Marine Policy 61 (2015) 66–76

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Stated preferences for size and bag limits of Alaska charter boat anglers ☆

Daniel K. Lew [a,b,*], Douglas M. Larson [c]

[a] National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, Seattle, WA 98115, United States
[b] Department of Environmental Science and Policy, University of California, Davis, CA 95616, United States
[c] Department of Agricultural and Resource Economics and Giannini Foundation of Agricultural Economics, University of California, Davis, CA 95616, United States

ARTICLE INFO

Article history:
Received 27 January 2015
Received in revised form
7 July 2015
Accepted 7 July 2015
Available online 24 July 2015

Keywords:
Alaska
Fishing regulations
Recreational fishing
Stated preference methods

ABSTRACT

Over the last several years, significant regulatory changes related to Pacific halibut *Hippoglossus stenolepis* have occurred in the for-hire recreational charter boat fishing sector in Alaska. In addition to limited entry restrictions and adoption of a catch sharing plan that provides a formal means of determining allocation between the commercial and charter boat fishing sectors, more restrictive harvest regulations were placed on anglers fishing from charter boats. This article provides insights into how the value anglers place on charter boat fishing is affected by these regulations, principally bag and size limits. Such information is helpful in assessing the trade-offs in economic benefits associated with different regulatory tools used to manage angler harvest levels. Stated preference choice experiment data from a 2012 survey are analyzed using a panel rank-ordered mixed logit model to estimate the economic value, or willingness to pay (WTP), non-resident anglers place on saltwater charter boat fishing trips in Alaska and to assess how changes in characteristics of fishing trips, particularly harvest restrictions related to Pacific halibut, affect this value. The model specification accounts for a wide array of size and bag limit restrictions that have been recently implemented or are under consideration by Pacific halibut fishery managers. The results indicate that very strict harvest restrictions have the effect of driving WTP to zero, while allowing at least one (potentially) large fish to be caught is valuable to anglers. The results also suggest that WTP for fishing trips with bag limits that allow two or more fish to be harvested with no size restrictions on the first fish harvested are not statistically different from the value for trips for larger bag limits or for the case where all the fish in the limit can be any size. This suggests that fishery managers can restrict the size of the second fish in a two-fish bag limit and still maintain economic values for fishing trips.

Published by Elsevier Ltd.

1. Introduction

In Alaska, almost all recreational fishing for saltwater fish occurs in Southeast Alaska or Southcentral Alaska (Fig. 1). These regions represent different fishery management areas for state-managed Pacific salmon (*Oncorhynchus* spp.) and for federally-managed Pacific halibut (*Hippoglossus stenolepis*). For these species, which are the primary fish targeted by recreational anglers in saltwater in the state, fishery managers rely on bag and size limit restrictions as the principal management tools to manage harvest levels. For salmon, bag limits and minimum size limits (minimum length of a fish) vary depending upon the time of year and specific location.[1] For Pacific halibut, management of the sport fishery in Alaska has undergone a makeover in recent years due to concerns over declining stocks and allocation disputes between commercial and recreational charter boat fishing interests, leading to changes

☆This article and its findings do not necessarily reflect the views of the Department of Commerce, the National Oceanic and Atmospheric Administration, or the National Marine Fisheries Service.

* Corresponding author at: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Resource Ecology and Fisheries Management Division, Alaska Fisheries Science Center, Seattle, WA 98115, United States.
E-mail address: Dan.Lew@noaa.gov (D.K. Lew).

[1] See http://www.adfg.alaska.gov/index.cfm?adfg=fishingSportFishingInfo.main for the latest regulations.

http://dx.doi.org/10.1016/j.marpol.2015.07.007
0308-597X/Published by Elsevier Ltd.

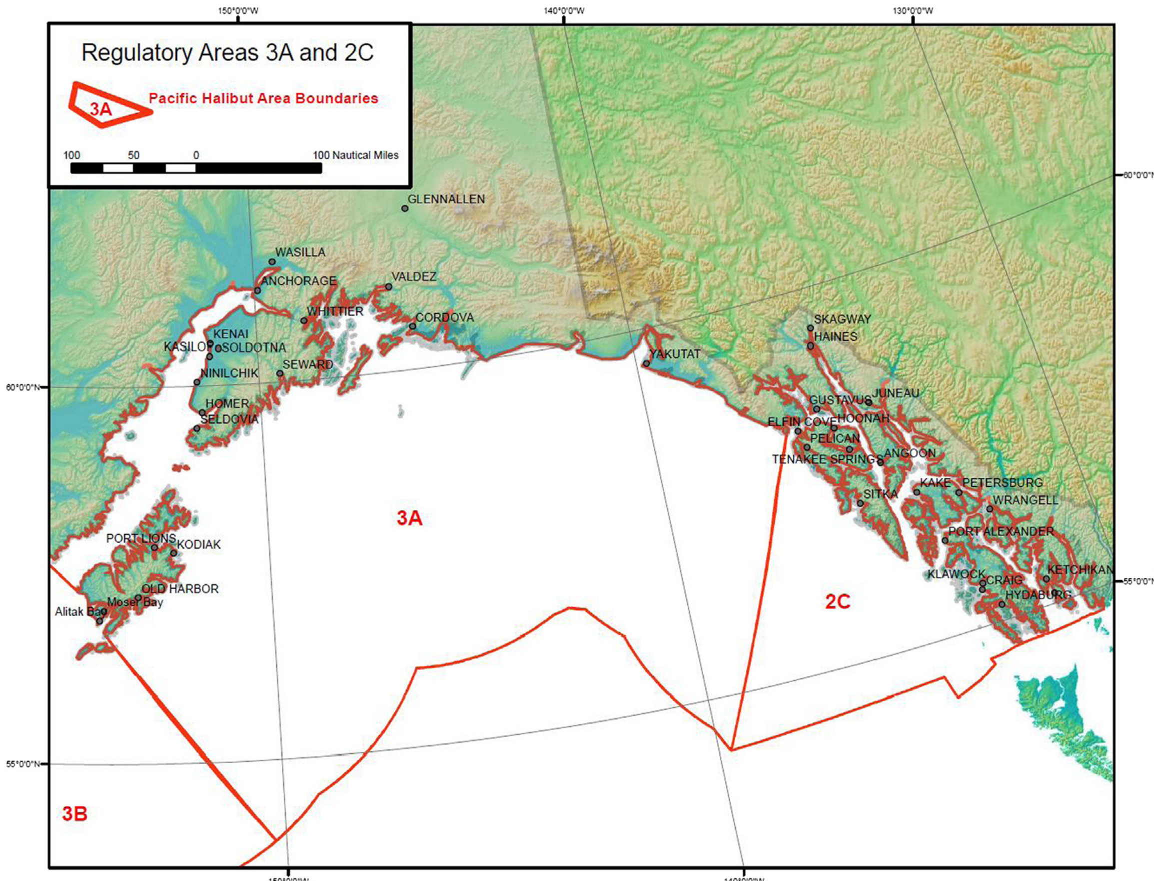


Fig. 1. International Pacific Halibut Commission Regulatory Areas 2C (Southeast Alaska) and 3A (Southcentral Alaska).

in recreational harvest restrictions.

Until recently, Pacific halibut bag limits were the same for unguided and guided (charter boat) anglers throughout the state – two fish per day with no size restrictions. Starting in 2007 more restrictive bag and size limit regulations were imposed for halibut caught on charter boat fishing trips in Southeast Alaska (74 Federal Register 21194). The most restrictive limits were imposed during the 2011 fishing season, when charter anglers in Southeast Alaska were subject to a one-fish bag limit with a maximum size limit of 37 in. Since then, the bag limit has remained at one fish, but charter anglers have been allowed to harvest either a very large fish or a small fish (called a "reverse slot" size restriction).[2] In 2014, Southcentral Alaska charter boat anglers began facing the same types of charter-specific bag and size limit restrictions, being limited to a two-fish bag limit but with one of the two fish in the bag limit being subject to a maximum size limit restriction (29 in.) (79 Federal Register 13906). Under the Halibut Catch Sharing Plan (CSP), which went into effect during 2014, the management tools used to regulate harvest of Pacific halibut in the recreational sector are evaluated annually (79 Federal Register 13906).

