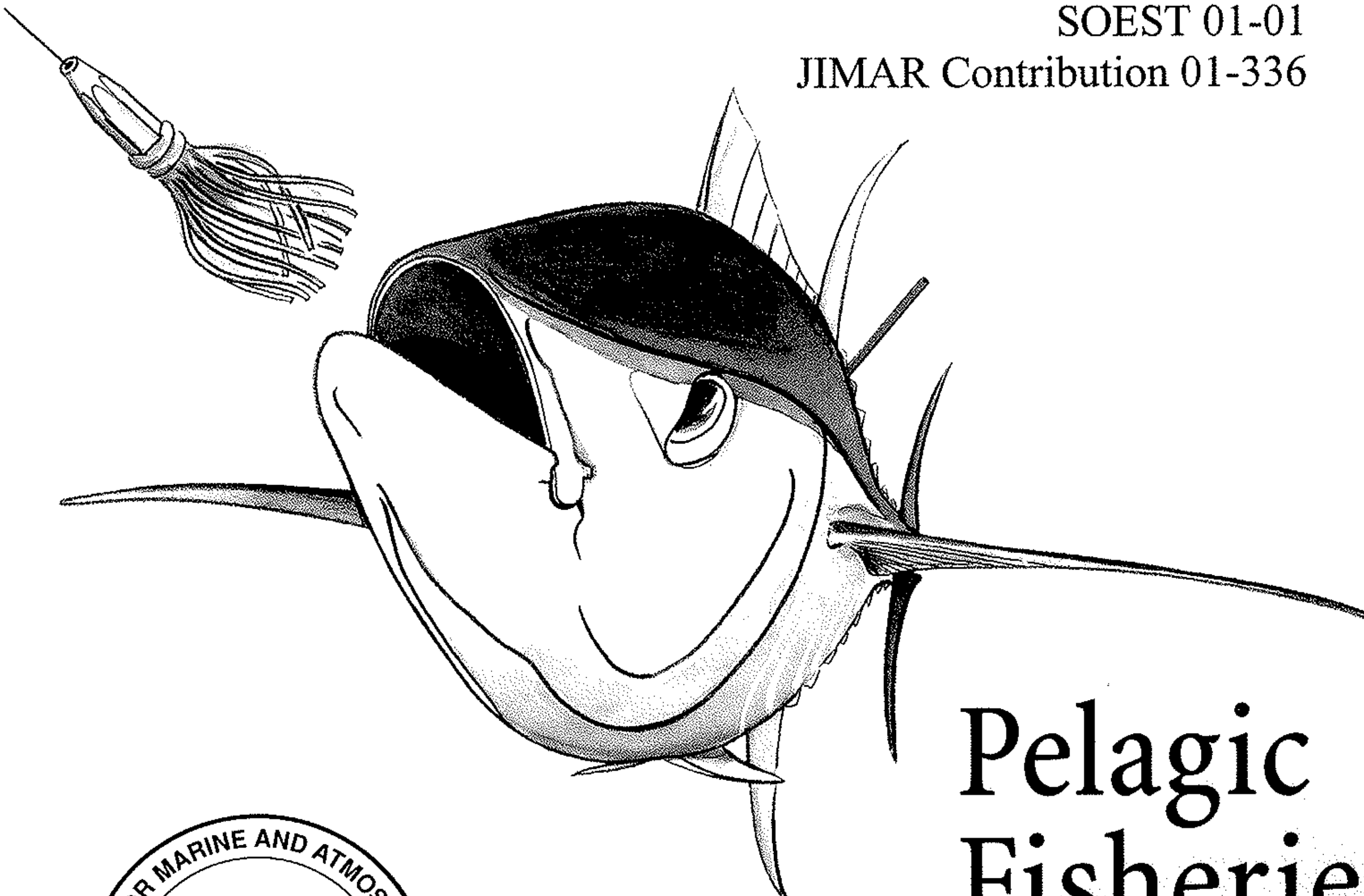
Small Boat Fishing in Hawaii: Choice and Economic Values

Kenneth E. McConnell & Timothy C. Haab

SOEST 01-01
JIMAR Contribution 01-336



JOINT INSTITUTE FOR MARINE AND ATMOSPHERIC RESEARCH ~UH-NOAA~ JIMAR

Pelagic Fisheries Research Program

Small Boat Fishing in Hawaii:
Choice and Economic Values

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Contents

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1. Introduction

The purpose of this report is to investigate the economic dimensions of small boat fishing, as well as describe the basic characteristics of fishermen who take part in the fishery. It is a complex fishery. Small boat fishermen[1] are not strictly commercial, though many sell their catch. The fishery is not completely recreational, although many anglers fish for the fun of it, often releasing their catch. Eating the fish they catch motivates many other small boat fishermen. Further there is a cultural component to the fishing. Fishermen learn from one another about what's running and where, and the act of giving fish away is an important part of fishing and a traditional communal activity. The small boat fishery is worth studying for its own sake because of its role in the daily lives of many in Hawaii. But the evolution of commerical fishing and the policies that have been developed in response to changes in commercial fisheries make it even more important to study the small boat fishery.

The report is written to help understand the economic dimensions of the small boat fishery. It does not attempt to estimate landings for the fishery. Although this is an important aspect of the fishery, it takes a special type of survey, one that intercepts fishermen when they have just completed their trips or during their fishing. Occasionally a survey can serve the purposes of both economic and biological research. But in this economic study, a phone survey proved to the best method of gathering data, and such a survey is not a good means of gathering catch data.

Fishing is a way of life for many people in Hawaii. In times when the technical means of harvesting were limited and stable, and the harvests were bound for limited local consumption, harvesting could stay in equilibrium with the natural productive capacities of the ocean. When temporary declines in the natural productive capacity or improvements in harvesting abilities threatened this equilibrium, local and informal institutions evolved to help allocate scarce resources. The historical development of fisheries not only induced equilibrium in the harvesting of fisheries resources, but cemented fishing as a way of life in Hawaii.

The introduction of mechanized means of harvesting fish, the growth of interstate and international trade in fisheries products, and the development of more complex governing institutions have banished for good most informal arrange-

[1] In referring to all people as fishermen, rather than fishermen or fisherwomen or even fishers, I have followed the precedent of Linda Greenlaw, captain of the longline vessel Hanna Boden and author of "The Hungry Ocean" who insists on being called a fisherman.

ments for allocating fisheries resources, in Hawaii and elsewhere. These informal arrangements were initially overwhelmed by open access to fisheries. The larger-scale fishing vessels can quickly overexploit fisheries that were harvested by more traditional means.

The initial gains by larger, more mechanized sectors, and consequent losses by the small boat fishery, have led to fishery policy measures to reserve some resources for the small scale sectors. For example, the restriction on long-lining in the near-shore fishing areas of Hawaii represents an attempt to allocate fish away from the strictly commercial sector to the small boat sector. The small boat sector differs from the strictly commerical sector in more than scale. In addition to the scale of the vessels, the chief distinction between the informal small boat sector and the commercial sector is the influence of profit maximization. In the small boat sector, market forces and prices may influence behavior, but decisions to enter and exit the fisheries that characterize commercial fisheries are generally absent.

Distinguishing between recreational and commercial fishing takes on a greater importance when regulations are designed to allocate between the two sectors. The distinction between the two sectors is often blurred. Many fishermen who sell their catch fish mainly for the enjoyment. Hence sales of catch is not a good discriminant. Many captains of large commercial vessels not only earn income but also enjoy the enterprise. In Hawaii, selling catch is common among many who would otherwise be considered recreational. For purposes of this report, we take large-scale ommercial fishing to be the activity undertaken for the main source of earned income of the individual. This discriminates between the commercial sector and the small boat sector imperfectly, because some fishermen in this sector do earn most of their incomes from fishing.

Fishery policy is made for many reasons–for fairness in allocation, to satisfy major political forces, and for good and efficient uses of scarce resources. Fairness and political motives work themselves out through lobbying. But in the long run it is wise to avoid undue wasteful or inefficient use of scarce resources. For the efficient allocation of scarce fish stocks, harvests should provide the same economic values in different harvesting sectors and the additional economic value of fish harvested from increased fishing in different sectors should be equal. The marginal (that is, incremental) value of landing a fish equals the gross extra value of having the fish, less the full cost of landing it. In the commercial sector, the self-interest of fishermen working in the market tends to equate the economic value of increased fishing across activities. In the commercial sector, the marginal value equals the price less the full marginal cost of harvesting the fish. In the small boat sector, the marginal value of catching the fish may be the price for those who sell, the consumption value for those who consume, and the aesthetic value of pure recreation. When the marginal values of catching fish are equal in different sectors, and they account for the future value of scarce fish, then fish stocks are allocated efficiently. Hence implementing policies that induce efficient use of resources requires that we know the value of catching fish in the small boat sector.

Estimating the marginal values of catch fish in the small boat fishery is one of the chief goals of this research. Marginal values can be discovered by finding the economic value of access to different fishing areas. The discovery of the value of fishing areas is not straightforward, however. Compare it with the market for vacant lots in a real estate market. In a market-driven system, lots would go to the use with the highest value, some as parking lots, others as building sites. Both a fishery and a vacant lot are valuable natural resources, but similarities end there.

The allocation of fish stocks and fishing locations is naturally quite different from the allocation of land. Property rights on fish and locations to fish are for the most part not assigned and cannot be bought and sold. Instead, these fishery resources are allocated informally, by individual arrangements, by competition, by political means, and on a first-come, first-served basis. Economic values play a role in these allocations. Large commercial enterprises are able to invest in lobbying efforts to secure access to fishery resources from regulators[2] If the returns to fishing were small, the enterprises would be less willing to lobby for access. In the small boat sector, the economic value is measured by the amount of income that is equivalent to the opportunity to fish. Economic values may also be high for small boat fisheries, but they lack visibility compared with the commercial sector. In commercial fisheries, it is easy to see economic value, because the product is sold. For the small boat fishery, fishing activity also generates economic value, even when there is little market activity. This report measures some parts of the economic value for the small boat fishery and estimates central tendencies of important economic components of the fishery. For a view of what the fishery is like from a social perspective, see Glazier 1999b[3].

[2]Numbers of votes count too. This helps explain why the small boat fishery can lobby successfully.

[3]The report by Glazier (Social Aspects of Hawaii's Small Vessel Troll Fishery) provides a great deal of information about how the small boat fishery actually works. And anyone wanting to

The report measures the economic value of the small boat fishery. The research is based on a phone survey of small boat owners whose boats are registered with the state of Hawaii. The survey, conducted in 1997-1998 and 1999, provides the basis for two approaches to estimating economic value: a random utility model, based on the behavior of anglers as revealed in the survey, and a contingent valuation model, which stems from direct questions to the anglers about their preferences under hypothetical circumstances.

To be useful, economic values must be comparable across sectors. This is critical for the small boat fishery, where much of the output is not destined for the market. Economics has a logically consistent and unambiguous definition of economic value: it is the amount of additional income that is equivalent to (or compensates for) changes in circumstances. The key word in this definition is income. For an improvement in circumstances, economic value is the amount of income that would be equivalent to the improvement. That is the minimum amount of income an individual would accept in lieu of the improved circumstances. For diminished circumstances, economic value is the amount of money that would compensate an individual for the change–that is, make him indifferent between accepting the monetary compensation and the diminished circumstances. Economic value can be attached to commodities, rights, services and opportunities. In the case of fishing, economic value can be attached to the broad notion of the opportunity to fish in a particular area for a given length of time, or narrowly to the catching of a particular fish. In the commercial sector, economic value to the producer is straightforward: the net monetary gains, equal to revenues from harvest less costs from harvest. In the elementary case of one fish, the economic value to producers is the price of the fish less the cost of harvesting the fish.

Aggregate measures of income or equivalent income have one important drawback: they typically tell us little about how the income changes are distributed. The same dollar value of a change in equivalent income can be distributed in many different ways. For example, a policy that brings an increase of $1 million distributed evenly among 10,000 households would probably be viewed as more desirable than an increase of $1 million where 10,000 households get an increase of $200 and 10,000 households suffer a loss equivalent to $100. While distributional issues are not always important, it is worthwhile to bear in mind that aggregate measures do not tell us anything about how the income changes are distributed. In this report, we estimate measures of central tendency–i.e., means and medians

know the difference between a model and the real world should compare the present report and the report of Glazier of economic values for representative anglers. In the case of the small boat fishery, we will estimate aggregate economic values but not how the values would be distributed.

1.1. What Are Good Measures of 'Economic Importance'?

Measures of the size and contribution of an industry's, or sector's, proposed activity to a region's or state's economy are often sought as a means of justifying government support in the form of subsidies or tax breaks. This is true in Hawaii, where state resources are especially scarce, and the geographical isolation of the economy exacerbates its vulnerability. And in the case of fisheries, different sectors compete not only for state support, but for the resource itself. Many kinds of economic measures are constructed and used to justify state support or resource allocation. Not all measures are equally valid in making allocation decisions.

Economic value can be defined as *the amount of income for an individual that is equivalent to (or compensates for) specified changes in circumstances.* Consequently a good measure of economic importance of a project, policy or proposed change is the aggregate amount of the equivalent income change induced by the policy or project. The most efficient use of resources is the one that increases income or income-equivalent the most for the relevant population. In decisions that involve only residents of Hawaii, judging resource allocation would entail measurement of the changes in real income or its equivalent for residents of Hawaii.

Two issues arise in recognizing equivalent real income increases. The first is that some dollar measures such as total spending or total economic impact induced by projects overestimate equivalent real income because they include payment for the costs of goods and services in addition to income. This is true of measures of economic impact, which typically overstate equivalent real income increases. The second is that resource allocation decisions can often improve or reduce equivalent real income without causing a discernible change in spending or other monetary aggregates. This is especially true when non-market resources such as fisheries are concerned. Consequently, it is critical to recognize the dimensions of economic value.

The definition of economic value has three critical qualifications:

Focus on change in economic value. Governmental policies make changes in resource allocations, and the relevant evaluation is of the increases or decreases in equivalent income, not total income. Measures of total economic value are typically not relevant to the immediate policy questions because they do not provide information on how incomes of individuals change. Rather, a sensible approach would look for policies that increase income, or attempt to avoid policies that decrease income.

Income as a basis of evaluation. Measures of economic value should help sort good projects and policies from bad or wasteful ones by identifying circumstances that improve well-being. The economic measure that is least likely to lead to the misuse of resources is real income. Other measures, such as sales revenue, expenditures, or costs, may be composed in part of income, but typically overstate income increases, and do not reflect increases that are valued by individuals. Consider two projects: one brings $1 million worth of goods into Hawaii and resells them for $1.1 million; another reduces the cost of doing business by $200,000. The latter project would provide the greater improvement in the well-being of residents of Hawaii.

