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Final Report

An Economic Assessment of the Sport Fisheries for Halibut, Chinook and Coho Salmon in Lower and Central Cook Inlet

by

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Project Organization

Mark Herrmann and Keith Criddle were responsible for overall project management. Todd Lee and Mark Herrmann adopted the data from the Alaska Sea Grant sponsored UAF saltwater sportfishing survey to meet the information requirements of this project. Todd Lee led in the specification and estimation of the participation rate model. Mark Herrmann spearheaded derivation of the compensating variation estimates with assistance from Todd Lee. Hans Geier and Charles Hamel developed, groundtruthed, and modified the IMPLAN input–output model to more accurately reflect patterns of economic activity on the Kenai Peninsula. Charles Hamel, Mark Herrmann, and Todd Lee developed the Cook Inlet Region Marine Sportfishing Economic Assessment program. Keith Criddle, Mark Herrmann, Charles Hamel, and Todd Lee developed alternative management scenarios and estimated the corresponding impacts. Keith Criddle and Mark Herrmann drafted the quarterly and annual project reports. Mark Herrmann, Keith Criddle, Todd Lee, and Charles Hamel drafted the final project report. Joshua Greenberg contributed to the development of the input–output model specification. Carol Lewis and Joshua Greenberg also participated in drafting and review of the annual and final project reports.

Any views expressed are solely those of the authors, and should not be construed as representing those of the institutions by which they are employed.

The tangible results of a good day's work (play)—Homer, Alaska.

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1. Executive Summary

The Cook Inlet Planning Area includes and abuts productive commercial, subsistence, and sport fishing grounds. Outer continental shelf minerals exploration, development and production activities could affect the productivity of these fisheries, the quality of recreation opportunities, and the demand for tourism-related services. The marine sport fisheries of lower and central Cook Inlet are the focus of a large recreation based economic sector that provides non-monetary benefits to participants and monetary benefits to tourism-related businesses. This study and a companion study, Lee et al. [1999b], develop a predictive model of participation rate changes that can be linked to a regional input–output model to estimate net benefits to sport fishers and the regional economic impact of marine sportfishing on the Kenai Peninsula economy.

The probability that a typical sport fisher would take a halibut or salmon sportfishing trip in lower or central Cook Inlet is modeled as a random utility function of the expected trip cost and catch (species, size, number). The model, estimated using a binary probit estimation technique, allows for declining marginal utility as well as the interactions between salmon and halibut sportfishing catches. The model is used to predict changes in participation given changes in expected catch that may result from changes in mean catch that could arise from changes in biomass (abundance) or changes in catch limits. The estimated probability of taking a trip is transformed into a prediction of changes in total sportfishing effort.

Net benefits to sport fishers are measured by compensating variations, 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, compensating variation is a measure of the consumer surplus from sportfishing and changes in the total compensating variation are measures of changes in consumer surplus. The total compensating variation in 1997 ($19.2 million) is the product of the estimated mean compensating variation per day ($97.30) and the number of sportfishing-days (197,556). Reductions in expected catch reduce the compensating variation in two ways. First, the marginal participant will drop out of the fishery as the expected benefits (in terms of catch) decrease, thereby decreasing the total net benefits of the sportfishing. Second, the net benefit of taking a trip is also reduced for those who continue to participate because the average trip produces less net benefit when the catch rate declines.

In contrast to net benefits, which are a measure of economic efficiency, economic impact is a measure of the distribution of economic activity. Changes in sportfishing effort affect regional economies by altering primary and secondary expenditure patterns. For example, if fishing effort were to diminish, fishing-related expenditures would also decline. However, estimates of these changes must account for the possibility that some individuals might engage in other Kenai Peninsula recreation activities as substitutes for the foregone sportfishing-days. The Cook Inlet Region Marine Sportfishing Economic Assessment simulation model accounts for these substitution effects and declining marginal utility and allows estimation of the economic impact of lower and central Cook Inlet sportfishing for halibut and salmon under varying conditions of stock abundance and harvest limitations [see Appendix B or Hamel et al. 2001].

Five examples of changes to sportfishing trip attributes are examined: two increases (10% and 20%) and three decreases (–10%, –20%, and –30%) from the baseline (1997) mean catch per fishing trip. The five scenarios reflect changes in expected harvests that might result from natural stock dynamic processes; changes in allocation shares among commercial, subsistence, and sport fishers; changes in catch limits; or population, regulatory, or economic and behavioral responses to environmental damage that might result from accidents associated with minerals exploration, development, production, or transportation.

The results indicate, for example, that for a 10% decrease in expected salmon and halibut catch, net benefits to sport fishers will decrease by 23% ($4.4 million). The concomitant decrease in participation can be expected to result in a $2.5 million decrease of direct, indirect, and induced output expenditures in the Kenai Peninsula region, a $1.0 million reduction in personal income, and a loss of 72 jobs.

2. Introduction

Outer continental shelf minerals exploration, development and production activities in the Cook Inlet Planning Area (Figure 1) could affect the productivity of commercial, subsistence, and sport fisheries, the quality of recreation opportunities, and the demand for tourism-related services.

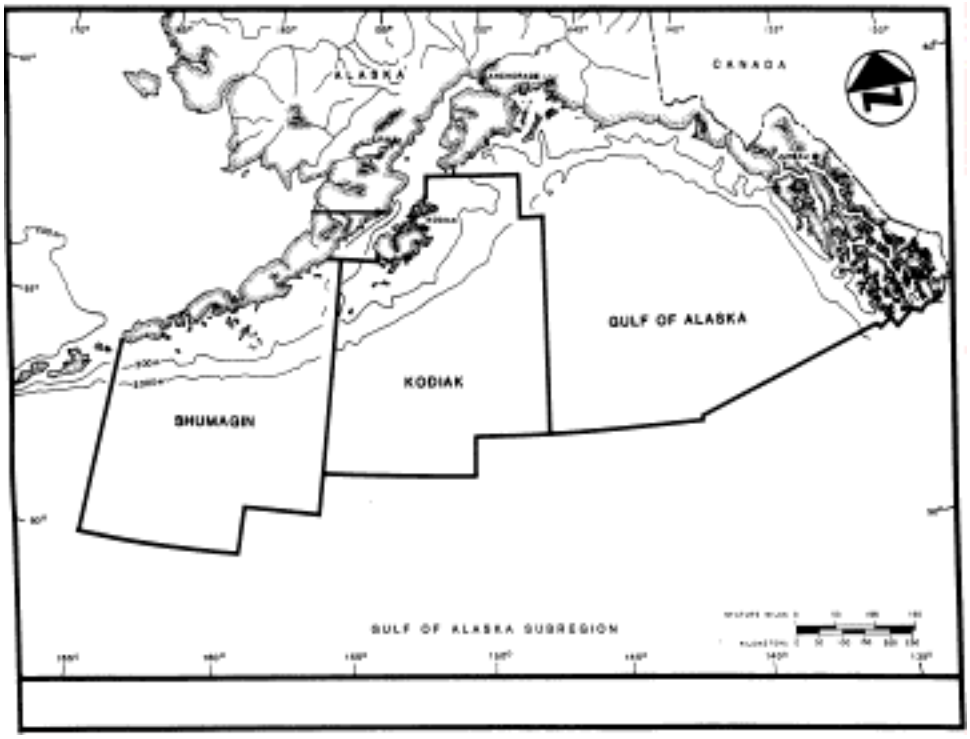


Figure 1. Minerals Management Service Gulf of Alaska subregion, Cook Inlet Planning Area.

The sport fisheries of Cook Inlet (Figure 2) contribute to the economic well-being of residents of the Kenai Peninsula, Alaska, and the nation. In this analysis, we focus primarily on the sport fishery for Pacific halibut (*Hippoglossus stenolepis*). However, because the marine salmon sport fishery is both a substitute and a complement for the halibut sport fishery, the analysis also addresses the marine sport fisheries for chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*).

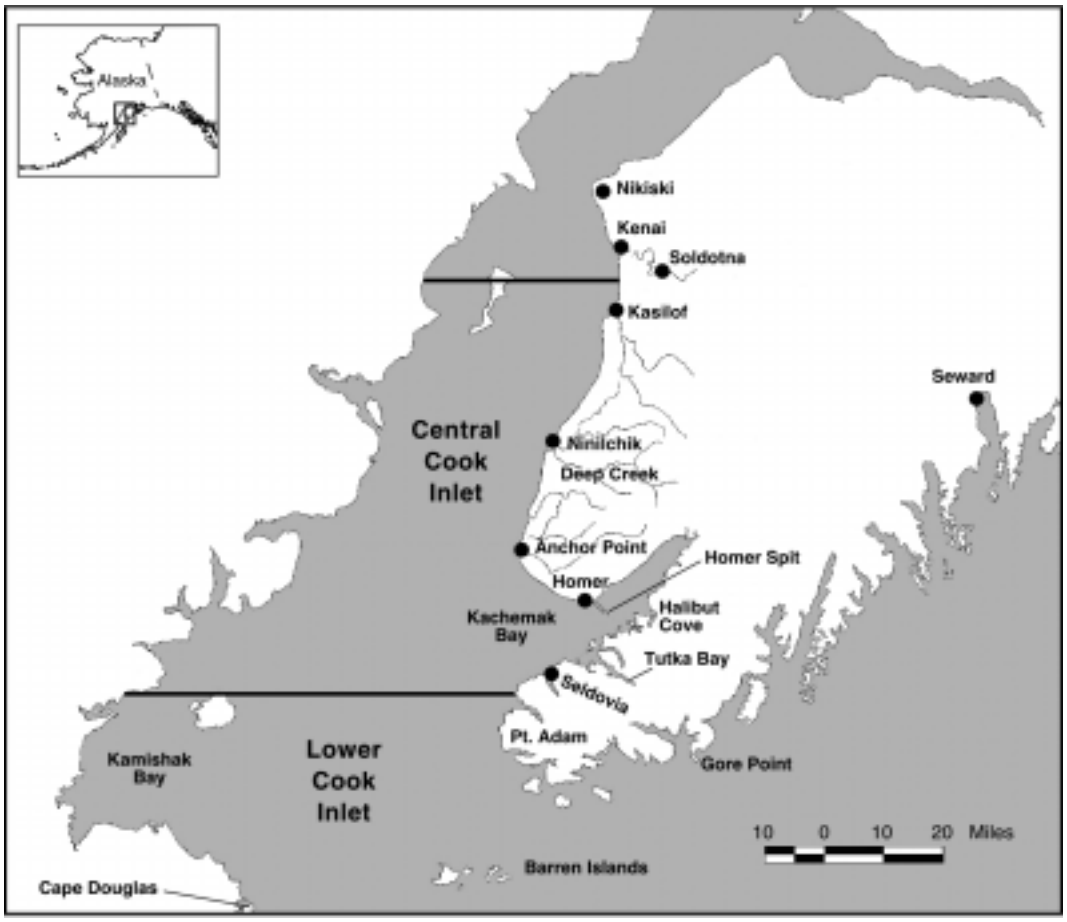


Figure 2. Cook Inlet study area.

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 ten management zones (2A-C, 3A, B, 4A-E) in the North Pacific, Gulf of Alaska, and eastern Bering Sea (Figure 3), 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 (636 metric tons in IPHC area 2C and 1,777 metric tons in IPHC area 3A), 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. Under an IFQ, open markets would serve to allocate the combined TAC and GHL (specified as a percentage of the ABC) among commercial fishers and charterboat operators.

