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Participation Decisions, Angler Welfare, and the Regional Economic Impact of Sportfishing

KEITH R. CRIDDLE
Utah State University

MARK HERRMANN
University of Alaska

S. TODD LEE
National Marine Fisheries Service

CHARLES HAMEL
University of Alaska

Abstract *We link a stochastic binary choice model of individual decisions to participate in the marine sport fisheries in Cook Inlet, Alaska, with a simulation-based sample enumeration procedure for aggregating estimates of individual angler welfare and a regionally adjusted zip code-level input-output model of regional economic activity. The result is a behaviorally based model for predicting changes in angler welfare and regional economic activity occasioned by changes in the demand for sportfishing that arise from changes in trip costs or the expected number, size, or mix of species caught. The advantages of this approach are that: changes in angler participation are determined by variables that are observable, predictable, or subject to management control; participation reflects declining marginal utility, and substitution and complementary effects across trip attributes; estimates of changes in aggregate angler welfare and changes in regional economic impacts are derived from changes in individual participation probabilities.*

Key words Recreational demand, angler welfare, regional economic impacts.

JEL Classification Codes Q22, Q26, R12, C25, C67.

Introduction

The marine sport fisheries of Lower and Central Cook Inlet, Alaska, support a large, recreation-based economic sector that provides non-pecuniary benefits to participants and income and net revenues to residents and businesses of the Kenai

Keith R. Criddle is a professor in the Department of Economics at Utah State University, Logan, UT 84322-3530, email: kcriddle@econ.usu.edu. Mark Herrmann is a professor in the Department of Economics at the University of Alaska Fairbanks, Fairbanks, AK 99775-6080, email: ffmlh@uaf.edu. S. Todd Lee is an industry economist at NOAA Fisheries, Northwest Fisheries Sciences Center, National Marine Fisheries Service, 2725 Montlake Blvd., E. Seattle, WA 98112-2097, email: Todd.Lee@noaa.gov. Charles Hamel is a research associate in the Department of Economics at the University of Alaska Fairbanks, Fairbanks, AK 99775-6080, email: ffcdh1@uaf.edu.

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Peninsula region. Although the primary focus of this analysis is the fishery for Pacific halibut (*Hippoglossus stenolepis*), the region's most important saltwater sports fishery, the marine sport fisheries for chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon are treated as potential substitutes and complements. These fisheries are subject to intrinsic and fishery-induced variations in abundance and are managed under overlapping and evolving combinations of state and federal regulations and international agreements that affect the magnitude and allocation of sustainable harvests across commercial, subsistence, and recreational fisheries.

Pacific halibut are managed under the aegis of the Halibut Convention of 1923, an international treaty between the US and Canada. Under this agreement, the International Pacific Halibut Commission (IPHC) is responsible for establishing area-specific limits on the total direct and incidental harvest of Pacific halibut. The constant exploitation yield (CEY) management strategy used by the IPHC can be motivated as a strategy that maximizes the expected sustainable yield of halibut. Authority to apportion the CEY among competing commercial, sport, and subsistence interests is delegated to the individual nations. Allocations of the halibut CEY off Alaska are set by the US Secretary of Commerce based on recommendations of the North Pacific Fishery Management Council (Council).

Several current and potential policy issues highlight the importance of modeling changes in aggregate angler welfare and changes in regional economic impacts associated with recreational fisheries. For example, the *SS Glacier Bay* and *SS Exxon Valdez* oil spills occasioned a need for assessment of damages to commercial and recreational fisheries (Northern Economics 1990; Cohen 1993). Similarly, leasing of outer continental shelf minerals exploration and development rights requires an economic impact analysis that describes the likelihood that an oil spill could occur and how a spill would affect commercial and recreational catches, welfare, and regional economic activity (Herrmann, Lee, Hamel, and Criddle 2001). Another example is the allocation of catches between user groups. Historically, the Council has specified a commercial total allowable catch (TAC) for Pacific halibut as the regionally apportioned CEY less a bycatch allowance and expected non-commercial (sport and subsistence) catches. As the share of halibut caught by sport fishers has increased, commercial fishers have lobbied the Council to take actions to limit erosion of the commercial TAC. Growth of halibut sportfishing catches has been particularly pronounced in the Central Gulf of Alaska Region (Prince William Sound, Resurrection Bay, Kodiak, Yakutat, and especially Cook Inlet and adjacent portions of the Gulf of Alaska), where landings have increased from less than 2% of the CEY in the late 1970s to over 18% of the CEY before the end of the 1990s. During the same period, the number of Alaska resident sportfishing licenses sold increased 41% (from about 122,000 to 172,000 per year) and nonresident license sales increased 480% (from about 56,000 to 269,000 per year). In response to the increasingly acrimonious allocation conflicts between commercial and sport interests, the Council recently approved a guideline harvest level (GHL)—a flexible cap for charterboat-based sportfishing catches of halibut. The initial GHL was set equal to the 1995–99 average catch with provisions for adjustments in response to changes in halibut biomass (NPFMC 2000). Under the GHL, expected subsistence harvests and expected harvests by sport fishers who do not hire charterboat services continue to be deducted from the CEY and thus from the commercial TAC. If approved by the Secretary of Commerce, the GHL will be implemented in 2003. The GHL is regarded as a stopgap measure because there is little confidence that traditional sport fishery management measures can hold catches to no more than the GHL. To address these concerns, the Council approved the establishment of an individual fishing quota (IFQ) program for charter-based sportfishing catches of halibut (NPFMC 2001). Under the IFQ program, voluntary market transactions will allocate halibut within the charterboat sector and between commercial and charter operations. Subject to approval by the Secretary of Commerce, the charter IFQ program will replace the GHL. Cost-benefit analyses of these policy alternatives require an understanding of how the alternatives would affect angler participation rates, angler welfare, and regional economic activity.

There are two components to a comprehensive evaluation of the economics of marine sportfishing: estimation of the net benefits that accrue to sport fishers and assessment of the economic impact generated by marine sportfishing. We use a binary choice model of individual participation decisions to derive estimates of angler welfare and a regionally adjusted input-output model to estimate regional economic impacts.

The two most widely applied models for binary choice panel data are the fixed effects model (Chamberlain 1982) and the random effects model (Butler and Moffitt 1982). The fixed effects model accounts for heterogeneity by allowing individual-specific parametric shifts in the response function; thus it is appropriate for forecasting responses for those particular individuals. In contrast, the random effects model assumes that each individual's responses are correlated. Consequently, the random effects framework is more appropriate when the data are a random sample of individuals from a larger population of interest (Maddala 1987; Greene 1997). Moreover, the random effects model allows inclusion of variables that do not vary across trips (*e.g.*, socioeconomic variables), while the fixed effect model does not. A Monte Carlo experiment by Guilkey and Murphy (1993) has shown that use of the standard binomial probit model in cases where there is a random effect can bias the estimates of the parameters' standard errors. We use a random effects probit model of individual participation decisions and a Monte Carlo-based aggregation procedure to estimate changes in angler welfare conditioned on changes in sportfishing trip attributes. Many marine sport fishers contract with private charter operators for guide services. However, because the number of charter service providers is large and the barriers to entry are small, we assume that the charter sector can be characterized as perfectly competitive; thus charter operators earn normal profits. The economic impact of expenditures by anglers and charter operators is represented in a regional input-output model of the Kenai Peninsula region. We use a simulation model that links the participation rate, angler welfare, and regional economic impact models to estimate the changes in regional economic activity occasioned by environmental or regulatory changes.