Equivalent income. Occasionally changes in resource allocations can change equivalent income or economic welfare without changes in monetary aggregates. This is especially true when non-market activities such as recreation or subsistence are concerned. For example, consider a fishery where local anglers make their own gear, catch their own bait and consume their catch. Hence most activity is outside the market. A policy that constrained their access to the fishery could easily go unrecorded in monetary aggregates but would most certainly reduce the well-being of local anglers. To be complete, economic value includes the income equivalent of the change in the conditions of access for local anglers. The trick is to find circumstances that allow one to infer the equivalent income changes that would compensate anglers for changes in fishing circumstances.

In summary, good measures of economic value should represent the equivalent of changes in real income for policies or projects.

The measures of economic value estimated in this report are equivalent income measures for small boat fishermen in Hawaii. These measures are typically called willingness to pay. They represent estimates of the changes in income that anglers would give up for the specified improvements in circumstances. We estimate willingness to pay for various aspects of small boat fishing, including geographical restrictions, improvements in catch, and a variety of other circumstances. In this report there is no research on the economic impact of small boat fishing on the state's economy per se.

1.2. Past Research on Small Boat Fishing in Hawaii

The research in this report builds on a series of studies on recreational fishing in Hawaii. These studies provide three sorts of estimates: economic value, economic impact, and aggregate catch and effort for recreational fishing. Research from the 1970s to the present has been motivated by the same concerns of the present report: to determine the economic and biological significance of small boat fishing in Hawaii. A larger survey of this literature can be found in the report by Glazier[4].

Studies by Karl Samples and associates in the 1980s are the most complete on the economics of small boat fishing in Hawaii. Samples' work focused on the charterboat industry. Given the definition of commercial fishing proposed above—that the activity of fishing is the main source of income for the participants—one may wish to designate charterboat fishing as a commercial activity. Their work focused not only on the economic impact of charterboat fishing, but also on the willingness to pay by patrons of charterboats, the latter being relevant to the present research. Willingness to pay is another expression meaning equivalent income. It is synonymous with economic value. When economists measure willingness to pay, as Samples and associates did and is done throughout this report, they measure households' willingness to give up income in exchange for specified alternatives. The charterboat research on patrons estimated the willingness to pay for two kinds of services: a charter trip and harvesting a marlin on a charter trip. In Samples and Schug, the estimates of these values are $57 per trip and $23 for an extra marlin. That is, a charterboat patron would pay an extra $57, above the ordinary costs of the trip, rather than forego the trip. And a patron would give up an additional $23 in income to obtain an additional marlin. (In 2000 prices these values would be about $94 for a trip and $38 for an extra marlin per trip.)

The values estimated by Samples and Schug are similar to the kinds of values the present report estimates for the small boat fishery. Further, the techniques exploited by Samples and in this report have in common the use of discrete choice contingent valuation. The chief difference is the study population. The charter patrons are principally visitors to Hawaii. Hence economic values for the charter patrons, while important for the continued health of the charter fleet, are not values enjoyed by residents of Hawaii. The key difference between Samples and Schug's work and the present report is the target population. In dealing with the small boat fishery, this report explicitly excludes charter boats. Implicitly charter

[4] This document gives an excellent coverage of the relevant literature.

patrons are also excluded, except to the extent that they own and operate a small boat.

A study by Meyer Resources Inc. focused on the small boat fishery group, with some of the same goals in mind. The Meyer report sought to estimate the economic value of time spent fishing. It proceeded by informal interviews with members of boat clubs in Hawaii. Meyer used some unconventional techniques to arrive at an aggregate value of small boat fishing in the neighborhood of $240 million (equivalent to $355 million in 2000 prices). This is total value that was arrived at by finding a 'fair' value per hour of non-market activity, and then multiplying by an estimate of the aggregate number of hours of the activity. While it may be comforting for proponents of the small boat fishery to believe that it provides services of such prodigious value, the method by which the services were measured has not been exposed to the usual scrutiny given to non-market valuation. Further, other than the possibility of the complete loss of the recreational fishery, this aggregate value does not address any obvious issues in fisheries policy. That is, it does not estimate the change in equivalent income from any proposed change in policy.

The studies concerned with sampling to estimate aggregate catch and effort, while not directed at economic values, are useful for the present report. Efforts to estimate aggregate catch for Hawaii extend back at least to the National Marine Fisheries Service (NMFS) marine recreational fishing surveys of 1979 to 1981. NMFS has supported recreational fishing surveys on most of the mainland on an annual basis since 1979. The survey was conducted in Hawaii during the period 1979 to 1981 but aggregate estimates were never published from survey results. Several proposals to sample boat fishing for the purpose of estimating aggregate catch and effort were made during the 1980s (Omnitrak Research and Marketing Group, 1988; Sen, Sampling Methodology for a Boat Fishing Survey Design for Hawaii, unpublished report) but were never undertaken. A test study conducted by the state of Hawaii on small boat fishing on Oahu provides valuable information on the level of activity at eight ramps or harbors (Hamm and Lum). In the survey, approximately 1,350 interviews were conducted at the ramps with returning fishermen. These completed interviews give critical information on the nature of fishing, such as gear, method, and sales activity. It also provides good estimates of the relative activity at different ramps. This information can be compared with survey information in the present study.

1.3. Outline of the Report

This report is composed of three sections. The first section explains the survey and provides descriptive statistics for the survey participants. The descriptive statistics have no immediate economic content but help explain the survey and the characteristics of respondents. The second section reports on a random utility model of small boat fishing in Oahu. It is based on reported behavior of survey respondents. The third section reports the analysis of contingent valuation questions. For some important questions relevant for fisheries policy, such as the willingness to pay to catch particular species, behavioral models may provide little evidence. In those cases, a contingent valuation study is preferred. In addition, in one important respect, random utility models cannot reveal what anglers would be willing to pay to fish for a single trip. In these cases, contingent valuation, the use of hypothetical responses to direct questions, is a suitable and commonly employed alternative.

2. The Survey of Hawaii Small Boat Anglers

The empirical analysis in this report is based on a systematic phone survey of Hawaii small boat anglers in 1997 and 1998. The sample survey was conducted by SMS, Inc., a professional survey firm in Honolulu.. The basis for the sampling is the list of registered boats in Hawaii. Any boat over six feet long and not documented through the Coast Guard must be registered with the state of Hawaii—the Division of Boating and Ocean Recreation in the Department of Land and Natural Resources (DLNR). From this list the types of vessels that are typically not used in fishing—sailing, thrill craft, and motor vessels more than 65 feet in length—were eliminated. This created a population of about 6,600 boat owners in Hawaii. The list also contained names and addresses of boat owners, which allowed the recovery of phone numbers.

The year-long survey was divided into six 2-month sampling periods. While the basic survey was a phone survey, it was initiated by a letter that was mailed to potential respondents.[5] Sampling periods were two months in length. Every sampling period, SMS drew 300 names from the population of boat owners. These

[5]The letter was sent on the University of Hawaii's Joint Institute of Marine and Atmospheric Research (JIMAR) stationery in an effort to convince respondents that the survey was motivated by scientific concerns. The letter also offered the respondent the opportunity of declining to participate in the survey.

names were matched with phone numbers. SMS mailed out letters to the 300 boat owners. From the initial mailout, some respondents no longer had boats, and some did no fishing. Eliminating those respondents created the phone list from which respondents would be called. The disposition of the phone list is described in Table 1.

Table 1: Disposition of Attempts to Call from the Phone List.

Refusals	3%
No boating or fishing	17%
Not able to reach	49%
Completed survey 1008 Respondents	31%
Phone list	100%

Those who did not boat or fish (even though they may have owned a boat) were legitimately out of the survey. The refusals were quite low at 3 percent, well below refusal rates for other surveys, which are often as high as 50 percent The largest proportion of non-contacts came from the boat owners who could not be contacted for one reason or another. The great majority of calls in the 'Not able to reach' category were due to respondents not being home. The 'Not able to reach' category can potentially cause non-representative sampling in the survey.[6]

To test the representativeness of the sample when compared with the 'Not able to reach' category, we designed a special survey that was carried out in February and March 1999. In this survey, SMS resampled respondents who originally fell in the 'Not able to reach' category. Much greater effort was made to reach each respondent, with the number of callbacks increased from 3 to 10. This testing survey resulted in 182 interviews with respondents who initially fell in the 'Not able to reach' category. Table 2 shows a comparison of several relevant variables across the two samples. (Not all of the attempts to reach this group were successful. SMS, Inc. attempted 243 callbacks, of which 182 were completed.) None of the differences in the means reported in this table are significantly different from zero. A comparison of the means of many more variables leads to a similar conclusion: there is no systematic difference between the respondents who were interviewed for the main survey and those who could not be reached on the main survey.

[6]The initial rate of attempted callback was three calls.

Table 2: Comparison of Original Sample with Sample of Non-Respondents

	Original Survey[a]		Sample of Non-Respondents[b]	
Variable	Mean	S.E.[c]	Mean	S.E.
Trips: Last Two Months	4.37	.22	3.55	.89
Last Six Months	13.23	3.37	13.86	.68
Next Two Months	6.47	.26	5.67	1.05
% Catching Something	22.0	1.31	19.8	3.0
% Retake Last Trip	85.2	1.1	87.1	2.5
Household Size	3.31	.05	3.37	.11

[a]Based on the original survey of 1008 respondents.
[b]Based on the 182 observations of the followup survey.
[c]S.E.. is the standard error of the mean.

2.1. Descriptive Survey Results

The basic purpose of this report is the economic analysis of fishing decisions made by the sampled anglers. The economic models are estimated for Oahu and for all of the islands combined. There is additionally a wealth of information on anglers. This section reviews several types of information about anglers. This information will be provided on all of the anglers interviewed. Two kinds of data will be analyzed: data on the anglers and their characteristics and data on the anglers' choices.

The survey commenced in March 1997 and was completed in February 1998. The survey design called for 1,000 completed interviews. The total of completed interviews was 1,008. The survey was conducted to cover six 2-month periods, with the number of completed interviews distributed evenly across the year. The distribution across islands should reflect the distribution of registered boats, not the distribution of population. The distribution of interviews over periods and across islands is given in Figure 1. The variation across interview period is minor. The numbers change little from one period to the next.

Although it cannot be discerned from Figure 1, the interviews are distributed differently from Hawaii's population. This is principally due to the distribution of registered boats by island. Table 3 shows the distribution of interviews compared to the distribution of registered boats and population. Oahu has a greater proportion of population and smaller proportion of registered boats and interviews,

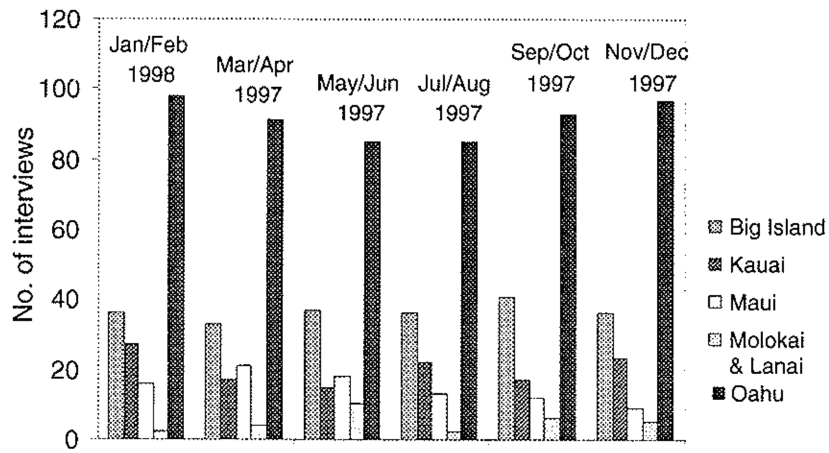

Figure 1: Number and dates of angler interviews.

principally because of the urban nature of Honolulu.

The survey gathered various forms of information about the respondents. Here we show the most basic demographics: income, age, ethnic identification, and place of birth. These demographics can serve two roles. First, if we had independent information on the population of boat owners, a comparison of demographics could help us assess whether the sample of boat owners is representative of the population of boat owners. Independent information on the population of boat owners typically is not available. So under the assumption that the sample is representative, we can compare the sample of boat owners with the population of Hawaii. Table 4 gives the income class of respondents. Income here is best construed as before-tax income for the household. Table 5 gives the age distribution of respondents. There are no published statistics that correspond with these tables, because the tables refer to the select population of boat owners. So the real value of these demographics is simply that they help understand the population that has been surveyed. Almost 35 percent have incomes below $50,000, and a small proportion, 5.6 percent, have incomes above $150,000. Comparing the dis-

Table 3: Percent of Interviews, Registered Boats and Population, by Island

Island	Interviews[a]	Registered Boats[c] (1993)	Population (1992)
Big Island	21.9%	14.4%	11.3%
Kauai	12.0	10.7	4.7
Maui	11.6[b]	9.7	9.3
Oahu	54.5	63.6	74.7

[a]Based on the original 1008 set of interviews.
[b]Includes Molokai and Lanai, about 3% of interviews.
[c]Includes all vessels, not just fishing vessels.
Source for 3rd and 4th columns: The State of Hawaii Data Book 1993-1994.

Table 4: Income Distribution of Respondents Compared with Population of Hawaii

Income ($1000s)	< 15	15-25	25-35	35-50	50-75	75-100	100-150	> 150
Survey Responses[a]	1.7%	4.3%	11%	19.1%	26.8%	21.5%	10.0%	5.6%
Households in Hawaii[b]	15.0%	14.9%	14.6%	19.1%	20.6%	8.7%	4.9%	2.2%

[a]Non-responses to this question were 17.4% of sample of 1,008 respondents. [b]Source: The State of Hawaii Data Book 1993-1994.

Table 5: Age Classification of Sample[a]

Age	<18	18-24	25-34	35-39	40-44	45-49	50-54	55-64	65-69	>69
Percent	0.2%	0.8%	9.3%	12%	15.6%	17%	15%	18.4%	5.7%	5.4%

[a]Non-responses were .8% of the sample of 1,008 respondents.

tribution of income among households in Hawaii with the boat owners' income, we see that boat owners tend to have a greater proportion of households with higher incomes. The non-response rate is the highest for any item in the survey, as is usually the case for income data. While the data reveal that the population of boat owners is not exclusively wealthy or uniformly low income, they have higher incomes than the general population.

Table 5 gives the age distribution of the sample. As in the case of income, comparing this distribution with the population distribution is not informative, because we have no independent information on the age distribution of the population of boat owners. The age distribution of boat owners tends to be skewed, for financial reasons, to the older age groups. It takes time to accumulate the capital required to own a boat, and it takes some income to operate and maintain boats. Two additional pieces of information round out the summary of the socioeconomic characteristics: the self-described ethnic group and the place of birth. In Figure 2, we have the self-reported ethnic group. Respondents were allowed to describe themselves as belonging to one of several ethnic groups. The predominant group is of Japanese origin, with Caucasian being second. About 150, roughly 15 percent of the sample, describe themselves as Hawaiian or part Hawaiian. Figure 3 shows the frequency of small boat owners by place of birth. Almost 75 percent were born in Hawaii.