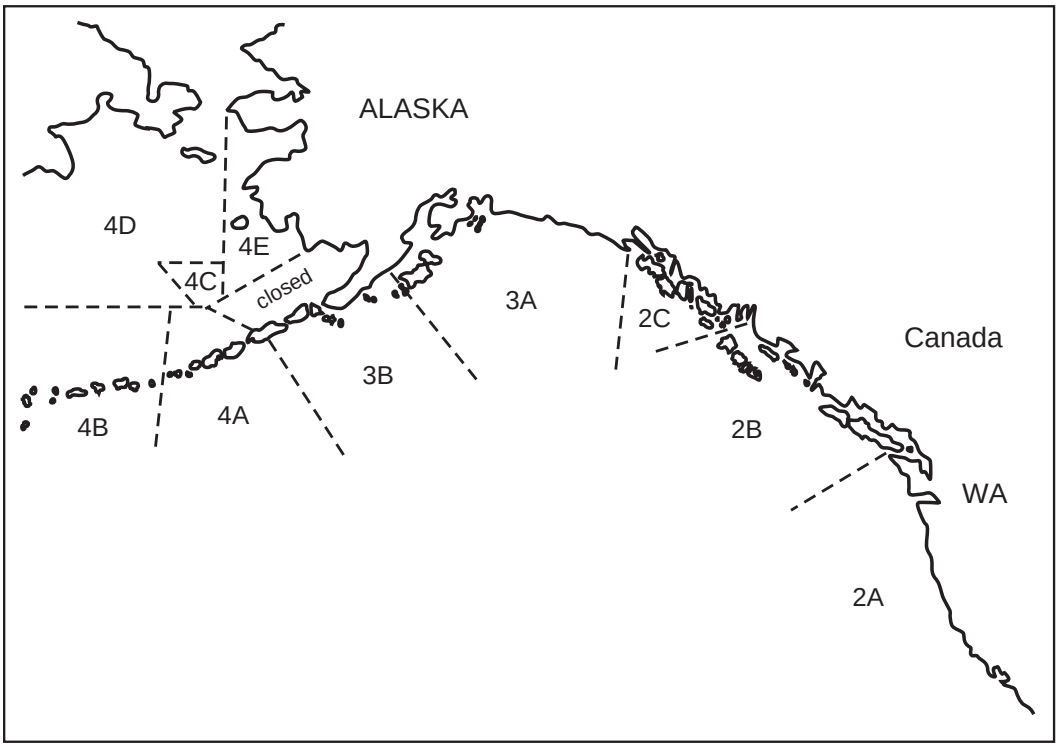


Figure 3. IPHC halibut management areas [IPHC 1999].

While the Council has exercised direct management of the commercial catch and bycatch of halibut, it has relied on the Alaska Department of Fish and Game (ADF&G) to manage the sport fishery under bag and possession limits established by the Alaska Board of Fisheries. Current regulations stipulate a 1 February–31 December open season with a two fish daily bag limit and a four fish possession limit. Under the recently adopted management structure, sportfishing bag limits could be reduced if the charterboat GHL is exceeded.

Although salmon management is also subject to international agreement and federal oversight outside of state waters, for all practical purposes the Alaska Board of Fisheries controls salmon catches off Alaska. ADF&G manages the salmon fisheries off Alaska according to guideline harvest ranges established by the Board. These guideline harvest ranges are intended to allow for the satisfaction of escapement objectives, while serving to allocate catch among subsistence, sport, and commercial fishers.

Cook Inlet saltwater sportfishing regulations specify a daily bag and possession limit of six other (coho, sockeye, chum, and pink) salmon in combination. Bag and possession limits for chinook salmon differ depending on whether the catches are taken above or below Bluff Point near Homer. To the north of Bluff Point, the daily bag and possession limit is one chinook salmon. To the south of Bluff Point, the daily bag and possession limit is two chinook salmon. In addition, there is an annual catch limit of five chinook salmon from Cook Inlet salt waters (north of a line between Cape Douglas and Point Adam, see Figure 2).

Recent sport catches of halibut from Cook Inlet, Prince William Sound, Resurrection Bay, Kodiak, Yakutat, and adjacent portions of Gulf of Alaska (IPHC Area 3A) have exceeded 3,409 metric tons round weight (Figure 4). During the past two decades, the share of halibut catch taken in the sport fishery has grown from less than 2% to over 18% (Figure 5).

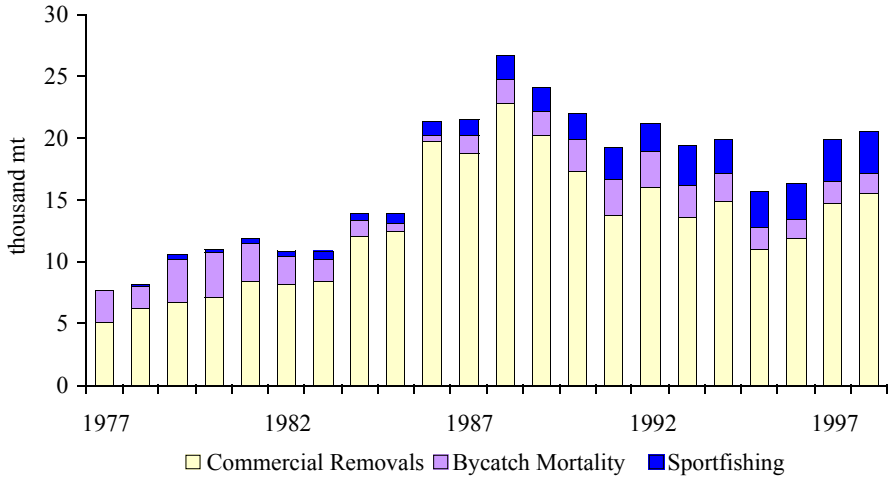


Figure 4. Commercial and sportfishing catches and bycatch mortality of Pacific halibut in IPHC area 3A [IPHC 1999 and Howe et al. 1999].

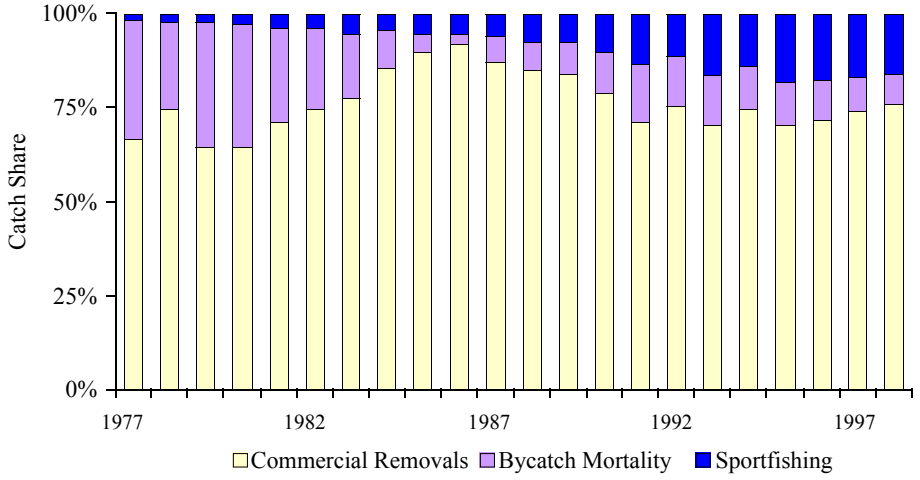


Figure 5. Percentages of Pacific halibut mortality due to commercial and sportfishing catches and bycatch in IPHC area 3A [IPHC 1999 and Howe et al. 1999].

The growth of halibut sportfishing (Figures 4 and 5), combined with the adoption of individual fishing quotas in the commercial fishery, and growth in the number of vessels licensed to offer charter services (Figure 6) have led to proposals to cap sportfishing harvests of halibut.

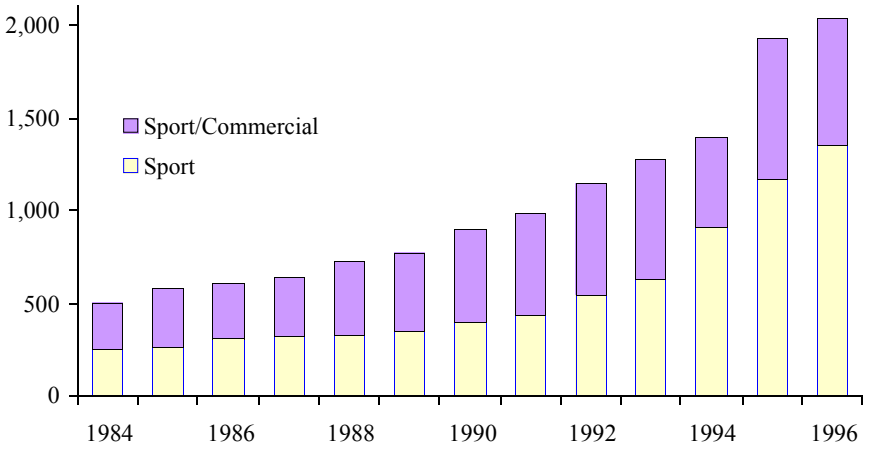


Figure 6. Numbers of vessels licensed by the IPHC for sport (charter) and sport (charter)/commercial fishing off Alaska [NPFMC 2000].[1]

Lower and central Cook Inlet sportfishing catches of chinook salmon have grown from an average of less than 25% of the total number caught in the early 1980s to a recent average of around 20,000 fish or nearly 50% of the combined commercial and sportfishing removals [Lafferty et al. 1998] (see Figures 7 and 8).

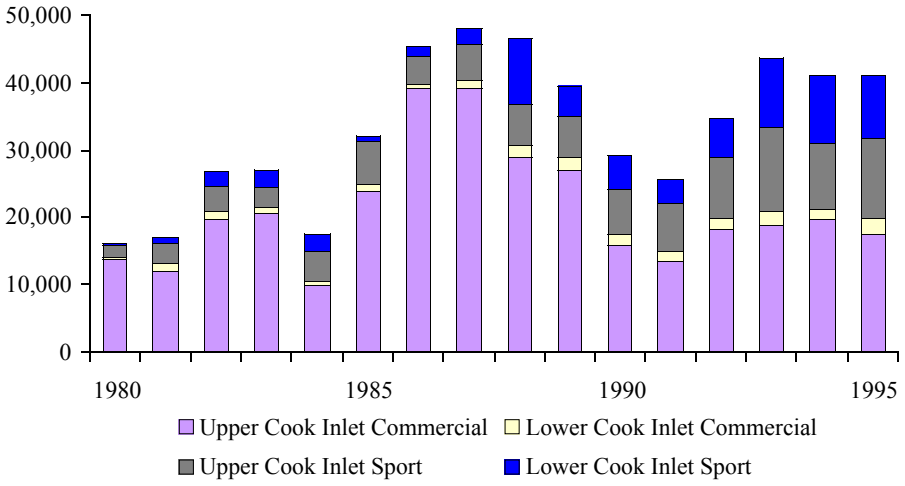


Figure 7. Commercial and sport catches (numbers) of chinook salmon from Cook Inlet [Lafferty et al. 1998].

[1] The data series ends in 1996 when licensing functions were delegated to the Alaska Commercial Fishery Entry Commission.

