An Economic Discussion of the Marine Sport Fisheries in Central and Lower Cook Inlet

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Abstract. This paper reports on the valuation of the marine halibut and salmon sport fishery of central and lower Cook Inlet, Alaska. The project was designed to simulate changes in economic value and regional economic impacts for environmental analysis but has also been used in fishery allocation management. This study develops a predictive model of participation rate changes for estimation of net benefits to anglers and links the resulting demand function to a regional input-output model for determining expenditure-based impacts of marine sportfishing to the Kenai Peninsula economy. The participation rate model is driven by changes in mean sport fishery attributes such as the expected catch rate and weight for various species as well as the average cost of a fishing day. The total estimated new money brought into the Kenai Peninsula as a result of 259,615 saltwater angler days in central and lower Cook Inlet was $37.4 million in 1997, and the total compensating variation, $25.4 million. Simulations involving changes to sportfishing trip attributes from a 1997 baseline trip are examined and reported in the paper.

Keywords: sportfishing, halibut, participation-rate, charter, impact analysis, consumer surplus.

INTRODUCTION

Research into the determinants of the economic value of Alaska's sport fisheries lags behind commercial fisheries research. Historically, the commercial sector's dominance as a mainstay of Alaska's economy has overshadowed interest in recreational fisheries. But even as allocation conflicts have spurred anglers to cast their interests into the policy arena with greater frequency, data scarcity continues to limit the extent and scope of inquiry into the economics of Alaska's recreational fisheries. This work was motivated by environmental impact considerations and the potential effects on recreational fisheries of outer continental shelf minerals exploration, development and production activities in the Cook Inlet Planning Area (Herrmann et al. 2000). Our findings were also applied towards characterizing the economics of the guided sport fishery for halibut for use by the North Pacific Fishery Management Council in its consideration of halibut charterboat management measures in the Gulf of Alaska (NPFMC 2000).

The sport fisheries of Cook Inlet contribute to the economic well being of residents of the Kenai Peninsula, Alaska, and the nation (see Figure 1). In this paper we focus on the most important saltwater sport fish specie in Cook Inlet, Pacific halibut (*Hippoglossus stenolepis*). Pacific halibut are managed by an international agreement between the U.S. and Canada. Under the auspices of this agreement, the International Pacific Halibut Commission (IPHC) establishes overall harvest limits in the North Pacific, Gulf of Alaska, and eastern Bering Sea while

authority to allocate catches among competing commercial, sport, and subsistence interests is delegated to the individual nations. With passage of the Fishery Conservation and Management Act of 1976 (MSFCMA), the North Pacific Fishery Management Council (Council) was given responsibility for allocating halibut catches off
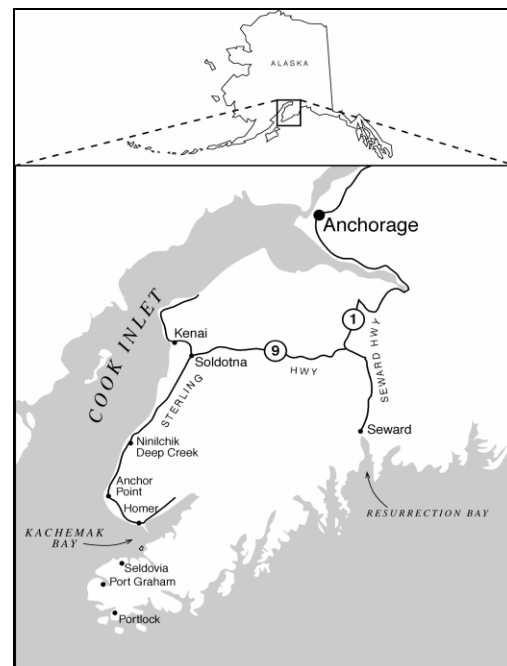
Alaska. Until recently, the commercial TAC (total allowable catch) for Pacific halibut has been determined by subtracting the bycatch allowance and expected non-commercial (sport and subsistence) catches from the ABC (allowable biological catch), a limit set by the Council consistent with IPHC limits.

In February 2000, the Council approved for recommendation to the Secretary of Commerce, a management structure that sets a guideline harvest level (GHL) for charterboat-based sportfishing catches of halibut equal to the 1995-1999 average catches with provisions for a reduction in the GHL if stock biomass declines. Under the proposed regulations, harvests by sport fishers who do not hire charterboat services will continue to be accommodated through reductions of the commercial TAC. Subject to Secretarial approval, the new management scheme will be implemented in 2001. The Council has also indicated an interest in development of an individual fishing quota (IFQ) management structure, as an alternative to the GHL. The commercial halibut and sablefish fisheries are managed under IFQs. If the charter vessel based sport fishery were also managed under an IFQ, open markets would serve to allocate a combined commercial and guided sport TAC (specified as a percentage of the ABC) among commercial fishers and charterboat operators.