Development of our model and presentation of the results is organized in three sections. We begin with a description of the data used to estimate model coefficients. In the second section, we describe the model framework and baseline parameter estimates. The third section integrates the participation-rate, angler welfare, and regional impact models in a set of simulations for various halibut catch levels and trip costs.

Description of Data

Three data sources were used to support our analyses: voluntary responses to two postal surveys and onsite interviews with Kenai Peninsula region local government officials and business community members.

UAF Angler Survey

The University of Alaska Fairbanks (UAF) angler survey (Lee *et al*. 1998; Herrmann, Lee, Criddle, and Hamel 2001) was developed and administered following Dillman's Total Design Method (Dillman 1978). An initial draft of the survey was administered to a small sample of anglers intercepted in the cities of Homer and

Seward, Alaska. Respondent comments were used to guide the development of a revised draft survey which was pre-tested using verbal protocol analysis (Ericsson and Simon 1993)—one-on-one interviews of randomly selected potential survey recipients from Fairbanks and Anchorage. These interviews provided an opportunity to study angler attitudes and vocabulary, their decision-making processes, and their ability to answer the survey questions. Information from all pre-testing stages was used to improve the content and clarity of the survey instrument, questions, format, cover design, and cover letters. The survey was mailed to 4,000 anglers randomly drawn from a list of individuals who purchased an Alaskan sportfishing license in 1997. The initial survey mailing was followed by a reminder card. Non-respondents were sent a second copy of the survey 14 days after the initial survey mailing. The first two survey mailings and the reminder card were sent by first class mail. A third survey was sent by certified mail to those who did not respond within 14 days after the second survey mailing. All survey mailings included a cover letter motivating the survey and a prize entry card to increase the response rate. Survey recipients were informed that by returning the prize entry card, they would be entered into a drawing for their choice of either a one-day halibut sportfishing trip aboard a charter vessel based in Homer, Alaska, or $150. The cover letter noted that three prizes would be awarded based on a random drawing from the entry cards returned.[1] The overall response rate was 70.1% on the 3,767 delivered surveys. Of the 2,641 respondents, 352 took at least one salmon or halibut sportfishing trip in marine waters off the Kenai Peninsula during 1997.

Responses to the UAF angler survey provided baseline demographic information (household after tax income, household size, and respondent gender, age, and education level), information about expenditures incurred and attributes of recent sportfishing trips taken in Lower or Central Cook Inlet, and angler preferences regarding hypothetical trips. Information on expenditures included transportation (*e.g.*, vehicle rental fees, vehicle fuel expenditures, and airfare), food and lodging (*e.g.* grocery purchases, restaurant and bar expenses, hotel/motel room rentals, vacation rentals, campground fees, other lodging), and fishing expenditures (*e.g.*, guide and charter fees and tips, fishing gear purchased specifically for the trip, fish processing and packaging fees, fishing derby entry fees, boat fuel and lubricants, and moorage and haulout fees). Survey responses were used to develop the individual-level participation rate model and to parameterize a regional economic model.

Nonresidents spent an average of $294.21 per charter-based sportfishing day: $103.87 in transportation and living expenses and $190.34 in fishing expenses. Nonresident fishing expenditures were dominated by charter fees ($140.75) and fish handling/processing charges ($32.72). Alaska residents from outside the Kenai Peninsula Borough spent an average of $204.91 per charter-based sportfishing day. Locals (Kenai Peninsula Borough residents) averaged $167.47 in fishing expenditures per day of charter-based fishing. The average cost-per-day for charter-based sportfishing trips was 64% higher than the average for trips taken on private vessels. Overall angling effort was distributed: 40% charter; 46% private vessel; and 14% from shore. While charter-based effort accounted for only 25% of the angling effort by Alaskans, it accounted for 59% of the angling effort by nonresidents. When aggregated across charter vessel, private vessel, and shore-based fishing modes, the average saltwater fishing trip yielded catches of 1.71 halibut for Alaskans and 2.43 halibut for nonresidents. Anglers who participated in dedicated halibut charters averaged catches of 3.51 fish per angler-day. Most survey respondents who took a saltwater sport fishing trip to the Cook Inlet region during 1997 took only one trip.

[1] All three prize winners selected the cash award.

ADF&F Angler Survey

The annual Alaska Department of Fish and Game (ADF&G) angler survey was sent to 22,000 individuals in 1997 and yielded a response rate of 45.8% on delivered surveys after three mailings (Howe *et al.* 1998). Sportfishing effort in Lower and Central Cook Inlet during 1997 was estimated to total 197,556 angler-days. Participation by nonresidents accounted for 44% of total days fished (86,970 angler-days). In the more expensive charter fishery, nonresidents comprised 65% of the total charter effort, while comprising just 28% and 37% of the private vessel and shoreline fishing days, respectively. A Monte Carlo simulation procedure was used to combine the participation rate model and effort estimates from the ADF&G survey to form estimates of total angler participation and net benefits.

Onsite Interviews

Responses to the UAF angler survey were combined with State and Borough employment and earnings data and information gathered through onsite interviews with local government officials and business leaders. It was then used to update and groundtruth the technical coefficients of a regional input-output model of the Kenai Peninsula economy and to disaggregate the sportfishing sector (Herrmann, Lee, Hamel, and Criddle 2001; Herrmann, Lee, Criddle, and Hamel 2001).

Because marine sportfishing was not the sole or primary motivation for trips taken by some survey respondents, it would have been inappropriate to attribute all of the trip expenses to the existence of marine sportfishing opportunities.[2] Expenditure estimates were, therefore, adjusted downwards using data on trip purpose from the survey (see Herrmann, Lee, Criddle, and Hamel 2001). The total spending directly attributable to the fishing component of trips taken in 1997 (*i.e.*, money that would not have been spent if the fishing component were cancelled) was estimated at $34.1 million, $28.5 million of which was spent on the Kenai. Because we assumed that local residents would substitute spending on other regional recreational activities (*e.g.*, freshwater sportfishing or marine sportfishing in Prince William Sound) for foregone marine sportfishing expenditures, their expenditures ($3.5 million) were also deducted. The $25.0 million remainder reflects an estimate of the infusion of spending on the Kenai Peninsula that would not have occurred in the absence of marine sportfishing opportunities in Lower and Central Cook Inlet (table 1). The adjusted 1997 expenditure data were used as a baseline in the regional economic model.

Model Framework and Baseline Estimates

Individual Participation Decisions

Changes in trip costs, expected catch rates, fishery regulations, and environmental quality affect the expected net benefit associated with sportfishing, and therefore the decision to participate in (take) a sportfishing trip. Previous studies (*e.g.*, Holland and Ditton 1992, Aas 1995, Thunberg *et al.* 1999) have used variation in demo-

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[2] While the unadjusted values may be a better predictor of the level of expenditures attributable to the mix of participants in the fishery in a typical year, only expenditures by those whose trip destination decision was influenced by the existence of marine fishing opportunities can be viewed as being contingent on the existence and attributes of the marine sport fisheries.