To fully evaluate trade-offs between alternative regulatory tools for managing charter halibut sport harvest, it is important to understand how angler values are affected. In recent years, stated preference (SP) methods have been employed to evaluate the effect harvest restrictions have on recreational fishing values (e.g., [5,14,15,1]). Stated preference methods use responses to carefully-constructed questions, generally asked in a survey, to provide information about people's preferences and values [11,2,21]. Since fisheries managers are often interested in the effects from angler harvest regulations that have yet to be implemented, it is not possible to collect data on observed behavior related to angler responses to new regulations, which precludes the use of revealed preference (RP) methods like the travel cost model (e.g., [4]).

One particular type of SP method, the choice experiment (CE), has increasingly been favored by researchers interested in valuing the effects of angler harvest regulations due to its flexibility for providing economic value information across a range of potential policy changes. A typical CE question presents a survey respondent with a choice between two or more alternatives (e.g., fishing trip options) that are described in terms of several attributes (e.g., trip cost, regulations, fish targeted), one or more of which are policy variables (e.g., bag or size limits). Commonly, each survey will contain multiple CE questions that differ in the levels of the attributes that make up each option. Responses to these CE questions are analyzed using random utility maximization (RUM) models [17] and the estimated model can be used to generate estimates of the marginal value of changes in the attributes.

In the United States, CE studies have been applied to value the effects of regulatory changes on summer flounder fishing in the U. S. Northeast region [18], Pacific salmon fishing in Oregon and Washington [1], and grouper, red snapper, dolphinfish, and king mackerel fishing in the U.S. Southeast region [5]. In addition, several studies examining the effects of bag limit changes on pre-2007 Pacific salmon and Pacific halibut saltwater fishing in Alaska have been conducted [13,14,7]. The CE approach has also been employed to value recreational fishing outside the United States (e.g., [12]; [9]).

This article investigates how economic values for charter boat fishing trips are affected by different angler harvest regulations, specifically bag and size limits. Using CE data from a 2012 survey

[2] This is intended to protect the female spawning biomass [22].

of non-resident Alaska anglers, estimates of the economic value, or willingness to pay (WTP), these anglers place on saltwater charter boat fishing trips in Alaska are generated and then assessed with respect to how they are affected by changes in characteristics of fishing trips, particularly harvest restrictions related to Pacific halibut. The data and model specification cover a wide array of size and bag limit restrictions that have been recently implemented or are under consideration by Pacific halibut fishery managers. This allows for formal testing for differences in the WTP for charter boat fishing trips under alternative bag and size limit restrictions. In addition, this study provides updated estimates of the value of charter boat fishing trips in Alaska that were previously estimated using older data collected prior to the use of size limit restrictions [13].

2. Data

Data for this analysis are from a mail survey conducted during the first half of 2012 of non-resident anglers who purchased sportfishing licenses in Alaska during 2011 in order to fish during that year. The survey was similar in content to earlier surveys of Alaska non-resident anglers conducted in 2007 [15], but was revamped to accommodate changes in harvest regulations that have occurred in recent years (primarily size restrictions for Pacific halibut). Qualitative pretesting was conducted with members of the target population via cognitive interviews [25] and focus groups held in several U.S. West Coast cities. The survey also benefitted from input provided by fisheries analysts involved in Alaska fishery management.

Each survey contained four CE questions that each asked respondents to identify, from two saltwater charter boat fishing trip options and a third, non-saltwater charter boat fishing, option, the option they liked best and second best, which allows for a full rank ordering. The survey versions differed slightly in terms of the specific trip attributes in the CE questions. Respondents were asked about charter boat fishing trips taken in both Southeast and Southcentral Alaska. The attributes of these charter fishing trips included the species caught (either one or two of the three species – Pacific halibut, king (Chinook) salmon, or silver (coho) salmon); the daily bag (take) limit; size restriction (if any); the number of fishing days on the trip; and the fishing-related costs (only the Alaska-related costs of fishing, excluding costs associated with travel to and from the state).[3]

The experimental design was constructed to maximize statistical efficiency (D-efficiency) using techniques described in [10]. This resulted in a total of 30 versions of the survey, which differed only in the levels of attributes describing the trips. An example of a CE question is displayed in Fig. 2. In the overall experimental design, there were three levels for each of the catch-related attributes, which differed by species (Table 1); three fishing trip lengths (1, 3, or 5 days); six cost levels, which ranged from US$200 to $1000 per day; and two levels for the region fished attribute. This range of cost levels was determined using information from focus groups, interviews, and the in-state fishing travel costs of non-resident anglers from a previous survey [15].

The survey implementation followed a modified Dillman Tailored Design Method [8]. It consisted of an advance letter, a survey mailing (survey booklet, cover letter, map, business reply envelope, and a small monetary incentive), a thank-you/reminder postcard, and a second full survey mailing. A follow-up telephone contact was also used to elicit participation. Of the initial sample of 2080 non-resident license holders drawn randomly from the Alaska Department of Fish and Game (ADF&G) license database, 82 surveys were undeliverable (bad addresses). A total of 1073 surveys were returned, resulting in a response rate of 53.7% (1073/1998). After removing respondents who did not answer the CE questions correctly (e.g., selecting the same trip option as both the best and second best choice) or at all, as well as protest responses [20], the sample size used in the analysis was 825.

The sample consisted primarily of older and very experienced Caucasian/white male anglers (Table 2). Three-quarters of anglers in the sample were male, the mean age was 52.6 years, mean income was a little over $110,000, and the average number of years of fishing experience was over 35. Almost 95% of anglers were Caucasian/white. In addition, about two-thirds had at least some college education.

3. Modeling approach

In the RUM model, the utility of alternative j (j=A, B, or C) for question i (i=1,...,4) is assumed to be composed of a systematic component, consisting of observable characteristics or attributes, and a random component:

$$U_{ij} = V_{ij}(\boldsymbol{\beta}) + e_{ij} \tag{1}$$

where $V_{ij}(\boldsymbol{\beta})$ is the systematic part of utility and a function of attributes for alternative j in question i, $\boldsymbol{\beta}$ are parameters of the utility function, and ε_{ij} is an independent and identically distributed Type I extreme value (TEV) error term that represents the part of utility unknown to the researcher. This model set-up leads to the conditional logit model, which is susceptible to a number of restrictive behavioral assumptions, such as the Independence from Irrelevant Alternatives (IIA) property [19].

A common generalization that relaxes the IIA assumption is the random parameters, or mixed, logit, which introduces heterogeneity of preferences by allowing some of the parameters of V_{ij} (i.e., a subset of the full parameter vector $\boldsymbol{\beta}$, denoted $\boldsymbol{\beta}_\mathbf{n}$) to be randomly distributed over the sample [24]. This approach allows the model to capture individual preference heterogeneity. Here it is assumed that the random parameters follow a normal distribution, which is common [24]. To this end, let $\boldsymbol{\beta}_\mathbf{n} \in \boldsymbol{\beta}$ be distributed $\boldsymbol{\beta}_\mathbf{n} \sim N(\bar{\beta}_n, \boldsymbol{\Omega}_{\boldsymbol{\beta}})$, where $\bar{\beta}_n$ is a vector of mean parameters and $\boldsymbol{\Omega}_{\boldsymbol{\beta}}$ is a variance-covariance matrix. In practice, this means two parameters for each random parameter are estimated, a mean and standard deviation, which describe the distribution.