The importance of accurate economic analysis of recreational fishing continues to increase as the demand for sport fishing grows. Figure 2 shows the dramatic growth in the number of anglers purchasing fishing licenses in Alaska between 1961 and 1997. Purchases of fishing licenses by Alaska residents increased from 1961 to 1986, and leveled off thereafter. However, total purchases continued to increase fueled by non-resident visitation rates. Non-residents increased their percent of total licenses from 26% in 1961 to 58% in 1997. During this same time total purchases of licenses have increased from 90,565 to 431,894 for a 377% increase.
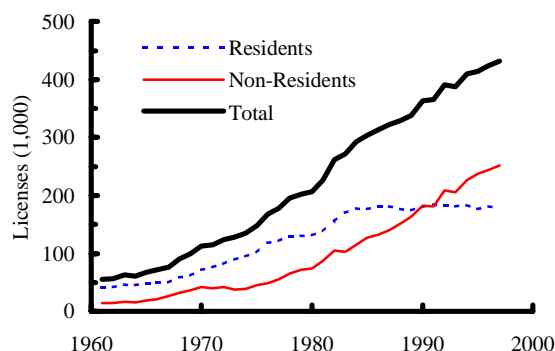

Figure 2: Number of Alaska Sportfishing Licenses by Residency (1961-1997).

The economics of the commercial halibut fishery have been subject to considerable analysis, beginning with Crutchfield and Zellner (1962). The demographics of the commercial halibut fishery were examined in the EA/RIR for the implementation of the halibut/sablefish IFQ program (NPFMC 1991). Criddle (1994) describes the bioeconomics of the commercial halibut fishery. NRC (1999) includes an evaluation of the adoption of individual fishing quotas in the commercial halibut fishery. Lin et al. (1988), Homans (1993), and Herrmann (1996, 1999, 2000) develop econometric models of the exvessel demand for halibut. In contrast, until recently, there has been little formal analysis of Alaska's marine recreational fisheries for halibut or salmon. Coughenower (1986) provides a qualitative description of the halibut guide/charter fishery. Jones and Stokes (1987) provide a small sample estimate of the consumer surplus associated with halibut and salmon sportfishing. Northern Economics (1990) provide an estimate of the economic impact of the S.S. Glacier Bay oil spill that includes a qualitative discussion of sportfishing benefits.

THE MODEL

A complete economic analysis of the central and lower Cook Inlet marine sport fishery would include a measure of economic efficiency (consumer surplus for all anglers and producer surplus derived by the charter industry) as well as a measure of regional impacts. While economic efficiency is a standard objective for economists, the Magnuson-Stevens Act emphasizes that distributional effects, across all stakeholders, be considered when managing the nations fisheries. Edwards (1994) provides an excellent discussion on the differences between cost benefit and economic impact analyses, and outlines their appropriate uses for an allocation analysis.

Though this study provides a comprehensive evaluation of the benefits enjoyed by anglers, we do not attempt to model the producer surplus that accrues to the charter vessel operators. Nonetheless, the consumer surplus estimates and regional impact modeling serve to fill an otherwise large void in the research to date.

To model the Cook Inlet sport fishery we developed a flow chart of the necessary components with identified funding sources (see figure 3).
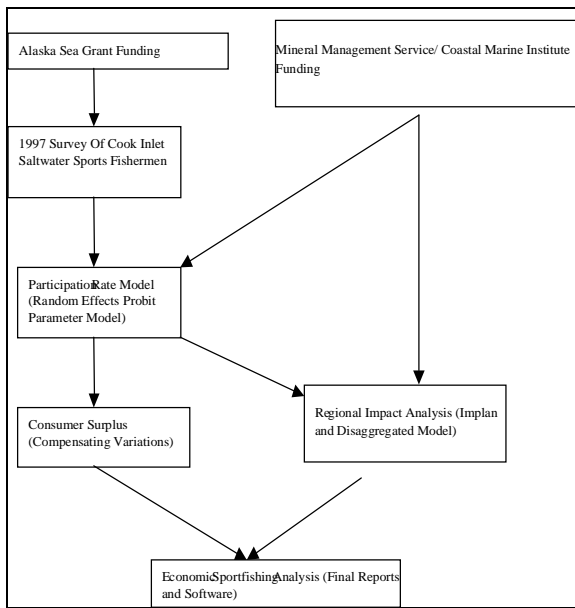
Figure 3: Components of the Cook Inlet sport fishing analysis