Table 1
Kenai Peninsula Area Expenditures by Alaskans (Non-local) and Nonresidents that can be Directly Attributed to Lower and Central Cook Inlet Halibut or Salmon Sportfishing Trips

	Expenditures ($ million)	
	Fishing Expenditures	Other Expenditures
Auto fuel		2.208
Auto/RV rentals		0
Lodge		3.061
Groceries		2.443
Restaurant & bar		1.997
Charter	9.518	
Gear	1.659	
Processing	2.202	
Derby	0.171	
Boat fuel	1.279	
Haul/moorage	0.433	
Total	15.263	9.710

graphic characteristics to explain changes in the demand for recreational fishing. While such models may provide useful descriptions of past participation decisions, they are not useful for predicting future participation rates because the resulting forecasts are conditional on uncertain conjectures about demographic change. That is, such models shift the focus from forecasting changes in participation to predicting demographic change and are not suitable 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 predictable or subject to management control. For example, total catch levels are a management choice subject to population dynamics that are well characterized for halibut and conditionally predictable for salmon. In addition to being constrained by overall catch limits, catch levels are subject to management actions related to season length, bag, possession, and catch-and-release regulations. Similarly, charter trip costs are subject to management influence through the erection of barriers to entry (license limitation) and the direct effect of permit and license prices. Consequently, our model is better suited for policy evaluation and forecasting participation rate responses to changes in trip costs and catch rates.

In the UAF survey, respondents 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 one of three cost levels ($100, $170, or $240 per day), one of four halibut keep and release levels (0, 2, 4, or 6 fish per trip), one of four average halibut weights (0, 20, 40, or 80 lbs. per fish), one of three chinook catch levels (0, 1, or 2 fish per trip), one of four average chinook weights (0, 15, 25, or 50 lbs. per fish), one of four coho catch levels (0, 2, 4, or 6 fish per trip), and one of two average coho weights (0 or 7 lbs. per fish). Attributes of the hypothetical trips were derived from historical mean catch and average weight data and pretest discussions with recreational fishers. 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. For consistency, average catch (weight) was set to zero whenever average weight (catch) was zero. In order to estimate an indirect utility function that includes the main effects and all relevant two-way interactions, 27 trips were selected and assigned to nine distinct three-trip blocks. The 27 trips and their nine blocks were simultaneously selected based on a criterion that maximized the determinant of the information matrix. The resulting parsimonious experimental design allows for the efficient identification of substitution and complementary effects across attributes, and for the possibility of nonlinear marginal utility. While these types of effects are predicted in economic theory, they are seldom identified in empirical studies of actual trips because attributes are often highly collinear or lack sufficient variation. Each of the 4,000 survey recipients was randomly assigned one of the nine blocks of three hypothetical trips.

The participation decision was modeled as a nonlinear random utility function. The utility that individual i derives from trip t is given by:

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

where the vector, x_{it}, describes the attributes of the t-th trip taken by the i-th individual; socioeconomic and demographic variables for each 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; and the errors, e_{it}, are normally distributed with an expected value of zero.

Respondents were asked whether they would take a trip, described by attributes x_{it}. Those who would take the trip obtain a utility level of u_{it}. Those who would not take the trip receive:

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

the utility level associated with not taking the trip, which is also the opportunity cost of taking the trip. 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 the respondent would take trip and $y^*_{it} = 0$ otherwise. Assuming that individuals make rational choices, $y^*_{it} = 1$ implies that the expected utility of taking the trip 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 $E(u_{it} < u_{i0})$.

We specified the random utility model as:

$$y^*_{it} = \alpha_0 + \alpha_1 P_t + w_t^T B w_t + n_t^T \Lambda n_t + z_t^T \Gamma \qquad (1)$$

$$= \alpha_0 + \alpha_1 P_t + \begin{bmatrix} w_t^h \\ w_t^{ch} \\ w_t^{co} \\ \hline 0 \end{bmatrix}^T \left[\begin{array}{c|ccc} \beta_{11} & \beta_{12} & 0 & 0 \\ \beta_{21} & \beta_{22} & \beta_{23} & 0 \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} \\ \hline 0 & 0 & 0 & 0 \end{array}\right] \begin{bmatrix} 1 \\ \hline w_t^h \\ w_t^{ch} \\ w_t^{co} \end{bmatrix}$$

$$+ \begin{bmatrix} n_t^h \\ 0 \\ 0 \\ \hline 0 \end{bmatrix}^T \left[\begin{array}{c|ccc} \lambda_{11} & \lambda_{12} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 \end{array}\right] \begin{bmatrix} 1 \\ \hline n_t^h \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} sex_i \\ age_i \\ edu_i \end{bmatrix}^T \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \end{bmatrix}$$

where the binary variable y_{it}^{*} was assigned a value of 1 when survey respondent i indicated a willingness to take trip t, and 0 otherwise. The variables P_t, n_t^s, and w_t^s are hypothetical attributes that denote the cost-per-day of taking trip t and the number and total weight (a product of the number of fish caught and average weight per fish) of species s caught on trip t, where halibut, chinook, and coho are denoted by the superscripts h, ch, and co, respectively. The variables sex_i, age_i, and edu_i are the gender, age, and education level reported by individual i. The superscript T is used to denote matrix transposition.

The data and coefficient matrices are partitioned to emphasize components responsible for linear and quadratic factors and to highlight the exclusion restrictions. Because the plausible catches for chinook were 0, 1, or 2 fish, the data lacked sufficient variation to estimate the linear, quadratic, and interaction terms that we considered to be important. The weight variable was not subject to this limitation because the hypothetical trips included total catch weights of 0, 15, 25, 30, 50, and 100 lbs. of chinook, enough variability to support the estimation of all of the linear and nonlinear direct and interaction terms of interest. Although we had ample variation in coho catches (0, 2, 4, 6), the invariance in coho weight (7 lbs. per fish for all hypothetical trips where coho were caught) would have caused the information matrix to be singular if we had included data representing both the weight and number of coho caught. We chose to exclude coho numbers in order to be able to estimate an interaction between coho and chinook, an interaction that focus groups suggested could be important. That is, because we lacked sufficient variation to specify a full set of interactions in B and Λ, we chose a full specification for B and a restricted specification for Λ.

The coefficient matrices α, B, Λ, and Γ, and a random effects parameter, ρ, were estimated simultaneously for resident and nonresident respondents using a random effects probit procedure. 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.

Coefficient estimates are reported in table 2. The random effect parameter, ρ, is statistically different from zero at the 99% level, confirming the presence of a random effect. The point estimates of the parameters accord well with economic theory: the price coefficient is negative; the coefficients on total halibut, chinook salmon, and coho salmon weights and halibut catches are positive; coefficients on the quadratic terms and cross products are negative, implying that recreational fishers experience decreasing marginal utility and that catches of each species are substitutes for catches of the others; and the probability of taking a trip increases as a function of income, age, and education, and is higher for males. With exception of the coefficient on squared halibut weight in the nonresident equation and the coefficient on squared coho weight in the Alaskan resident equation, all coefficients on price and linear, nonlinear, and cross-product terms for catch weight and numbers were significantly different from zero at the 5% level (table 2). Resident gender and nonresident education level were the only socioeconomic variables found to be statistically significant. Overall model performance was good: the log likelihood at convergence was –542.503 and –731.047 when the parameters were set to zero, and R^2 was 0.442.[3]

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[3] The log-likelihood at convergence is the value of the log-likelihood function evaluated at the parameter values we report. These are the parameter values that maximize the log-likelihood function and were found by using a numerical optimization algorithm. Our estimate of R^2 follows Veall and Zimmermann (1996):

$$R^2 = \frac{(LL_m - LL_0)}{(LL_m - LL_0 + N)} \Big/ \frac{-2\ LL_0}{(N - 2\ LL_0)},$$

where LL_m is the value of the log-likelihood function from the model, LL_0 is the value of the log-likelihood function with all of the slope coefficients set at zero, and N is the total number of observations.