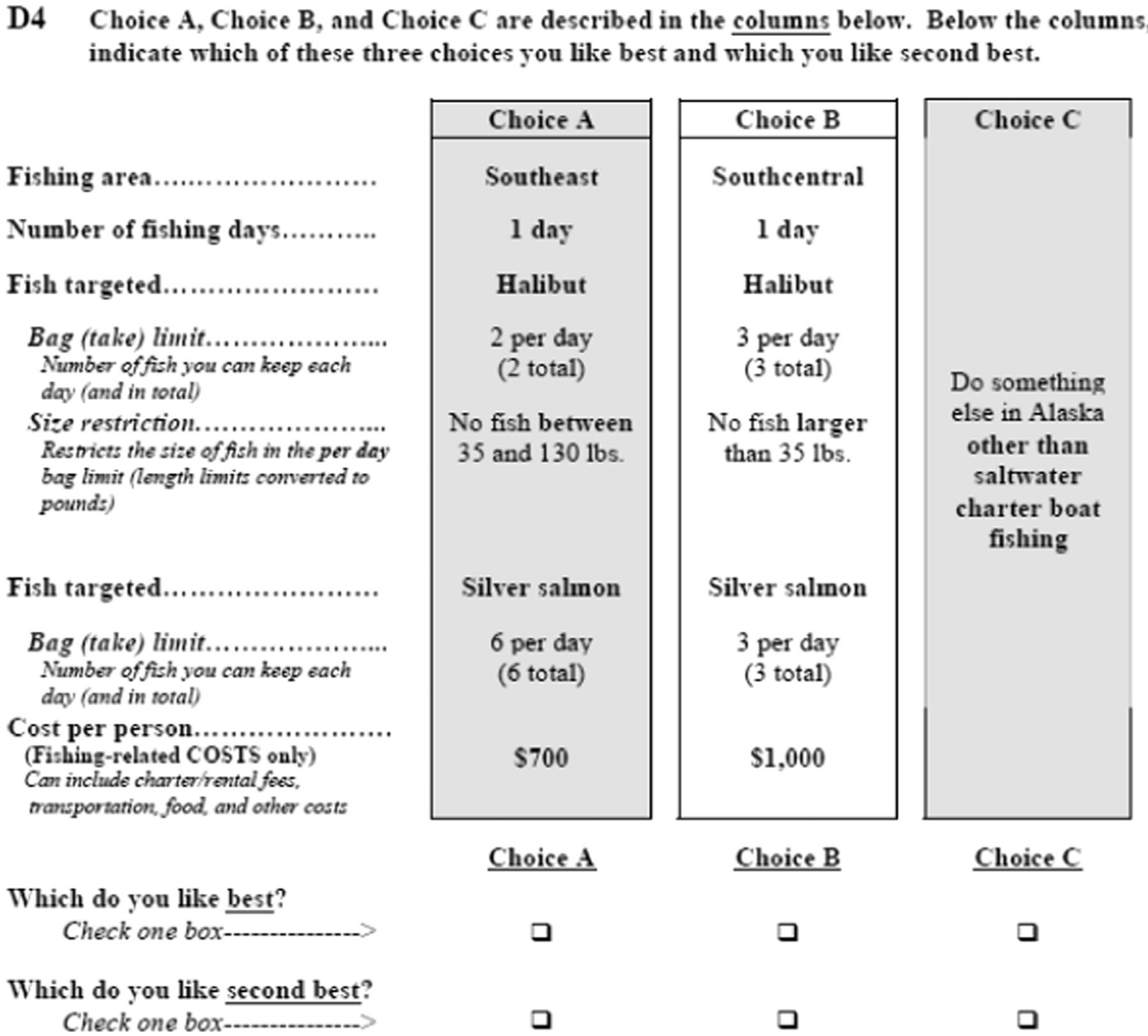
The rank-order nature of the data is accounted for by modeling the probability of observing choice j being selected as best from among choice alternatives j, k, and l ($j,k,l \in$ [A,B,C]), and choice k selected as second best, implying a preference ordering of $j > k > l$, as the following:

$$\Pr[j > k > l] = \Pr[j|j, k, l] \times \Pr[k|k, l], \tag{2}$$

where $\Pr[j|j,k,l] = \int \exp(V_j)/[\exp(V_j)+\exp(V_k)+\exp(V_l)]d\boldsymbol{\beta}$ and $\Pr[k|k,l] = \int \exp(V_k)/[\exp(V_k)+\exp(V_l)]d\boldsymbol{\beta}$ are probabilities evaluated over the distribution of random parameters, and the question number subscripts are suppressed. In addition, since respondents are asked four CE questions, the repeated choices are treated as a small panel dataset.

The resulting model is a panel rank-ordered random parameters (mixed) logit model, which explicitly accounts for both the rank-order nature of the CE data [3,6] and the panel nature of the data.

[3] The marginal decision non-residents are asked to make is whether they would be willing to incur the costs listed in order to have the fishing experience described in the saltwater fishing trip scenario. For this reason, there is no need to distinguish between those in Alaska primarily for fishing and those in Alaska for other reasons.


D4 Choice A, Choice B, and Choice C are described in the columns below. Below the columns, indicate which of these three choices you like best and which you like second best.

	Choice A	Choice B	Choice C
Fishing area........................	Southeast	Southcentral	Do something else in Alaska other than saltwater charter boat fishing
Number of fishing days..........	1 day	1 day	
Fish targeted.......................	Halibut	Halibut	
Bag (take) limit.................... *Number of fish you can keep each day (and in total)*	2 per day (2 total)	3 per day (3 total)	
Size restriction..................... *Restricts the size of fish in the per day bag limit (length limits converted to pounds)*	No fish between 35 and 130 lbs.	No fish larger than 35 lbs.	
Fish targeted.......................	Silver salmon	Silver salmon	
Bag (take) limit.................... *Number of fish you can keep each day (and in total)*	6 per day (6 total)	3 per day (3 total)	
Cost per person..................... (Fishing-related COSTS only) *Can include charter/rental fees, transportation, food, and other costs*	$700	$1,000	

	Choice A	Choice B	Choice C
Which do you like best? *Check one box--------------->*	❑	❑	❑
Which do you like second best? *Check one box--------------->*	❑	❑	❑

Fig. 2. Example of stated preference choice experiment survey question.

Table 1
Choice experiment attributes and levels.

Attribute	Levels
Fishing area	Southeast or Southcentral Alaska
Length of fishing trip	1, 3, or 5 days
Chinook salmon daily bag limit	1, 2, or 3 fish
Coho salmon daily bag limit	3, 4, or 6 fish
Halibut bag daily limit	1, 2, or 3 fish
Maximum size limit, 1st fish in limit	No limit, 18 lb, 23 lb, 28 lb, or 35 lb
Maximum size limit, 2nd+ fish in limit	No limit, 18 lb, 23 lb, 28 lb, or 35 lb
Minimum size limit (reverse slot)	No min size limit, 130 lb
Daily total fishing trip cost	$200–$1000

Table 2
Demographic characteristics of the choice experiment sample ($N=825$).

Variable	Description	Non-residents
Gender	% male	75.64%
Age	Mean in years	52.55
Fishing experience	Mean years	35.11
Household size	Mean number	2.16
Ethnicity	Asian	1.09%
	American Indian or Alaska Native	2.67%
	Black or African American	0.12%
	White	94.55%
Education	% with college degree or higher	67.27%
Household income	Mean income	$110,776

3.1. Model specification

The utility associated with the fishing trip alternatives (Choices A and B in each question) is assumed to be a linear-in-parameters function of two types of variables: regulatory and non-regulatory. The non-regulatory variables include an alternative specific constant (ASC) associated with the non-fishing trip option (Choice C), the trip length (DAY), cost (COST) and a dummy variable for the fishing area (SE Region). Table 3 contains a description of these non-regulatory variables.

There are two basic types of regulatory variables: bag limits and size limits. The salmon fisheries regulations of interest here use just bag limits. For Chinook salmon, the utility function specification includes dummy variables for bag limits of one (KLIM1), two (KLIM2), or three (KLIM3) fish, which covers the range of bag limits actually observed. For coho salmon, dummy variables for bag limits of three (SLIM1), four (SLIM2), and six (SLIM3) fish are used, corresponding to the higher harvest levels permitted in that fishery.

Fishing regulations in the Pacific halibut fishery are more complex. Both bag limits and size limits are used, and size limits apply to some, but not necessarily all, of the fish in the bag limit. The interaction of the two policies creates many possible regulatory outcomes. For example, a combination of a three-fish bag

Table 3
Base variables.