Naturally most of the survey deals with fishing. Here we summarize the fishing activity in terms of species caught and sought, as well as providing some data on gear used. Each respondent is asked the primary species targeted during the last trip. The results are summarized in Figures 4 and 5. In Figure 4, the target information is given by island. There are six groups of target species plus a catchall group labeled 'other.' The catchall group can include a variety of reef fish as well as non-fin fish. There are some general patterns across islands. Between 5 and 10 percent seek aku (skipjack tuna). The percent seeking tuna, excluding aku, is much higher on the Big Island, though for all islands it is in the range of 15 to 30 percent. The percent who target billfish is uniformly quite small, less than 5 percent. The percent not classified, that is, those who target other species, is quite high on Oahu and the rest of the islands. The differences in targeting suggest care in generalizing inferences from one island to the others.

The species actually caught tend to follow the same pattern as the species targeted. The species caught by island are given in Figure 5. Here we see that tuna and ono are more important for the Big Island than for the other islands. The success rate for billfish and bottomfish reflects the low percent of respondents

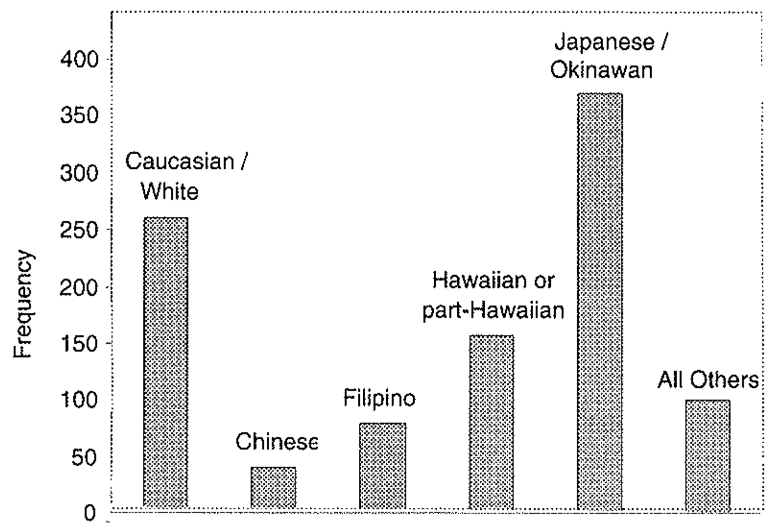

Figure 2: Primary ethnic group of respondents.

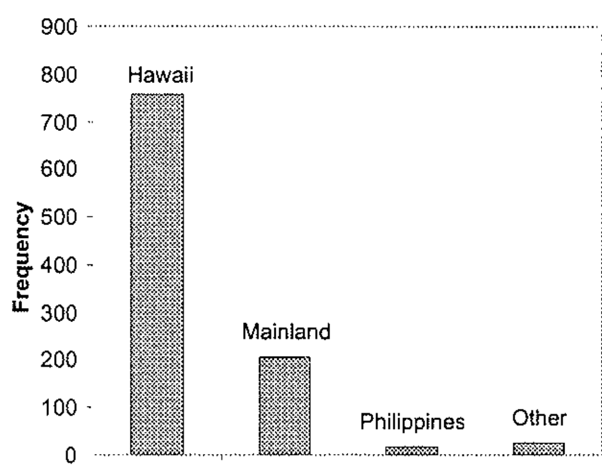

Figure 3: Birthplace of respondents.

seeking these species. Bottomfish in particular are not likely to be caught unless they are targeted. Anglers, whether commercial or recreational, are nothing if not optimistic—they tend to target species even when the prospects of success are low. In this regard, mahimahi are a surprise because the success rate exceeds the percent of respondents who target the group, except for Oahu, where the percent targeted and percent success are quite close. The high success rate for mahimahi can be attributed to their ubiquitous nature.

In pursuit of fish, anglers use an array of different gear, from GPS units to a variety of rods and reels. The diversity and distribution of gear types can be seen in Figure 6, where the ownership of different types of gear by respondents is shown. The dark columns count the number of respondents who do not use the gear in question, and the light columns the number who do use the gear. A CB radio is the most common gear aboard the small boats, followed by a cell phone. Very few respondents have radar or autopilots, but about two-thirds have depth finders. Line haulers are used principally by respondents who target bottomfish. Hence the distribution of this gear type is limited.

The importance of catching fish will be explored in the two sections on economic models that follow. But a crude understanding of the importance of catching fish can be gleaned from responses to a series of hypothetical questions aimed at measuring economic values. These questions are fully explored in the section on contingent valuation. After the respondent has answered questions on the costs and catch of his latest trip, the interviewer asks:

> Now, I want you to think about the details of your last fishing trip. Suppose you had known, in advance, how this last trip would turn out. For example you know what the catch would be, what the experience would be like, what it would cost you, the weather, and everything else that went into the trip. Knowing all these things in advance, would you still have taken this last trip?

The response to this question is typically yes, with about 80 percent responding in the affirmative. But it is instructive to look at the responses conditional on whether any fish were caught on the trip in question. This is given in Figure 7. Here we have the percent yes and no by whether the respondent caught fish. In the first two columns, the figure gives the percent yes and no given that the respondent caught one or more fish. When fish are caught on the trip, the percent yes to the question above is slightly more than 80 percent. When no

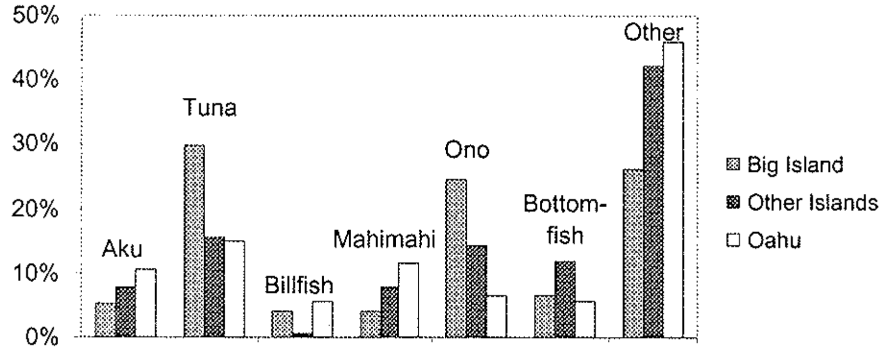

Figure 4: Primary fish species targeted.

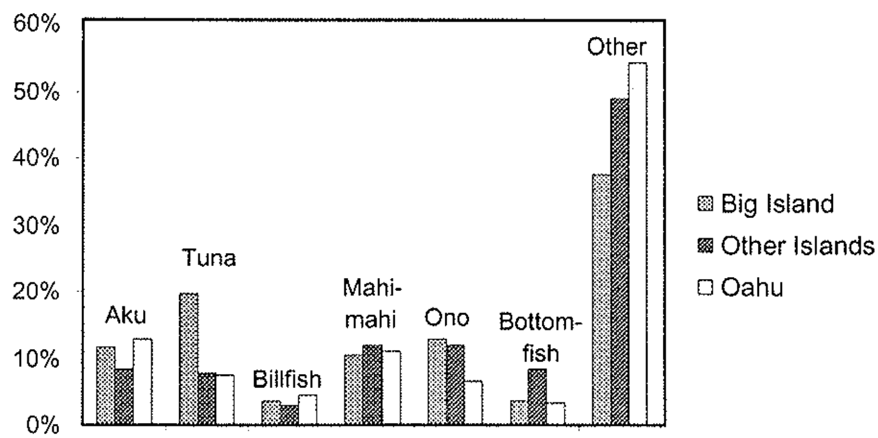

Figure 5: Primary fish species caught.

fish are caught, the percent yes falls to about slightly less than 20 percent while the percent no is about 45 percent. Whether respondents are willing to repeat a trip depends strongly on whether they caught fish on the trip. In the following sections, especially the section on the contingent valuation responses, we will find the means to quantify the willingness to pay for catching fish.

3. The Random Utility Model for Small Boat Fishing in Hawaii

In this section we explain and estimate a model of fishing site choice for small boat fishermen. This model is a random utility model, meaning that the fisherman chooses a fishing destination based on the utility it brings him, and that part of the utility involves factors that cannot be observed by the researcher. Hence the utility is random. Utility depends on characteristics of alternatives, such as cost, probability of catching different fish and other variables. The randomness of utility means that a researcher can only make probability statements about fishermen's choices. The essence of the random utility model is that it leads to a model of the probability of choosing a destination, and the estimation of this model gives parameters of fishermen's preferences. The estimated model can then be used to calculate income equivalents, or willingness to pay, for measurable characteristics of sites.

In the application for small boat fishing, the model explains the choice of launching ramp (or marina where applicable) and ocean based destination for the last trip of the interviewed anglers. Anglers are assumed to make their destination choice in two stages: first they choose the ramp from which they will launch their boat, and then they choose the ocean-based destination conditional on the choice of launch ramp. The obvious choice for modeling such a decision process is a two-stage nested random utility model. As will be shown, for the case of Oahu, it does not in fact appear that the destination choice is conditional on the choice of launch ramp, but instead, the ramp and final destination decisions are made simultaneously.

3.1. Description of the Data

The assembly of data in support of the conditional random utility models is substantial. Further, choice among alternatives is quite different among the islands. Hence the estimated model is limited to choices made by anglers on Oahu. Data

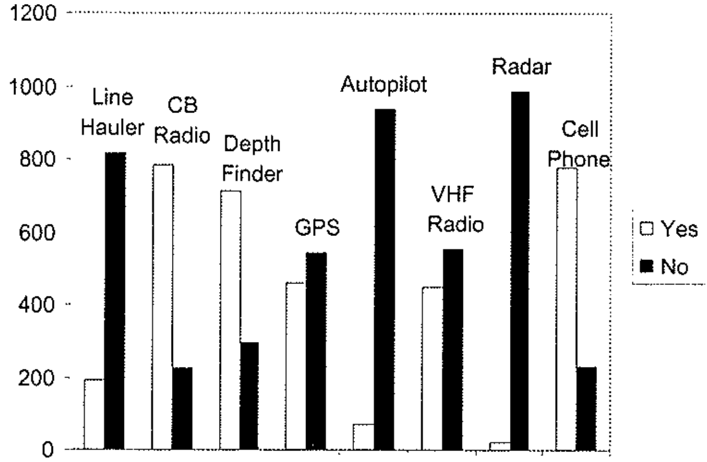

Figure 6: Frequency of gear type use.

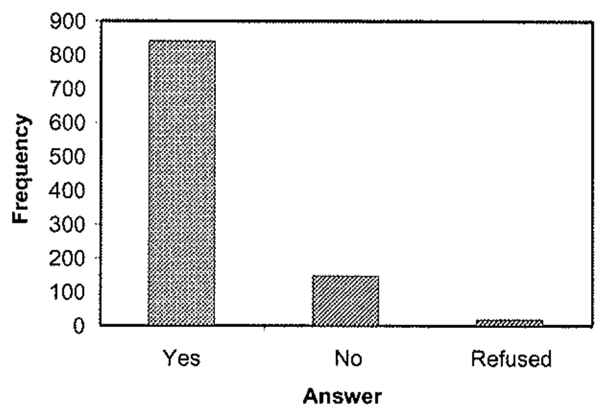

Figure 7: Would you take this trip again?

must be collected on angler choices of launch ramp and ocean-based destination. Ramp-specific characteristics, such as the travel expenditures and travel time to each ramp, convenience amenities at the ramps (parking spaces, etc.) and weather conditions at the ramp serve as determinants of launch ramp choice for anglers that trailer their boats. Characteristics of ocean destinations such as the travel costs, expected catch at each site for anglers that target specific species, size of the site, and number of fish aggregation devices (FADs) within each geographic boundary determine the ocean-based destination for each angler. Angler-specific characteristics are also important in identifying what ramps and ocean destinations an angler will choose. These might include the boat length, whether the angler targets a specific species (and if so, what species), and the employment status of the angler (full-time versus part-time, salaried versus wage, employed versus unemployed or retired). The following sections provide a description of the data used to estimate the random utility model of angling site choice on Oahu.

Characteristics of the Launch Ramps on Oahu

Based on angler interviews and personal communication with officials knowledgable of boating conditions on Oahu, a total of 12 ramps were identified as viable public ramps for launching a trailered boat on Oahu (see Table 6). In two cases, due either to geographic proximity or closure of a ramp, ramps were combined into a single ramp for model estimation purposes (Hawaii Kai/Maunalua Bay and Waianae/Pokai Bay). An additional choice category is considered: for moored boats (ramp 13 in Table 6). That is, respondents who moor their boats at a dock or marina do not choose launch ramps. They are instead assumed to choose the mooring site as their point of origin. Table 6 gives a brief description of each of the launch ramps and some of the characteristics associated with each. The fourth column gives the number of designated parking spaces for vehicles with trailers at each ramp. In addition to the designated parking spaces, a number of the ramps have undesignated parking available in adjacent parking lots. Because the number of spaces at each of these undesignated lots varies with tourist traffic, shopping traffic, and weather, and because these undesignated lots are typically not subject to Hawaii DLNR management, they are not considered here.

For several reasons, the modeling of seasonal weather is of value. If weather variables are omitted from the model but correlated with included variables, such as catch data, coefficients on the included variables will be inconsistent. Further, weather variables may be useful for policy analysis when seasonal policy measures are considered. Finally it is clear that weather patterns influence choices, and explaining the choices better increases the precision of parameter estimates for the more critical parameters on costs and catch.

The critical elements of weather are wind speed and direction. There are at least two effects of high winds. It makes it hard to launch boats, and it makes the fishing unpleasant. Fishing areas and ramps that are in the wind shadow would be on the south and west coasts when the wind is out of the north and east, for example. We attempt to capture the effect of wind in two ways. The simplest is with a dummy variable that takes the value of one for ramps on the north and east shores during periods when strong trade winds have typically prevailed. This approach captures much of the effect of wind. The second more sophisticated approach involves the use of wind speed and direction data from NOAA weather sites. In this approach, we calculate the maximum wind speed by week, along with the mean wind direction for the week. The wind variable is then calculated as follows:

$$WS_r = \text{Maxspeed} \cdot (180 - (WI^d - RA_r^d))/180$$

where

Maxspeed = maximum of wind speed for the week;

WI^d= the angle of the wind in degrees deviation from north;

RA_r^d= the angle of a perpendicular to a line parallel to the shore, in degrees deviation from the north. For example, when the wind comes out of the east a ramp facing east would have $WI^d = RA_r^d$, so that the wind speed variable would equal Maxspeed, the maximum weekly speed at the ramp. A ramp completely in the wind shadow would have the 180 degrees off the ramp direction, and so would be assigned a wind speed of zero. Unfortunately, the wind direction and speed do not appear to be a significant factor in explaining ramp choice in the models estimated below. Alternatively, it is hypothesized that the presence of trade winds presents undesirable conditions for small boats launched from ramps with north and north-east exposure. Table 6 reports the ramps exposed to trade winds.