Table 2
Random Effects Probit Model Parameter Estimates

	Alaskans (local and non-local)		Nonresidents	
	Estimates	t-ratios	Estimates	t-ratios
Intercept	–2.7965	–3.01	–1.4818	–1.94
Price	–0.0124	–7.59*	–0.0094	–6.98*
Total weight of halibut	0.0373	3.28*	0.0229	2.54*
Total weight of chinook	0.1038	4.35*	0.0734	3.62*
Total weight of coho	0.1263	3.02*	0.1165	3.20*
Squared halibut weight	–0.0001	–2.91*	–0.0001	–1.34
Squared chinook weight	–0.0006	–3.44*	–0.0004	–2.59*
Squared coho weight	–0.0008	–1.18	–0.0011	–1.82*
Product of total weight of halibut and coho caught	–0.0005	–3.55*	–0.0004	–3.22*
Product of total weight of halibut and chinook caught	–0.0007	–2.92*	–0.0005	–2.41*
Product of total weight of chinook and coho caught	–0.0018	–3.62*	–0.0010	–2.30*
Number of halibut caught	1.1228	2.11*	0.9263	2.36*
Squared number of halibut caught	–0.1513	–2.25*	–0.1300	–2.56*
Gender (1=male)	0.4048	2.17*	0.0970	0.59
Age	0.0103	1.44	0.0003	0.05
Education (1=college graduate)	0.3394	1.79	0.3839	2.50*
ρ	0.1942	2.82*	0.1942	2.82*

* Significantly greater (less) than zero at $p \leq 0.05$ for one-sided tests on all variables except the socioeconomic variables where two-sided tests were performed.

Although changes in resource abundance that arise from stock dynamics or changes in environmental conditions are not explicitly represented in the participation model, such changes affect the average weight and number of fish caught in the sport fishery, trip attributes that are explicitly represented in our model. This linkage is implicit in ADF&G's escapement-based management strategy for salmon and is explicit in the CEY management strategy for halibut. Although the management agencies (ADF&G for salmon and NPFMC for halibut) are not required to distribute changes in the salmon guideline harvest level or halibut CEY proportionally among commercial, sport, and other fisheries, the history of management actions in the salmon fishery is consistent with this assumption. In addition, subject to approval of the Secretary of Commerce, recent Council action (NPFMC 2001) explicitly specifies a proportionality principle for accommodation of changes in the halibut CEY.

Total Demand and Angler Welfare

The conditional individual participation probabilities were aggregated into estimates of total demand using a simulation-based sample enumeration method that takes into account differences in demographic characteristics and variability in the number of days fished per year. The sample enumeration method, described in BenAkiva and Lerman (1985), 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 Alaskan residents and nonresidents. The general formula for all forecasts is:

$$\%\Delta\mathbf{Y} = \frac{\sum_{i=1}^{n} \Phi(\hat{u}_{i,1})\, days_i - \sum_{i=1}^{n} \Phi(\hat{u}_{i,0})\, days_i}{\sum_{i=1}^{n} \Phi(\hat{u}_{i,0})\, days_i}, \tag{2}$$

where %ΔY is the percentage change in total participation occasioned by a change in trip attributes. The indirect utility that individual i derives from a trip with baseline attributes is denoted $\hat{u}_{i,0}$. In contrast, $\hat{u}_{i,1}$ denotes the indirect utility obtained from a fishing trip with attribute levels that reflect an α percent change from the baseline levels. The number of days fished by individual i in marine waters off the Kenai Peninsula during 1997 is represented by $days_i$. The notation $\Phi(\cdot)$ represents the cumulative normal distribution function. Because point estimates of percentage changes in the number of angler-days are highly nonlinear, confidence intervals were based on 10,000 draws of a Monte Carlo procedure described in Krinsky and Robb (1986).

Following Hanemann (1999), conditional estimates of angler welfare were calculated from the estimated participation rate model as the product of the weighted average compensating variation[4] per trip taken and the total number of angler-days spent fishing for salmon and halibut in Lower or Central Cook Inlet. The expected maximum utility that individual i derives from trip j can be represented by $M_{i,j} = E[\max(u_{i,1}, u_{i,0})]$, where $u_{i,1} = v_{i,1} + e_{i,1}$ denotes the utility received from taking a fishing trip and $u_{i,0} = v_{i,0} + e_{i,0}$ denotes the utility received from not taking a fishing trip. The economic welfare associated with the choice is $cv_{i,j} = -M_{i,j}/\pi_p$, where $cv_{i,j}$ is the compensating variation that individual i derives from trip j with corresponding attributes, and π_p is the marginal utility of income and is equal to the coefficient estimate on the price (cost of trip) variable. Since the marginal utility of income is held constant in our model, this welfare measure is also the equivalent variation welfare measure.

The value of $M_{i,j}$ can be calculated from the probability density function:

$$M_{i,j} = \int_{-\infty}^{+\infty}\int_{-\infty}^{v_0+e_0-v_1} (v_{i,0} + e_{i,0})\varphi(e_{i,0}, e_{i,1})\partial e_{i,1}\partial e_{i,0} + \int_{-\infty}^{+\infty}\int_{-\infty}^{v_1+e_1-v_0} (v_{i,1} + e_{i,1})\varphi(e_{i,0}, e_{i,1})\partial e_{i,0}\partial e_{i,1},$$

where $\varphi(\cdot)$ is the bivariate normal probability density function. If the utility of not taking a trip is normalized such that $u_{i,0} = 0$, then a trip will only be taken when $v_{i,1} + e_{i,1} \geq 0$, and M simplifies to:

$$M = \int_{-v_1}^{+\infty} (v_{i,1} + e_{i,1})\varphi(e_{i,1})\partial e_{i,1} = v_{i,1}\Phi(v_{i,1}) + \varphi(v_{i,1}).$$

[4] Compensating variation is a measure of net benefit to consumers. It can be motivated as an additional cost that, if added to the cost of a particular sportfishing trip, would leave the sport fisher indifferent between taking and not taking the trip.

The estimated weighted average compensating variation across all individuals for trip *j* with corresponding attributes is:

$$\hat{cv}_j = \frac{\sum_{i=1}^{n}\left[\hat{cv}_{ij}\ days_{ij}\Phi(\hat{u}_{ij})\right]}{\sum_{i=1}^{n}\left[days_{ij}\Phi(\hat{u}_{ij})\right]}, \qquad (3)$$

where $days_{ij}$ is the number of angler days fished by angler *i* during 1997 in the Lower and Central Cook Inlet salmon and halibut sport fisheries (Howe *et al.* 1998).