Variable	Description
ASC	Alternative specific constant: 1 = Choice C (non-fishing alternative selected); 0 otherwise
SE Region	Dummy variable for fishing trip in Southeast Alaska (versus SC)
DAY	Days fished (length of trip): 1, 3, or 5 days
HBL	Halibut daily bag limit (if present): 1, 2, or 3 fish; 0 otherwise
HLIM1	Halibut bag limit dummy: 1 = 1 fish, 0 otherwise
HLIM2	Halibut bag limit dummy: 1 = 2 fish, 0 otherwise
HLIM3	Halibut bag limit dummy: 1 = 3 fish, 0 otherwise
HMIN	Halibut minimum size limit (reverse slot option): 1 = yes, minimum size limit, 0 otherwise
HMAX1	Halibut maximum size limit on first fish: 1 = yes, 0 otherwise
HMAX2	Halibut maximum size limit on additional fish beyond 1st fish: 1 = yes, 0 otherwise
HSIZE1	Halibut maximum size limit on first fish (continuous): 0, 18, 23, 28, or 35
HSIZE2	Halibut maximum size limit on add'l fish beyond 1st (continuous): 0, 18, 23, 28, or 35
HNOMAX1	Dummy variable for whether the first fish in bag limit has no size restriction
HNOMAX2	Dummy variable for whether the second fish in bag limit has no size restriction
KBL	Chinook (king) salmon daily bag limit (if present): 1, 2, or 3 fish; 0 otherwise
KLIM1	Chinook (king) salmon daily bag limit dummy: 1 = 1 fish; 0 otherwise
KLIM2	Chinook (king) salmon daily bag limit dummy: 1 = 2 fish; 0 otherwise
KLIM3	Chinook (king) salmon daily bag limit dummy: 3 = 1 fish; 0 otherwise
SBL	Coho (silver) salmon daily bag limit (if present): 3, 4, or 6 fish; 0 otherwise
SLIM1	Coho (silver) salmon daily bag limit dummy: 1 = 3 fish; 0 otherwise
SLIM2	Coho (silver) salmon daily bag limit dummy: 1 = 4 fish; 0 otherwise
SLIM3	Coho (silver) salmon daily bag limit dummy: 1 = 6 fish; 0 otherwise
COST	Per day cost of fishing trip

limit and a size limit on the first fish creates potentially two different quality-levels of the retained catch – those fish constrained by the size limit, and those which are not. Thus, both the number of fish in a bag limit that are subject to a size limit and the number that are not can be important considerations for anglers. Because many regulations that have been implemented and are being considered have features like this example, there are considerably more halibut regulation attributes in the utility function.

These consist of dummy variables for halibut bag limits of one (HLIM1), two (HLIM2), or three (HLIM3) fish; variables representing the maximum size limit (in pounds[4]) on the first fish in the bag limit (HSIZE1) and on any additional fish beyond the first fish in the bag limit (HSIZE2); and dummy variables for whether the first fish (HNOMAX1) or second fish (HNOMAX2) in the bag limit can be any size or is restricted by a size limit. Together with the parameters on the bag limit variables for Chinook and coho salmon, these are referred to as *unconditional* regulatory variables, because they are always present in the model and are not conditional on whether or not the reverse slot restriction (which includes both a minimum and maximum size limit) is present. They are described further in Table 3.

Two additional variables are listed in Table 3 – one for the number of fish in the daily bag limit (HBL) and a dummy variable for whether or not a reverse slot is in place (HMIN). These are used in the construction of additional, *conditional* regulatory variables but do not themselves appear in the utility specification. The constructed variables listed and described in Table 4 are needed to represent regulations related to the reverse slot restriction for halibut. They are constructed by interacting variables defined above, and appear in the utility specifications for trips targeting halibut that have a size limit restriction on one or more fish.

The first set of these constructed variables applies to trips where there is *not* a reverse slot restriction, but there is a maximum size limit on one or more fish – these are trips where the regulation includes only a maximum size limit, not a maximum and a minimum. Three dummy variables (HBL1FSH, HBL2FSH, and HBL3FSH) define whether the first, second, or third fish in the bag limit (when applicable) are subject to a bag limit. The parameters estimated when these variables are in the model correspondingly measure the marginal utility of the xth fish (x = 1, 2, 3) when it is subject to a maximum size limit. In addition, since the marginal utility of a size-limited fish may vary depending on whether there are additional fish in the bag limit or not, two additional dummy variables define situations when there is a size limit on the first fish in a one-fish bag limit (HBL1MAX) and when there is a maximum size limit on the second (or third if the bag limit is three) fish in the bag limit (HBL3MAX).

Finally, Table 4 also contains definitions and descriptions of a set of conditional dummy variables that exactly parallel those described above, but which apply to fishing trips where there *is* a reverse slot option. Thus, by way of a brief summary, Table 3 presents and describes unconditional variables that appear in the utility specification for fishing trips involving any species (Chinook salmon, coho salmon, and/or Pacific halibut), while Table 4 describes additional conditional variables that only appear in cases where halibut size restrictions are involved.

4. Estimation results

The panel ordered mixed logit model was estimated using maximum simulated likelihood estimation [24]. The estimated model allowed for all non-cost parameters to be normally distributed over the population.[5] A comparison of the mixed logit model results with those from a conditional logit model showed significant improvement in statistical fit by introducing preference heterogeneity by way of random parameters. In fact, as shown in Table 5, 23 of the 29 random parameters in the model had statistically significant standard deviation parameters, indicating respondents across the sample varied in terms of how their utility was affected by most of the non-cost variables.

[4] In the CE questions, Pacific halibut size limits are presented in terms of weight (in pounds) instead of length (in inches) given focus group participant input strongly suggested size limits were interpreted in those terms. Standard Pacific halibut length-weight tables available from the International Pacific Halibut Commission were used to convert minimum size length restrictions into pounds.

[5] Several alternative model specifications were tried, but were not qualitatively different from the model presented here. They are available upon request from the authors.

Table 4
Constructed variables.

Name	Description	Term
HBL1FSH	No reverse slot: dummy variable for first fish in halibut bag limit with max size limit (halibut or no halibut)	(HMIN=0)*(HBL > 0)
HBL1MAX	No reverse slot: max size limit effect on first fish in bag limit when bag limit is 1 fish	(HMIN=0)*(HBL=1)*(HMAX1 > 0)
HBL2FSH	No reverse slot: dummy variable for second fish in 2 or 3-bag limit with max size limit	(HMIN=0)*(HBL > 1)
HBL3FSH	No reverse slot: dummy variable for third fish in 3-bag limit with max size limit	(HMIN=0)*(HBL > 2)
HBL3MAX1	No reverse slot: max size limit effect on first fish in bag limit when bag limit is 2 or 3 halibut	(HMIN=0)*(HBL > 1)*(HMAX1 > 0)
HBL3MAX2	No reverse slot: max size limit effect on second+ fish in bag limit when bag limit is 2 or 3 halibut	(HMIN=0)*(HBL > 1)*(HMAX2 > 0)
HML1FSH	Reverse slot: dummy variable for halibut bag limit with max size limit (halibut or no halibut)	(HMIN=1)*(HBL > 0)
HML1MAX1	Reverse slot: max size limit effect on first fish in bag limit when bag limit is 1 fish	(HMIN=1)*(HBL=1)*(HMAX1 > 0)
HML2FSH	Reverse slot: dummy variable for second fish in 2 or 3-bag limit with max size limit	(HMIN=1)*(HBL > 1)
HML3FSH	Reverse slot: dummy variable for third fish in 3-bag limit with max size limit	(HMIN=1)*(HBL > 2)
HML3MAX1	Reverse slot: max size limit effect on first fish in bag limit when bag limit is 2 or 3 halibut	(HMIN=1)*(HBL > 1)*(HMAX1 > 0)
HML3MAX2	Reverse slot: max size limit effect on second+ fish in bag limit when bag limit is 2 or 3 halibut	(HMIN=1)*(HBL > 1)*(HMAX2 > 0)

Table 5
Model results (N=825).