The final column of Table 6 reports the percentage of anglers reporting each ramp as their launch site on their last trip. Almost half of the anglers launched from either Waianae or Heeia-Kea on their most recent trips. Hickam Harbor, Marine Corps Air Station, and Rainbow Bay are located on military bases or installations and as such are restricted to military personnel only. Of the 413

Table 6: Ramps and Their Characteristics

Ramp Number	Ramp Name	Comments	Parking Spaces	% Recorded Visits
1	Ala Wai		19	3%
2	Haleiwa[a]		60	9%
3	Heeia-Kea[a]		65	22%
4	Hickam Harbor	Military Ramp	12	2%
5	Kahana[a]	Launch Difficult	28	1%
6	Kailua[a]	Launch Difficult	25	2%
7	Kaneohe	Private	130	1%
8	Keehi		59	15%
9	Marine Corps Air Station[a]	Military Ramp	30	1%
10	Rainbow Bay	Military Ramp	60	.5%
11	Hawaii Kai/ Maunalua Bay		65	8%
12	Waianae/ Pokai Bay		180	24%
13	Moored[b]			12%

[a]These ramps are assumed to be exposed to strong trade winds during the period January through April.

[b]This ramp is an artificial designation for all respondents whose boat was moored.

anglers reported to trailer their boats, only 15 reported an occupational status that can be classified as military (either the interviewee or spouse reporting their occupation as military). Twelve of these 15 anglers reported launching from one of the three military sites.

Description of Destination Sites

The thirty-four ocean sites visited by sampled anglers are defined by the Hawaii Division of Aquatic Resources (HDAR). The sites are often well known by the anglers, but vary greatly in size. For estimation purposes, this exogenous difference in size of the destination sites will be captured by including a measure of the water surface area of each HDAR site (in square-kilometers). Figure 8 shows the HDAR sites. Around Oahu, HDAR 400-409 represent what will be termed coastal HDARs. The distinction between coastal and non-coastal HDAR sites is important as it is expected that anglers with smaller boats (boat length <20 feet) tend to choose to fish in coastal HDAR sites, while anglers with larger boats (boat length $\geq$ 20 feet) will be more willing to venture into non-coastal HDAR sites. As stated above, the choice of HDAR is assumed to be joint with the choice of launch ramp. As such there are 442 possible ramp-HDAR combinations for each angler to choose from (13 ramps x 34 HDARs).

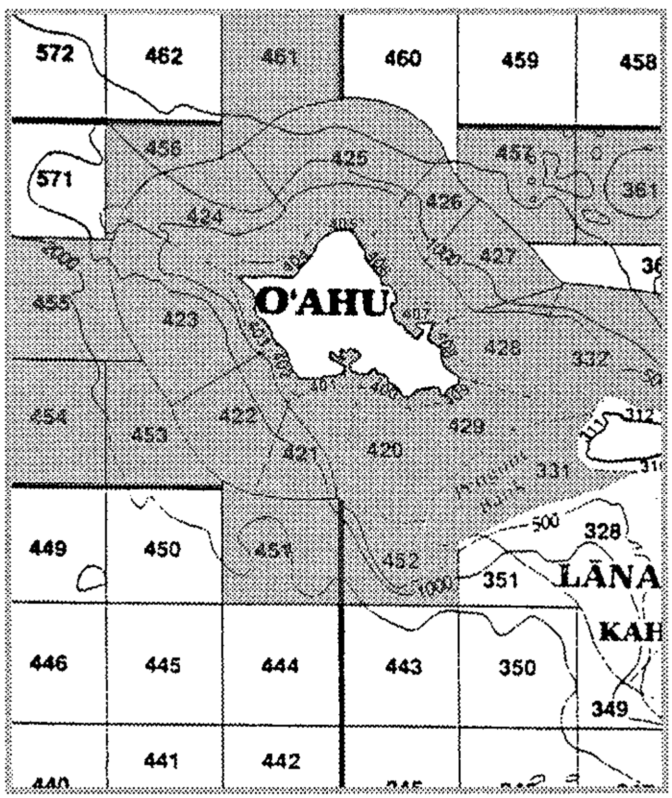

Figure 8: Destination sites; 400-409 are coastal HDRs.

Data on sales by species from vessels that sell their catch are recorded by the HDAR areas and date. The pounds of fish sold is strictly speaking not a measure of or proxy for expected catch at an HDAR area. Only if the anglers that sell a portion of their catch is a random subsample of the general population of anglers would fish pounds sold per angler at auction represent an estimate of expected catch at an HDAR area. Because the sale of fish is expected to vary systematically across anglers, we use catch sold simply as a proxy for fishing quality at a particular HDAR area. Small boat anglers want to catch fish. An ideal measure of the potential for catching fish would be a measure of stock abundance or density. A good proxy would be the catch rate (or catch per unit effort) for different species. If the anglers who sell a portion of their catch are a representative sample of the general population of anglers, then landings sold per angler at auction represent an estimate of expected catch at an HDAR area. Nevertheless, the higher HDAR landings should attract more fishermen. Because the landings can be expected to vary systematically across anglers, we use this measure as a proxy for fishing quality at a particular HDAR area. To account for the fact that larger HDAR areas would have higher landings even if the catch rates are the same, we also use the area of the HDAR sites as a site characteristic.

Characteristics of Anglers

The figures and tables in the introduction describe the general sample of fishermen. The random utility model (RUM) for Oahu is estimated on a subsample of 468 respondents. This subsample does not differ in any significant way from the full sample. Several characteristics of respondents are important for modeling their behavior on trips, however, and, these are summarized. The degree of attachment to the labor force influences an individual's allocation of time between work and leisure. Seventy-three percent of the respondents (340) are employed full time while 21 percent (97) are retired. Only 3 percent of respondents (14) reported being currently unemployed. Some ramps are only available to military personnel, but only 20 of the 468 respondents (4 percent) either are in the military or have a spouse in the military. Boat length also influences ramp choice. The average length of boats owned by the respondent is 18.3 feet, with a minimum length of 7 feet and a maximum length of 42 feet. The average boat length is 17.6 feet for those who trailer their boat, but moored boats average 23.7 feet.

3.2. Specification of Model and Variables

The Model

The model that we estimate, a random utility model, is described in detail below. It is important to understand the kind of information that can be inferred from the observed choices. The empirical analysis is based on the last trip taken by the interviewed angler. Because we do not observe a sample of anglers in which some take trips and some do not, we cannot make inferences about the decision to take a trip (although we will estimate the economic values for changes in several trip attributes). Consequently, we cannot infer the economic value of taking a trip, regardless of destination, from the random utility model. This shortcoming is not as serious as it may seem, because in the analysis of the contingent valuation data in the following section, we are able to make inferences about the value of taking a trip as well as the covariates that determine that value. What the random utility model can do well is capture the way in which individual anglers choose among alternatives. It is thus well designed to measure the gains and losses from changing the alternatives open to anglers. For example, we can estimate the economic losses from closing an existing ramp or the gains from opening a new ramp. Further, to the extent that the model includes measures of the attractiveness of sites based on their fish-catching potential, we can estimate the gains and losses from changing the availability of various fish.

Estimation of the parameters that describe behavior and determine the economic value of various changes begins with the specification of the utility function. The specification must precede the construction of the dataset, a major undertaking in the estimation of a random utility model. The deterministic portion of the utility function for angler j in period s, leaving from harbor or ramp r going to ocean site a, is assumed to take this form:

$$\begin{aligned} v_{ra}(j,s) &= \beta_1(c_{rj}+c_{raj}) + \beta_2 \cdot \delta_{wj} \cdot t_{rj} + \beta_3 \cdot \delta_{sj} \cdot t_{rj} + \sum_{f=1}^{4} \beta_{4f} q_{af} \delta_{fj} \\ &\quad + \sum_{f=1}^{4} \beta_{5f} q_{af} \delta_{nj} + \beta_6 \cdot KM_a^2 + \beta_7 \cdot WS_r + \beta_8 \cdot F_a \\ &\quad + \beta_9 \cdot P_r + \beta_{10} \cdot \delta_{bj} \cdot \delta_{ca} + \beta_{11} \cdot (1-\delta_{bj}) \cdot \delta_{ca} \end{aligned} \tag{1}$$

where

c_{rj} = travel cost from home to ramp or harbor r for angler j;
c_{raj} = travel cost by boat from ramp or harbor r to HDAR area a for angler j;
t_{rj} = travel time from home to ramp r for angler j;
q_{af} = pounds sales from area a of species group f;
f = 1 for billfish, 2 for bottomfish, 3 for other pelagics, and 4 for tuna;
δ_{wj} = 1 if the angler does not work flexible hours;[7]
δ_{sj} = 1 if the angler j is retired;
δ_{fj} = 1 if angler j targets species f;
δ_{nj} = 1 if angler j targets no species;
δ_{bj} = 1 if angler j has a boat of length greater than or equal to 20 feet;
δ_{ca} = 1 if HDAR a is a coastal HDAR;
F_a = number of fish aggregating devices (FADs) in area a;
KM_a^2 = surface area of HDAR site a in kilometers squared;
WS_r is a ramp specific weather variable that will be calculated from wind speed and direction or a dummy variable that equals 1 if the ramp has a northern or eastern exposure during trade wind months (January-April);
P_r = number of designated parking spaces at ramp r.

With the exception of wind speed and variables that do not change temporally, the variables are defined for the specific two-month period during which the angler took the trip. Wind speed is defined as the weekly average wind speed for the week in which the trip was taken.

The model structured this way has two nests: ramp or harbor r, and area a. The ramps are the well-known sites on Oahu where anglers can launch their boats. The areas are the HDAR fishing areas. There are four species groups aggregated across the major fisheries in Hawaii: Billfish, Bottomfish, Other Pelagic, and Tuna. The terms $\sum_{f=1}^{4} \beta_{4f} q_{af} \delta_{fj}$ and $\delta_{nj} \sum_{f=1}^{4} \beta_{5f} q_{af}$ are the sums of the recorded sales of each of the four species groups for those that target particular species and those that do not target any particular species. If an angler seeks a species group, then one of the indicator variables will equal one, and one term from the first sum will be picked out for the angler. For example, if angler j seeks Billfish, f = 1, then δ_{1j} =1, with δ_{nj} = 0 and δ_{fj} =0 for f >1. If an angler does not seek a species, then δ_{nj} =1 and the second sum will appear in the angler's utility function. The coefficients β_{4f} and β_{5f}, f = 1,..,4, capture the attraction of q_{af},which is the mean

[7] All of the indicator variables are equal to zero if the statements are not true.

sale of species group f from area a for the period in which the trip took place. The choice of ramp will depend on time and travel costs of hauling the angler's boat from home to ramp, as well as weather-related variables.

When a stochastic element is added to the deterministic utility described in equation (1), the utility per trip becomes

$$\begin{aligned} u_{ra}(j,s) \;=\; & \beta_1(c_{rj}+c_{raj}) + \beta_2\cdot\delta_{wj}\cdot t_{rj} + \beta_3\cdot\delta_{sj}\cdot t_{rj} + \sum_{f=1}^{4}\beta_{4f}q_{af}\delta_{fj} \\ & + \sum_{f=1}^{4}\beta_{5f}q_{af}\delta_{nj} + \beta_6\cdot KM_a^2 + \beta_7\cdot WS_r + \beta_8\cdot F_a \\ & + \beta_9\cdot P_r + \beta_{10}\cdot\delta_{bj}\cdot\delta_{ca} + \beta_{11}\cdot(1-\delta_{bj})\cdot\delta_{ca} + \varepsilon_{ra} \end{aligned} \tag{2}$$

If the unobservable error term ε_{ra} is distributed as a generalized extreme value random variable, the choices of ramp and HDAR can have a nested interpretation. If the choice of ramp and HDAR are not independent, then the probability of choosing a ramp-HDAR area combination can be written as product of the probability of choosing the area, given the ramp, and the probability of choosing the ramp:

$$\Pr(r,a) = \Pr(a|r)\cdot\Pr(r). \tag{3}$$

Intuitively, the second stage, the probability of choosing an area, would be estimated first, and at that stage the parameters associated with the area choice would be recovered. The ramp probability would be estimated second, with the remaining parameters to be recovered from the first stage. Given the generalized extreme value error assumption, the probability that angler j chooses HDAR area 'a' given that he launched from ramp 'r' is

$$\Pr_j(a|r) = \frac{\exp(\beta_1(c_{raj}) + \sum_{f=1}^{4}\beta_{4f}q_{af}\delta_{fj} + \delta_{nj}\sum_{f=1}^{4}\beta_{5f}q_{af} + \beta_6\cdot KM_a^2 + \beta_8\cdot F_a + \beta_{10}\cdot\delta_{bj}\cdot\delta_{ca} + \beta_{11}\cdot\left(1-\delta_{bj}\right)\cdot\delta_{ca})/\theta}{\sum_{a'=1}^{M_s}\exp(\beta_1(c_{ra'j}) + \sum_{f=1}^{4}\beta_{4f}q_{a'f}\delta_{fj} + \delta_{nj}\sum_{f=1}^{4}\beta_{5f}q_{a'f} + \beta_6\cdot KM_{a'}^2 + \beta_8\cdot F_{a'} + \beta_{10}\cdot\delta_{bj}\cdot\delta_{ca'} + \beta_{11}\cdot\left(1-\delta_{bj}\right)\cdot\delta_{ca'})/\theta}$$

where the sum is over all HDAR areas that are in the individual set of choices (M_s). In this probability, only the HDAR areas for the given ramp are part of the alternatives analyzed for the individual. For example, in the unrestricted choice set, there would be 34 areas (more on the definition of the set of relevant alternatives below). Estimation of the area choice gives back parameter estimates β_1/θ, β_{4f}/θ and β_{5f}/θ, for f = 1....4, β_7/θ, β_9/θ, and β_{10}/θ. The parameter θ is a structural parameter of the generalized extreme value distribution that can loosely be interpreted as the degree of dependence of the HDAR choice on the ramp choice. If $\theta = 0$ then the ramp and HDAR choices are independent and can be estimated separately. If $\theta = 1$ then the choice of ramp and HDAR are determined simultaneously, and each ramp-HDAR combination (442 in all) can be interpreted as a separate choice. That is, if $\theta = 1$ each ramp-HDAR combination is a unique site and a conditional logit model can be estimated.