The estimated total compensating variation for trip *j* with corresponding attributes is:

$$CV_j = \hat{cv}_j\ Days_j\left(1 + \%\Delta Y\right), \qquad (4)$$

where $Days_j$ is the total number of angler-days fished for salmon and halibut in Lower or Central Cook Inlet by all individuals, and %ΔY is the change in participation relative to the baseline 1997 season.

Changes in compensating variations will then be calculated as:

$$\Delta CV = CV_j - CV_k, \qquad (5)$$

where CV_j is the compensating variation associated with trips with attributes *j*, and CV_k is the compensating variation associated with trips with attributes *k*.

The estimated average daily compensating variation for fishing trips in 1997 was $82.51 for Alaskans and $118.88 for nonresidents (table 3). The corresponding estimate of total compensating variation was $19.46 million ($10.34 million for nonresidents and $9.12 million for residents). Every change that affects sportfishing trip attributes affects the average sport fisher's decision to participate, regardless of whether the attribute change is due to changes in the cost of a sportfishing trip, natural population fluctuations, regulatory change, or environmental damage. Changes in the probability of individual participation lead to shifts in the total demand for sportfishing trips and changes in angler welfare.

Table 3
Estimated Compensating Variation

		CV per Day ($)			Total CV ($ million)
Residency Category	Angler Days	Mean	90% Lower Bound	90% Upper Bound	Mean
Local	48,877	82.51	47.44	123.89	4.032
Alaskan	61,709	82.51	47.44	123.89	5.091
Nonresident	86,970	118.88	85.20	155.95	10.339
Total	197,556				19.463

Regional Impact Analysis

Marine sportfishing can take place from shore, private or rented boats, or charter boats. The expenditures associated with each of these choices contribute to regional economic activity; thus changes in participation that arise from changes in trip attributes affect regional economic activity. Impact analysis focuses on the direct, indirect, and induced effects that changes in expenditures have on output (production), income, and employment. Direct effects are changes associated with immediate changes in final demand. Indirect effects are changes associated with changes in the demand for inputs to the production process. Induced effects result from changes in household spending patterns that arise from changes in household income as a consequence of the direct and indirect effects.

The Magnuson-Stevens Fisheries Conservation and Management Act (US Department of Commerce 1996) places importance on both efficiency and equity issues when managing the nation's fisheries. While economic efficiency (*i.e.*, consumer surplus for anglers and producer surplus for charter operators) is a standard objective identified by economists, recent litigation involving fisheries has stressed distributional issues in addition to efficiency considerations (*e.g.*, Northern Economics 1990; Marine Advisory Program 1992; Cohen 1993). Economic impact analysis provides a snapshot of the economic interdependencies of various industries in a regional economy, and therefore allows analysts to model the downstream effects of demand changes for commodities or services. Because opportunity costs and willingness to pay do not enter into the impact assessment framework, the results of an economic impact analysis should not be confused with statements of value. It should be noted, however, that the results that yield the greatest value under a net benefit analysis could imply very disproportional allocations among stakeholders. Although notions of fairness and equity do not enter into the standard net benefits framework, economic impact analyses are useful tools for tracking and identifying impacts of alternative policies on revenue, income, and employment. For a more detailed discussion on the differences and appropriate uses of cost-benefit and economic impact analyses in fisheries, see for example, Edwards (1994) or Steinback (1999).

Development of the regional economic model is detailed in Herrmann, Lee, Hamel, and Criddle (2001) and Hamel *et al.* (2002); a brief summary is included here for convenience of the reader. We used IMPLAN (Olson and Lindall 1997) as the foundation of a zip-code level economic model of the Kenai Peninsula. Although the technical coefficients used by IMPLAN are regularly updated, regions such as Alaska, where the small numbers of firms creates disclosure problems, and where the economy is rapidly evolving, are not well characterized by the technical coefficients included in the IMPLAN database. To address this problem, we used State and Borough employment and earnings data, information reported in NPFMC (2000), and information gathered during two weeks of onsite interviews with local government officials and business leaders in Kenai Peninsula Borough communities. Individuals interviewed and specific changes to the IMPLAN technical coefficients are identified in Herrmann, Lee, Hamel, and Criddle (2001).

Although IMPLAN represents 528 economic sectors, sectors that are regionally important but small relative to other sectors in the national economy are often subsumed in general categories. For example, IMPLAN's amusement and recreation sector includes sportfishing and 105 other types of recreation. In order to highlight the regional economic impacts of changes in sportfishing participation levels, it was necessary to disaggregate marine sportfishing from the amusement and recreation sector. We followed a disaggregation procedure for the sportfishing sector suggested in Steinback (1999), which involved constructing additional sectors within the

IMPLAN framework and reprogramming the corresponding social accounting matrices to reflect the characteristics of the disaggregated subsector. This choice was driven by our interest in examining changes in final demand that might arise from incremental changes in predictable or controllable trip attributes. If we had wanted to measure the effects of a complete shutdown of the charter fishery to simulate, for example the result of a catastrophic oil spill, the supply side approach used in Leung and Pooley (2001) might have been more appropriate. However, because forward linkages from the charter sector to other industry sectors on the Kenai Peninsula are negligible (the guided sport fishery is fueled almost exclusively by angler demand), and given an absence of intra-sectoral sales, multipliers derived from a hypothetical extraction method would not have likely affected impacts of a significantly greater scale than those from a traditional demand shock. For a detailed accounting of the individual expense categories, corresponding Standard Industrial Classification codes and translation to the IMPLAN sectoral scheme, the reader is referred to Herrmann, Lee, Hamel, and Criddle (2001).

Individual sportfishing activities are accommodated differently from direct income-generating activities, such as guiding. We account for individual sportfishing activities by identifying their expenditure patterns in retail and service sectors; that is, by treating visiting anglers as “cost centers” for various goods and services rather than as an identifiable economic sector (Jensen Consulting 1997). We allocate recreational expenditures among these sectors, using angler expenditure data gleaned from the UAF angler survey (Herrmann, Lee, Criddle, and Hamel 2001). Finally, impact scenarios were run in IMPLAN to generate corresponding response coefficients for each of the retail service sectors frequented by anglers. These response coefficients and those developed for the charter sector were linked in a stand-alone recreational module (Hamel *et al.* 2001).

Simulation Results and Analysis

The simulation model integrates the participation-rate, angler welfare, and regional economic impact models and can be used to explore the effects of changes in trip costs and expected catches on angler-days fished, angler welfare, and regional economic activity.[5] The model was developed, in part, to meet the needs of environmental and regulatory impact analyses related to outer continental shelf minerals exploration, development, and production activities in the Cook Inlet Planning Area (Herrmann, Lee, Hamel, and Criddle 2001). However, preliminary model results have also been used in regulatory analyses related to recent management actions designed to constrain the expansion of charter-based sportfishing for halibut (NPFMC 2000) and analyses related to the adoption of individual fishing quotas for charter-based halibut catches (NPFMC 2001).

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[5] Due to space constraints, it is not possible to report all the details that went into the modeling and simulation analysis. Because of this, we offer the reader the following products that can be obtained by contacting the authors.