Figures 4 and 5 provide a graphical representation of our analytic approach and the implicit assumptions behind the model.
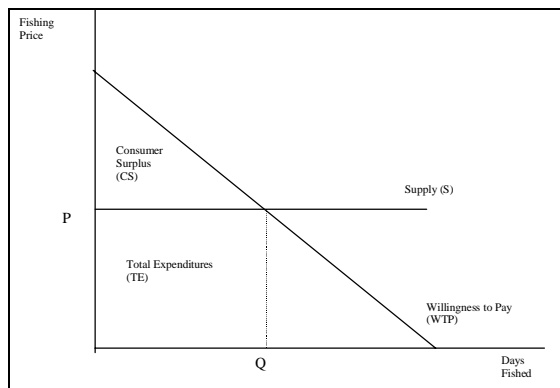

Figure 4: Willingness to pay, consumer surplus, and total

expenditures

Figure 4 shows a demand curve for fishing trips before any change to fishery attributes takes place. The vertical axis measures the price of the fishing trip and quantity is in days fished. The total expenditures are measured as P*Q or the rectangle labeled total expenditure. The consumer surplus is the area below the willingness to pay curve (WTP) and above the price of the trip (P).

Figure 5 shows an example of an inward shift in the demand for trips, caused, for example, by a reduction in expected catch among anglers. Here, for any given price, the number of trips taken is reduced.
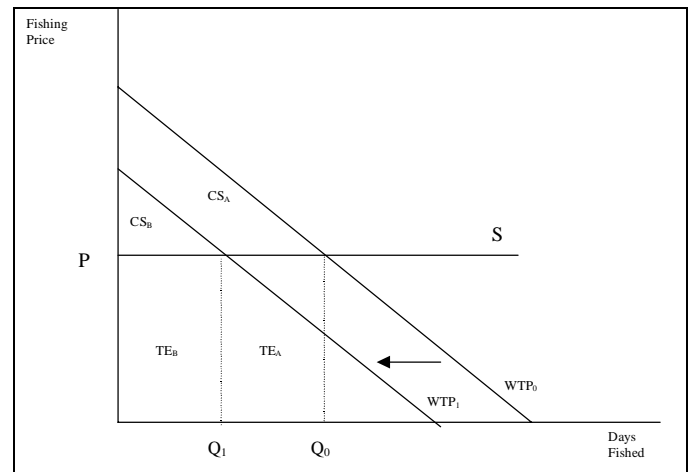

Figure 5: Effect of a decrease in willingness to pay on consumer surplus and total expenditures

When the demand curve for fishing days shifts inward (from WTP_0 to WTP_1) the total expenditures are reduced from TE ($TE_A + TE_B$) to TE_B. The local economy will be impacted to the extent that infusions of new money are reduced. If other recreational opportunities on the Kenai Peninsula are substituted for cancelled sportfishing activities, then expenditures will be redistributed away from businesses that provide fishing related services, such as guides, custom processors, and retail stores specializing in bait and gear. On the other hand, if a cancellation of the fishing trip results in a cancellation of the entire visit to the Kenai, then not only will the fishing expenditures be foregone, but so will all other expenses associated with the trip, including food, lodging, and other services. This second case represents a change in the circulation of new money introduced into the local economy, and is the basis for impact analysis.

An elementary treatment of consumer surplus dictates a decrease from CS ($CS_A + CS_B$) to CS_B. This is caused by both a reduction in total trips (Q_0 to Q_1) and a reduction in the surplus of those remaining in the fishery for whom the quality of the trip has deteriorated (i.e. the reduction in expected catch). We use the compensating variation measurement of consumer surplus as shown in Figure 6.

For example, in Figure 6, the price of a fishing day has been increased vis-à-vis the price of all other goods (y). The budget line rotates from b_0 to b_1 and the angler is made worse off as her utility decreases from I_0 to I_1. The compensation needed to bring the angler back to the original indifference curve (I_0) is $E_2 - E_1$. This is the compensating variation and is measured as the amount of compensation required to leave the sport fisher indifferent as to the original bundle of goods at the old price and the new bundle of goods at the new price.
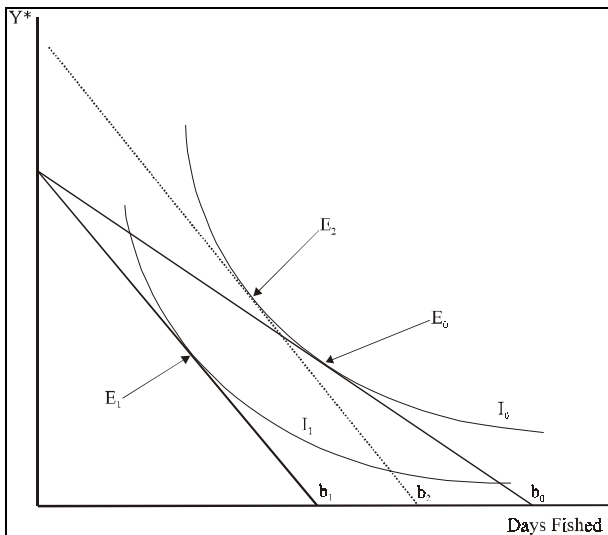
Figure 6: Compensating variation