Referring back to equation 3, the probability that angler j chooses launch ramp r is given by

$$Pr_j(r) = \frac{\exp(\beta_1 c_{rj} + \beta_2 \cdot \delta_{wj} \cdot t_{rj} + \beta_3 \cdot \delta_{sj} \cdot t_{rj} + \beta_7 \cdot WS_r + \beta_9 \cdot P_r + \theta I_r)}{\sum_{r'=1}^{N_r} \exp(\beta_1 c_{r'j} + \beta_2 \cdot \delta_{wj} \cdot t_{r'j} + \beta_3 \cdot \delta_{sj} \cdot t_{r'j} + \beta_7 \cdot WS_{r'} + \beta_9 \cdot P_{r'} + \theta I_r)}$$

where the sum is over all of the ramps accessible to the angler (equal to N_r) and the variable I_r is the inclusive value:

$$\begin{aligned} I &= \log(\sum_{a'=1}^{M_s} \exp(\beta_1(c_{ra'j}) + \sum_{f=1}^{4} \beta_{4f} q_{a'f} \delta_{fj} + \delta_{nj} \\ &\times \sum_{f=1}^{4} \beta_{5f} q_{a'f} + \beta_6 \cdot KM_{a'}^2 + \beta_8 \cdot F_{a'} + \beta_{10} \cdot \delta_{bj} \cdot \delta_{ca'} + \beta_{11} \cdot (1 - \delta_{bj}) \cdot \delta_{ca'})) \end{aligned}$$

The analysis of ramps uses the ramps only, but the calculation of the inclusive value requires that the HDAR data be used—costs and catch are part of the inclusive value. Estimation at this stage gives parameter estimates β_1, β_2, β_3, β_5 and θ. We can see from this specification that β_1 is the same at the area level (a) and the ramp level (r), because it is the coefficient on the cost of the alternative, whether ramp or area, and it also can be interpreted as the marginal utility of income. Given the estimate of θ from this stage, the non-normalized parameters from the first (area choice) stage can be recovered. The coefficient on the inclusive value, θ, is commonly taken to be a measure of similarity among branches, so that $\theta = 1$ is equivalent to no nesting. For consistency with utility maximization, $0 < \theta < 1$.

Numerous ramp-HDAR choice models are estimated using the two-stage structure described above. The nested-logit model tries to identify differences in patterns of substitution between HDARs across ramps. The consistent result across all models is that the inclusive value parameter θ is indistinguishable from one. This means that the ramp and HDAR choices are not nested but instead each ramp/HDAR combination is a unique choice. This is not surprising in this context since all of the HDARs are accessible from all of the ramps meaning that all HDARs appear in each nest of the two-stage model. The more the patterns of substitution differ across ramps, the closer the estimate of θ will be to 0. For these reasons, the remainder of this section discusses the conditional logit model of ramp-HDAR choice such that the probability of choosing ramp-HDAR combination 'r,a' is

$$\Pr(ra) = \frac{\exp(v_{ra}(j,s))}{\sum_{r'=1}^{N_r}\sum_{a'=1}^{M_s}\exp(v_{r'a'}(j,s))} \tag{4}$$

The conditional logit model of ramp-HDAR choice can be estimated in one step using full-information maximum likelihood.

The Expected Effects of Variables in the Model

It is useful to form some expectations about the variables included in the utility function (equation (1)). The costs of travel from home to ramp are transportation costs—that is, the vehicle costs of trailering a boat—plus the costs of time for individuals whose hours of work are flexible. Only transportation costs are used for individuals who cannot vary their hours of work. For the individuals who do not work or whose hours of work are not flexible, there are two categories: those who are retired (δ_{wj}=1) and those who work but do not have flexible hours (δ_{tj}=1). Consequently the costs for an angler with flexible time will be c_{rj} = transportation costs + $t_r \cdot vt_j$ where vt_j, the value of time for individual j, equals annual income divided by 2000, which is approximately equal to the average hourly wage of the respondent. This allocation of time and money costs (or out-of-pocket costs) is based on a model by Bockstael, Strand and Hanemann and does as well as any to capture the time and money trade-off. We have no clear priors on the relative magnitudes of β_2 and β_3, but expect both coefficients to be negative. The amount of time to travel from home to ramp is based on a regression of self-reported time as a function of distance, boat size, and ramp location. The travel costs on land will vary across individuals who might travel the same distance because they have to haul different size boats. Likewise travel costs in the water vary because boats of different length travel at different speeds. The water travel cost is based on self-reported costs per trip. This information is used to estimate a cost per mile traveled, based on boat size. The estimated travel cost equations are described in Appendix A.

In addition to the variables discussed above, a few ramps have characteristics that are not quantifiable, but that make them more or less desirable than other ramps with similar quantifiable characteristics. The launch ramp at Waianae is a very popular site during the yellowfin summer run. Yellowfin are easily accessible from Waianae during July and August. This is accounted for in the estimated model by including a dummy variable that equals 1 for Waianae ramps for angling trips taken during period 4 (July/August). Anecdotal evidence also shows that the ramps at Kailua and Kahana are exposed to high winds and are in general difficult and less desirable ramps. We include dummy variables for these two ramps in the estimated model. The full utility function then becomes

$$\begin{aligned} u_{ra}(j,s) &= \beta_1(c_{rj}+c_{raj}) + \beta_2\cdot\delta_{wj}\cdot t_{rj} + \beta_3\cdot\delta_{sj}\cdot t_{rj} + \sum_{f=1}^{4}\beta_{4f}q_{af}\delta_{fj} + \sum_{f=1}^{4}\beta_{5f}q_{af}\delta_{nj} \\ &\quad +\beta_6\cdot KM_{a'}^2 + \beta_7\cdot WS_r + \beta_8\cdot F_a + \beta_9\cdot P_r + \beta_{10}\cdot\delta_{bj}\cdot\delta_{ca} \\ &\quad +\beta_{11}\cdot(1-\delta_{bj})\cdot\delta_{ca} + +\beta_{12}\cdot\delta_{WIr}\cdot\delta_{4j} + \beta_{13}\cdot\delta_{KIr} + \beta_{14}\cdot\delta_{KAr} + \varepsilon_{ra} \quad (5) \end{aligned}$$

The full set of variables includes these:

c_{rj} = travel cost from home to ramp or harbor r for angler j;
c_{raj} = travel cost by boat from ramp or harbor r to area a for angler j;
t_{rj} = travel time from home to ramp r for angler j;
q_{af} = pounds sales from area a of species group f;
δ_{wj} = 1 if angler does not work flexible hours;
δ_{sj} = 1 if angler j is retired;
δ_{fj} = 1 if angler j targets species f;
δ_{nj} = 1 if angler j targets no species;
δ_{bj} = 1 if angler j has a boat of length greater than or equal to 20 feet;
δ_{ca} = 1 if HDAR a is a coastal HDAR;

$\delta_{WIr} = 1$ if ramp r is Waianae and zero otherwise;
$\delta_{4j} = 1$ if angler j took their last trip in period 4;
$\delta_{KIr} = 1$ if the ramp is Kailua and zero otherwise;
$\delta_{KAr} = 1$ if the ramp is Kahana and zero otherwise;
F_a = number of fish aggregating devices (FADs) in area a;
KM_a^2 = surface area of HDAR site a in kilometers squared;
WS_r is a ramp specific weather variable that will be calculated from wind speed and direction or a dummy variable that equals 1 if the ramp has a northern or eastern exposure during trade wind months (January-April);
P_r = number of designated parking spaces at ramp r.

Given the ramp and destination variables included in equation (5), we expect the variables to influence the probability of choosing a ramp, and the utility from the ramp choice, as follows:

1. Fishermen with smaller boats ($\delta_{bj} = 0$) will be more likely to visit coastal HDAR sites than anglers with larger boats. This implies that $\beta_{11} > \beta_{10}$.

2. Coastal HDAR sites will be less desirable than non-coastal HDARs for large boats, with possibly the opposite holding for smaller boats, implying $\beta_{10} < 0$, $\beta_{11} > 0$.

3. Higher species group sold from a particular HDAR area is expected to increase the likelihood that the HDAR area is chosen by an angler targeting that species ($\beta_{4f} > 0$ for all f).

4. We have no prior expectations on the effect of catch sold on choices made by anglers who do not target a particular species.

5. FADs will attract anglers (and fish) and therefore we expect a positive relationship between the number of FADs and the likelihood of a site being chosen ($\beta_8 > 0$).

6. An increase in the number of designated parking spaces is expected to have a positive impact on the likelihood of a ramp being chosen ($\beta_9 > 0$).

7. The higher the wind exposure of a ramp the less desirable that ramp becomes for launching ($\beta_7 < 0$).

8. Because Waianae is a more desirable ramp during yellowtail season, we expect $\beta_{12} > 0$.

9. Because Kahana and Kailua are reportedly undesirable ramps, we expect β_{13} and $\beta_{14} < 0$.

10. To control for the relative size of the HDARs, the areas of the sites are included. HDAR areas with greater area are more likely to be chosen, implying that $\beta_6 > 0$.

Definition of Choice Sets

As shown in equation 4, the probability of an angler choosing ramp-HDAR combination 'r,a' will depend on the set of ramps and the set of HDAR sites assumed to be available to the angler. There are potentially 442 ramp-HDAR combinations available to each angler. For fishermen who moor their boat at a specific ramp, 408 of those ramp-HDAR combinations are ruled out as possible choices. For each angler who has a moored boat, it is assumed that they choose from among the 34 feasible HDARs, but have no choice of ramps. Fishermen who trailer their boats are assumed to choose from among a subset of the 12 ramps and 34 HDARs (408 possible choices). If the angler or the angler's spouse reports a military occupation, then all 12 ramps are assumed to be available to the angler. If neither the angler nor angler's spouse is in the military, then the ramps at Hickam Harbor, Marine Corps Air Station, and Rainbow Bay are unavailable as they are restricted to military only. It is assumed that anglers make rational decisions when deciding on their ramp-HDAR combination such that the angler will not drive across Oahu to launch the boat only to circle the island and return to an HDAR site on the other side. Therefore, we assume that anglers will only consider HDAR sites that lie within the half-circle created by drawing a line through the center of the island parallel to a tangent line drawn to each ramp. For example, if the ramp lies at the northern-most point of Oahu, then only HDAR sites that lie north of a line drawn from east to west through the center of Oahu will be considered. This appears to be an accurate representation of anglers' behavior as none of the interviewed anglers took trips that would have fallen outside of the defined feasible area.[8]

[8]This assumption makes estimation somewhat easier, but has virtually no impact on the estimated coefficients.

Model Results

The results of the conditional logit model of ramp-HDAR choice among Oahu anglers are reported in Table 7. The pseudo R^2 is 0.33.[9] The wind speed variable described above is a poor predictor of ramp choice. Instead, we include the proxy dummy variable for WS_r that equals one if the ramp is exposed to strong trade winds in January-April and zero otherwise. This simple variable appears to have more explanatory power than the directional wind speed variable.

The results of this model are for the most part as we expected. Full travel cost has a negative and significant impact on the probability that a given ramp-HDAR is chosen and consequently, all else equal more distant sites provide less utility than closer sites. For fishermen who do not work for an hourly wage (they are either salaried or unemployed), travel time has a negative but insignificant impact on the probability of site choice. For fishermen who are retired, travel time has a strong negative and significant effect on utility.

Referring back to the list of prior expectations in the previous section, we see that the estimated model conforms for the most part to those expectations. Smaller boats appear to find coastal HDARs more desirable than do larger boats $(\beta_{11} > \beta_{10})$, and distant HDAR sites are more desirable than coastal HDAR areas for anglers with large boats $(\beta_{10} < 0)$. Increases in the catch sold of billfish and bottomfish for a given HDAR area significantly increase the probability that a particular HDAR will be chosen by anglers who target those species. However, the catch sold of tuna and other pelagics does not have a significant effect. For anglers who do not target species, the catch of bottomfish is the only significant catch variable (positive and significant). The mixed significance of the catch variables leads us to test their significance jointly. We test three joint null hypotheses:

H1: None of the HDAR catch variables are significant;

H2: The four HDAR variables for fishermen who target species are not significant;

H3: The four HDAR variables for fishermen who do not target species are not significant. As might be expected, the first hypothesis is rejected, with a

[9]Although measures of goodness of fit are not as informative with discrete choice models, it is feasible to calculate a pseudo R^2 from the likelihood values with coefficients equal to zero, and at their optimal values. This value ranges from zero to one, but lacks the intuitive appeal that comes with the R^2 from OLS models.

Table 7: Parameter Estimates for Random Utility Model: Basic Model

Parameter	Associated Variable	Parameter Estimate (Standard Error)
β_1	$c_{rj} + c_{raj}$	-.114[a](.004)
β_2	$\delta_{wj} \cdot t_{rj}$	-.257(.408)
β_3	$\delta_{sj} \cdot t_{rj}$	-1.76[a](.767)
β_{41}	$q_{aBILL}\delta_{BILLj}$	.011[a](.005)
β_{42}	$q_{aBOTTOM}\delta_{BOTTOMj}$	.017[a](.006)
β_{43}	$q_{aOTHER}\delta_{OTHERj}$	.002(.007)
β_{44}	$q_{aTUNA}\delta_{TUNAj}$	.0009(.003)
β_{51}	$q_{aBILL}\delta_{nj}$	-.0001(.001)
β_{52}	$q_{aBOTTOM}\delta_{nj}$	.007[a](.003)
β_{53}	$q_{aOTHER}\delta_{nj}$	-.003(.004)
β_{54}	$q_{aTUNA}\delta_{nj}$	.001(.001)
β_6	KM_a^2	.0009[a](.0002)
β_7	WS_r	-.752[a](.270)
β_8	F_a	.829[a](.095)
β_9	P_r	.011[a](.001)
β_{10}	$\delta_{bj} \cdot \delta_{ca}$	-2.344[a](.291)
β_{11}	$(1 - \delta_{bj}) \cdot \delta_{ca}$	.611[a](.232)
β_{12}	$\delta_{WIr} \cdot \delta_{4j}$	1.579[a](.404)
β_{13}	δ_{KIr}	-.705[a](.325)
β_{14}	δ_{KAr}	-.433(.488)

[a]Significantly different from zero at the 99% level of confidence.

calculated Chi-squared statistic of 18.6, compared with a table value of 11.1 for the 97.5 percent level of significance. The second hypothesis is also rejected, with a calculated Chi-squared statistic of 12.7. The non-seeking group has a p-value 0.13, meaning that it is not significant at the 90 percent level of confidence. However, as Appendix B shows, the equation that excludes the HDAR variables for those not seeking species is generally quite close to the model that includes them. We use the parameters in Table 7 for purposes of benefit estimation.

The other variables work according to expectations. The size of the HDAR area has a very strong effect. Boats travel to larger sites, all else equal. The presence or number of FADs increases the likelihood of visits to an HDAR area, even when the recorded catch has been accounted for. As the number of designated parking spaces increases at a ramp, the utility of visiting that ramp increases significantly. Two explanations for this are possible: First, the more designated parking spaces, the less likely the ramp will be congested with boat trailers; and second, the number of designated parking spaces can potentially capture unobservable quality attributes of particular ramps. That is, ramps that have desirable but unmeasured qualities might also have more parking spaces because the extra spaces have been provided for the better ramps. Ramps that are exposed to trade winds are significantly less desirable during trade wind months, and the ramp at Waianae is significantly more desirable during yellowfin runs.