Variable	Mean parameter estimate	Asy. *t*-value	Standard deviation parameter estimate	Asy. *t*-value
Random parameters				
ASC	−0.0492	−0.1713	**4.4495**	**19.9067**
SE Region	**−0.3838**	**−3.7402**	**−1.7408**	**−12.7416**
DAY	**0.4809**	**3.4763**	**0.6513**	**16.3112**
DAY^2	**−0.0435**	**−1.9821**	**0.0849**	**9.5489**
HLIM1	−0.4979	−1.4124	**0.9598**	**4.5920**
HLIM2	−0.1652	−0.6230	**1.1097**	**6.1874**
HLIM3	−0.1702	−0.5389	−0.4907	−1.6098
HSIZE1	**0.0615**	**4.4400**	**0.0576**	**10.6242**
HSIZE2	−0.0073	−0.8238	0.0096	1.6479
HNOMAX1	0.0358	0.1966	**−1.4919**	**−6.7251**
HNOMAX2	0.2551	0.4933	1.1105	1.3192
HBL1FSH	**1.1834**	**3.0554**	**1.0557**	**6.7957**
HBL1MAX	**−2.2702**	**−4.8850**	**−0.9342**	**−2.7045**
HBL2FSH	−0.3930	−1.2019	0.1806	0.7281
HBL3FSH	**0.7389**	**2.3408**	**−1.1911**	**−3.9101**
HBL3MAX1	**−2.7763**	**−6.0737**	**0.4865**	**1.9754**
HBL3MAX2	*1.0237*	*1.9373*	−0.2159	−0.9930
HML1FSH	**1.3946**	**3.6468**	**0.4882**	**2.7903**
HML1MAX1	**−2.4048**	**−5.0214**	0.1219	0.3398
HML2FSH	0.2819	0.8648	**0.8494**	**3.4329**
HML3FSH	**0.6053**	**2.1177**	**1.1621**	**4.5438**
HML3MAX1	**−2.2944**	**−4.8521**	**−0.5958**	**−2.4259**
HML3MAX2	−0.0010	−0.0019	**−1.0624**	**−5.1976**
KLIM1	**0.6295**	**3.2666**	**−0.7904**	**−3.2126**
KLIM2	**1.4250**	**8.2484**	**0.5105**	**2.5642**
KLIM3	**1.7619**	**9.7168**	**1.0473**	**5.2961**
SLIM1	**1.6540**	**8.5586**	**0.8267**	**3.6249**
SLIM2	**1.2596**	**7.0918**	**−0.6009**	**−3.0900**
SLIM3	**1.6736**	**7.8637**	**−0.7878**	**−3.1536**
Fixed parameter				
COST	**−0.0010**	**−13.4777**		
Mean log-likelihood	−5.1716			
AIC (corrected)	8660.3152			
BIC	8929.2679			

Parameters in **bold** (*italics*) are statistically significant at the 5% (10%) level.

The ASC mean parameter was negative but not statistically significant, indicating that on average the non-charter boat fishing trip option (Choice C) was not preferred over the charter boat fishing trip options. However, the large and significant standard deviation parameter associated with the ASC suggests there was considerable variation in preferences toward the non-fishing option across the sample with some preferring it to the fishing options and others preferring the fishing options.

The other mean parameters were generally statistically significant and of the expected sign. The SE Region mean parameter was negative and significant, indicating that non-resident anglers tended to value fishing in Southcentral Alaska higher than in Southeast Alaska. The positive sign on the trip duration variable, DAY, and the negative sign on the squared trip duration variable, DAY^2, indicate that the marginal utility of time spent fishing is positive but declines as the length of the fishing trip increases. Chinook salmon bag limit parameter estimates were positive, statistically significant, and indicate that fishing trips with higher limits are more valuable, but at a declining rate. Coho salmon bag limit parameters were also positive and significant, as expected if anglers prefer positive bag limits (versus a catch-and-release only fishery). However, despite the parameter on a bag limit of six fish having the largest positive value among the coho salmon bag limit parameters, the parameter for a four fish bag limit was lower than that for a three fish bag limit (though they were not statistically different from one another).

Fourteen of the 19 halibut-related attributes in the model had either a significant mean parameter or standard deviation parameter, or both. The unconditional halibut parameters for the size (HALSIZE1, HALSIZE2, HNOMAX1, HNOMAX2) and bag limit (HBL1, HBL2, HBL3) variables were generally less significant than the conditional parameters, suggesting that the type of size limit applied on a trip (i.e., regardless of whether a reverse slot restriction or just a maximum size limit is used) matters. The only unconditional halibut-related mean parameter that was statistically significant was HALSIZE1, which was positive. This implies that the larger the maximum size limit on the first fish in the bag limit is, the greater the utility of the fishing trip.

In contrast, many of the Pacific halibut conditional mean parameters are statistically significant. For both fishing trips with and without a reverse slot size restriction, the first fish in the bag limit parameter (HBL1FSH and HML1FSH) was positive and statistically different from zero, implying the first fish in the bag limit has value. The mean parameters on the third fish in the bag limit, when present, were also positive but much smaller in magnitude for both cases, which suggests a diminishing marginal value for larger quantities of fish harvested, all else being equal. The standard deviation parameters for the first fish and third fish parameters under both the reverse slot and non-reverse slot restrictions were statistically significant and large relative to the mean parameters, suggesting considerable variation of preferences over the sample. Somewhat surprisingly, the mean and standard deviation parameters on the second fish in the bag limit were not statistically significant, though this may be a consequence of multicollinearity due to the large number of dummy variables required to describe regulations used and contemplated by fishery managers.

There was a large and negative mean effect on utility when the first fish in the Pacific halibut bag limit was limited by a maximum

Table 6
Total willingness to pay for charter boat Pacific salmon fishing trips, and marginal values of trip characteristics (in $).

Trip characteristics	Lower bound of 95% CI	Mean	Median	Upper bound of 95% CI
Total willingness to pay for trips				
Southeast area, Chinook salmon,2 fish bag limit	1111.72	1552.90	1546.96	1954.27
Southcentral area, Chinook salmon,2 fish bag limit	1553.22	1945.14	1933.17	2383.39
Southeast area, coho salmon, 4 fish bag limit	983.49	1383.95	1378.18	1811.73
Southcentral area, coho salmon, 4 fish bag limit	1399.64	1780.59	1778.56	2194.57
Marginal values of trip characteristics				
Southeast region dummy variable	−943.53	−364.04	−360.77	−173.72
1 day trip	205.06	444.07	444.61	684.08
Increase in days from 1 to 2	191.86	351.50	351.58	506.30
Increase in days from 2 to 3	162.27	267.68	269.56	362.91
Increase in days from 3 to 4	41.15	176.23	183.22	285.10
Increase in days from 4 to 5	−108.19	88.87	95.11	260.33
Chinook salmon bag limit of 1 fish	243.14	649.71	638.89	1057.22
Increase in Chinook salmon bag limit from 1 to 2	509.61	804.89	799.99	1100.35
Increase in Chinook salmon bag limit from 2 to 3	16.49	343.45	337.68	701.79
Coho salmon bag limit of 3 fish	1260.14	1686.74	1675.52	2162.10
Increase in coho salmon bag limit from 3 to 4	−780.18	−413.10	−409.39	−90.88
Increase in coho salmon bag limit from 4 to 6	80.33	411.80	414.44	744.60

size limit, regardless of whether or not anglers were allowed to harvest a large fish under a reverse slot restriction. However, holding everything else equal, the marginal effect of additional fish beyond the first fish in the bag limit (e.g., a second or third fish) having a maximum size limit was not statistically significant. Thus, the marginal impact of size restrictions on the second and third fish in the bag limit appears to be unimportant on average. Note that for fishing trips where there were maximum size restrictions, but the reverse slot restriction was not imposed, the standard deviation parameters are statistically insignificant. When the reverse slot restriction was available, however, there was significant variation in the preferences for the first fish in the bag limit when it was the only fish (i.e., the standard deviation of the HML1FSH1) and the second or third fish in the bag limit (i.e., the standard deviation parameter of HML3FSH2). This implies that when there was at least one fish with a reverse slot when more than one fish was allowed to be harvested, the marginal value of the first fish in the bag limit varied quite a bit over the sample with some having large negative values while others being only mildly affected if at all (some may even view restricting the size of the first fish as a good thing when the bag limit is only one fish). Similarly, the preferences for the second or third fish in a multiple fish bag limit in the presence of a reverse slot size restriction encompassed both negative and positive values over the sample.

5. Economic values for fishing

Using the estimated model results, two types of economic values are calculated: marginal economic values of an attribute associated with a one unit change and the total economic value of, or willingness to pay for, a fishing trip with a specific set of attribute levels. The former are important for understanding the marginal effect trip characteristics, such as location and trip duration, have on the value of charter fishing trips holding everything else constant. They also include estimates of the marginal value of increasing the bag limit by one fish, all else being equal. In contrast, total economic values of fishing trips represent the willingness to pay for a fishing trip given a specific set of regulations on target species, duration (trip length), and location.