THE SURVEY

This project relied on data collected by a postal survey of a random sample of 4,000 anglers who purchased an Alaskan license in 1997, (see Lee et. al. 1999 for complete survey methods and results). The overall response rate based on delivered surveys was 70.1%. The survey solicited socioeconomic and catch data, and stated preferences for hypothetical trips. Moreover, respondents were asked to provide detailed information regarding expenses incurred on their most recent salmon and halibut fishing trips. In addition to monies related to fishing, respondents were also queried for a number of other trip expenses including transportation and lodging costs. See Figure 7 for a breakdown of angler day expenditures by residency.

Average angler day expenditures were then estimated by residency and three fishery modes: charter, private boat, and shoreline. Charter trips were unequivocally the costliest across all residencies. Non-residents spent $294 per client day, of which $104 was spent on transportation and living expenses and $190 on fishing related goods and services. The vast majority of the non-resident fishing expenses were spent on guide fees ($141) and processing and packing charges ($33). Alaska residents living outside the Kenai spent on average $205 and locals spent $167 per day charter fishing.

For other fishery modes expenditures break down as follows: On average, local (Kenai) residents spent $33 per shoreline angler day and $63 a day for private vessel fishing. Daily expenditures for non-local Alaskans were $39 for shoreline fishing and $90 for private vessel fishing. For non-residents, shoreline fishing costs averaged $129 per angler day and private vessel costs averaged $114 (for a complete account see Herrmann et al. 2000 and Lee et al. 1999).
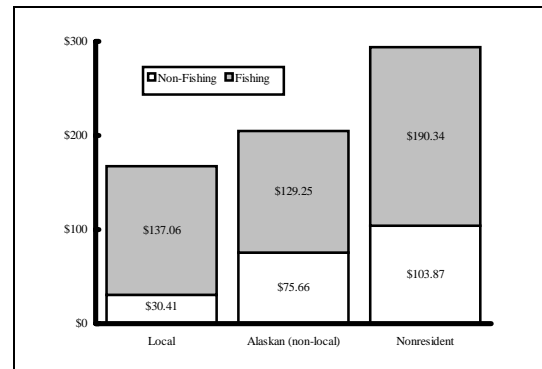

Figure 7: Mean daily expenditures, by residency category, for charter fishing in Cook Inlet

By applying these averages to yearly effort measures estimated by the Alaska Department of Fish and Game (ADF&G 1998), total angler expenditures were computed for 1997. These calculations take into account the reported amount of time respondents spent on the Kenai versus elsewhere in Alaska, and angler day expenditures were apportioned to reflect these regional spending patterns. These expenses totaled $62.7 million spent in Alaska. However, not all of these expenses are directly attributable to fishing. For purposes of deriving economic impacts, we are interested in the money that would not have been spent if the fishing component of the trip were cancelled. We re-estimated the totals by weighting respondents' expenditures according to how they ranked sportfishing relative to other purposes for visiting the Kenai Peninsula. Of the $62.7 million, total expenditures attributable to sportfishing amounted to $44.6 million (see Table 1, page 5).

Of the $44.6 million directly attributable to sportfishing, $37.4 was spent on the Kenai. Because our economic impact analysis is intended to isolate the monetary effects to the western Kenai Peninsula of changes in participation in the Cook Inlet saltwater sport fisheries, it is important that we only use those expenditures that are directly attributable to sportfishing. This value can be regarded as a measure of the economic significance of the marine sport fishery in terms of sales, or output, according to the lexicon of regional economic analysis. However, this measure is likely to be comprised of a significant amount of spending by local residents, which needs to be netted out before deriving the impacts of altered spending patterns. It is assumed that local residents will substitute spending on other regional recreational activities absent the opportunity to sport fish; hence, despite their contribution to the economic significance of the Cook Inlet saltwater sport fishery, they must be disregarded for purposes of impact analysis. Netting out locals' expenditures leaves $32.7 of new money flowing into the region.