Measuring the Benefits of Angling in the Small Boat Fishery on Oahu

With the parameters estimated for the random utility model, we are able to estimate the economic benefits—that is the income equivalents—provided by various amenities associated with small boat fishing. An understanding of the benefits of angling can aid in the formation of fishery management policies. The remainder of this section looks at various benefit measures for the small boat fishery on Oahu. Bockstael, McConnell and Strand give a detailed overview of welfare measurement for multiple site random utility models. All of the measures described below can be classified into one of two categories: loss of benefits due to loss of access to a subset of sites, or loss/gain in benefits due to a change in the amenities of a site.[10]

Defining S_j as the set of all sites available to angler j, and S_j^- as the set of sites available to angler j after elimination of some subset of site, we then define the value of lost access (also known as willingness to pay or equivalent income) to

[10] We could also calculate the value of introducing a new ramp if such a proposal were concrete.

that subset of sites:

$$WTP_j\,(access) = \frac{\ln\left(\sum\limits_{ra\in S_j} e^{v_{ra}}\right) - \ln\left(\sum\limits_{ra\in S_j^-} e^{v_{ra}}\right)}{|\beta_1|} \tag{6}$$

Intuitively, the first term in the numerator above represents the expected maximum utility for by angler j when all sites are available, and the second term in the numerator is the expected maximum utility for the angler when a subset of sites are removed from consideration. Given the linear utility function assumed in equation (1), the denominator in equation (6) represents the marginal utility of income and serves to convert the lost utility in the numerator into an income equivalent.

If instead of measuring the willingness to pay for access to particular sites we want to measure the change in willingness to pay for a change in amenities at one or more sites, an analogous procedure can be used. First we measure the change in expected maximum attainable utility from the change in site attributes. This is measured as

$$\Delta E_{\max}\,(v_{ra}) = \ln\left(\sum_{ra\in S_j} e^{v^0_{ra}}\right) - \ln\left(\sum_{ra\in S_j} e^{v^1_{ra}}\right) \tag{7}$$

where v^0_{ra} is the deterministic utility function from equation (1) evaluated at the current values of the right-hand side variables, and v^1_{ra} is the deterministic utility function evaluated at the new values of the right-hand side variables. For example, to value an increase in the number of parking spaces at a particular ramp, one would first evaluate the deterministic utility function at the current number of parking spaces at that ramp (and the current values of all other variables) and then evaluate the deterministic utility function at the increased number of parking spaces (and the current values of all other variables). To convert to a money metric, the change in expected maximum utility is divided by the marginal utility of income so that for the linear utility function, the value of the change in attributes becomes

$$WTP_j\,(\text{change in attributes})\;\frac{\ln\left(\sum\limits_{ra\in S_j} e^{v^0_{ra}}\right)-\ln\left(\sum\limits_{ra\in S_j} e^{v^1_{ra}}\right)}{|\beta_1|} \tag{8}$$

The Value of Lost Access to Ramps. Table 8 reports the sample mean WTP of lost access per trip per angler for each of the 12 ramps on Oahu (i.e., the average lost welfare due to ramp closure for a single fishing trip). Note that these values are for trailered boats only. Column 2 reports the sample mean, Columns 3 and 4 report the average value by military status. The minimum and maximum WTP for each subsample are reported parenthetically.

Table 8 should be interpreted cautiously. These values represent the cost of substituting from hypothetically closed sites to the next best alternative. The values reported in each row represent the willingness to pay to prevent the closing of each ramp while keeping the remaining ramps open and available for launches. It is therefore not possible to add the values together to obtain the value of closing multiple ramps simultaneously. For example, the value reported for Ala Wai assumes that all other ramps remain open.

At first glance it appears that the lost welfare due to a single ramp closure is low. The maximum average lost value due to ramp closure is for Waianae at \$1.68 per angler per trip. On average, military personnel value non-military ramps lower than do non-military personnel. The values for the military ramps (Marine Corps Air Station, Rainbow Bay and Hickam Harbor) are somewhat misleading in that they include a large number of zero values from non-military personnel (since they do not have access to these ramps). The column for military personnel only drops the zeros so that the measures are only for those fishermen who have access to the ramps.

While the mean value per trip appears to be low, taken in aggregate, the lost values can be substantial. To illustrate, we can expand by the number of trips. The median number of trips taken by anglers over the past 6-month period prior to the interview is six trips per angler (or 12 per year). Aggregating over the estimated 6,600 small boat anglers on Oahu leads to an estimate of 79,200 trips per year. Multiplying by the average lost value per trip per angler due to ramp closure for Waianae (\$1.69) gives an aggregate welfare loss per year of \$133,056. The minimum average value of lost access for non-military sites occurs

Table 8: Economic Losses from Ramp Closings, per Trip per Angler

Ramp	Value of Lost Access N=413	Military N=15	Non-Military N=398
Ala Wai	\$.94 (0, 10.71)	\$.61 (.13, 1.01)	\$.95 (0, 10.71)
Haleiwa	\$1.60 (0, 58.73)	\$.45 (.01, 2.09)	\$1.64 (0, 58.73)
Heeia-Kea	\$1.59 (0, 8.63)	\$.91 (.30, 2.08)	\$1.61 (0, 8.63)
Hickam Harbor	\$.05 (0, 8.02)	\$1.47 (.09, 8.02)	\$0 (0, 0)
Kahana	\$.27 (0, 2.86)	\$.23 (.01, 2.86)	\$.28 (0, 1.81)
Kailua	\$1.83 (0, 9.26)	\$.08 (.02, .12)	\$1.90 (0, 9.26)
Kaneohe	\$1.19 (0, 5.87)	\$.68 (.25, 1.14)	\$1.21 (0, 5.87)
Keehi	\$.89 (0, 25.52)	\$1.30 (.23, 2.27)	\$.87 (0, 25.52)
Marine Corps Air Station	\$.01 (0, .36)	\$.21 (.06, .36)	\$0 (0, 0)
Rainbow Bay	\$.07 (0, 8.08)	\$1.84 (.12, 8.08)	\$0 (0, 0)
Hawaii Kai/ Maunalua Bay	\$.55 (0, 2.03)	\$.22 (.06, .35)	\$.56 (0, 2.03)
Waianae/ Pokai Bay	\$1.69 (0, 17.17)	\$1.99 (.21, 6.19)	\$1.68 (0, 17.17)

Table 9: Losses per Trip from Closing Groups of Ramps

South Shore: $2.94	*Windward Shore: $6.80*
Ala Wai	Heeia-Kea
Hickam Harbor	Kahana
Keehi	Kailua
Rainbow Bay	Kaneohe
Hawaii Kai	Marine Corps Air Station

for the Kahana ramp. The aggregate lost value per year for closure of Kahana is $21,384.

The values reported are potentially lower than the value of ramp closures that might be found for mainland U.S. fisheries because substitution among ramps does not inhibit the ability of an angler to reach a particular HDAR to the same degree as it would on a linear coastline. Because close substitutes exist for each ramp and the set of feasible HDARs from each ramp overlap significantly, the lost value of the closure of a single ramp is somewhat moderated. It would be useful to calculate the value of lost access to all ramps simultaneously, but this is not possible with a random utility model, which assumes that fishermen choose one of the ramps. The alternative of not choosing a fishing site is not analyzed. Because the sample used here is conditioned on having taken a fishing trip in the past six months, the value of lost access to all sites would be infinite.

It is of interest to estimate the equivalent lost income from closing groups of ramps simultaneously. Oahu can be roughly divided into four distinct geographic coastal regions: the north shore, the windward coast, the south shore, and the leeward coast. The north shore and the leeward coast each contain only one feasible public boat ramp in the group of visited ramps: Haleiwa and Waianae. The lost value of closure of those coast is therefore estimated as the value of closing those individual ramps. The south shore and the windward coast each has five visited ramps. The south shore ramps are Ala Wai, Hickam Harbor, Keehi, Rainbow Bay and Hawaii Kai. The windward ramps are Heeia-Kea, Kahana, Kailua, Kaneohe, and Marine Corps Air Station. The values of lost access to the south shore ramps and windward coast ramps are $2.94 and $6.80 respectively (see Table 9). The values obtained by summing over the individual ramp closures in Table 8 would be $2.50 and $4.89. Failing to account for the lost substitution opportunities results in underestimating the value of lost access by 16-28 percent in this case.

Lost Value Due to Closure of Coastal HDARs Here we look at the economic losses when access to the HDAR fishing sites is hypothetically constrained. In particular, we estimate the losses when small boat fishing is prohibited in the coastal HDAR areas. The full sample average lost benefits (or willingness to pay to prevent closure) due to closure of the coastal HDARs is $10.61 per angler per trip. The mean lost value broken down by small/large boats and trailered versus moored boats appears as follows:

	Moored Boats	Trailered Boats
Small Boats (<20 feet)	$13.44	$5.91
Large Boats	$35.02	$14.37

As expected, the losses for anglers with moored boats is greater than the lost value for those who trailer their boats. Small boats appear to have a smaller value for coastal HDAR sites than do larger boats. This might seem counterintuitive because it is expected that fishermen with smaller boats will have a higher probability of choosing a coastal HDAR site relative to those with larger boats, but this appears to be outweighed by the large value that larger boat owners place on a fishing trip. On a yearly basis, averaged across all boats, the equivalent income loss would be $840,312.

This measure of willingness to pay might be compared with gains for commercial fishing, if access to some HDAR areas were restricted to one group or another.

The Value of Additional Parking

The previous two sections report the values of closing particular subsets of sites. It is also possible to value changes in site amenities using the random utility framework. For example, due to concerns about congestion, it might be useful to know what anglers are willing to pay for (or analogously, the gain in equivalent income from) additional designated parking at ramps. This can be done on a per ramp basis or an across the board increase at all ramps. We have chosen to report the latter. By simplifying equation 8[11], the value of a one unit change in one of the attributes across all sites can be found by dividing the parameter associated with that attribute by the marginal utility of income. For the case of parking spaces, the value per angler per trip of one additional parking space at each ramp can be found by dividing the parameter estimate associated with

[11] See Whitehead and Haab, MRE 1999 for a detailed derivation.

Table 10: The Losses per Trip from Reductions in FADs

HDAR Area	Number of FADs	Percent of Sample Trips	Losses: One FAD	Losses: All FADs
403	1	7.5	$0.31	[a]
421	2	5.6	0.29	0.43
423	3	12.4	0.48	0.84
424	1	3.4	0.12	[a]
425	2	2.8	0.13	0.19
426	2	3.9	0.14	0.20
427	2	7.3	0.22	0.32
428	1	2.4	0.13	[a]
452	1	0.2	0.05	[a]

[a] When there is only one site, the losses are the same as for all FADs.

parking spaces ($\beta_9 = .011$) by the utility of income ($-\beta_1 = .114$), which yields a willingness to pay of $0.09 per angler per trip for an additional parking space. An alternative value for additional parking can be found by increasing parking by 10 percent at each ramp. The willingness to pay per angler per trip for a 10% increase in parking at all ramps is $0.86. Multiplying by the expected 72,900 trips per year gives an aggregate value of $68,112 per year for a 10% increase in designated parking spaces at all ramps.

The Value of FADs

The presence and number of FADs in an HDAR area has a significant effect on the probability of choosing to fish in the area. Hence the loss of a FAD means a real economic loss. Table 10 shows the per trip losses from the loss of FADs at the given HDAR area. These losses are underestimates because they assume that the aggregate catches are maintained in the absence of FADs, when in fact these catches are in many cases a consequence of the presence of FADs and would decline without them. To gauge the size of these losses, suppose that the FAD for HDAR area 403 were lost. This would be lost for about 12 trips per fisherman, for the 6500 fishermen, for a total loss of about $24,000 per year.

4. Contingent Valuation for Hawaii Small Boat Fishermen

In this section we analyze responses to a contingent valuation question addressed to the small boat anglers. This question attempts to uncover the preferences of anglers by determining what they would be willing to pay rather than go without the trip covered by the interview. Contingent valuation (CV) is a well-developed alternative to behavioral methods (such as the random utility model of the previous section) for valuing natural resources and the environment. It has the advantage over behavioral methods of the capability of valuing dimensions of services that are too small or have no use value and so would be missed by behavioral methods. The CV method also has the potential for being handled badly, from questionnaire design to model estimation. An extensive debate has taken place about whether CV can measure non-use (passive use) values effectively. (See Diamond and Hausman, 1994 and Hanemann, 1994). But there is some agreement that when the method is properly employed, it can provide reasonable measures of economic value.[12]

Although the random utility model provides a good basis for the economic analysis for the small boat fishery, the CV analysis will supplement it in three fruitful ways. First, by its nature, the random utility model (RUM) does not provide estimates of what an individual would be willing to pay for a single trip. The CV question is designed precisely for that purpose. Second, the CV responses can be exploited to give values of catching different species. Under the right circumstances the RUM can yield estimates of the value of improving catch rates.[13] Currently in Hawaii there are insufficient data on the historical catch per unit effort of the small boat fishery to permit the estimation of the effects of these catch rates in a RUM. Finally the CV model will be estimated for Maui, the Big Island, Molokai, Lanai and Kauai, as well as Oahu. This will give insight into the small boat fishery on the other islands in comparison to Oahu.

[12]There have been so many tests of CV that they are impossible to categorize. One of the most instructive is a study by Carson et al. (1996), who show in a comparison of CV versus behavioral approaches that the behavioral approaches yield systematically higher values, alleviating at least the concern that CV estimates are always too high.

[13]McConnell and Strand (1994) estimate the values of changes in the catch rates of various species groups of marine sport fish for the east coast of the U.S.

4.1. Constructing the Contingent Valuation Model

The logic of the CV approach is that the respondent is asked a question or a series of questions that require him to assess his own preferences or willingness to pay in order to respond. In current practice the respondent is typically given a yes or no question that can be answered with knowledge of willingness to pay. In the CV analysis of the Hawaii small boat fishery, we exploit the yes-no or discrete choice CV.

The CV question is part of the phone interview. The method of payment in the CV question is an increment in the cost per trip on the fisherman's most recent trip. The idea is to ask the respondent if he would take the trip if costs were higher and to use the response to determine the maximum willingness to pay for the trip. An important difference between this retrospective CV question and a forward-looking question is the outcome of random variables, for example, catch and weather. In the case of a bad outcome (no catch, rain, seasickness) the respondent might not take the trip again with the costs actually incurred, much less at an increased cost. In such a case, it makes no sense to ask the respondent if he would take the trip again at higher costs. To deal with this issue, we first ask respondents whether they would take the trip again under the same circumstances they experienced initially. For those who answer yes, the interviewer proceeds to ask if they would take the trip at a higher cost. With this initial question, we can exploit the responses of those who say they would not take the trip under the initial circumstances, by asking if they would take the trip if the costs were lower.

The series of questions pertaining to CV comes towards the end of the survey, after questions about the costs of the trip. The respondent is asked the following:

> Now I want you to think about the details of your last fishing trip. Suppose you had known, in advance, how this last trip would turn out. For example, you knew what the catch would be, what the experience would be like, what it would cost you, the weather, and everything else that went into the trip. Knowing all these things in advance, would you still have taken this last trip?