- The simulation program <$FISH.XLS> can be downloaded as a compressed file, extracted, and run in Microsoft Excel.
- The manual to <$FISH.XLS> (Hamel *et al.* 2001) is available as an Adobe Acrobat (pdf) file.
- The final project report to Minerals Management Service-University of Alaska Coastal Marine Institute (Herrmann, Lee, Hamel, and Criddle 2001) is available as an Adobe Acrobat (pdf) file. This file also includes the software manual to run $FISH.XLS.
- The survey data and methods are more fully explained in a final report to Alaska Sea Grant, Lee *et al.* (1998), available as an Adobe Acrobat (pdf) file.

Changes in the probability that the average sport fisher will take a trip are calculated using the parameters estimated from the probit model and aggregated into predictions of changes in total sportfishing effort. They are then used to predict changes in angler welfare and regional economic impacts. Figure 1 depicts changes in the magnitude of sportfishing effort as a function of changes in the expected catch of halibut.[6] For example, a 30% reduction in expected catch-per-day is predicted to lead to a 25.1% reduction in angler participation, while a 30% increase would be expected to increase total angler-days fished by 11.0%. Because the estimated participation model is nonlinear and convex, successively larger increases in the expected catch of halibut lead to successively smaller incremental increases in the number of angler-days fished. That is, changes in participation show a declining marginal utility of catch and that Alaskans are more sensitive than nonresidents to changes in expected catch.

Reductions (increases) in expected catch reduce (increase) the compensating variation in two ways. First, the marginal sport fisher will drop out (enter) of the fishery as the expected benefits (in terms of catch) decrease (increase), thereby decreasing (increasing) the total net benefits of the fishery. Second, the net benefit of taking a trip is also reduced (increased) for all the sport fishers who continue to participate because each trip produces less (more) net benefit when the catch rate declines (increases). These changes are represented in figure 2. For example, a 30% reduction in expected catch is predicted to lead to a 56.7% reduction in total compensating variation. Conversely, changes in halibut abundance or management

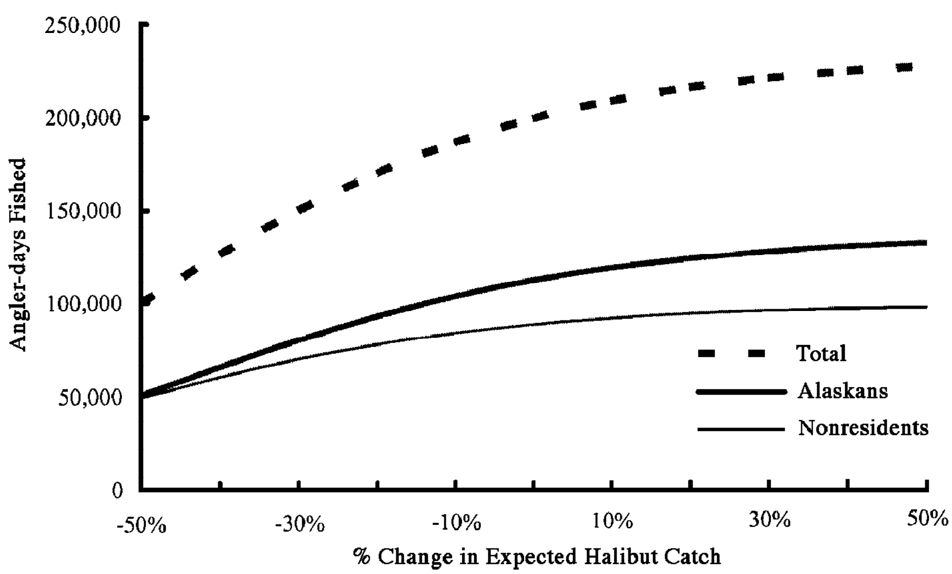

Figure 1. The Effect of Changes of Expected Halibut Catch on Angler Participation

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[6] Changes in fishery regulations or environmental changes that affect fishery biomass can be expected to change the total weight of harvested fish through both fish numbers and average weight of the fish. In this manuscript, we hold the average weight of fish constant and focus our analysis on changes to expected catch, which is likely to be the dominant change to total weight from regulatory or environmental changes.

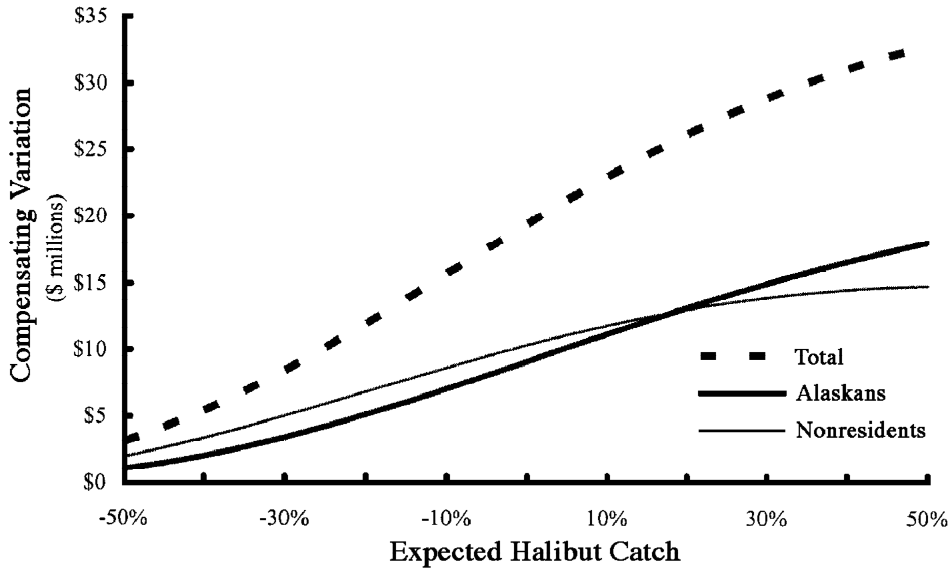

Figure 2. The Effect of Changes in Expected Halibut Catch on the Magnitude of Total Compensating Variation

policies that increase expected halibut catch-per-day by 30% could be expected to increase angler net benefits by $5.8 million for residents and $3.6 million for nonresidents, a 48.4% increase in total angler welfare. Note that the total net benefits that accrue to Alaskan anglers are more responsive to changes in expected catch than are those obtained by nonresidents.

Unlike angler net benefits, which are a measure of economic efficiency, impact analysis is a measure of distribution. That is, changes in average daily compensating variation affect regional economic activity when they lead to changes in the total number of sportfishing days. Furthermore, the net regional impact is limited to those 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. Assessment of the regional economic impacts of marine sportfishing on the Kenai Peninsula Borough begins with a baseline of expenditures that fluctuates as sport fisher behavior responds to changes in fishing conditions. Table 1 breaks out the $25 million of "new" money to the region spent by non-local Alaskans and nonresidents ($15.3 million of fishing related expenses and $9.7 million of other expenses). Changes in expected angler success (catch) affect participation decisions and, consequently, angler expenditures, industry output, personal income, and employment. The magnitudes of these effects are reported in table 4. The results indicate, for example, that for a 10% decrease in expected halibut catches, net benefits to resident and nonresident sport fishers will decrease by $3.7 million (19.2%). The regional impacts include a $2.0 million (7.1%) decrease in marine sport fishing related direct, indirect, and induced output expenditures in the Kenai Peninsula region, which will result in a decrease of $0.9 million (7.1%) in personal income and a loss of 59 jobs related to the marine sport fishery. For a 10% increase in expected halibut catch-per-day, net benefits to sport fishers will increase by 18.1%, and there will be a 5.3% increase in direct, indirect, and induced output expenditures in the Kenai

Peninsula region, which will result in a 5.3% increase in personal income and a 5.2% increase in related jobs. The marginal effect of each of these impacts is smaller at higher catch levels and larger at lower catch levels, a consequence of the declining marginal value of catches and, therefore, participation.