	Fishing ($)	Non-Fishing ($)	Total ($)
Residency			
Local	2,659,299	2,057,083	4,716,382
Alaska	5,736,569	6,420,600	12,157,168
Nonresident	14,687,551	13,050,356	27,737,907
Total	23,083,418	21,528,038	44,611,456
Fishing Mode			
Shore	464,053	2,273,685	2,737,738
Private	5,185,328	6,457,600	11,642,929
Charter	17,434,037	12,796,752	30,230,789
Total	23,083,418	21,528,038	44,611,456

Table 1: Expenditures attributable to sportfishing for halibut and salmon in Cook Inlet, by residency and sportfishing model

PARTICIPATION-RATE MODEL

Environmental fluctuations that alter resource abundance, fishery regulations, and trip costs can all affect the expected net benefit associated with sportfishing, and therefore influence the angler's decision of taking a trip. Consequently, the ability to forecast changes in participation rates is paramount for predicting the economic consequences of a dynamic sport fishery. Previous studies have relied on demographic characteristics to explain changes in the demand for recreational fishing (Holland and Ditton, 1992; Aas, 1995; Thunberg et al., 1999). The disadvantage of these models is that the resulting forecasts are wholly conditional on conjectures about demographic change. That is, such models simply shift the focus from forecasting changes in participation to predicting demographic change. Moreover, demography-based participation models are ill-suited for predicting changes in the demand for recreational fishing that might arise in response to changes in trip costs, fishing conditions, or management actions. Our approach avoids these problems by focusing on explanatory variables that are subject to direct control. Consequently, our model is better suited for policy evaluation and for forecasting participation rate responses to changes in trip costs and catch rates. (The modeling and results presented in this section are based on a stated preference survey described in much greater detail in Lee et al. 2000).

In addition to being asked to provide information about various economic and demographic variables and actual trips taken, respondents to the survey were presented a set of hypothetical fishing trips, and asked to identify which trips they would take. Each hypothetical trip was described in terms of six trip attributes and a cost per day. The trip attributes were the average size and number of halibut, chinook, and coho caught. The cost per day was identified as the sum of sportfishing related costs such as tackle and bait purchased specifically for the trip, charter/guide fees, and trip specific transportation costs such as auto and boat fuel.

Trip-by-trip preferences were elicited through a binary choice variable that indicated whether the respondent would take a particular hypothetical trip. The advantage of this approach is that it is possible to construct an experimental design that allows for substitution and complementarity effects across attributes, and for the possibility of nonlinear marginal utility. While these types of effects are predicted by economic theory, they are difficult to identify in empirical studies of actual trips because attributes are often highly collinear or lack sufficient variation. Hypothetical trip attributes were derived from historical means (ADF&G 1998) and pretest discussions with recreational fishers.

The participation decision was modeled using a random utility framework where the utility of individual i associated with trip t is given by

(1) $u_{it} = f\left(x_{it}, z_i, \beta, \gamma\right) + e_{it}$.

The vector, x_{it}, describes the attributes of the t-th trip taken by the i-th individual. Socioeconomic and demographic variables for the i-th individual are included in the vector z_i. β and γ are vectors of parameters associated with the fishing trip attributes and socioeconomic variables, respectively. The errors, e_{it}, are normally distributed with an expected value of zero.

Respondents were asked whether they would take trip t, described by attributes x_{it}. The i-th respondent who takes trip t obtains a utility level of u_{it}. Those who do not take trip t receive

(2) $u_{i0} = f\left(0, z_i, \beta, \gamma\right) + e_{i0}$,

	Alaskans (local and non-local)		Nonresidents	
	Estimates	t-ratios	Estimates	t-ratios
Intercept	-2.8415	3.03	-1.4746	1.86
Price	-0.0124	7.39	-0.0094	6.96
$w_{halibut}$	0.0371	3.30	0.0228	2.53
$w_{chinook}$	0.1037	4.32	0.0732	3.56
W_{coho}	0.1242	2.95	0.1163	3.19
$w_{halibut}^2$	-0.0001	2.88	-0.0001	1.33
$w_{chinook}^2$	-0.0006	3.41	-0.0004	2.52
w_{coho}^2	-0.0008	1.13	-0.0011	1.82
$w_{halibut}w_{chinook}$	-0.0005	3.50	-0.0004	3.20
$w_{halibut}w_{coho}$	-0.0007	2.84	-0.0005	2.38
$w_{chinook}w_{coho}$	-0.0018	3.60	-0.0010	2.26
Halibut	1.1033	2.05	0.9241	2.33
Halibut²	-0.1492	2.19	-0.1297	2.52
Per-Capita Household income	0.0945	1.09	0.0021	0.04
Gender (1=male)	0.3853	2.03	0.0963	0.57
Age	0.0080	1.04	0.0003	0.05
Education (1=college graduate)	0.2827	1.39	0.3853	2.49
ρ	0.192	2.77	0.192	2.77

Table 2: Random effects prohibit model parameter estimates

the utility level associated with not taking the trip, which is also the opportunity cost of taking trip *t*. Since the actual levels of utility are unobservable, the model is made operational by specifying a binary indicator y^* that denotes which choice was made, that is, $y_{it}^* = 1$ if respondent *i* would take trip *t* and $y_{it}^* = 0$ otherwise. Assuming that individual *i* makes rational choices, $y_{it}^* = 1$ implies that the expected utility of taking trip *t* is greater than the expected utility of not taking the trip, that is, $E(u_{it} \geq u_{i0})$. Conversely, $y_{it}^* = 0$ implies that $E(u_{it} < u_{i0})$.