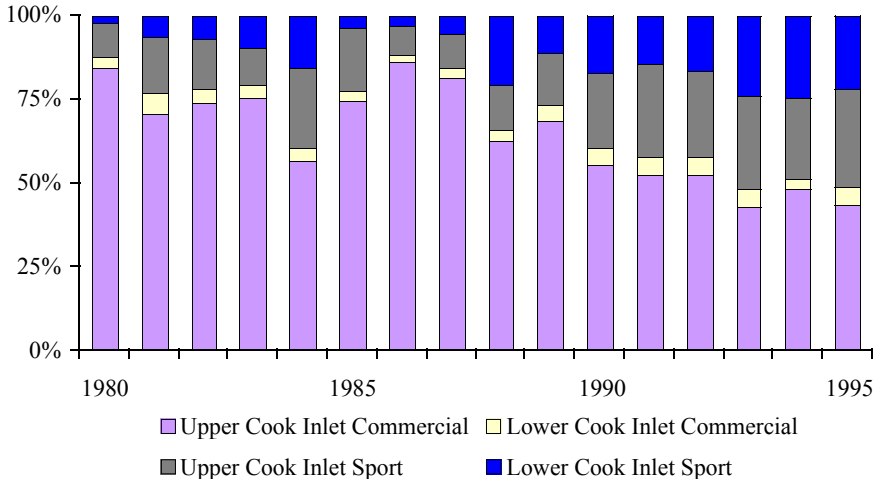


Figure 8. Percentages of commercial and sport catches (numbers) of chinook salmon from Cook Inlet [Lafferty et al. 1998].

Most of the commercial harvest of coho (98%) is taken in upper Cook Inlet. Two-thirds of the sportfishing catches are taken in the Homer area with the remainder coming from waters along the eastern shore of upper Cook Inlet. The share of Cook Inlet catches of coho taken in sport fisheries has grown from about 15% (2,000 fish) in the early 1980s to more than 50% [Robert Clark, ADF&G Sportfish Division, personal communication 1999] (see Figures 9 and 10).

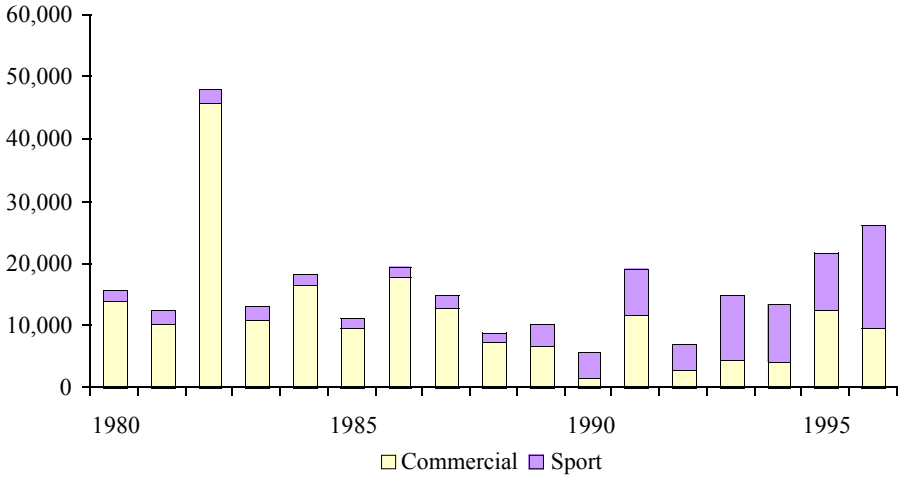


Figure 9. Commercial and sport catches (numbers) of coho salmon from Cook Inlet excluding sport catches from Seward and commercial catches from the Lower Cook Inlet Eastern District [Robert Clark, ADF&G Sportfish Division, personal communication 2000].

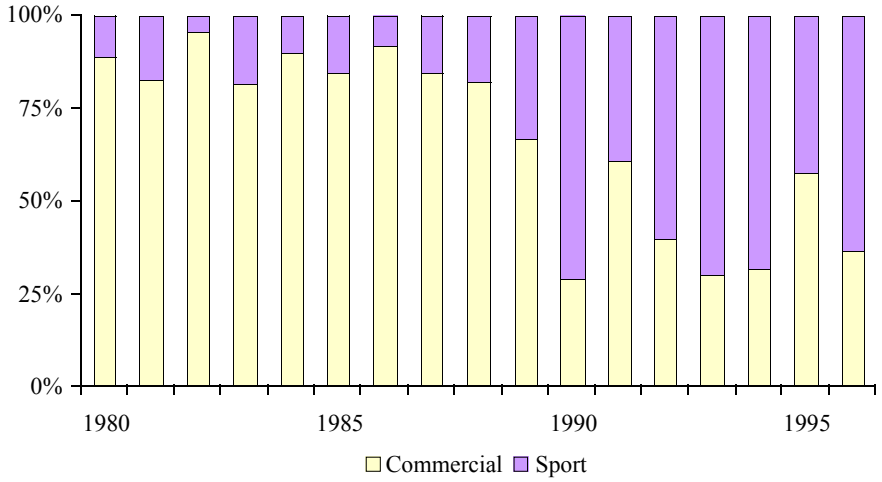


Figure 10. Percentages of commercial and sport catches (numbers) of coho salmon from Cook Inlet excluding sport catches from Seward and commercial catches from the Lower Cook Inlet Eastern District [Robert Clark, ADF&G Sportfish Division, personal communication 2000].

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 (environmental assessment/regulatory impact review) for the implementation of the halibut/sablefish IFQ program [NPFMC 1991a, b]. Criddle [1994] describes the bioeconomics of the commercial halibut fishery. The National Research Council's (NRC) Committee to Review IFQs [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. The economics of Alaska's commercial salmon fishery have also been the subject of rigorous study and are described in, for example, Herrmann [1994], Herrmann and Greenberg [1994], and Herrmann [1993].

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 Cook Inlet halibut and salmon sportfishing. Northern Economics [1990] provides an estimate of the economic impact of the S.S. *Glacier Bay* oil spill that includes a qualitative discussion of sportfishing benefits. Layman et al. [1996] provide a recent estimate of the economic benefits of chinook salmon sportfishing on the Gulkana River, Alaska. Henderson et al. [1999] report estimates of the economic value of subsistence and personal use salmon fisheries on the Copper River, Alaska. ISER (Institute for Social and Economic Research) [1996], Berman et al. [1999], and Berman and Kim [1999] report on the sportfishing related economic value of Kenai River sockeye salmon. Lee et al. [1999b] describe the results of a survey that will be used to obtain estimates of the consumer surplus that accrues to participants in lower Cook Inlet sport fisheries. The analysis relies extensively on the data developed in Lee et al. [1999b].

There are two components to a comprehensive evaluation of marine sportfishing: estimation of the net benefits that accrue to sport fishers and assessment of the economic impact generated by marine

sportfishing. Recreators fish because they anticipate that the expected benefits from the sportfishing and associated activities will exceed their expected costs. While assessment of the net non-market benefits that accrue to sport fishers is difficult, several estimation techniques have achieved broad acceptance. We use a participation rate model to estimate changes in compensating variations given changes in expected fishing behavior. (Lee et al. will undertake a more thorough examination of non-market benefits in forthcoming research.)

The main focus of this study centers on the impact analysis. To estimate the changes in regional impacts for possible environmental changes we develop a model of the relationship between trip attributes and participation rates and an input–output model that estimates the economic impact of various levels of participation. These model components are briefly discussed below and in greater detail in Sections 4 and 5, respectively.

Participation rates are estimated using an econometric model of the form:

$$\text{(1)} \qquad \mathrm{P}(T_i) = f(cost_i, catch_{ij}, size_{ij}, other)$$

where $\mathrm{P}(T_i)$ is the probability of taking trip i, $cost_i$ is the cost of trip i, $catch_{ij}$ is the number of fish of species j caught on trip i, $size_{ij}$ is the average size of fish of species j caught on trip i, and *other* includes qualitative variables to differentiate between the responses of resident and nonresident recreators, and to account for other demographic characteristics. The data used for estimating the parameters of this model are reported in Lee et al. [1999a].

Marine sportfishing can take place from shore, from private or rented boats, or from 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 estimates the direct, indirect, and induced effects on output (production), income and employment by industry and aggregated industries. Direct effects are production changes associated with immediate final demand changes. Indirect effects are those associated with changes in inputs to the production process. Induced effects are those caused by changes in household spending patterns due to changes in household income generated by direct and indirect effects. Most economic activities generate secondary impacts (indirect effects). That is, when goods or services are purchased, the seller in turn purchases other goods and services. Secondary impacts are generated whether the initial activity involves commerce or recreation. However, different activities generate different impacts. Moreover, the impact of alternative activities depends on the scale considered. It is traditional to examine economic impacts at local, regional, and national scales. Our focus on the Kenai Peninsula dictates a regional based impact assessment. Input–output (I–O) is the most widely applied tool for assessing regional economic impacts.

Figure 11. Sportfishing for halibut from a charter vessel in Cook Inlet.

3. Baseline Expenditures

The baseline expenditures for residents fishing in the Cook Inlet marine sport fishery were calculated for 1997 using information from the annual Alaska Department of Fish and Game sport fish survey[2] [ADF&G unpublished data] and data reported from the University of Alaska Fairbanks (UAF) survey undertaken for Alaska Sea Grant [Lee et al. 1999b]. Specifically, the ADF&G survey was used for effort estimations while the UAF survey was used for all other computations (see Section 4 for survey methodology).

Number of sportfishing-days

The annual ADF&G postal survey is used to estimate the total number of sport fishers and days fished for all of the major sportfishing regions in Alaska. Vincent-Lang [1998] reports: "Mills and Howe [1992] and Meyer [1994] have reviewed the postal survey and suggest that the estimates are sufficiently precise and accurate for management of 'large' marine fisheries, such as those for halibut or rockfish."

Based on responses to the 1997 ADF&G postal survey, ADF&G estimated that 140,905 residents participated in Kenai Peninsula-area marine sport fisheries. The UAF survey estimate of 151,590 anglers is slightly higher than ADF&G's number, but that is most likely due to the fact that the UAF survey emphasized the Kenai saltwater sports fishery and may have had a higher return from these participants

[2] The Alaska Department of Fish and Game pulled its reports for 1995–1997 that reported on the annual postal survey of effort and fish harvest due to errors. The data used in this report is the updated data that was received from ADF&G that will eventually be used in the new reports as the corrected data.

than from non-Kenai participants[3]. ADF&G aggregate data estimates a total of 286,521 saltwater sport days fished off the Kenai in 1997[4]. However, because the ADF&G survey incorporates data from all marine sport fisheries off the Kenai Peninsula, and the UAF survey focused on lower and central Cook Inlet sport fisheries, it was necessary to disaggregate the ADF&G data, exclude the Seward and "other Gulf Coast East of Gore Point" reporting areas, and aggregate the remaining areas to permit comparison. Members of the charterboat industry [Robert Ward, Homer Charter Association, personal communication 1999] indicated that the majority of the boats fishing the "Barren Islands" and "other Cook Inlet/Gulf Coast west of Gore Point" regions are ported in Homer.

After these adjustments are made, the ADF&G estimate of angler-days fished off the Kenai Peninsula in 1997 is 197,556 days: 78,587 charter vessels days, 91,139 private vessel days, and 27,830 shore days (see Table 1). We have grouped recreational fishers into nine categories: three residency categories and three sportfishing modes. Residency is comprised of *locals* (Kenai Peninsula residents), *Alaskans* (Alaskan residents who do not live in the Kenai Peninsula Borough), and *nonresidents* (U.S. residents from outside Alaska). The sportfishing mode category is separated into *charter* (marine sportfishing from aboard licensed charter boats), *private* (marine sportfishing from aboard privately owned or rented boats), and *shore* (marine sportfishing from the shore). Although this level of detail is not available in the annual ADF&G sportfishing survey reports, ADF&G was able to provide it to us. Tables 2 and 3 report our estimates of recreational fishing days for various areas in Cook Inlet during 1997.

Table 1. Angler-days fished from lower and central Cook Inlet ports during 1997 [ADF&G unpublished data].