Total willingness to pay for four benchmark one-day salmon trips are presented in Table 6, along with marginal value estimates for key attributes. The fishing trips used to assess total willingness to pay all have either a 2-fish Chinook limit or a 4-fish coho limit, and differ in the area fished and the salmon species caught. Total willingness to pay for a trip with a 2-fish Chinook salmon limit in the Southeast region is estimated to be worth $1553 (with a 95% confidence interval of [$1112, $1954])[6]; the same trip in the Southcentral region is valued at $1945 ([$1553, $2383]). A coho salmon trip with a 4-fish limit in Southeast Alaska generates total willingness to pay of $1384 ([$983, $1812]), while the same trip taken in Southcentral Alaska is valued at $1781 ([$1400, $2195]). These estimates illustrate two basic patterns. First, a trip taken in Southeast Alaska has lower total willingness to pay than one taken in Southcentral Alaska, which reflects the negative marginal value associated with the Southeast region dummy variable of −$364 (this is the first marginal value listed in Table 6). Second, a Chinook salmon trip generates mean total willingness to pay estimates that are somewhat, but not greatly, larger than coho salmon trips.

Beyond the marginal value of area fished that was noted above, there are two other basic attributes of trips whose marginal values are of interest: length of trip and unconditional bag limits (i.e., limits on number of fish that may be harvested without additional restrictions on their composition). The remainder of Table 6 presents marginal values of these attributes for salmon trips. In each case, estimates of marginal value are presented for the first unit (the first day or fish) and for increases in marginal value for increases in days fished or bag limits.

The marginal willingness to pay for a one-day trip is $444 (to go from zero to one day fished), and declines by $88 per day. Thus, the willingness to pay to add a second day to a one-day trip is $356; to add a third day to a two-day trip is $268; and so on. The marginal values of additional days fished are statistically significant up to the change from 4 days to 5 days.

Since the salmon bag limits are represented in the utility specification by dummy variables for specific bag limits, three marginal values of getting an additional fish in the bag limit for Chinook salmon were calculated. First, the marginal value of going from zero to one fish is $650 (with a 95% confidence interval of [$243, $1057]), the marginal value of the dummy variable for a bag limit of one Chinook salmon. Second is the value of going from one to two fish, or $805 ([$510, $1100]), which is the difference in the marginal values of the dummy variable parameters for bag limits

[6] Confidence intervals in this paper are calculated using the Krinsky–Robb simulation approach.

of one and two fish. Finally, the marginal value going from two to three Chinook salmon is $343 ([$16, $702]), the difference in marginal values of the dummy variables for bag limits of two and three fish. Thus, the marginal values of additional Chinook salmon are all positive and statistically different from zero. Due to the amount of overlap of confidence intervals, it is likely the marginal values are not statistically different from one another, which means one cannot rule out a constant marginal value of an additional Chinook salmon.

Similarly, marginal values for coho salmon are calculated, although the marginal values are for changes in bag limits from zero to three fish ($1687 with a 95% confidence interval of [$1260, $2162]), three to four fish (−$413, [−$780, −$91]), and four fish to six fish ($412, [$80, $745]). Going from a bag limit of three to a bag limit of four coho salmon yields a negative and statistically significant marginal value, which is unexpected, but going from four to six fish is positive and statistically significant. The marginal value of going from zero to three fish is statistically larger than the marginal value of going from four to six fish, which perhaps suggests a declining marginal value for coho salmon bag limits.

With the large number of Pacific halibut-related attributes, it becomes difficult to provide succinct and meaningful marginal value estimates since many things will affect them.[7] Two of the three basic attributes of trips, area fished and duration of a trip, were discussed above in connection with salmon values. For Pacific halibut, marginal values for the third basic attribute, unconditional bag limits, are all statistically insignificant. That is, the marginal values for increasing bag limits from 0 to 1 fish, 1 to 2 fish, and 2 to 3 fish, all else being equal, are statistically insignificant and therefore provide little information on marginal values. All the other marginal attributes associated with Pacific halibut are used in defining additional restrictions on halibut bag limits, and in addition to there being a great many of them, their marginal values have little meaning in isolation.

More informative, however, are the total willingness to pay estimates associated with several different types of Pacific halibut charter fishing trips that account for a wide range of regulations.[8] Since one of the principal aims of this research was to understand how sensitive economic values for fishing trips were to changes in Pacific halibut size and bag limits, WTP for several types of fishing trip scenarios that generally span recent regulations in Southeast and Southcentral Alaska are focused upon. These policy scenarios differ in the specific bag limit and size restriction applied to Pacific halibut catch. The scenarios span bag limits of one or two fish with or without size limits on one or more fish, with several size restrictions selected to match as closely as feasible recent regulations.[9] For simplicity, one-day charter fishing trips where only Pacific halibut are targeted are assumed.[10] The WTP for a total of 16 policy scenarios are calculated, nine for charter fishing trips in Southeast Alaska and seven for trips in Southcentral Alaska.

Table 7 presents the mean, median, and 95% confidence intervals of WTP estimates for each of the policy scenarios. In both Southeast Alaska and Southcentral Alaska, the WTP for the most restrictive charter fishing trip, one in which only a single fish that is small (by Pacific halibut standards) can be caught and retained, is not statistically different from zero; meaning that for the average respondent, this trip is not worth taking (i.e., it has no value). However, halibut charter fishing trips where the angler is limited to one fish of any size are valued at $810 ([$30, $1554]) for a Southeast Alaska trip and $1225 ([$491, $1987]) for Southcentral Alaska trip. Under a bag limit of one fish and size restrictions permitting either small fish or very large fish can be harvested, but not fish within a certain size range (i.e., under a reverse slot size restriction), trip values are positive and significant with mean values ranging from $759 to $1276 in Southeast Alaska, depending upon the lower bound of the reverse slot. Interestingly, these trip value estimates are not statistically different from the one associated with a bag limit of one fish with no size restriction. For Southcentral Alaska, the reverse slot halibut trip is estimated to be valued at $1156, and similarly is not statistically different from the trip with the same bag limit but no size restriction.

When the bag limit for halibut is two fish in Southeast Alaska, where at least one of the fish can be any size, the estimated mean trip values range from $1057 to $1686, with the lowest value associated with a trip in which both fish can be any size. However, none of these values are statistically different from one another, suggesting that so long as one fish can be any size, there are no significant differences in value. For Southcentral Alaska trips, the same pattern emerges. The lowest value trip is the two-halibut-of-any-size trip, with a mean of $1414, and when one of the fish in the limit is restricted by a reverse slot size restriction, the mean trip values range from $2017 to $2081. Again, there is no statistical difference between any of the two-halibut bag limit fishing trips, regardless of the size restriction on the second fish in the limit.

6. Discussion

These results indicate that the option to catch and keep at least one large fish, even potentially (via a reverse slot restriction), is valuable for halibut anglers, and that the 2011 Southeast Alaska regulations (with a one fish limit and 23 lb maximum size restriction) resulted in a WTP for halibut charter trips by non-residents that was indistinguishable from zero. The results also suggest that the WTP for fishing trips with bag limits that allow two fish to be harvested with no size restrictions on the first fish harvested is not statistically different from the value for trips for larger bag limits or for the case where all the fish in the limit can be any size.[11] This suggests that fishery managers can restrict the size of the second fish in a two-fish bag limit and still maintain economic values for fishing trips.

The fact that charter fishing trips in which anglers are able to harvest two halibut of any size are just as valuable (statistically) as trips in which one of the two fish in the bag limit is constrained to be very small can be explained by a couple of possible motivations. First, there may be an awareness or acceptance by the non-resident charter anglers of the need to conserve the halibut resource (e.g., [13]). It is well-known among commercial fishermen and charter operators that Pacific halibut stocks have been declining in recent years [23], which has been a principal driver contributing to the stricter harvest regulations on sport fishing, and declining total allowable catch levels in the commercial fishery. Second, non-resident anglers may take charter fishing trips for the possibility of

[7] The presentation of marginal values associated with changes in halibut-related attributes are limited to bag limits since the marginal effects of size limits are manifold and are conditional on multiple interactions between attributes. However, all marginal effects in the presence of halibut size limits are calculable from the estimated model in Table 5.

[8] These values are not the net economic values associated with fishing trips; the cost of making the trip must be deducted from these estimates to generate the net value of the fishing trip.

[9] These scenarios approximate the regulations since the size regulations are in terms of inches and in the survey they are measured in pounds, and the upper end of the reverse slot size restriction in the survey does not exactly match those in the regulations from 2012 to 2014.