A probabilistic choice model can then be formulated by noting that

$$(3) \quad P\left[y^* = 1 \mid x_{it}, z_i\right] = P\left[u_{it} \geq u_{i0}\right]$$

$$= P\left[f(x_{it}, z_i, \beta, \gamma) + e_{it} \geq f(0, z_i, \beta, \gamma) + e_{i0}\right]$$

$$= P\left[f(x_{it}, z_i, \beta, \gamma) - f(0, z_i, \beta, \gamma) + e_{it} - e_{i0} \geq 0\right]$$

$$= P\left[f(x_{it}, z_i, \beta, \gamma) - f(0, z_i, \beta, \gamma) + \varepsilon_{it} \geq 0\right]$$

where $\varepsilon_{it} = e_{it} - e_{i0}$.

To ensure that the participation decisions were grounded in recent experience, coefficient estimation was based on the 352 surveys returned by respondents who took at least one salmon or halibut sportfishing trip in marine waters off the Kenai Peninsula during 1997. Each respondent answered questions regarding three different hypothetical trips, yielding a total of 1,056 observations. Utility was

modeled as a hybrid quadratic function to allow for non-constant marginal utility and substitution/complementarity effects across species, and because it can readily accommodate socioeconomic variables, and finally, because polynomial models are linear in the parameters. Catch and average size were combined to create an instrumental variable representing the weight of the fish measured in pounds (*w*). This allows for a more parsimonious model given the large number of parameters that need to be estimated, allows for the identification of all quadratic terms, and can be modified to add separate variables (species catch or species size) where appropriate. The fish weight variables, the products of halibut, chinook salmon, and coho salmon catches and weights, are denoted $w_{halibut}$, $w_{chinook}$, and w_{coho}, respectively. The variables *Halibut* and *Halibut²* were included to allow for additional variation that was due to catch alone. *P* denotes the cost of a fishing trip. The model to be estimated, including the demographic variables is

$$(4) \quad y_{it}^* = \beta_0 + \sum \beta_s w_{it,s} + \sum_j \sum_s \lambda_s w_{it,s} w_{it,j} + \pi_P P +$$

$$\pi_{HC} Halibut + \pi_{HC^2} Halibut^2 + \sum_l \gamma_l z_{i,l}$$

Where *s* and *j* index species (halibut, chinook, coho), and the Z_l are categorical variables representing *Per-capita Household Income*, *Gender*, *Age*, and *Education*. An additional indicator variable was used to differentiate between Alaskans and nonresidents. Because the same general study design was presented to each group, we only estimate one random effect parameter.

The model was estimated with Limdep 7.0 for Windows (Greene, 1998). The estimated coefficients are reported in Table 2. The random effect parameter, ρ, is statistically different from zero at the 99% level ($p = 0.0057$), supporting the presence of an identifiable random effect. The point estimates of the parameters accord well with economic theory. As expected, the price coefficient is negative, and the coefficients on halibut, chinook salmon, and coho salmon weights and halibut catches are all positive. The weight squared terms and the cross terms are all negative, implying that recreational fishers experience decreasing marginal utility and that catches of each species are substitutes for catches of the others. The log likelihood at convergence is 542.503; the log likelihood was 731.047 when the parameters were set to zero. The McFadden R^2 is 0.249. The Veall and Zimmermann R^2 is 0.442.

SIMULATION MODEL

Every change that affects expected catches or the size of fish caught (changes in trip attributes), will affect the average sport fisher's decision to participate, regardless of whether the attribute change is due to natural population fluctuations, regulatory change, or environmental damage. The simulation model employs the sample enumeration method discussed in BenAkiva and Lerman (1987). The sample enumeration method takes into account differences in socioeconomic characteristics and variability in the number of days fished per year by developing forecasts for each individual in the sample. We use this information to weight the simulations by the number of days fished. The simulation provides separate results for Alaskans and nonresidents.

The general formula for all forecasts is:

$$(5) \quad \% \Delta Participation_\alpha =$$

$$\frac{\sum_i [\Phi(\hat{u}_{i,1})\, days_i] - \sum_i [\Phi(\hat{u}_{i,0})\, days_i]}{\sum_i [\Phi(\hat{u}_{i,0})\, days_i]},$$

where $\hat{u}_{i,j}$ is the forecast of indirect utility for individual i with the fishing attributes j, $j = 0$ denotes the initial or starting point fishing trip attributes and $j = 1$ denotes the new fishing trip attribute levels based on an α percent change from the $j = 0$ levels, %Δ means percentage change, $\Phi(\cdot)$ is the cumulative normal distribution function, and $days_i$ is the number of days individual i fished in marine waters off the Kenai Peninsula in 1997.