Fishing Area	Charter	Private	Shore	Total
Anchor River, Whiskey Gulch, Deep Creek, and Ninilchik River	30,693	48,841	1,132	80,666
Other Cook Inlet/Gulf Coast West of Gore Point	37,401	40,489		77,890
Other Cook Inlet North of Ninilchik River	769	339		1,108
Barren Islands	9,724	1,470		11,194
Seldovia Bay			1,642	1,642
Homer Spit (Kachemak Bay)			23,218	23,218
Shoreline – Other			1,838	1,838
Total	78,587	91,139	27,830	197,556

[3] The ADF&G unpublished data estimates of days fished include effort directed at species other than halibut and salmon while the UAF survey focused exclusively on halibut and salmon effort.

[4] The UAF survey found a higher average number of days fished than did the ADF&G survey. This is despite the fact that the survey results correspond closely in nearly all other respects. Both surveys estimated almost identical numbers of fishers in 1997. However, the UAF survey estimated a higher amount of effort in the Kenai region than did the ADF&G survey. For example, for sport fishers just taking halibut trips the UAF survey estimated an average of three days per sport fisher. This number was even higher when the average sport fisher days were calculated for trips targeting salmon or halibut. Unable to resolve this single, but important difference in survey results, we have adopted the ADF&G estimates because of their long and self-consistent estimates of sportfishing-days per sport fisher.

Table 2. Person-days fished in lower and central Cook Inlet during 1997 by fishing area, residency, and sportfishing mode [ADF&G unpublished data].

Fishing Area	Local	Alaskan (non-local)	Nonresident	Total
Charter				
Anchor River, Whiskey Gulch, Deep Creek, and Ninilchik River	2,209	7,872	20,612	30,693
Other Cook Inlet/Gulf Coast West of Gore Point	3,350	9,590	24,461	37,401
Other Cook Inlet North of Ninilchik River	30	47	692	769
Barren Islands	1,929	2,389	5,406	9,724
Seldovia				
Homer Spit (Kachemak Bay)				
Shoreline – Other				
Total	7,518	19,898	51,171	78,587
Private or bare-boat charters*				
Anchor River, Whiskey Gulch, Deep Creek, and Ninilchik River	14,575	20,150	14,116	48,841
Other Cook Inlet/Gulf Coast West of Gore Point	13,349	16,252	10,888	40,489
Other Cook Inlet North of Ninilchik River	47	164	128	339
Barren Islands	527	478	465	1,470
Seldovia				
Homer Spit (Kachemak Bay)				
Shoreline – Other				
Total	28,498	37,044	25,597	91,139
Shore-based				
Anchor River, Whiskey Gulch, Deep Creek, and Ninilchik River	515	285	332	1,132
Other Cook Inlet/Gulf Coast West of Gore Point				
Other Cook Inlet North of Ninilchik River				
Barren Islands				
Seldovia	1,070	99	473	1,642
Homer Spit (Kachemak Bay)	10,629	3,522	9,067	23,218
Shoreline – Other	647	861	330	1,838
Total	12,861	4,767	10,202	27,830
All sportfishing modes				
Anchor River, Whiskey Gulch, Deep Creek, and Ninilchik River	17,299	28,307	35,060	80,666
Other Cook Inlet/Gulf Coast West of Gore Point	16,699	25,842	35,349	77,890
Other Cook Inlet North of Ninilchik River	77	211	820	1,108
Barren Islands	2,456	2,867	5,871	11,194
Seldovia	1,070	99	473	1,642
Homer Spit (Kachemak Bay)	10,629	3,522	9,067	23,218
Shoreline – Other	647	861	330	1,838
Total	48,877	61,709	86,970	197,556

* Bare-boat charters are boats available for rent. Rentals may include fishing poles, bait, and advice, but do ***not*** include an on-board guide or skipper. Consequently, bare-boat charters are not subject to the restrictions and regulations that govern charter boats and they are treated as private vessels by the fisheries management agencies.

The effort estimates in Tables 1 and 2 are summarized in Table 3 and expressed as percentages in Table 4.

Table 3. Person-days fished by residency category and sportfishing mode [ADF&G unpublished data].

	Charter	Private	Shore	Total
Local	7,518	28,498	12,861	48,877
Alaskan (non-local)	19,898	37,044	4,767	61,709
Nonresident	51,171	25,597	10,202	86,970
Total	78,587	91,139	27,830	197,556

Table 4. Effort distribution (%) by residency category and sportfishing mode [ADF&G unpublished data].

	Charter	Private	Shore	Total
Local	3.8%	14.4%	6.5%	24.7%
Alaskan (non-local)	10.1%	18.8%	2.4%	31.2%
Nonresident	25.9%	13.0%	5.2%	44.0%
Total	39.8%	46.1%	14.1%	100.0%

Figure 12 shows the effort by sportfishing mode and residency.

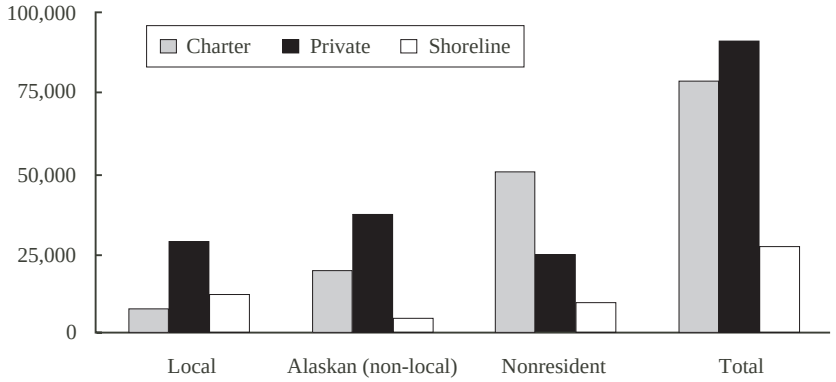


Figure 12. Person-days fished in lower and central Cook Inlet during 1997 by residency and sportfishing mode [Howe et al. 1999].

Tables 2, 3, and 4, and Figure 12 indicate that while most nonresident sportfishing effort is charter-based, many Alaskans use private vessels and bare-boat charters. In total, 46% of the marine sportfishing effort in 1997 was conducted from private boats or bare-boat charters. By comparison, 40% of the Cook Inlet region marine sportfishing occurred on charter boats. Most, 83%, of the respondents who engaged in shore-based marine sportfishing did so on the Homer spit, the locus of a tidal terminal fishery for hatchery-reared salmon.

Figure 13. A young sport fisher hooked into a halibut from aboard a charter boat in Cook Inlet.

Average daily fishing and non-fishing expenditures

In the UAF survey, respondents were asked to provide detailed information regarding expenses incurred on their most recent salmon and halibut fishing trips. The average daily expenditures for the fishers are weighted by fishing days for the fishing expenditures and total days spent on the trip for living expenses. Table 5 reports the average expenses incurred by respondents who sport fished in Cook Inlet during 1997 or 1998.

Table 5. Average daily expenditures for lower and central Cook Inlet sportfishing trips, by residency and sportfishing mode ($/day) [Lee et al. 1999a].

	Local*			Alaskan (non-local)			Nonresident		
	Shore	Private	Charter	Shore	Private	Charter	Shore	Private	Charter
Auto or Truck Fuel	7.82	7.82	7.82	14.57	12.99	15.81	9.34	7.81	8.08
Auto or RV Rental					0.39	3.97	28.91	2.92	18.92
Airfare					0.35	5.15	26.90	24.76	32.04
Other Transportation	0.70	0.70	0.70		1.31	1.83	0.93	2.30	2.33
Lodging	3.15	3.15	3.15	3.86	6.20	21.19	14.83	7.83	22.94
Groceries	8.00	8.00	8.00	12.43	14.44	13.76	7.47	10.72	9.93
Restaurant and Bar	10.74	10.74	10.74	3.43	9.58	13.95	10.20	6.65	9.63
Total Transportation and Lodging	30.41	30.41	30.41	34.29	45.26	75.66	98.58	62.99	103.87
Charter or Guide			112.86			116.40			140.75
Fishing Gear	2.14	7.12	2.00	4.50	5.53	3.58	20.00	17.12	15.50
Fish Processing		0.92	10.50		2.33	7.14	9.62	7.87	32.72
Derby		0.36	11.70		0.18	2.13	0.95	1.65	1.37
Boat Fuel and Repairs		15.89			31.53			15.76	
Moorage or Haul Out		8.36			5.48			9.00	
Total Fishing Expenditures	2.14	32.65	137.06	4.50	45.05	129.25	30.57	51.40	190.34
Total Non-Fishing Day Expenditures	30.41	30.41	30.41	34.29	45.26	75.66	98.58	62.99	103.87
Total Fishing Day Expenditures**	32.55	63.06	167.47	38.79	90.31	204.91	129.15	114.39	294.21

* For "local" expenditures, the aggregate non-fishing expenditures for all types of fishing were used because of the low number of total observations. For instance, the survey only had three observations of local residents' expenditures for shore-based fishing.
** Total expenditures on days fished are the sum of the fishing expenditures and the living expenditures which were averaged across the total days spent on a trip.

Mean transportation and living expenditures total $30.41 per day for local residents. Transportation and living expenses for other Alaskans ranged between $34.29 and $75.66 per day, and from $62.99 to $103.87 for nonresidents. Mean living expenditures were lower for nonresidents who fished off private vessels than for those who fished from shore or from charter boats, due in part to the fact that the primary trip purpose for many such respondents was to visit friends and family. However, not all of these base expenditures are spent on the Kenai Peninsula or elsewhere in Alaska.

Mean local fishing expenditures ranged between of $2.14 and $137.06. Alaskan (non-local) and nonresident fishing expenditure means varied from $4.50 to $129.25 and from $30.57 to $190.34, respectively. These expenditures varied greatly with the different type of sportfishing mode (Table 6).

Table 6. Average (across residency categories) daily expenditures for lower and central Cook Inlet sportfishing trips by sportfishing mode ($/day) [Lee et al. 1999a].

	Shore	Private	Charter
Auto or Truck Fuel	11.87	9.82	11.27
Auto or RV Rental	14.74	1.65	11.26
Airfare	13.72	12.77	18.44
Other Transportation	1.78	1.71	1.93
Lodging	9.32	6.59	20.79
Groceries	11.39	12.05	11.13
Restaurant and Bar	10.10	7.56	11.88
Total Non-Fishing Day Expenditures	72.92	52.14	86.70
Charter or Guide			128.64
Fishing Gear	12.21	11.58	9.53
Fish Processing	4.91	5.04	20.48
Derby	0.48	0.95	2.55
Boat Fuel and Repairs		22.21	
Moorage or Haul Out		7.52	
Total Fishing Day Expenditures	17.60	47.29	161.19
Total Daily Expenditures*	90.52	99.43	247.89

* Total expenditures on days fished are the sum of the fishing expenditures and the living expenditures which were averaged across the total days spent on a trip.

The mean fishing expenditure, across residents, for shore-based fishing was $17.60, for private boat $47.29, and $161.19 for charter. Mean daily living expenditures were $72.92, $52.14, and $86.70 for shore-based, private vessel-based, and charter-based recreators, respectively. Again, the relatively low expenditure level for private boat-based sportfishing is most likely due to the fact that many such individuals identified visiting Kenai Peninsula area friends or family as a primary trip purpose. The largest expenditures are associated with customers of the charter industry. Figure 14 shows the expenses for the charter industry by residency.