Angler net benefits and regional economic impacts are also affected by changes in trip costs (figures 3, 4). Trip costs might increase as a result of increased license fees, as an unintended consequence of management actions taken to limit halibut sportfishing catches, or other changes in the supply of or demand for trips. Figure 3 illustrates that the number of angler-days fished by Alaskans is more sensitive to trip cost increases than is the number of angler-days fished by nonresidents. Consequently, if fishery managers seek to limit sportfishing catches through an equal

Table 4
Changes in Compensating Variation (CV) and Regional Economic Impacts in Response to Changes in Halibut Catch

% Change in Catch	% Change in Participation	Change in Total CV ($ million)	Change in Expenditures ($ million)	Change in Personal Income ($ million)	Change in Employment (Jobs)
–50%	–50.2%	–16.4	–16.8	–7.1	–487
–40%	–37.1%	–14.1	–12.2	–5.1	–353
–30%	–25.1%	–11.0	–8.1	–3.4	–234
–20%	–14.8%	–7.5	–4.7	–2.0	–136
–10%	–6.5%	–3.8	–2.0	–0.9	–59
0%[1]	197,556	$19.5	$28.5	$12.0	822
+10%	4.9%	3.5	1.5	0.6	43
+20%	8.5%	6.7	2.6	1.1	75
+30%	11.0%	9.4	3.3	1.4	96

[1] These values are baseline levels and provided to add a relative context to the absolute changes.

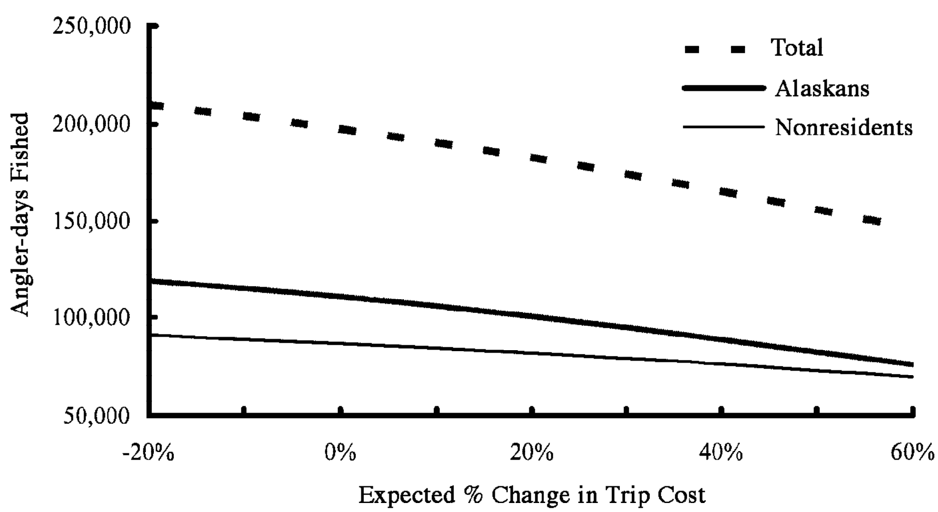

Figure 3. The Effect of Expected Fishing Trip Costs Changes on Angler Participation

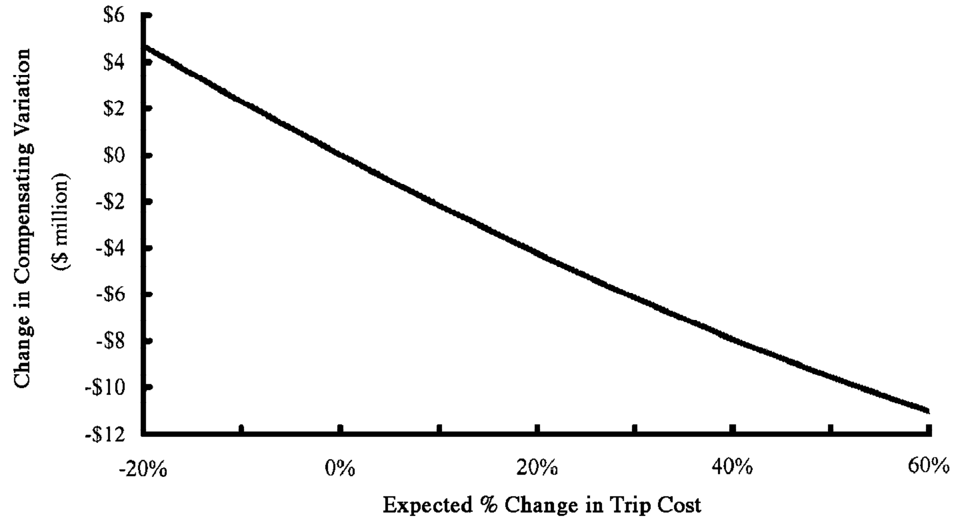

Figure 4. The Effect of Expected Fishing Trip Costs Changes on the Magnitude of Total Compensating Variation

increase in resident and nonresident license fees, the percent reduction in trips taken by Alaskans will be larger than the percent reduction in trips taken by nonresidents. Alternatively, if managers wanted to achieve identical percent reductions in resident and nonresident trips, they could impose a larger fee increase on nonresidents than residents. Moreover, if managers were strictly concerned with benefits to Alaskan resident anglers and concerned that the imposition of a binding GHL might lead to increases in the cost of charter trips, they could select a nonresident license fee that would induce a reduction in nonresident demand sufficient to choke off any upward pressure on charter trip prices. It should be noted that such fees would need to be based on the number of days fished or the number of fish caught. No such fees currently exist for halibut sportfishing in Alaska, and the authors do not necessarily advocate the creation of such fees.

The regional economic impacts of changes in trip costs are reported in table 5. Note that although participation is a linear function of trip cost, angler welfare and regional economic activity are nonlinear. The results indicate, for example, that for a $10 increase in expected trip costs, the number of angler-days fished will decline by 3.6%, net benefits to sport fishers will decrease by $2.2 million (11.3%), sportfishing related expenditures in the Kenai Peninsula region will fall by $1.1 million (4%), Kenai Peninsula Borough personal income will decline by $0.5 million (4%), and there will be a loss of 33 related jobs. Again, these effects are nonlinear, with increasingly larger impacts at increasingly higher prices.