COMPENSATING VARIATIONS

The compensating variation formula for individual i on trip j is $\hat{c}_{ij} = -\hat{u}^*_{ij} / \hat{\pi}_p$, where $\hat{c}_{ij}$ is the estimated individual compensating variation, $\hat{u}^*_{ij}$ is the mean of the individual's utility index from a censored standard normal distribution, and $\hat{\pi}_p$ is the estimated price coefficient (see equation (4)). The individual's mean utility level from a censored standard normal distribution ($\hat{u}^*_{ij}$) is used instead of the mean utility level from a normal distribution function ($\hat{u}_{ij}$) as is often done because an individual will only realize non-negative compensating variations. That is, if a fisherman fishes he will realize non-negative compensating variations and if he does not fish he will obtain a level of compensating variation of zero. The censored standard normal distribution is straightforward:

$$(6) \quad E(u_i) = \frac{\phi(c)}{1 - \Phi(c)} P(u_i \geq c).$$ where u_i is the indirect utility associated with individual i, c is the point where u_i is truncated, $\phi(c)$ is the standard normal distribution function and $\Phi(c)$ is the cumulative standard normal distribution function. Since, for our individual fishermen, we want to censor the compensating variations at zero,

$$(7) \quad c_i = 0 - \hat{u}_i = -\hat{u}_i$$

then

$$(8) \quad \hat{u}_i^* = (\hat{u}_i + \frac{\phi(-\hat{u}_i)}{1 - \Phi(-\hat{u}_i)}) * \Phi(\hat{u}_i)$$

where $\hat{u}_i^*$ is the estimated mean of an individual's indirect utility function index from a censored standard normal distribution and $\hat{u}_i$ is the estimated mean of an individual's indirect utility function index from a standard normal distribution. The industry-wide estimated compensating variation is then

$$(9) \quad \hat{C}_j^\bullet = \hat{c}_j^\bullet \bullet D_j,$$

where $\hat{c}_j^\bullet$ is the weighted (by individual's expected days fished) average industry compensating variation for a trip with the attributes j, and D_j is the total number of lower and central Cook Inlet salmon and halibut sportfishing-days taken by all individuals, according to desired grouping, as reported by ADF&G in 1997 and adjusted away from the baseline level $j = 0$ by *% Δ Participation$_\alpha$* for an α change in trip attributes.

Changes in compensating variations will then be calculated as

$$(10) \quad \hat{C}_\Delta^\bullet = \hat{C}_B^\bullet - \hat{C}_S^\bullet,$$

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the simple estimated difference in the industry-wide compensating variation for the baseline trip $\hat{C}_B^{\bullet}$ and the simulated trip $\hat{C}_S^{\bullet}$.

Average estimated daily (and total) compensating variation is reported in Table 3.

Residency Category	Mean CV per Day	Sportfishing Days	Total CV
Local	$81.47	64,481	$5,253,341
Alaskan	$81.47	82,820	$6,747,440
Nonresident	$119.79	112,314	$13,453,682
Total	$98.05	259,615	$25,454,463

Table 3: Estimated compensating variations

% Change in Catch	% Change in Participation	Change in Mean Total CV ($)	Change in Output ($)	Change in Personal Income ($)	Change in Employment (Jobs)
-20%	-18.5%	-$11,301,371	-7,669,649	-3,239,031	-222
-10%	-8.0%	-$5,712,696	-3,276,484	-1,384,345	-94
0%	0.0%	0	0	0	0
+10%	5.9%	$5,439,623	2,341,072	989,801	67
+20%	10.0%	$10,324,185	3,953,222	1,671,875	114

Table 4: Changes in compensating variations (CV) and regional economic impacts in response to changes in catch

The estimated daily average compensating variations are $80 for Alaskans and $118 for nonresidents. Total compensating variations are $25.4 million ($13.4 million for nonresidents and $11.9 million for residents).

IMPACT ANALYSIS

To model the regional impact of the sport fishery on the Kenai Peninsula we selected IMPLAN (Olson and Lindall, 1997), the most commonly used I-O model, as a base for our analysis. IMPLAN includes 21 economic and demographic variables for 528 industrial sectors for all US counties (and boroughs). Although the national level data are regularly updated, the regional data are infrequently updated. Moreover, regions may have unique economic sectors or linkages that are not well represented in IMPLAN. Consequently, in regions such as Alaska, with small numbers of firms (frequent disclosure problems), and a rapidly evolving and heavily resource dependent economy, it is particularly essential that the transaction coefficients be thoroughly updated and carefully groundtruthed with local data and expert knowledge.