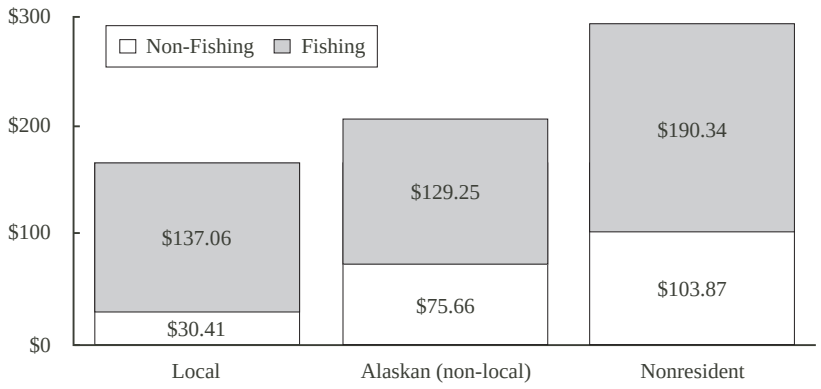


Figure 14. Mean daily expenditures, by residency category, for charter fishing in lower and central Cook Inlet [Lee et al. 1999a].

The next step in estimating the baseline expenditures for sportfishing effort in Cook Inlet is to estimate the distribution of these expenditures between the Kenai Peninsula, other Alaskan regions, and areas outside of Alaska. This question was not directly addressed in the UAF survey. The UAF survey asked about total expenditures, not a regional disaggregation of those expenditures. The following assumptions were used to disaggregate trip expenditures to the level of detail required for the impact model:

- *Auto and Truck Fuel.* Allocated proportionally by the number of days spent in each area.
- *Auto or RV Rental Fees.* All vehicle rental fees were assumed to have been paid in Alaska, but outside of the Kenai Peninsula (Anchorage or Fairbanks). This assumption may underestimate expenditures made on the Kenai Peninsula, but probably not too much since there were no reported rentals by Kenai Peninsula residents.
- *Airfare.* All airfare expenses were assumed to flow out-of-state. This assumption may underestimate expenditures in the Alaska portion of the study.
- *Lodging (trailer parks, campgrounds, hotels, motels, B&B, etc.).* Allocated proportionally by the number of days spent in each area.
- *Food and Drink (Groceries) purchased at grocery or convenience stores.* Allocated proportionally by the number of days spent in each area.
- *Food and Drink purchased at restaurants or bars.* Allocated proportionally by the number of days spent in each area.
- *Guides or Charter Fees.* Assumed to have been incurred on the Kenai Peninsula.
- *Fishing Gear (bought only for this trip).* We assumed that non-local Alaskans purchased 75% of reported fishing gear on the Kenai Peninsula and 25% elsewhere in Alaska and that nonresidents and locals purchase 100% on the Kenai Peninsula. This is a pretty arbitrary assumption. While it is likely that nonresidents purchase the majority of their gear on site, some gear may be purchased in their home states or elsewhere in Alaska. Alaskans will have a better idea of what gear is needed for sportfishing in Cook Inlet and may purchase a substantial amount of gear before traveling to the Kenai Peninsula. Locals are assumed to have purchased most of their gear for this particular trip on site. Because the gear purchase questions were specific to the most recent trip, most larger purchases that may be made outside of Alaska, like fishing rods, will have previously been made and not be reported here.

- *Fish Processing and Packing Fees.* Assumed to have been made on the Kenai Peninsula.
- *Fishing Derby Entry Fees.* Assumed to have been incurred on the Kenai Peninsula.
- *Boat Fuel, Lubricants, and Repairs.* Again, a somewhat arbitrary assumption that any locals and other Alaskans buy 75% of their boat fuel on the Kenai Peninsula and 25% elsewhere in Alaska.
- *Moorage and Haul Out Fees.* Assumed to have been made on the Kenai Peninsula.
- *Other Transportation.* (*for example, cruises, bus tours, etc.*). A relatively minor expense that is assumed to flow out of Alaska.

Days spent on the Kenai and in Alaska

The UAF survey asked recreational fishers how many days they fished on their last trip, the number of days of that trip spent on the Kenai Peninsula, and how many days were spent away from their principal residence. Unfortunately, for nonresidents, the survey did not differentiate between the trip days spent elsewhere in Alaska and those spent outside of Alaska. To estimate this we assumed that nonresidents who flew spent all of their time in Alaska (flew directly to Alaska) while those that drove spent some of their trip-days outside of Alaska. Table 7 shows the amount of time spent on the entire trip per fishing day for the three different sportfishing modes for nonresidents who did and did not fly.

Table 7. Ratios of trip length to lower and central Cook Inlet fishing-day for nonresidents by travel and sportfishing mode [Lee et al. 1999a].

	Overall Mean	Mean for Fliers	Mean for Non-Flyers	% that Flew
Shore	8.29	3.15	16.63	50%
Private	4.76	3.94	5.94	64%
Charter	7.63	4.89	11.56	63%

To estimate the amount of time spent in Alaska (Kenai and non-Kenai portions) for nonresidents we assumed that the amount of time spent in Alaska per fishing day by tourists who drove to be the same as that amount spent by tourists who flew. Therefore, we assume that whether a nonresident flew or not s/he spent 3.15 days, on average, in Alaska for each shore-based fishing day (inclusive of the fishing day), 3.94 for those fishing in private boats, and 4.89 for those fishing on charters (Table 8).

Table 8. Ratios of total days spent on the Kenai and elsewhere in Alaska per lower and central Cook Inlet fishing day [Lee et al. 1999a].

		Shore	Private	Charter
Kenai Days/Fishing Day	Local	1.29	1.00	1.00
	Alaskan (non-local)	1.03	1.45	1.73
	Nonresident	2.00	2.92	2.03
Other Alaska Days/Fishing Day	Local	0.00	0.00	0.00
	Alaskan (non-local)	0.06	0.00	0.52
	Nonresident	1.15	1.02	2.86

So, for instance, the UAF survey reported nonresidents to have spent 2.03 days on the Kenai for each day fished inclusive of the day fished. We assume that nonresident charter-based sport fishers spend 4.89 days in Alaska per day fished so we calculate the time spent in Alaska outside of the Kenai to be the difference of 2.86 days.

Total expenditures assuming that all trip expenditures are attributable to fishing

Baseline expenditure estimates were obtained by combining the estimated daily expenditures and the estimated time spent per fishing day, and allocating these expenditures among regions. Tables 9, 10, and 11 report 1997 expenditure estimates for Kenai Peninsula residents who participated in Cook Inlet salmon and halibut fisheries. Tables 12, 13, and 14 report estimated expenditures for Alaskans living outside the Kenai Peninsula area that participated in Cook Inlet salmon and halibut fisheries. Tables 15, 16, and 17 include estimated expenditures by nonresidents. Table 18 summarizes the individual expenditures across residency category. Table 19 summarizes the total expenditures by residency category and sportfishing mode.

Table 9. Total expenditures by local residents fishing for halibut and salmon from the lower and central Cook Inlet shore [Lee et al. 1999a].

	Days			Expenditures ($)					
	Ratio	% of Total	Total	$/Day	Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	1.000	6.5%	12,861						
Days spent on Kenai[1]	1.290		16,591						
Days spent in Alaska[2]	0.000								
Auto				7.82		129,739			129,739
RV									
Lodge				3.15		52,261			52,261
Groceries				8.00		132,726			132,726
Restaurant & Bar				10.74		178,184			178,184
Charter									
Gear				2.14	27,523				27,523
Processing									
Derby									
Boat Fuel									
Haul									
Total					27,523	492,909			520,432

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 10. Total expenditures by local residents fishing for halibut and salmon from private boats in lower and central Cook Inlet [Lee et al. 1999a].

	Days			Expenditures ($)					
	Ratio	% of Total	Total	$/Day	Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	1.000	14.4%	28,498						
Days spent on Kenai[1]	1.000		28,498						
Days spent in Alaska[2]	0.000								
Auto				7.82		222,854			222,854
RV									
Lodge				3.15		89,769			89,769
Groceries				8.00		227,984			227,984
Restaurant & Bar				10.74		306,069			306,069
Charter									
Gear				7.12	202,906				202,906
Processing				0.92	26,218				26,218
Derby				0.36	10,259				10,259
Boat Fuel				15.89	452,833				452,833
Haul				8.36	238,243				238,243
Total					930,460	846,676			1,777,135

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 11. Total expenditures by local residents fishing for halibut and salmon from charter boats in lower and central Cook Inlet [Lee et al. 1999a].

	Days			Expenditures ($)					
	Ratio	% of Total	Total	$/Day	Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	1.000	3.8%	7,518						
Days spent on Kenai[1]	1.000		7,518						
Days spent in Alaska[2]	0.000								
Auto				7.82		58,791			58,791
RV									
Lodge				3.15		23,682			23,682
Groceries				8.00		60,144			60,144
Restaurant & Bar				10.74		80,743			80,743
Charter				112.86	848,481				848,481
Gear				2.00	15,036				15,036
Processing				10.50	78,939				78,939
Derby				11.70	87,961				87,961
Boat Fuel									
Haul									
Total					1,030,417	223,360			1,253,777

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 12. Total expenditures by Alaskan (non-local) residents fishing for halibut and salmon from the lower and central Cook Inlet shore [Lee et al. 1999a].

	Days			Expenditures ($)					
	Ratio	% of Total	Total	$/Day	Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	1.00	2.4%	4,767						
Days spent on Kenai[1]	1.03		4,910						
Days spent in Alaska[2]	0.06		286						
Auto				14.57		71,539		4,167	75,706
RV									
Lodge				3.86		18,953		1,104	20,057
Groceries				12.43		61,031		3,555	64,587
Restaurant & Bar				3.43		16,841		981	17,822
Charter									
Gear				4.50	16,089		5,363		21,452
Processing									
Derby									
Boat Fuel									
Haul									
Total					16,089	168,364	5,363	9,808	199,623

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 13. Total expenditures by Alaskan (non-local) residents fishing for halibut and salmon from private boats in lower and central Cook Inlet [Lee et al. 1999a].

	Days			Expenditures ($)					
	Ratio	% of Total	Total	$/Day	Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	1.00	18.8%	37,044						
Days spent on Kenai[1]	1.45		53,714						
Days spent in Alaska[2]	0.00								
Auto				12.99		697,742			697,742
RV				0.39				20,948	20,948
Lodge				6.20		333,026			333,026
Groceries				14.44		775,627			775,627
Restaurant & Bar				9.58		514,578			514,578
Charter									
Gear				5.53	153,640		51,213		204,853
Processing				2.33	86,313				86,313
Derby				0.18	6,668				6,668
Boat Fuel				31.53	875,998		291,999		1,167,997
Haul				5.48	203,001				203,001
Total					1,325,620	2,320,973	343,213	20,948	4,010,754

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 14. Total expenditures by Alaskan (non-local) residents fishing for halibut and salmon from charter boats in lower and central Cook Inlet [Lee et al. 1999a].

	Days			Expenditures ($)					
	Ratio	% of Total	Total	$/Day	Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	1.00	10.1%	19,898						
Days spent on Kenai[1]	1.73		34,424						
Days spent in Alaska[2]	0.52		10,347						
Auto				15.81		544,236		163,585	707,822
RV				3.97				177,739	177,739
Lodge				21.19		729,435		219,252	948,687
Groceries				13.76		473,668		142,374	616,042
Restaurant & Bar				13.95		480,208		144,340	624,548
Charter				116.40	2,316,127				2,316,127
Gear				3.58	53,426		17,809		71,235
Processing				7.14	142,072				142,072
Derby				2.13	42,383				42,383
Boat Fuel									
Haul									
Total					2,554,008	2,227,547	17,809	847,291	5,646,654

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 15. Total expenditures by nonresidents fishing for halibut and salmon from the lower and central Cook Inlet shore [Lee et al. 1999a].