In the participation-rate model, when estimating changes in the probability that individual fishers would take a trip, given varying trip attributes, it is assumed that the price of the trip will remain constant at P. In other words, we assume that supply is perfectly elastic. While this assumption is appropriate for shore and private trips, it is probably not entirely accurate for the charter sector. To the extent that charter trips make up a sizeable portion of sportfishing effort, and to the extent that charter trips do not exhibit perfectly elastic supply curves, there may be price adjustment, especially in the short run. For example, charter operators might respond to a short-

Table 5
Changes in Days Fished and Regional Economic Impacts in Response to Increases in the Average Cost of a Sportfishing Trip

Change in Average Trip Cost	% Change in Angler-days Fished	Change in Total CV ($ million)	Change in Expenditures ($ million)	Change in Personal Income ($ million)	Change in Employment (Jobs)
+$5	–1.8%	–1.1	–0.6	–0.2	–16
+$10	–3.6%	–2.2	–1.1	–0.5	–33
+$15	–5.6%	–3.3	–1.8	–0.7	–51
+$25	–9.7%	–5.3	–3.0	–1.3	–88
+$50	–21.3%	–9.7	–6.7	–2.8	–193
0[1]	197,556	$19,463,536	$28,524,174	$12,034,000	822

[1] The values reported in the last row are baseline levels and provided to add a relative context to the absolute changes.

run change in expected catches by lowering their prices and keeping their customer base rather than holding prices constant and losing customers as assumed in our model. While our assumption is valid in the long run, it may be somewhat unrealistic in the short run. (If there is an upward sloping supply curve for charters, then there would still be a loss in surplus associated with the charter industry when there is an environmental change; however, some of the surplus would come from producers instead of consumers.) Additionally, if price were lowered to maintain the current level of participation, there would be little regional impact outside of fish processing. Therefore, for the charter industry, our results more closely reflect long-run rather than short-run results, especially with respect to income distribution. For shore and private vessels, this is not a factor.

Conclusions

This study develops estimates of the net economic benefits that accrue to participants in the Lower and Central Cook Inlet halibut sport fisheries, the relationship between catch, size of catch, and the number of sportfishing days, and the regional (Kenai Peninsula area) economic impact of changes in the annual total number of person-days fished. The integrated model is used to explore changes in net benefits and changes in regional impacts associated with changes in trip costs and angler success. Changes in expected catch could result from predictable changes in stock abundance; conditionally predictable environmental damages resulting from minerals exploration, development, production, or transportation activities; or from controllable management actions that affect the allocation between commercial, subsistence, and sport fishers, bag and possession limits, fishing methods, or other measures that affect average catches. Changes in cost might arise as a result of predictable shifts in the demand for sportfishing; as the result of deliberate management actions such as changes in resident or nonresident license fees, stamps, or endorsements; or incidental to management actions such as the GHL or charter IFQ, which may affect the supply or character of sportfishing trips.

The advantages of our integrated model are that: changes in participation are determined by variables that are observable, predictable, or subject to management control; nonlinear preferences are easily accommodated; aggregation of the individual participation probabilities provide a method for estimating angler welfare;

and estimated changes in aggregate participation can be linked to a regional input-output model to provide estimates of the regional economic impacts of changes in trip attributes. Although the model was developed, in part, to meet the needs of environmental and regulatory impact analyses related to outer continental shelf minerals exploration, development, and production activities in the Cook Inlet Planning Area (Herrmann, Lee, Hamel, and Criddle 2001), preliminary model results have also been used in regulatory analyses related to recent management actions designed to constrain the uncompensated reallocation of halibut from the commercial fishery to the charter-based sport fishery (NPFMC 2000, 2001).

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Appendix

There are many reasons for visiting Alaska and the Kenai Peninsula. Respondents to the UAF angler survey (Herrmann, Lee, Criddle, and Hamel 2001) cited nine primary trip purposes. Table A1 summarizes the reasons given by respondents who fished for halibut or salmon in Cook Inlet.

Table A1
Primary Purpose of Trip to Alaska

	Alaskans (non-local)	Nonresidents
Saltwater fishing in Cook Inlet	87.9%	43.0%
Visit/vacation (in Alaska) in areas outside of Kenai Peninsula	2.9%	24.4%
Visit relatives	1.7%	12.0%
Freshwater fishing on Kenai Peninsula	5.2%	11.2%
Business trip	1.2%	3.7%
Combined marine/freshwater fishing	0.0%	2.5%
Visit friends	1.2%	0.4%
Cruise ship		1.2%
Hunting		1.7%

Because there is not an exact correspondence between visits to Alaska and the desire to fish for halibut or salmon in Cook Inlet, it was necessary to adjust the total expenditure estimates to reflect those regional expenditures that are uniquely attributable to fishing in the Cook Inlet. Consequently, after discussion with fishery participants and representatives of related tourism and fishery sectors, we adopted a set of assumptions regarding what respondents would do if the Cook Inlet sportfishing portion of their trip were cancelled (table A2).

Table A2
Assumed Response of Respondents to Cancellation of the Cook Inlet Sportfishing Portion of their Trip

Main Trip Purpose	Alaskans (non-local)	Nonresidents
Saltwater fishing in Cook Inlet	Cancel entire trip to the Kenai	Cancel entire trip to the Kenai
Visit/vacation (in Alaska) in areas outside of Kenai Peninsula	Replace days on Kenai with days elsewhere in Alaska	Replace days on Kenai with days elsewhere in Alaska
Visit relatives	Take full Kenai trip	Take full Kenai trip
Freshwater fishing on Kenai Peninsula	Reduce trip length by lost fishing days	Reduce trip length by lost fishing days
Business trip	Take full Kenai trip	Take full Kenai trip
Combined marine/freshwater fishing	Reduce trip length by lost fishing days	Reduce trip length by lost fishing days
Visit friends	Take full Kenai trip	Take full Kenai trip
Cruise ship	No observations	Take full Kenai trip
Hunting	No observations	Take full Kenai trip

The total amount of effort from table A1 was combined with the assumptions of what an individual would do of the fishing trip were cancelled, to form the overall reduction in expenses associated with a reduction in Cook Inlet sportfishing effort (table A3).

Table A3
Reduction in Fishing or Visitation Rates for a 100% Reduction in Fishing Effort (days)

	Alaskans (non-local)	Nonresidents
Fishing reduction	100%	100%
Kenai living expenses	89.5%	64.0%

For example, if a person does not take a fishing trip, we assumed that there would be a 100% reduction of new money flowing into the Kenai Peninsula from marine sportfishing-related expenditures (as the trip is not taken). However, there still may be reason for the trip to be taken even if the individual does not fish. Our calculations indicate that if an Alaskan (non-local) does not fish, 89.5% of the redistribution of primary living expenditures from outside to inside the Kenai Peninsula will not take place (note that 88% of the Alaskans took their Kenai Peninsula trip primarily to engage in marine sportfishing). For nonresidents, we estimate that approximately 64.0% of the living and transportation expenditures taking place on the Kenai Peninsula are a direct result of the fishing component of the saltwater fishing trip (36% of these primary living expenditures would still take place, as there are more reasons for non-residents to visit the Kenai Peninsula than for non-local Alaskans.

Although these are very broad assumptions, and other scenarios (such as substitute fishing trips) are plausible, we believe that estimates based on these assumptions are better than estimates that assume that all trip expenditures are derived from the Cook Inlet halibut and salmon-fishing component. By reducing total expenditures attributable to fishing, we represent a conservative view which is not only more plausible, but also more defensible when valuing a fishery and calculating economic impacts of fishery changes to changes in expected fishing harvest.