[10] The mean number of charter boat fishing days reported by the sample was 1.17 with a median of 1 day.

[11] WTP associated with scenarios involving bag limits of three halibut were calculated and available upon request, but were excluded from the discussion since such high bag limits have not been in place in decades and current stock trends suggest a return to those levels in the near future is highly unlikely.

Table 7
Willingness to pay for charter boat Pacific halibut fishing trips in Southeast and Southcentral Alaska (in $).

Policy scenario	Lower bound of 95% CI	Mean	Median	Upper bound of 95% CI
Southeast Alaska (Area 2C)				
One halibut no larger than 23 lb[a]	−599.29	−74.68	-67.54	423.36
One halibut no larger than 35 lb or greater than 130 lb	102.72	759.45	760.41	1401.91
One halibut no larger than 40 lb or greater than 130 lb[b]	548.37	1275.79	1267.43	2019.16
One halibut no larger than 43 lb or greater than 130 lb[c]	381.25	1066.07	1061.66	1790.04
One halibut of any size[d]	29.83	809.80	803.54	1553.72
Two halibut; one any size; one no larger than 14 lb[e]	919.77	1726.59	1730.20	2604.65
Two halibut; one any size; one no larger than 18 lb	894.39	1686.08	1661.88	2501.24
Two halibut; one any size; one no larger than 23 lb	821.18	1649.00	1649.16	2570.96
Two halibut of any size[f]	−265.68	1056.88	1058.40	2351.61
Southcentral Alaska (Area 3A)				
One halibut no larger than 23 lb	−245.37	328.97	342.79	861.16
One halibut no larger than 35 lb or greater than 130 lb	522.17	1155.86	1141.97	1853.21
One halibut of any size	491.16	1224.91	1227.86	1986.76
Two halibut; one any size; one no larger than 10 lb[b]	1253.34	2112.10	2105.61	2996.67
Two halibut; one any size; one no larger than 18 lb	1265.01	2080.76	2085.88	2883.81
Two halibut; one any size; one no larger than 23 lb	1271.07	2017.35	2004.57	2809.71
Two halibut of any size[f]	84.92	1413.71	1424.80	2569.87

[a] 2011 Halibut regulation.
[b] 2014 Halibut regulation.
[c] 2012–2013 Halibut regulation.
[d] 2009–2010 Halibut regulation.
[e] 2007–2008 Halibut regulation.
[f] Pre-2007 halibut regulation.

landing a large trophy fish, but have little interest in catching multiple large Pacific halibut since they are less likely to be interested in the fish for the meat, but rather the sport and experience. Charter anglers from out-of-state catching large fish will need to have the fish processed and shipped home, which can be expensive and undesirable for very large fish (e.g., the amount of meat packaged for a large halibut conforming to the reverse slot size restriction can easily exceed 100 lb).[12] This was a common sentiment among non-resident anglers who participated in pre-testing activities (focus groups and cognitive interviews) during the development of the survey. The WTP pattern for trips with bag limits of two halibut holds regardless of whether those trips are in Southeast Alaska, where more restrictive harvest regulations have been in place since 2007, or in Southcentral Alaska, where 2014 was the first year charter angler harvest had been regulated more strictly than unguided fishing.

The results also provide insights about past and present charter-specific halibut regulations. For instance, angler WTP for Southeast Alaska fishing trips with Pacific halibut charter regulations resembling the 2012–2014 regulations (one-fish bag limit with a reverse slot size restriction) was statistically the same despite the differences in the reverse slot size restrictions. Additionally, the WTP estimates for Southeast Alaska fishing trips that approximate the 2007–2008 charter halibut regulations (two-fish bag limit with one fish of any size and another one that is small) are not statistically different from the one-fish bag limit trips that allow for a single fish that is either very small or very large (i.e., subject to a reverse slot size restriction), which are like those that have prevailed since the 2009 fishing season, with the exception of 2011. In that year, charter harvest regulations in Southeast Alaska were the most restrictive to date, limiting charter anglers to a single small halibut (37 in., or about 22 lb, or smaller). This greatly reduced the number of Pacific halibut harvested in the charter sector (77 FR 16742), and eventually led to a relaxation of the strict maximum size limit to a reverse slot limit in the following year. This is consistent with the small estimated WTP (statistically indistinguishable from $0) for a halibut fishing trip under the 2011 regulations, and provides evidence that restricting harvest to only small halibut would greatly reduce demand (since the average angler would not be willing to pay for this type of trip).[13]

In addition, the results suggest that the recent change to more stringent charter angler halibut harvest restrictions in Southcentral Alaska (two-fish bag limit with one of those fish restricted to be less than 29 in., or 18 lb) is unlikely to significantly impact fishing trip demand since the WTP of fishing trips is (statistically) unchanged from the less restrictive regulations of past years (i.e., a bag limit of two fish of any size). In fact, the results suggest that reducing the bag limit to one fish with a reverse slot size restriction could be accommodated without having a statistically significant effect on fishing economic values (although politically, it may have significant effects).

Drawing lessons from the WTP estimates in Table 7 should be done with caution for a few reasons. First, the experimental design of the stated preference choice experiment questions precludes us from modeling the exact reverse slot size restrictions. At the time the survey was being developed, the upper bound of the reverse slot (i.e., the smallest a “large halibut” could be) was being discussed at about 130 lb, which is what was used in the SP questions. However, the upper bounds used in the actual reverse slot size restrictions from 2012 through the present have been larger – corresponding to 160 lb in 2012 and 2013 and 235 lb in 2014. Therefore, the WTP estimates calculated for the reverse slot fishing trips allowed for smaller “large” halibut than the actual regulations. As a result, they likely represent upper bounds on WTP. Second, to incorporate the effects of the full set of regulatory tools in current use for managing charter halibut fishing in Alaska, a utility specification that relied on interacting a number of different attributes from the SP questions was utilized. The estimated WTP captures the variance in the estimated model parameters, and thus

[12] Alaska resident anglers are more likely to be interested in maximizing the amount of Pacific halibut harvested as a food source, and therefore have different preferences that may favor maximizing both the bag limit and size of fish.

[13] Note that, in fact, the 2011 halibut harvest restrictions were deemed “too restrictive” (p. 7) in Area 2C, with only about 44% of the expected catch made that year [22]. Subsequently, the harvest restrictions were relaxed somewhat.

have fairly wide confidence intervals. For this reason, it may not be surprising that a range of size and bag limit restrictions was found over which WTP values were not statistically different.[14] Third, it is important to keep in mind that the estimated economic values are willingness to pay values, not net economic values. Thus, the charter prices need to be accounted for. Based on recent surveys of Alaska charter businesses [16], average halibut charter boat fishing trip prices in recent years have ranged from about $300 for a single day trip to about $1500 for a multi-day trip. Fourth, the model results suggest heterogeneity is important, with considerable variation across the sample in terms of how the fishing values of non-resident anglers are affected by bag limits and size restrictions.

Finally, it is worth noting that the estimated charter halibut trip values in this study are generally smaller than the values estimated for non-resident charter boat trips in Alaska in previous work. The value of a one-day charter halibut fishing trip with a bag limit of two halibut with no size restrictions was estimated to be about $2760 (in 2012 dollars) for a Southeast Alaska trip and $2870 for a Southcentral Alaska trip by [13] using data from 2007. As noted above, in this study these trips are valued at $1057 and $1414, respectively. The same is true for the one-day charter salmon fishing trips, which had estimated mean WTP values of $2549 and $2639 (in 2012 dollars) for Southeast and Southcentral Chinook salmon charter fishing trips, respectively, in [13]. In this study, the corresponding mean trip values were lower ($1553 and $1945, respectively). Similarly, mean WTP values for coho salmon charter fishing trips were lower in this work ($1384 in Southeast Alaska and $1781 in Southcentral Alaska) than in the previous study ($2007 and $2110, respectively, in 2012 dollars). In part, this may be due to the effects of the Great Recession, which may have caused both a reduction in disposable income available for leisure activities such as saltwater sport fishing activities in Alaska (e.g., the mean income of non-resident anglers in the 2007 survey was about $117,000 compared to $111,000 in this survey, both in 2012 dollars), as well as a shift in anglers' preferences for what activities on which they would like to spend their money.