	Days			Expenditures ($)					
	Ratio	% of Total	Total	$/Day	Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	1.00	5.2%	10,202						
Days spent on Kenai[1]	2.00		20,404						
Days spent in Alaska[2]	1.15		11,732						
Auto				9.34		190,573		109,580	300,153
RV				28.91				929,060	929,060
Lodge				14.83		302,591		173,990	476,581
Groceries				7.47		152,418		87,640	240,058
Restaurant & Bar				10.20		208,121		119,669	327,790
Charter									
Gear				20.00	204,040				204,040
Processing				9.62	98,143				98,143
Derby				0.95	9,692				9,692
Boat Fuel									
Haul									
Total					311,875	853,703		1,419,940	2,585,518

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 16. Total expenditures by nonresidents fishing for halibut and salmon from private boats in lower and central Cook Inlet [Lee et al. 1999a].

	Days			Expenditures ($)					
	Ratio	% of Total	Total	$/Day	Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	1.00	13.0%	25,597						
Days spent on Kenai[1]	2.92		74,743						
Days spent in Alaska[2]	1.02		26,109						
Auto				7.81		583,745		203,911	787,656
RV				2.92				294,488	294,488
Lodge				7.83		585,240		204,433	789,673
Groceries				10.72		801,248		279,888	1,081,135
Restaurant & Bar				6.65		497,043		173,624	670,667
Charter									
Gear				17.12	438,221				438,221
Processing				7.87	201,448				201,448
Derby				1.65	42,235				42,235
Boat Fuel				15.76	403,409				403,409
Haul				9.00	230,373				230,373
Total					1,315,686	2,467,274		1,156,344	4,939,305

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 17. Total expenditures by nonresidents fishing for halibut and salmon from charter boats in lower and central Cook Inlet [Lee et al. 1999a].

	Days			Expenditures ($)					
	Ratio	% of Total	Total	$/Day	Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	1.00	25.9%	51,171						
Days spent on Kenai[1]	2.03		103,877						
Days spent in Alaska[2]	2.86		146,349						
Auto				8.08		839,327		1,182,500	2,021,828
RV				18.92				4,734,280	4,734,280
Lodge				22.94		2,382,941		3,357,247	5,740,189
Groceries				9.93		1,031,500		1,453,246	2,484,746
Restaurant & Bar				9.63		1,000,337		1,409,341	2,409,678
Charter				140.75	7,202,318				7,202,318
Gear				15.50	793,151				793,151
Processing				32.72	1,674,315				1,674,315
Derby				1.37	70,104				70,104
Boat Fuel									
Haul									
Total					9,739,888	5,254,105		12,136,615	27,130,608

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 18. Total expenditures by all sport fishers fishing for halibut and salmon in lower and central Cook Inlet [Lee et al. 1999a].

	Days	Expenditures ($)				
		Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	197,556					
Days spent on Kenai[1]	344,678					
Days spent in Alaska[2]	194,823					
Auto			3,338,547		1,663,744	5,002,291
RV					6,156,516	6,156,516
Lodge			4,517,896		3,956,027	8,473,923
Groceries			3,716,345		1,966,704	5,683,049
Restaurant & Bar			3,282,124		1,847,956	5,130,080
Charter		10,366,927				10,366,927
Gear		1,904,030		74,385		1,978,415
Processing		2,307,448				2,307,448
Derby		269,302				269,302
Boat Fuel		1,732,240		291,999		2,024,239
Haul		671,617				671,617
Total		17,251,564	14,854,913	366,384	15,590,946	48,063,807

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 19. Total expenditures by all sportfishers for halibut and salmon in lower and central Cook Inlet, by residency and sportfishing mode [Lee et al. 1999a].

		Fishing ($)	Non-Fishing ($)	Total ($)
Residency				
	Local	1,988,399	1,562,945	3,551,344
	Alaska	4,262,100	5,594,931	9,857,032
	Nonresident	11,367,449	23,287,982	34,655,431
	Total	17,617,949	30,445,859	48,063,807
Fishing Mode				
	Shore	360,849	2,944,724	3,305,574
	Private	3,914,978	6,812,216	10,727,194
	Charter	13,342,122	20,688,918	34,031,040
	Total	17,617,949	30,445,859	48,063,807

To this point, it has been assumed that all of the living and traveling expenditures (reported in Tables 9–19) will have been incurred as a direct result of the respondents' desire to fish for salmon and halibut in lower and central Cook Inlet. Obviously, this is not the case. Some travelers would have taken the Alaska and Kenai trips, and incurred some of the same expenditures, even if the sportfishing opportunities had been unavailable or less attractive. For example, visitors on business trips may well have visited Alaska whether or not they were planning to fish on the Kenai. It is fairly accurate to assume that fishing expenses would not have been incurred if the respondents had not fished, but assumptions about whether the trip would have been taken, and whether the other living and traveling expenses would have been incurred, are less certain.

The baseline scenario incorporates the nine sets of total expenditures representing the three residency categories and three sportfishing modes. These expenditures are totaled and summarized in Table 18. Total expenditures for salmon and halibut sportfishing-related activities in lower and central Cook Inlet are estimated to have been $48.1 million during 1997: $17.2 million in direct fishing expenditures and $14.9 million in living and traveling expenditures on the Kenai Peninsula, and $0.5 million in fishing expenditures and $15.6 million in living and traveling expenditures elsewhere in Alaska. That is, the lower and central Cook Inlet sport fisheries resulted in a total of $32.2 million in direct expenditures on the Kenai Peninsula and $16.0 million elsewhere in Alaska.

The largest category of direct fishing expenditures was Guide and Charter Fees, which totaled $10.4 million. Processing, Boat Fuel, and Gear accounted for $2.0 to $2.3 million each. The single largest category of living expenses, Lodging, is estimated to have exceeded $8.5 million. All other expenses ranged between $5.0 and $6.2 million.

Table 19 summarizes total expenditures by residency category and sportfishing mode. Nonresidents are estimated to have spent $34.7 million (72.1%) of the total. Fishing and living expenditures attributable to sportfishing activities supported by the charter industry were responsible for 70.8% of the total expenditures ($34.0 million). Expenditures attributable to private boat and shore-based sportfishing were estimated at $10.7 million and $3.3 million, respectively.

Total expenditures assuming that some trip expenditures are not attributable to fishing

There are many reasons for visiting the Kenai Peninsula. Respondents to the UAF survey [Lee et al. 1999b] who fished for halibut or salmon in lower and central Cook Inlet reported nine primary trip purposes (Table 20).

Table 20. Primary purpose of trip to Alaska [Lee et al. 1999a].

	All	Alaskans (non-local)	Nonresidents
Fishing for halibut or salmon in Cook Inlet	63.5%	87.9%	43.0%
Visit/Vacation Alaska	14.3%	2.9%	24.4%
Kenai area freshwater fishing	8.7%	1.7%	12.0%
Visit relatives	7.0%	5.2%	11.2%
Business	2.5%	1.2%	3.7%
Saltwater/Freshwater fishing	1.6%	0.0%	2.5%
Visit friends	0.9%	1.2%	0.4%
Cruise ship	0.7%		1.2%
Hunting	0.9%		1.7%

The majority (63.5%) of respondents identified fishing for halibut or salmon in lower and central Cook Inlet as the primary purpose of their most recent trip. This response was even more pronounced for non-local Alaskans, 87.9% of whom listed fishing for halibut or salmon as the main reason for their trip. However, less than half of the nonresidents (43%) identified fishing for halibut or salmon in lower and central Cook Inlet as the primary motive of their trip. Another important reason (24.4%) for nonresident trips was simply to visit and vacation in Alaska. Freshwater fishing and visiting relatives were also important motives for nonresidents.

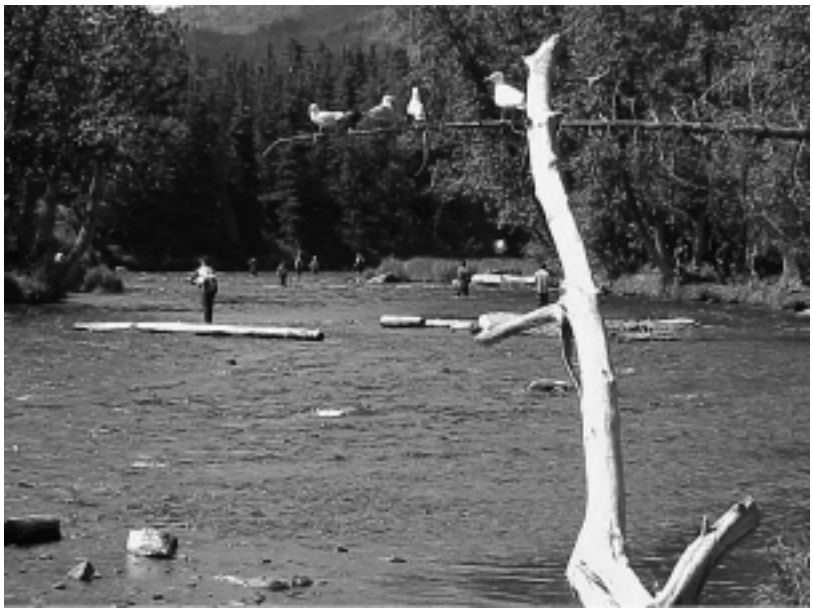


Figure 15. Salmon fishing on the Russian River. Freshwater fishing ranked third highest among reasons for taking a trip that included fishing for halibut or salmon in lower and central Cook Inlet.

Because there is not an exact correspondence between visits to the Kenai Peninsula and the desire to fish for halibut or salmon, it was necessary to adjust the total expenditure estimates to reflect those expenditures that are uniquely attributable to fishing in lower and central Cook Inlet. Consequently, we adopted a set of assumptions regarding what respondents would do if the lower and central Cook Inlet sportfishing portion of their trip were cancelled (Table 21).

Table 21. Assumed response to cancellation of the lower and central Cook Inlet sportfishing portion of their trip.

Main Trip Purpose	Alaskans (non-local)	Nonresidents
Fishing for halibut or salmon in Cook Inlet	Cancel entire trip	Cancel entire trip
Visit/Vacation in Alaska (non-Kenai focus)	Replace Kenai trip days with days in other parts of Alaska	Replace Kenai trip days with days in other parts of Alaska
Visit relatives	Take full trip	Take full trip
Freshwater fishing on Kenai Peninsula	Reduce trip length by lost marine fishing days	Reduce trip length by lost marine fishing days
Business trip	Take full trip	Take full trip
Combined marine/freshwater fishing	Reduce trip length by lost marine fishing days	Reduce trip length by lost marine fishing days
Visit friends	Take full trip	Take full trip
Cruise ship	No observations	Take full trip
Hunting	No observations	Take full trip

To estimate the amount of reduction in time spent on the Kenai and in Alaska for reduced fishing effort we re-ran the scenarios in Table 19 for the number of days fished (instead of number of people), days spent on the Kenai Peninsula, and days spent in Alaska. We then combined this data with the assumptions in Table 21 to estimate the reduction in expenses associated with a reduction in lower and central Cook Inlet sportfishing effort (Table 22).

Table 22. Reduction in fishing or visitation rates for a 100% reduction in fishing effort (days).

	Locals	Alaskans (non-local)	Nonresidents
Fishing Reduction	100%	100%	100%
Kenai Living Expenses	100%	89.5%	64.0%
Alaska Living Expenses	100%	57.3%	23.8%

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 attributable to the lower and central Cook Inlet halibut and salmon-fishing activity. These percentages can also be used to estimate the amount of the baseline expenditures attributable to the fishing component of the trip assuming a dollar for dollar expenditure pattern with days spent in Alaska[5]. The calculations in Table 22 indicate that, for Alaskans, nearly 90% of the Kenai Peninsula area living and transportation expenditures can be attributed to the fishing component of the trips as can 57.3% of the living and transportation expenditure in Alaska. 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 but that only 23.8% of the total expenditures in Alaska are directly attributable to the fishing component of the trip.