The respondent may answer 'yes', 'no' or refuse to answer. This question is not the CV question, but it sets the stage for the CV question. Those who answer 'yes' are then asked the following question:

> Now, what if everything else—the catch, the experience, the weather and everything that went into the trip—was the same. But your cost

for the trip was \$Δc more. Would you still have taken the last trip if it was \$Δc more?

The \$Δc is varied randomly as \$25, \$50, \$75, or \$200. Respondents who answered 'no' to the question of whether they would retake their trip are asked an analogous question, except that the phrase '\$Δc more' is replaced by '\$Δc less', and \$Δc =\$25, \$50, or \$75[14]. The answers to these questions give us a series of yes-no responses, along with a cost to the respondent for each response.

The responses to these questions can be modeled in a random utility framework or with a random willingness to pay function.[15] Because it facilitates extensions of the model, we adopt the willingness to pay function. This simply means that we specify a function for fisherman j, denoted $w(s_j)$, where s_j is a vector of fishing and socioeconomic variables pertaining to individual j and the last fishing trip of j, such as age, income, employment status, catch, weather, etc. The function represents the maximum amount individual j would pay for the last fishing trip. For the trip under consideration, the individual would take the trip if

$$w(s_j) \geqslant c$$

where c is the cost of taking the trip. Now consider the mechanics of the CV question. Would the respondent take the trip if costs increase by \$Δc? This is equivalent to asking if

$$w(s_j) \geqslant c + \Delta c.$$

The respondent will answer yes if willingness to pay for the last trip exceeds the actual plus the hypothetical increase in costs, and no otherwise. The framework can model the respondents who say no to the retake question and then are asked if they would take the trip at a lower price. This is equivalent to asking if

$$w(s_j) \geq c - \Delta c$$

The two responses can be modeled by giving $w(s_j)$ a functional form and introducing randomness explicitly. Suppose that $w(s_j)$ is of the form

$$w(s_j) = exp(\alpha \cdot s_j + \varepsilon_j)$$

[14]The \$200 reduction in cost is eliminated in order to avoid the possibility that an individual would have negative costs.

[15]The general willingness to pay function can be derived from a utility function. Different functional forms may or may not be consistent with utility functions.

where α is a vector of parameters to be estimated and ε_j is a random variable assumed to be distributed N(0,σ^2). The exponential model has the virtue that willingness to pay cannot be negative, no matter how negative the error. This model can be estimated as a log-probit with covariates s_j and -log(c$\pm\Delta c$) and parameters α/σ and $1/\sigma$.[16]

The constructed model is useful because it provides estimates of mean and median willingness to pay, and explains how these estimates depend on the covariates s_j. These measures all require that the model be given a set of covariates and estimated.

4.2. Empirical Analysis of Contingent Valuation Responses.

In this section we report on the estimation of the CV model and the calculation of willingness to pay for various scenarios that relate to small boat fishing and that have some plausible policy relevance.

Model Estimation

Given the functional form of the willingness to pay function and the distribution of the random terms, the next step in estimating the CV response model is to choose the appropriate set of regressors. In addition to the cost of the trip, there are three kinds of variables that can influence the likelihood of taking a trip: personal characteristics such as age and income; fishing equipment variables such as boat size and fishing gear; and the characteristics of the trip, such as the species sought and the success of the trip. For purposes of understanding fishing and the value of fishing in Hawaii, the most important variables are the cost of fishing and the nature of fishing activity.

The survey gathered two kinds of information about fishing: the species sought and the species caught (if any). The descriptive statistics for the basic data are given in the earlier section of the report on the survey. For empirical analysis, the seven species have been aggregated to four as follows:

Tuna: aku and all other tuna;
Pelagic: mahimahi and ono;
Billfish: not aggregated;

[16] In this analysis it is assumed that the structure of preferences is the same for those who answer 'no' and those who answer 'yes' to the original question asking if the respondent would take the trip again. In a test of this assumption, we cannot reject the hypothesis that they are the same.

Other: deep sea bottomfish and other species.
Both the species sought and the species caught are aggregated in this fashion. There are potentially eight indicator variables—two for each species group—that could be included as an independent variable in the model. Initial tests rejected most of the species sought categories as significant variables. The four species group variables in Table 11 (SBILL, PELAGIC, BILL, TUNA, SCOTHER) are consistently significant across different specifications and so remain in the final model. Two species group variables are created out of individual respondent characteristics: SBILL and SCOTHER. The variable SBILL is constructed so that it equals one when a respondent both seeks and catches a billfish. This species is glamorous—actually catching a billfish is prestigious. The other group is SCOTHER, which takes a value of one when a respondent whose vessel is registered for commercial use, or who sells his catch, is successful in catching deep sea bottom fish or 'other' species. The rationale for this categorization is that catches of these species matter for fishermen who have some commercial motives. Without commercial motives, fishermen are assumed not to value this group. The presence of commercial motives is measured by the use classification of the boat as commercial fishing or by selling fish on the trip in question.

In addition to the cost variable and the species group variables, the basic model includes indicator variables for the islands where the boats are registered. These are indicator variables for Oahu, Kauai, and the Big Island. The default locations are therefore Maui and Lanai-Molokai. There are two variants of the basic model: one with household income[17] and one with equipment variables. The means for all these independent variables are given in Table 11. This table also gives the mean cost per trip, which includes the boat costs as well as travel and imputed time costs.

The responses to the dichotomous CV question are the dependent variables and will be used later to calculate mean willingness to pay non-parametrically. They measure responses unconditionally, that is, how the respondents answer the CV question, independent of the variables that influence or describe their preferences. In Table 12 the responses to the CV question by those who would retake the trip are given as a function of the increased cost. In the second column, the amount of added cost is given, and in the fourth column the proportion of No's to the CV question. On average, the proportion of No's should increase, as it does in this

[17] The household income is computed from eight interval responses. The respondent answers yes-no questions about the range of household income. The ranges are (in 1,000s) $15 and below, $15 to $25, $25 to 35, $35 to 50, $50 to 75, $75 to 100, $100 to 150, and above $150.

Table 11 : Descriptive Statistics: Independent Variables of Contingent Valuation Model.

Abbreviation	Description of Variable	Mean[b]	Standard Deviation
COST	trip cost (excluding hypothetical cost)	73.07	99.68
SBILL	sought and caught billfish[a]	.014	.117
TUNA	caught tuna[a]	.220	.415
PELAGIC	caught mahi or ono[a]	.208	.406
BILL	caught billfish[a]	.048	.213
SCOTHER	caught other/bottomfish, and SELL or COMM[a]	.092	.289
OAHU	boat registered on Oahu[a]	.545	.498
KAUAI	boat registered on Kauai[a]	.120	.325
BIG I	boat registered on the Big Island[a]	.217	.413
HHINC	household income ($1000s)	69.47	36.47
LINE	owns line hauler[a]	.189	.391
GPS	owns GPS[a]	.459	.498
RODS	number of large rods owned	2.75	2.17
COMM	vessel registered as commercial fishing vessel[a]	.073	.261
SELL	sold fish on most recent trip[a]	.159	.365

[a]These are indicator variables that take on the value of 1 when the statement is true for the respondent on the most recent trip, and 0 otherwise.

[b]All statistics are based on 1,008 observations except for COST, which used 949, and HHINC, which used 883.

Table 12: Contingent Valuation Data for Respondents Who Would Retake Trip

k	Added Cost (Δc_k)	Number Responding	Proportion of No's	Proportion of $\$\Delta c_{k-1} \leq$WTP$<\$\Delta c_k$
1	\$25	205	.240	.240
2	\$50	206	.379	.139
3	\$75	217	.530	.151
4	\$200	215	.749	.219

table. These responses will be useful in the calculations of mean WTP when the time comes.

The basic model for willingness to pay is

$$w(s_j) = exp(\alpha \cdot s_j + \varepsilon_j)$$

where α is vector of the parameters to be estimated and s_j the vector of independent variables of individual j. The model can be estimated as a log-probit when ε is normally distributed. The basic specification is

$$\begin{aligned} Prob(yes) \;=\; & Prob(Const. - (1/\sigma)log(c \pm \Delta c) + \alpha_1^{'}SBILL + \alpha_2^{'}TUNA \\ & +\alpha_3^{'}PELAGIC + \alpha_4^{'}BILL + \alpha_5^{'}SCOTHER + +\alpha_6^{'}OAHU \\ & +\alpha_7^{'}KAU + \alpha_8^{'}BIGI > \theta) \end{aligned}$$

where $\alpha_k^{'} = \alpha_k/\sigma$ and θ is distributed N(0,1). This is the standard form for the probit. The other variants—the models including the equipment variables and household income—are analogous. The log(c$\pm\Delta c$) variable is the log of total cost plus the cost increment for the respondents who would retake the trip, and total cost minus the cost increment for those respondents who would not retake the trip. The parameter estimates in Table 13 are the relative coefficients, $\alpha_k^{'}$ and $1/\sigma$.

In this specification, all of the variables except the cost variable are categorical. To understand the sign and magnitude of the location variables, we bear in mind the excluded or default categories. For the location of the vessel, the excluded islands are Maui and Lanai-Molokai. Consequently the coefficients on OAHU, KAUAI, and BIG I measure the incremental effect over the combination of Maui-Lanai-Molokai. There are no excluded categories for the species, with the exception that the SCOTHER variable captures only part of the group of respondents catching deep sea bottom fish or species not otherwise mentioned.

The parameter estimates in Table 13 show the responses after the fact, that is, after the uncertainty has been revealed. Hence it is the catch, rather than the seeking, that influences the choice to retake the trip. The coefficients on BILL, PELAGIC, TUNA, and SCOTHER represent the propensity to respond yes when one of these is caught. Consider TUNA in the basic model. When an angler catches one of these species, the effect equals 0.311. In general, the catch of these species groups—tuna, pelagic, billfish and the miscellaneous group—are positive and significant. Further, there is a special bonus from catching a billfish when the respondent actually sought one. This comes from the coefficient on SBILL, which is quite high at 0.98. The actual catch of a billfish is even more exciting when the respondent is seeking one. Note that the coefficient on SBILL is significant only at about the 10 percent level for two of the three models. There is high correlation between BILL and SBILL, causing imprecise parameter estimates. But a test of the hypothesis that BILL and SBILL are both zero is strongly rejected in all three models.[18] Note that the catch of the other species (deep sea bottom fish and otherwise not mentioned) influence only respondents who have some inclination to fish commercially—they sell their fish or their vessel is registered as a commercial fishing vessel.

The differences among the three specifications is slight. Income is a strongly significant influence, suggesting a wealth effect. The equipment variables, the use of line hauler, GPS, and the number of large rods (80 pound test or better equipment) are marginally significant. The only strongly significant equipment is the number of large rods.[19] In all models, the island variables are significant. They show that the respondents are more likely to retake their trips on Maui-Lanai-Molokai than Oahu, Kauai, or the Big Island. This result is strong and

[18]The Chi-squared value for the three models—basic, income, and equipment—are 15.8, 12.46 and 14.46 for the hypothesis that BILL and SBILL are jointly zero. The critical value for the .995 level of confidence is 10.6.

[19]The equipment variables can be made more significant by interacting the equipment with the kinds of fishing planned. For example, a variable formed by the product of having a line hauler and fishing for deep sea bottom fish has a significant effect on the probability of a yes response. However, this and other modifications of the set of independent variables do not change the estimate of the median willingness to pay. Further these refinements have no direct policy implications. While additional refinements may provide more intuitively appealing models, they have no strong implications for choices or policies.

Table 13: Parameter Estimates for Contingent Valuation Models.

	Basic Model	Income Variant	Equipment Variant
Variable	Parameter Estimate	Parameter Estimate	Parameter Estimate
Const.	1.43 (.318)[a]	1.46 (.364)	1.35 (.321)
COST	-.243 (.060)	-.297 (.068)	-.265 (.060)
SBILL	0.884[b] (.570)	.821[c] (.607)	0.985[b] (.587)
TUNA	0.311 (.106)	0.336 (.116)	0.226 (.109)
PELAGIC	0.231 (.107)	0.194[b] (.118)	0.131[d] (.112)
BILL	0.561 (.253)	0.549 (.265)	0.489 (.254)
SCOTHER	0.225[c] (.149)	0.245[c] (.162)	0.227[c] (.155)
OAHU	-.473 (.138)	-.606 (.155)	-.486 (.143)
KAUAI	-.425 (.173)	-.542 (.192)	-.449 (.179)
BIG ISLAND	-.344 (.154)	-.397 (.170)	-.369 (.157)
HHINC	—	0.0046 (.0013)	—
LINE HAULER	—	—	0.155[c] (.119)
GPS	—	—	0.116[d] (.097)
RODS	—	—	0.054 (.022)
N|ln L	932| -616.38	783| -508.73	924| -603.06

Unless otherwise noted, all estimates are significantly different from zero at the 2.5% level of confidence.

[a]Standard errors in parentheses beneath parameter estimates.

[b]Significantly different from zero at 5% level of significance for a one-tailed test.

[c]Significantly different from zero at 10% level of significance for a one-tailed test.

[d]Not significantly different from zero (p>.1).

surprising, and not sensitive to changes in specification.

The Economic Value of Small Boat Fishing

Two kinds of willingness to pay or equivalent income calculations are of interest. The first measure is the amount of income that is equivalent to the opportunity to take a single fishing trip. This willingness to pay depends on the characteristics of the fishing trip and the angler. Since we are interested in fisheries, for the second measure we will calculate the effect of the fishing characteristics on willingness to pay. One is the willingness to pay for a day of fishing. The second is the incremental WTP for characteristics of the fishing trip. In all cases we use a measure of central tendency of the WTP.

A measure of central tendency—what would anglers tend to be willing to pay for their last fishing trip—is of special interest because it describes what a respondent would pay rather than go without fishing at the opportunity to fish at the time the choice to fish was made. This calculation is appealing because it is the closest one can find to a measure of economic importance of small boat fishing. Further, this is a calculation that cannot easily be made with the random utility model. There are two approaches to this calculation. The most conservative is a non-parametric approach that uses the fact that when a respondent says he will pay $\$\Delta c$, the $\$\Delta c$ can be used as an estimate of his willingness to pay. It is conservative because he may be willing to pay more. Using this approach results in a lower bound estimate of willingness to pay.[20] Table 12 provides the basic information on the CV responses for anglers who would repeat their trip. The logic of the estimate of the lower bound is to use only the information that the respondents give, rather than expanding beyond the response. So when a respondent says that he will pay $25, then we know that he will pay at least that much, so it is conservative. The expected lower bound for WTP for this non-parametric approach is

$$EWTP(lowerbound) = \sum_{k=1}^{m+1} \Delta c_{k-1} p_k$$

where p_k is the proportion who answer yes to Δc_{k-1} and no to Δc_k. It is the last

[20] This approach is spelled out in detail in Haab and McConnell (1997). It is an application of the Turnbull estimator.

column of Table 10. By assumption, $\Delta c_0 = 0$ and $\sum_{k=1}^{m+1} p_k = 1$. Using this formula with the quantities in Table 12, we get

$$EWTP(lowerbound) = \$77.65$$

This is the net WTP, which is in addition to the costs that are incurred. It is an estimate of the income equivalent of a day of fishing, based on individual responses to hypothetical questions.