Because the recreational fishing sector is not explicitly represented in IMPLAN, we have developed a programming module that disaggregates IMPLAN sectors that include recreation-related activities to identify those activities affected by sportfishing. This module utilizes IMPLAN generated response coefficients and secondary regional economic data as inputs in model formulation. The secondary model data is augmented with data for the target sectors (e.g., sport/charter industry) supplied by primary data collection. Thus this module, through its I-O framework, explicitly accounts for linkages between various economic sectors, according to production and consumption patterns.

Individual sportfishing activities are accommodated differently from direct income generating activities such as guiding, harvesting, and processing. Individual sportfishing activities are accounted for by expenditure patterns in retail and service sectors, rather than treated as an identifiable economic sector. The recreational fishing module allocates recreational expenditures among these sectors. The sportfishing expenditure data were obtained from Lee et al. (1999). The operating cost data required for modeling charter operations were drawn from NPFMC (1997) and updated in the groundtruthing process (for a detailed discussion of the impact modeling see Herrmann 2000).

SIMULATION RESULTS

The estimated change in the probability of the typical sport fisher taking a trip is transformed into a prediction of changes in total sportfishing effort measured in fishing days. These changes in fishing effort simulate the response of recreators to changes in expected catch and are used to predict changes to the net benefits of sportfishing as well as regional economic impacts.

Net benefits to recreational fishers are measured by compensating variations. That is, the value of a sportfishing trip is measured as the amount of money that could be added to the price of the trip until the sport fisher would be indifferent to taking the trip. Consequently, the compensating variation is a measure of the consumer surplus occasioned by sportfishing. Reductions in expected catch reduce the compensating variation in two

ways. First, the marginal sport fisher will drop out of the fishery as the expected benefits (in terms of catch) decrease, thereby decreasing the total net benefits of the fishery. Second, the net benefit of taking a trip is also reduced for all the sport fishers who continue to participate because the trip produces less net benefit when the catch rate declines.

Unlike net benefits, which are a measure of economic efficiency, impact analysis tracks the multiplicative effects of changes in spending patterns as money circulates throughout an economy. Changes in compensating variations only affect regional economic activity when they lead to changes in the total number of sportfishing-days. Moreover, the net impact is limited to recreators who do not substitute other types of expenditures on the Kenai Peninsula in lieu of expenditures that they would have made if they had gone fishing. However, even within the local economy, changes in spending patterns redistribute wealth. These two measures, net benefits (efficiency) and impact analysis (distribution), make up the economic analysis undertaken in this study.

We examined five scenarios: a continuation of the status quo; 10, 20, and 30% decreases in catch; and, 10 and 20% increases in catch. The results, aggregated across residency and fishing mode, for changes in the participation-rate, changes in the compensating variation, and changes in total expenditures (direct, indirect, induced) for output, personal income, and employment are presented in Table 4.

The results indicate that a 10% decrease in expected salmon and halibut landings will cause participation to fall by 8%, resulting in a $5.7 million drop in net benefits to sport fishers. The reduced spending effected by diminished participation results in a total of $3.3 million of decreased sales for the western Kenai Peninsula, taking into account direct, indirect, and induced effects. For all impacts, the higher the baseline catch rate the smaller the marginal change in impact. Since the participation rate model incorporates declining marginal utility and substitution effects, the resulting economic impacts likewise reflect nonlinearities with respect to attribute levels. While the linear assumptions underlying I-O still affect the model's estimation of impacts, the driving variables exert a nonlinear influence.

STUDY LIMITATIONS AND NEED FOR FUTURE RESEARCH

In any large-scale economic study, analysts face a tradeoff between economic realism and cost. Though the literature affords plenty of theoretical work on recreational fisheries, this study explores relatively new territory in applied analysis. While analytically complex,

this study is limited by a number of assumptions and data limitations.

An assumption inherent in the participation rate model's estimates of probability for taking trips is that supply is perfectly elastic. While this assumption is appropriate for shore and private trips, it is probably incorrect for charter trips. It would be reasonable to assume that price adjustment occurs in the charter fishery, especially in the short-run. For example, charter operators might respond to a short-run change in expected catch by lowering their prices and keeping their customer base rather than holding prices constant and losing customers as assumed by our model. While our assumption is acceptable in the long run, it may be unrealistic in the short run. If there is an upward sloping supply curve for charters then there would be implications for producer surplus changes associated with participation changes. These considerations were outside the scope of this study and therefore losses to consumers in terms of net benefits may underestimate total losses. Future work should include an estimation of the producer surpluses.

Additionally, if price were lowered to maintain the current level of participation, there would be little regional impact besides decreased purchases of processing and packing services and inputs for charter operation. Therefore, for the charter industry, our results more closely reflect long-run rather than short-run results especially with respect to income distribution.

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