Using the assumptions in Table 22 we revised the expenditure tables (Tables 9–19) to reflect the estimated actual expenditures that are strictly attributable to halibut and salmon sportfishing trips in lower and central Cook Inlet. Only the recalculations of Tables 18 and 19 for the adjusted expenditures are produced here (Tables 23 and 24). The calculations to derive the trip adjusted expenditures, as well as a complete set of trip adjusted expenditure tables, can be found in the Appendix to Section 3.

[5] There is still the issue, for living expenditures, of whether Alaskans would have spent some portion of these amounts to live and do other things on the lost fishing days. We assume that most of these living expenditures are trip specific but there is likely to be some overlap with what they would have spent on living and doing an alternative activity. This issue will be discussed in Section 5.

Table 23. Total expenditures by all sport fishers fishing for halibut and salmon in lower and central Cook Inlet that are directly attributable to the saltwater halibut and salmon fishing trip.

	Days[1]	Expenditures ($)				
		Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	197,556					
Days spent on Kenai[2]	263,260					
Days spent in Alaska[3]	49,930					
Auto			2,619,715		452,168	3,071,883
RV					2,697,502	2,697,502
Lodge			3,226,870		1,015,354	4,242,224
Groceries			2,864,102		516,962	3,381,063
Restaurant & Bar			2,561,923		488,496	3,050,419
Charter		10,366,927				10,366,927
Gear		1,904,030		74,385		1,978,415
Processing		2,307,448				2,307,448
Derby		269,302				269,302
Boat Fuel		1,732,240		291,999		2,024,239
Haul		671,617				671,617
Total		17,251,564	11,272,610	366,384	5,170,482	34,061,041

[1] Days are the number of days spent that are attributable to the saltwater fishing portion of the trip.
[2] Includes days fished on the Kenai Peninsula.
[3] Excludes days spent on the Kenai Peninsula.

Table 24. Expenditures attributable to sportfishing for halibut and salmon in lower and central Cook Inlet, by residency and sportfishing mode [Lee et al. 1999a].

		Fishing ($)	Non-Fishing ($)	Total ($)
Residency				
	Local	1,988,399	1,562,945	3,551,344
	Alaska	4,262,100	4,775,483	9,037,583
	Nonresident	11,367,499	10,104,664	21,472,113
	Total	17,617,949	16,443,092	34,061,041
Fishing Mode				
	Shore	360,849	1,770,663	2,131,512
	Private	3,914,978	4,884,698	8,799,675
	Charter	13,342,122	9,787,732	23,129,853
	Total	17,617,949	16,443,092	34,061,041

Using the estimate of living and transportation expenditures attributed directly to the lower and central Cook Inlet halibut and salmon sportfishing trip reduced our estimate of total expenditures from $48.1 million to $34.1 million. This $14.0 million reduction comes from the living and transportation expenditure reductions of $3.6 million on the Kenai and $10.4 million from elsewhere in Alaska. Table 24 indicates that nonresidents continue to contribute the majority of the spending (63.4%) and that participants in the charter industry are responsible for 68.3% of the total spending by sportfishing mode.

4. Participation Rate Model

Changes in fishery regulations, environmental quality, and resource abundance, as well as trip costs, can affect the expected net benefit associated with sportfishing, and therefore the decision to participate in (take) a sportfishing trip. Consequently, the ability to forecast changes in participation rates is important in many policy settings. Previous studies have used 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 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 directly to regulatory control and changing environmental conditions. 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 Lee et al. [1999b]. The survey was developed and administered following the Total Design Method [Dillman 1978]. Surveys were mailed to a random sample of 4,000 sport fishers drawn from the population of U.S. residents who purchased 1997 Alaska State sportfishing licenses. Alaskans comprised 49.3% of the sample, closely resembling their actual license sales proportion (49.7%). Sampled license holders received one of nine versions of the survey during the first mailing, followed by a reminder card. Non-respondents were sent a second survey 14 days after the initial survey was mailed. 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 was mailed. All survey mailings contained a cover letter, a prize entry card (to increase the response rate), a business reply envelope, and survey. A total of 2,640 completed, or partially completed, surveys were returned for an overall response rate of 70.1% based on delivered surveys. For more details and summary of the survey see Lee et al. [1999b].

In addition to being asked to provide information about various economic and demographic variables and actual trips taken, 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 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 complementary effects across attributes, and for the possibility of nonlinear marginal utility. Substitution and complementary effects refers to the catch of one species either diminishing or increasing the utility derived from the catch of the other species. Nonlinear marginal utility refers to economic theory that would predict that the utility derived from each additional catch diminishes. Therefore, the landing of the first halibut on a trip would give more satisfaction than the landing of the second halibut all else (like the halibut weight) equal. 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 [Howe et al. 1998] and pretest discussions with recreational fishers. Table 25 lists the attribute levels used in the Lee et al. [1999b] survey.

Table 25. Hypothetical trip attribute levels.

Attribute	Level			
Cost per day ($)	100	170	240	
Halibut catch per day	0	2	4	6
Average halibut weight (lbs.)	0	20	40	80
Chinook salmon catch per day	0	1	2	
Average chinook salmon weight (lbs.)	0	15	25	50
Coho salmon catch per day	0	2	4	6
Average coho salmon weight (lbs.)	0	7		

These attribute levels combine to describe 4,608 unique trips[6]. However, some of these hypothetical trips are nonsensical or highly improbable and were dropped from consideration. For example, trips where no fish are caught, but the average weight is positive are nonsensical. Similarly, trips with positive catches of all three species during one day are implausible. The SAS Optex procedure was used to rank experimental designs based on the D-optimality criterion. The D-optimality criterion maximizes the determinant of the information matrix, $\mathbf{X'X}$. Block designs with large D-optimality scores have a greater potential for elucidating the effect of individual attributes. Block designs where at least one trip was dominated by at least one other trip were dropped from further consideration.[7] While this approach has the advantage of maximizing the information content of the stated preference observations, it does not allow testing of the transitivity of preferences. Based on projected survey returns and the need to conserve degrees of freedom, nine three-trip blocks (27 unique trips) were selected for use in the survey. Each of the 4,000 surveys was randomly assigned one of the nine blocks of three hypothetical trips. This design results in a panel data set with multiple observations on each respondent's participation decisions.

Econometric model

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

$$u_{it} = f(x_{it}, z_i, \beta, \gamma) + e_{it} \,. \tag{2}$$

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

$$u_{i0} = f(0, z_i, \beta, \gamma) + e_{i0} \tag{3}$$

[6] The product of the number of categories of each attribute: 3 cost levels, 4 halibut catch levels, 4 halibut average sizes, 3 chinook catch levels, 4 chinook average sizes, 4 coho catch levels, and 2 coho average sizes.

[7] In determining dominance, it was assumed that: catches of large fish are preferred to catches of small fish (within a species); catches of more fish are preferred to catches of fewer fish (within a species); and that lower cost trips are preferred to higher cost trips (when the trips are equal in all other characteristics).

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

$$
\begin{aligned}
\mathrm{P}\left[y^* = 1 \mid x_{it}, z_i\right] &= \mathrm{P}\left[u_{it} \geq u_{i0}\right] \\
&= \mathrm{P}\left[f(x_{it}, z_i, \beta, \gamma) + e_{it} \geq f(0, z_i, \beta, \gamma) + e_{i0}\right] \\
&= \mathrm{P}\left[f(x_{it}, z_i, \beta, \gamma) - f(0, z_i, \beta, \gamma) + e_{it} - e_{i0} \geq 0\right] \\
&= \mathrm{P}\left[f(x_{it}, z_i, \beta, \gamma) - f(0, z_i, \beta, \gamma) + \varepsilon_{it} \geq 0\right]
\end{aligned}
\tag{4}
$$

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

Several econometric models are appropriate for binary choice panel data. The two most widely applied are the fixed effects model [Chamberlain 1982] and the random effects model [Butler and Moffitt 1982]. The fixed effects model assumes that individual heterogeneity must be captured by 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 individuals' responses are correlated with themselves. 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, z_i), while the fixed effect model does not.

The random effects model assumes that the error term in Equation 4 is the sum of two independently distributed components: one (μ_{it}) that varies across individuals and trips and another (v_i) that only varies across individuals. That is, $\varepsilon_{it} = \mu_{it} + v_i$, where each component is from an independent normal distribution with zero mean and unit variance. The model is therefore called a random effects probit model[8]. The μ_{it} are usually assumed to have constant correlation across t, an assumption that greatly reduces dimensionality of the problem, and requires the estimation of only one additional parameter, $\rho = Corr(\varepsilon_{it}, \varepsilon_{ir,})$, the correlation for an individual across trips. The presence of a statistically significant random effect can be tested using the estimated t-ratio[9] for ρ. 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.

Coefficient estimates

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. The socioeconomic data provided

[8] A probit model is an abbreviation for "probability unit" model [Aldrich and Nelson 1984]. A binary probit model is used to estimate the nonlinear functional form (nonlinear in the parameters) where the probability of choosing an event ranges between 0 and 1 and the cumulative distribution function is assumed standard normal.

[9] The number of standard errors away from zero.

by the respondents included household after-tax income, gender (a binary indicator variable equal to one if the individual is male and zero otherwise), age (years), education (a binary indicator variable equal to one if the individual is a college graduate), and a categorical variable to differentiate between Alaskan residents and nonresidents. Summary statistics for these variables are presented in Table 26.

Table 26. Statistical summary of respondents' socioeconomic characteristics [Lee et al. 1999a].

	Alaskans N=158				Nonresidents N=194			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Per Capita Household Income	$21,580	$12,660	$200	$70,000	$28,140	$17,020	$2,500	$110,000
Gender (1=male)	0.734	0.443	0	1	0.753	0.433	0	1
Age	42.373	11.982	17	74	48.139	14.321	16	83
Education (1=college graduate)	0.348	0.478	0	1	0.500	0.501	0	1
Days Fished	9.101	11.905	1	63	4.229	5.025	1	48

Utility was modeled as a hybrid quadratic function to allow for non-constant marginal utility and substitution/complementarity effects across species, because it can readily accommodate socioeconomic variables, and because polynomial models are linear in the parameters. Catch and average size were combined to create an instrumental variable (w) representing the weight of the fish measured in pounds. 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 $Halibut^2$ (the catch and squared-catch of halibut, respectively) were included to allow for additional variation that was due to catch alone.[10] P denotes the cost of a fishing trip. The model to be estimated, including the demographic variables is

$$(5) \qquad y_{it}^{*} = \beta_0 + \sum_s \beta_s w_{it,s} + \sum_j \sum_s \lambda_s w_{its} w_{itj} + \pi_P P + \pi_{HC} Halibut + \pi_{HC^2} Halibut^2 + \sum_l \gamma_l z_{il}$$

where s and j index species (halibut, chinook, coho), and z_l are categorical variables representing *Per Capita Household Income*, *Gender*, *Age*, and *Education* and β, λ, and π are the associated parameters to be estimated.

Equation 5 was estimated along with indicator variables to differentiate between Alaskans and nonresidents.[11] Because the same general study design was presented to each group, we only estimate one random effect parameter.[12]

[10] Variables for coho and chinook catch were not included because there was only one size category for coho salmon and only two catch levels for chinook, consequently catch and size are highly collinear with weight.

[11] The p-value on the null hypothesis that all parameters are the same across Alaskans and nonresidents is 0.18. Although not statistically significant, we have chosen to model the Alaskans and nonresidents separately because many of the individual and grouped parameters are statistically different from each other and the evaluation of certain policy considerations necessitates separate estimates.

[12] Furthermore, the p-value for the null hypothesis that $\rho_{AK} = \rho_{other\ US}$ is 0.52 (χ^2= 0.4134 with 1 degree of freedom), indicating that it is unlikely that they do not share a common random effect parameter (a χ^2= 3.85 would yield a p-value of 0.05 for example).