An alternative approach is to use the parametric model. With this model the median is a conservative estimate of WTP.[21] The formula for the median is

$$Median(WTP) = exp(\alpha \cdot \overline{s}) - \overline{c}$$

where $\overline{s}$ is the mean vector of covariates and $\overline{c}$ is the mean cost. This estimate is the median of the willingness to pay, given the mean vector of covariates. The mean $\overline{s}$ relates to variation over the sample and the median (WTP) relates to uncertainty inherent in preferences—that is, the part of the preferences unknown to researchers. Note that the manner of modeling willingness to pay makes $\exp(\alpha \cdot \overline{s})$ an estimate of the gross WTP and that to get an estimate comparable with the lower bound estimate, costs must be subtracted. Using the basic model, the calculations for net willingness to pay are

$$exp(\alpha \cdot \overline{s}) - \overline{c} = \$72.84.$$

This measure of the median is lower than the lower bound mean estimate. There is no inherent reason for the median to be greater than the lower bound. The estimates are based on different distributional assumptions. But they are both conservative and reassuringly close. Both approaches show the willingness to pay to be in the neighborhood of \$75 per trip. These results are summarized in Table 14.

[21]The mean for a log-normal distribution depends on the variance, and a large variance can give a very large estimate of mean willingness to pay. This makes the mean an unattractive estimate of the central tendency of willingness to pay.

Table 14: Estimates of the Willingness to Pay per Trip of Small Boat Fishing

Method of Estimation	Value per Day
Parametric: Median	\$72.84
Non-parametric: Lower Bound of Mean	\$77.65

One of the advantages of a parametric model of willingness to pay is that it permits the estimation of hedonic effects—how various attributes of trip influence the willingness to pay for the trip. From the perspective of fisheries management, the most important attribute is the success in catching fish. The first set of estimates include the value of catching a fish—BILL, TUNA, or PELAGIC. These values represent the increase in willingness to pay when the attribute is present over the absence of the attribute—e.g., willingness to pay when BILL = 1 versus BILL = 0.[22] Since these are increases in attributes that are exogenous to the individual, the costs do not change and can be ignored. The value of increments in the catch is calculated for species groups identified. The value calculated is the ex post value of catching one fish over catching none. For the tuna and pelagics, the values are not conditioned on what the respondents were seeking. These values are \$52 for tuna and \$38 for pelagics. These figures mean that if we could guarantee that an individual would catch one of the species, he would be willing to pay this amount. Likewise, if we could guarantee a billfish, the respondent would be willing to pay \$111 for the fish. The difference among the species represents the intrinsic value of catching different species, measured as willingness to pay or equivalent income.

These measures of the value per fish can be compared with earlier research on the charter fleet patrons by Samples and Schug. In 2000 dollars, the Samples and Schug estimate of the value per trip comes to \$94 (Samples and Schug, p. 59), and the value of a marlin to about \$57 (Samples and Schug, p. 63). An important difference is the study population. The Samples and Schug sample was chosen from charterboat patrons, who might be expected to have a much higher valuation of recreational opportunities, since that is in many cases what brought

[22] These values are calculated conditional on the mean values of all other independent variables. The increment in willingness to pay when an attribute equals one: $w(s_i = 1) - w(s_i = 0)$ for the exponential functional form is given by $\overline{w}_{-i} \cdot \exp(\alpha_i - 1)$. This can also be written as $\overline{w} \cdot \exp(-\alpha_i \overline{s}_i) \cdot (\exp(\alpha_i - 1))$. This can be approximated by $\partial w / \partial s_i = \alpha_i w$.

them to Hawaii. Also, other things equal, a charter trip ought to be more highly valued because the angler gets considerable additional services in the small boat fishery that he must provide himself.

The results are useful when they can be viewed in the aggregate. But there are two sorts of results: willingness to pay for catching extra fish, as shown in Table 14, and the willingness to pay for a day of fishing. The difference between these two measures is that the willingness to pay for catching extra fish should be aggregated over a total number of fish, while the willingness to pay for a day of fishing should be aggregated over days of fishing. Consider first the value of catching fish. Suppose for the sake of argument there are 1,000 extra fish to allocate. If these fish are tuna and they are caught by small boat anglers, then the willingness to pay for the extra fish will be 1,000*$52= $52,000. This estimate assumes that the fish are caught by the representative small boat fisherman. If the fish are pelagic, by the same logic the willingness to pay would be $38,000. Now suppose that the fish are billfish. If they go to fishermen seeking billfish, the willingness to pay would be $473,000. If fishermen not seeking billfish catch them the aggregate value would be $111,000. If we look at the survey results, bearing in mind that these results are not meant to give precise estimates of catch, we find that 29.1 percent of the billfish are caught by anglers who were seeking billfish. Using this information we can estimate the value of 1000 extra billfish as 1000*(.291*473+.709*111)= $216,342. Thus the value of the 1,000 extra billfish exceeds $200,000, but the differences in value between those who seek the billfish and those who just happen to catch one suggest the possibility of efficient allocation. That is, the fishermen who target billfish would be willing to pay more for the extra billfish than other fishermen.

The value per trip gives a feasible approach to estimating the total value of small boat fishing. To estimate the total value we can multiply the total number of days of small boat fishing per year by the value per day. An estimate of the total trips is given by the product of the number of small boat owners and the number of days fishing per owner. From analysis that established the sample frame, the number of small boat owners who meet the criteria of the survey is 6,600. The survey offers several approaches to estimating the number of trips per angler. The survey asks respondents for the number of their small boat trips in the last two months and the last six months. A conservative measure of trips per six months would be the median. This would eliminate some very large estimates of the number of trips that would powerfully influence the mean. Using the six months median of 6 gives an estimate of 12 trips per year. Combining the information gives us the following estimate of the total value of small boat fishing: 6,600*12*72=$5,702,400. This is an estimate of the maximum annual amount that respondents would pay for access to small boat fishing.

These estimates of willingness to pay are subject to the usual uncertainty that accompanies statistical inference from hypothetical responses. The estimate of the total value of small boat fishing is biased down because the willingness to pay for an extra trip will go up if the number of trips goes down. Consider the representative respondent who takes 12 trips and who is willing to pay about $70 for the most recent trip. If we were to value the 12th trip when the first 11 had been eliminated, then the marginal value would be much higher, depending on the elasticity of demand for small boat fishing. Without estimating this demand we cannot infer the total value more accurately. But it is clear that the estimate derived above is below the true total value.

Table 15 : Incremental Values of Selected Attributes:
Basic Model

Attribute	Description	Incremental Value
BILL	Catch billfish	$111
TUNA	Catch tuna	$52
PELAGIC	Catch ono or mahimahi	$38
SBILL & BILL	Catch and seek billfish	$473
SCOTHER	Catch other or deep, given SELL or COMM	$38

4.3. Assessing the Contingent Valuation Results

The contingent valuation results can be assessed on the internal consistency of the empirical results by comparing the model with other results. In terms of internal consistency, the CV results appear valid. For example, the ranking of the willingness to pay for catching species, as shown in Table 14, appears plausible. It would seem implausible if catching ono or mahimahi were valued more than catching billfish or tuna. Further, the non-parametric and parametric approaches to valuing a day of fishing yield similar results. In terms of comparisons with other results, the best measure is the willingness to pay per day of fishing. The value estimated for Hawaii, in the $70 range, is similar to other values derived from contingent valuation for recreation at many mainland sites. The model fits well statistically, and can be used in many ways to provide economic content to questions concerning the small boat fishery.

5. Conclusions

This report has focused on the economic behavior and values of small boat anglers in Hawaii. The purpose of the research is to demonstrate the range of economic values that are derived from this sector, which is composed of people who fish for recreation, for subsistence, and for commercial motives. The research is based on a main survey and supplementary survey completed in March 1999. In the report we provide two kinds of analyses: a random utility model that derives economic values from the behavior of anglers; a contingent valuation survey that derives values from responses to hypothetical questions.

The economic values or willingness to pay, as they are referred to, studied in this report represent the true or net economic value to the small boat fishermen. They are estimates of the economic worth that are equivalent income changes. The willingness to pay measures stem from the opportunity to fish. They depend on catch of various species for sure, but on many other dimensions of fishing as well, such as nearness of ramps, the presence of FADs, parking spaces, and time of year.

The two types of analyses provide complementary insights into the values of small boat fishing. The contingent valuation study gives willingness to pay per fishing trip that might be useful in certain kinds of policy analysis. A reasonable range of values centers on a value per day of around $75 (see Table 13). The random utility model can be easily adapted for policy purposes to the analysis of restricted access of launch ramps and fishing areas. For example, if an accidental oil spill were to cause a group of ramps to be closed, the random utility model can help determine the economic costs of the spill. Or if certain ocean sites were to have access restricted, the model can help assess the economic losses to the small boat sector.

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Appendix A: Cost, Time and Distance Relationships

The following statistical models are essential components for the estimation of the random utility model. They are estimated from the survey responses and from additional information on distances.

The relationship between land travel distance and time

This relationship describes how long it takes to trailer a boat from a respondent's home to the various ramps in the choice set. The established relationship is based on the respondent's self-reported time to go from home to the chosen ramp and the GIS-based estimate of this distance. Since towing larger boats would be slower, it would take more time. Further, some ramps may take longer to reach than others, given the distance. Based on an empirical analysis of respondents who trailered their boats on Oahu, the following equation is estimated for miles per minute (MPM):

$$MPM = \exp(\underset{(5.63)}{-1.58} - \underset{(1.89)}{.188}\log(Feet) + \underset{(19.3)}{.54}\log(Miles) - \underset{(3.87)}{.21}\,Waianae).$$

This equation is based on 329 observations of self-reported time for trailered boats on Oahu, for positive values of time and for miles per minute less than 1.25, with an $\bar{R}^2$ equal to .54. T-statistics are in parentheses below the estimated coefficients. The error variance of the residual, σ^2, equals .167. This is relevant because the estimated mean for MPM, given the values of the independent variables, is written

$$\widehat{MPM} = \exp(X\beta + \sigma^2/2)$$

Without the variance, the estimator for MPM would be the median. The means increases the MPM by about 8%. The variable Feet is the length of the respondent's boat, Miles is the one-way distance from home to ramp, and Waianae takes on a value of one for trips to Waianae, zero otherwise. The longer the boat, the slower the speed and hence the greater the time. Distance has a big impact on speed, accounting for the ability to search for faster routes and take more open roads on longer trips. When anglers go to Waianae, the travel is slower, principally because of congestion in that direction of Oahu. With this equation, for example, an angler traveling 30 miles, with a 25-foot boat and not going to Waianae, would travel at a rate of .7 miles per minute, or 42 miles per hour. A trip of 40 miles would be traveled at a rate of 49 miles per hour. For the round-trip time, the number of miles for the round trip must be included.

Using this estimated equation, we calculate the amount of one-way time in terms of hours as

$Hours = (\frac{Miles}{60 \cdot MPM})$.

Using the examples above, a 30-mile trip with a 25-foot boat would take .71 hours, while a 40-mile trip would take .82 hours (using the median estimate of speed), the one-way time if the 40 miles is the one-way distance. These figures don't really account for the fixed time at the start and end of each trip—hooking up trailers, launching boats, and so forth.

The relationship between water travel distance and time

The relationship between water travel distance and time is not included in the random utility model as it is difficult to distinguish the typical loss of utility associated with travel time from the possible gains in utility associated with water-based travel time. That is, the typical assumption of random utility travel cost based models is that the likelihood of visiting a particular destination decreases with increases in travel cost and the time to get to the destination. However, with small boat angling, it is plausible that anglers receive utility from the time spent reaching the destination and not simply the activities at the destination. Because these two effects cannot be disentangled, the water-based travel time to the chosen HDAR site is assumed to not affect the site choice.

The relationship between water travel distance and costs

This relationship gives the cost per mile of ocean travel. The monetary costs vary according to the length of the boat, with larger boats costing more. The relationship is estimated from respondents' self-reported expenditures on gasoline for the last trip. The model provides an empirical basis for the relationship between ocean distance and monetary costs. The following equation is estimated for respondents from Oahu:

$Cost = \exp(\underset{(1.65)}{-.678} + \underset{(9.21)}{1.37}\log(Feet) + \underset{(7.19)}{.24}\log(Miles))$

This was estimated with 446 observations of anglers who reported total costs for their last trip, with an $\bar{R}^2$ equal to .32. The error variance of the residual, σ^2, equals .767. For a boat of 25 feet and a trip of 30 miles (round trip), the median estimate of cost of ocean travel would be \$94.45, while for a trip of equal length but for a boat of 15 feet, the median cost per trip would be about \$47.

The difference in costs is partly gas consumption and partly other costs that go into a fishing trip with a larger boat.

The relationship between land travel distance and costs

The cost of land travel is calculated as $.50/mile traveled to launch site. This per mile figure is higher than what is typically assumed for travel cost studies (usually $.30-.35/mile). This accounts for relatively higher fuel prices in Hawaii, and increased travel costs from towing a boat. It is reasonable to assume that travel cost per mile would vary with the type of vehicle and the size of the boat trailered. Unfortunately, self-reported travel costs are difficult to obtain and information on costs associated with different vehicle types is elusive. As such, we assume a constant $.50 per mile traveled on land for all anglers.

Appendix B: Alternative Random Utility Parameter Estimates

The following table provides the parameter estimates for a model that excludes HDAR sales by species groups variables for non-seeking anglers.

Parameter Estimates for Random Utility Model:
Non-seeking Variables Excluded

Parameter	Associated Variable	Parameter Estimate (Standard Error)
β_1	$c_{rj} + c_{raj}$	-.114[a](.004)
β_2	$\delta_{wj} \cdot t_{rj}$	-.237(.406)
β_3	$\delta_{sj} \cdot t_{rj}$	-1.73[a](.764)
β_{41}	$q_{aBILL}\delta_{BILLj}$	.010[a](.005)
β_{42}	$q_{aBOTTOM}\delta_{BOTTOMj}$	.015[a](.007)
β_{43}	$q_{aOTHER}\delta_{OTHERj}$	.003(.007)
β_{44}	$q_{aTUNA}\delta_{TUNAj}$	.0009(.003)
β_6	KM_a^2	.0009[a](.0002)
β_7	WS_r	-.562[a](.257)
β_8	F_a	.847[a](.094)
β_9	P_r	.011[a](.001)
β_{10}	$\delta_{bj} \cdot \delta_{ca}$	-2.278[a](.283)
β_{11}	$(1 - \delta_{bj}) \cdot \delta_{ca}$	.715[a](.283)
β_{12}	$\delta_{WIr} \cdot \delta_{4j}$	1.559[a](.402)
β_{13}	δ_{KIr}	-.699[a](.325)
β_{14}	δ_{KAr}	-.421(.487)