7. Conclusions

This article has presented the results from a stated preference choice experiment study that estimates the value of saltwater charter boat fishing trips in Alaska by non-resident anglers. Using data from a 2012 survey of non-resident anglers in Alaska, the WTP for charter boat fishing trips under a variety of regulatory scenarios were estimated. One objective of this study is to increase the knowledge about economic values associated with recreational charter boat fishing, in particular by providing more recent updates that reflect changes in regulations, personal preferences for fishing, and broad economic conditions.

In addition, a perhaps more important goal is to be responsive to the potential needs of fishery managers when considering modifications to existing regulations. While economic values of both Pacific salmon and Pacific halibut saltwater sport harvest are both examined here, the regulatory landscape is changing more rapidly for the latter, so the focus was placed primarily on regulations for the Pacific halibut sport fishery in Alaska. This is especially important since an annual evaluation of recreational harvest regulations is now a formal part of the regulatory process under the newly-implemented catch sharing plan. And in particular, since recent regulations for Pacific halibut have been applied specifically to the charter sector in Alaska in recent years and are stricter than those applied to unguided anglers, the role of regulations on the charter sector are emphasized.

The results suggest that recent charter-specific bag and size limit restrictions may not have had a significant effect on the economic value of these fishing trips. In fact, they suggest that in Southcentral Alaska, where charter-specific restrictions on halibut were implemented for the first time in 2014, fisheries managers may have some latitude to restrict harvest using a more restrictive set of restrictions than are currently in place without diminishing non-resident angler fishing values considerably, so long as these anglers are allowed to catch at least one fish that is large.

While the information in this study provides useful insights for decision makers about economic values for recreational charter fishing and how they are affected by harvest regulations, it is important to recognize that the values presented here are from only a subset (albeit an important one) of the angler population benefitting from Alaska fishing opportunities. As important, if not more so, are the economic values that Alaska residents hold for those fishing opportunities, and how they are changed by regulations. Providing economic value information for each of the principal types of fishery users can help fishery managers better understand the effects that changes in regulations have on different groups of people, which may well differ. Updating previous estimates of the Alaska resident anglers' economic values is an important direction for future work.

Finally, it is important to note that maximizing net economic benefits to anglers is but one of numerous considerations that fishery managers must balance when evaluating policies. While biological and ecological concerns about declining stock sizes are likely to remain the primary consideration in policy discussions, the results from this study suggest a range of restrictions that could be implemented to achieve the biological and ecological goals without hurting fishing values.

Acknowledgments

The authors thank an anonymous reviewer, Ron Felthoven, Chang Seung, and participants of the 2013 North American Association of Fisheries Economists Biennial Forum for useful comments. All remaining errors or omissions are the responsibility of the authors. Funding support from the NOAA Fisheries Office of Science and Technology is gratefully acknowledged.

References

[1] L.E. Anderson, S.T. Lee, Untangling the recreational value of wild and hatchery salmon, Mar. Resour. Econ. 28 (2013) 175–197.
[2] I.J. Bateman, R.T. Carson, B. Day, M. Hanemann, N. Hanley, T. Hett, M. Jones-Lee, G. Loomes, S. Mourato, E. Ozdemiroglu, D.W. Pearce, R. Sugden, J. Swanson, Economic Valuation with Stated Preference Techniques: A Manual, Edward Elgar, Northampton, MA, 2002.
[3] S. Beggs, S. Cardell, J. Hausman, Assessing the potential demand for electric cars, J. Econom. 16 (1981) 1–19.
[4] N.E. Bockstael, K.E. McConnell, Environmental and Resource Valuation with Revealed Preferences: A Theoretical Guide to Empirical Models, Springer, Dordrecht, The Netherlands, 2007.
[5] D.W. Carter, C. Liese, The economic value of catching and keeping or releasing saltwater sport fish in the Southeast USA, N. Am. J. Fish. Manag. 32 (2012) 613–625.
[6] R.G. Chapman, R. Staelin, Exploiting rank ordered choice set data within the stochastic utility model, J. Mark. Res. 19 (3) (1982) 288–301.
[7] K.R. Criddle, M. Herrmann, S.T. Lee, C. Hamel, Participation decisions, angler welfare, and the regional economic impact of sportfishing, Mar. Resour. Econ. 18 (2003) 291–312.

[14] Another potential caveat is that the model specification does not allow us to test the possibility that anglers on different length fishing trips have different marginal effects related to regulations. However, since addressing this dimension greatly complicates the specification and would require a larger sample size than is currently available to generate sufficient precision, this line of inquiry is left for future research.

[8] D.A. Dillman, Mail and Internet Surveys: The Tailored Design Method, 2nd edition,. John Wiley and Sons, New York, 2007.
[9] M. Dorow, B. Beardmore, W. Haider, R. Arlinghaus, Winners and losers of conservation policies for European eel, *Anguilla anguilla*: an economic welfare analysis for differently specialised eel anglers, J. Fish. Manag. Ecol., 17, (2010) 106–125.
[10] J. Huber, K. Zwerina, The importance of utility balance in efficient choice designs, J. Mark. Res. 33 (3) (1996) 307–317.
[11] B.J. Kanninen, Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Approach to Theory and Practice, Springer, Dordrecht, The Netherlands, 2006.
[12] K.S. Lawrence, Assessing the value of recreational sea angling in South West England, Fish. Manag. Ecol. 12 (2005) 369–375.
[13] D.K. Lew, D.M. Larson, Economic values for saltwater sport fishing in Alaska: a stated preference analysis, N. Am. J. Fish. Manag. 32 (4) (2012) 745–759.
[14] D.K. Lew, D.M. Larson, Is a fish in hand worth two in the sea? Evidence from a stated preference study, Fish. Res. 157 (2014) 124–135.
[15] D.K. Lew, J. Lee, D.M. Larson, Saltwater Sportfishing in Alaska: A Summary and Description of the Alaska Saltwater Sportfishing Economic Survey, 2007, U.S. Department of Commerce, NOAA Tech Memo NMFS-AFSC-214, 2010.
[16] Lew, Daniel K., Gabriel Sampson, Amber Himes-Cornell, Jean Lee, and Brian Garber-Yonts. "Costs, Earnings, and Employment in the Alaska Saltwater Sport Fishing Charter Sector, 2011-2013." U.S. Dept of Commerce, NOAA Technical Memorandum NMFS-AFSC-2738, 2015, 134 p. Available at http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-299.pdf.
[17] J.C. Louviere, D.A. Hensher, J.D. Swait, Stated Choice Methods: Analysis and Applications, Cambridge University Press, Cambridge, UK, 2000.
[18] M. Massey, S.C. Newbold, B. Gentner, Valuing water quality changes using a bioeconomic model of a coastal recreational fishery, J. Environ. Econ. Manag. 52 (2006) 482–500.
[19] D. McFadden, Conditional logit analysis of qualitative choice behavior, in: P. Zaremba (Ed.), Frontiers in Econometrics, Academic Press, New York, 1973, pp. 105–142.
[20] J. Meyerhoff, M.R. Morkbak, S.B. Olsen, A meta-study investigating the sources of protest behaviour in stated preference surveys, Environ. Resour. Econ. 58 (2014) 35–57.
[21] R.C. Mitchell, R.T. Carson, Using Surveys to Value Public Goods: The Contingent Valuation Method, Resources for the Future, Washington, D.C., 1989.
[22] National Oceanic and Atmospheric Administration, Regulatory Amendment for a Catch Sharing Plan for the Pacific Halibut Charter and Commercial Longline Sectors in International Pacific Halibut Commission Regulatory Areas 2C and 3A, Final Environmental Assessment, Regulatory Impact Review, Initial Regulatory Flexibility Analysis, November 2013, 315 pages. ⟨http://alaskafisheries.noaa.gov/analyses/halibut/earirirfa_halibut_csp1113.pdf⟩.
[23] I.J. Stewart, S. Martell, Assessment of the Pacific Halibut Stock at the end of 2013, International Pacific Halibut Commission Report, 2014.
[24] K.E. Train, Discrete Choice Methods with Simulation, Cambridge University Press, Cambridge, UK, 2003.
[25] Gordon B. Willis, Cognitive Interviewing: A Tool for Improving Questionnaire Design, Sage Publishing, Thousand Oaks, CA, 2005.