The model was estimated with Limdep 7.0 for Windows [Greene 1998]. The estimated coefficients are reported in Table 27. 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. A total of 35 parameters were estimated. Fifteen of the parameters are significantly different from zero at the 1% level, ten additional parameter estimates are significant at the 5% level and two are significant at the 10% level. The point estimates of the parameters accord well with economic theory. The price coefficient is negative, as expected, indicating a downward sloping demand curve for recreational fishing. The coefficients on halibut, chinook salmon, and coho salmon weights and halibut catches are all positive, indicating that each variable increases the demand for trips, all else equal. 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 and 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.

Table 27. Random effects probit model parameter estimates.

	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*
Halibut^2	–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*

*Significantly greater (less) than zero at $p \leq 0.05$.[13]

[13] The log-likelihood at convergence is the value of the log-likelihood function for this model 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. The McFadden R^2 is $1 - LL_m / LL_0$, where LL_m is the value of the log-likelihood function from the model, and LL_0 is the value of the log-likelihood function with all of the slope coefficients set at zero. This is used as a measure of the model's fit. The Veall and Zimmermann measure is:

$$\frac{(LL_m - LL_0)}{(LL_m - LL_0) + N} \Big/ \frac{-2LL_0}{(N - 2LL_0)}$$

where N is the total number of observations [see Veall and Zimmermann 1996].

Simulation model

Every change that affects expected trip attributes such as species mix, number, or size of fish caught 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. For the purposes of the impact assessment model we have grouped recreational fishers into categories according to residency (locals, non-local Alaskans, and nonresidents) and sportfishing mode (charter, private, shore). Thus, we model nine distinct expenditure patterns. For the participation model this type of disaggregation was not possible because respondents to the stated preference questions were not segregated by sportfishing mode. Consequently, the participation rate model forecasts do not differentiate between charter, private, or shore sportfishing modes. Future studies may benefit from a finer level of disaggregation.

Answers to the UAF survey questions regarding respondents' most recent lower and central Cook Inlet halibut or salmon sportfishing trip were used to calculate the average trip attributes by residency category. To ensure that the data were current, we only used observations from recreators who took a trip in 1997 or 1998. Our survey was administered in the middle of the fishing season in 1998. Of the survey respondents who fished in 1997 or 1998, 73% of the respondents listed 1997 as their most recent trip and 27% listed 1998. The 1997 trips would tend to be near the end of the season while the 1998 trips represent early season trips. This may skew the information for the fishery toward the end of the year somewhat, especially for Alaskans who may take multiple trips. Figure 16 shows the seasonal distribution of most recent trips.

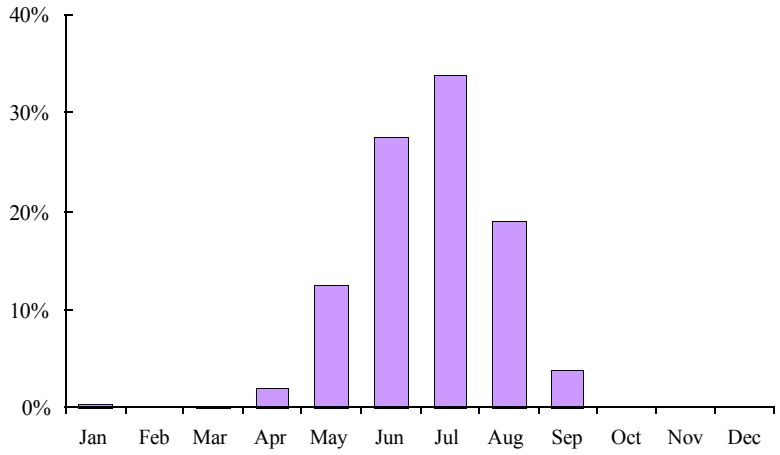


Figure 16. Month in which survey respondents took their most recent trip [Lee et al. 1999b].

Table 28 summarizes average fishing costs, mean catches, retained catches, and average weights for halibut, chinook, and coho, derived from the Lee et al. [1999b] survey. For instance, the mean (across sportfishing modes and target species) nonresident fishing trip for halibut in Cook Inlet resulted in a catch of 2.43 halibut, of which 1.04 fish were retained and 1.40 released.

Table 28. Mean attributes of lower and central Cook Inlet sportfishing trips [Lee et al. 1999a].

			Alaskans (local and non-local)	Nonresident
Fishing Cost			$56.52	$130.71
Halibut	Retained		0.72	1.04
	Released		0.98	1.40
	Total caught		1.71	2.43
		Average weight (lbs.)	34.18	42.66
Chinook	Retained		0.08	0.11
	Released		0.11	0.04
	Total caught		0.19	0.14
		Average weight (lbs.)	28.34	30.87
Coho	Retained		0.05	0.13
	Released		0.01	0.18
	Total caught		0.06	0.31
		Average weight (lbs.)	10.60	9.60

The first row is the mean fishing cost per fishing-day. This is the cost calculated by combining the expenditure data from the UAF survey (Table 5) with the percent of effort by sportfishing mode derived from the ADF&G survey (Table 4). For example, the mean cost of a nonresident sportfishing-day ($130.71) is the product of the nonresident charter trip percentage (58.9%)[14] and the mean cost of a charter-based nonresident sportfishing-day ($190.34), plus the product of the nonresident private boat sportfishing trip percentage (29.6%) and the mean cost of a private boat based nonresident sportfishing-day ($51.40), plus the product of the shore-based trip percentage (11.8%) and the mean cost of a shore-based sportfishing-day ($30.57). Alaskan trips are 32.3% charter, 60.2% private, and 7.5% shore. The smaller fishing costs for Alaskans ($56.52) reflects a lesser reliance on charter trips as well as lower trip costs across sportfishing modes. Fishing expenditures are directly related to the sportfishing trip and include the cost of the charter (including tipping), fishing gear, fish processing, derby fees, boat repairs, moorage fees (and haul out) and miscellaneous expenditures, but do not include living expenses. Finally, average weights are reported for each category. It is interesting to note nonresidents report halibut catches that are, on average, 9 pounds heavier than those reported by residents.[15]

The data in Table 28 can be disaggregated by residency category and sportfishing model (Appendix to Section 4) or at other levels of aggregation to facilitate comparisons with other surveys. For example, it is interesting to compare the charter catch estimates from the UAF and ADF&G surveys, and the halibut charter logbook program (Tables 29 and 30).

[14] From Table 4, the percent of nonresident trips that are charter based is the percent of nonresident charter trips divided by the percent of trips taken by nonresidents: 58.9% = 25.9% / 44.0%

[15] This difference could reflect a greater reliance on charter services (larger boats able to fish deeper water and more experienced skippers), or biased estimates of weight.

Table 29. Average daily charter halibut catch* for all Kenai Peninsula sport fishers [Herrmann et al. 2001].

		Charter	95% Confidence Interval
UAF survey	Retained	1.20	1.12 to 1.28
	Released	1.71	1.32 to 2.10
	Total catch	2.91	2.49 to 3.33
ADF&G survey	Retained	1.24	
	Released	1.35	
	Total catch	2.59	

*For trips where a variety of species are targeted.

Table 30. Average daily charter halibut catch* for all Kenai Peninsula sport fishers to the west of Gore Point [Herrmann et al. 2001].

		Charter	95% Confidence Interval
UAF survey	Retained	1.43	1.23 to 1.63
	Released	2.08	1.48 to 2.68
	Total catch	3.51	2.89 to 4.32
ADF&G survey	Retained	1.85	
	Released	1.96	
	Total catch	3.81	

*For halibut targeted trips only (also see footnote #4).

Side-by-side comparisons of the UAF and ADF&G estimates and the UAF and halibut charter logbook estimates agree closely. The halibut charter logbook program [Dean and Howe 1999], first administered in 1998, requires charter operators to maintain a daily catch log. Because the logbook program is new, the first year results are preliminary and may not be precise. Nevertheless, when allowance is made for the differences in methodology and time period sampled, there is surprisingly close agreement between the logbook results for 1998 and the 1997–98 UAF results (Table 30).

The simulation model employs the sample enumeration method discussed in BenAkiva and Lerman [1985]. 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.[16] The simulation provides separate results for Alaskans and nonresidents.

The general formula for all forecasts is:

$$\%\Delta Participation_{\alpha} = \frac{\sum_i [\Phi(\hat{u}_{i1}) days_i] - \sum_i [\Phi(\hat{u}_{i0}) days_i]}{\sum_i [\Phi(\hat{u}_{i0}) days_i]} \tag{6}$$

[16] In practice, weighting by the number of days fished has a very small effect of the simulations. This is because the demographic variables are much less "important" than the fishing attribute variables in terms of making a forecast. Since the fishing attribute variables are constant across all individuals with the Alaskan and nonresident designations, the effect of weighting by days fished is very small.

where $\hat{u}_{ij}$ 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, $\%\Delta$ means percentage change, $\Phi(\bullet)$ 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.

The first set of simulations shows the responsiveness of participation rate to changes in the fishing cost or price per sportfishing-day. Changes in the probability that an average sport fisher would take a sportfishing trip are explored in simulations of three different costs per sportfishing-day, as each cost per day is decreased and increased over a 30% interval. The results are represented in Figure 17 and Table 31. (Note that changes in price are on the horizontal rather than vertical axis.) The price elasticity can be determined by dividing the percentage change in the probability of taking a trip by the percent change in the cost. As expected, elasticity is an increasing function of cost per day, for residents and nonresidents, and the response of Alaskans is more elastic than that of nonresidents. It is interesting to note that price is relatively inelastic for costs per day similar to those observed during actual fishing trips, $56.52 for Alaskans and $130.71 for non-residents (see Table 28).

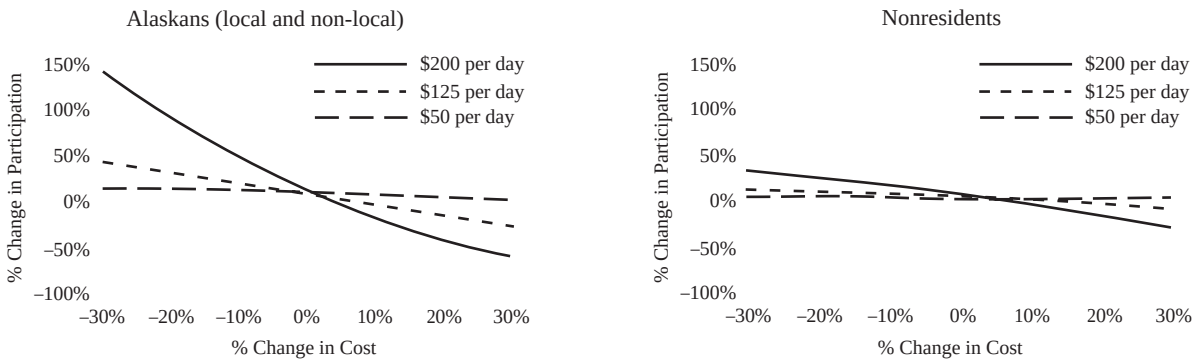


Figure 17. Percentage change in the probability that the average sport fisher will participate as a function of changes in the cost per sportfishing-day. (All other trip attributes are set at the survey mean levels reflected in Table 28.)

Table 31. Percentage changes in days fished in response to changes in the cost per sportfishing-day.

	Alaskans (local and non-local)			Nonresidents		
	$200 per day	$125 per day	$50 per day	$200 per day	$125 per day	$50 per day
Change in Cost	%Δ in days fished					
30%	–71	–34	–6	–34	–11	–1
25%	–63	–29	–5	–28	–9	–1
20%	–54	–23	–4	–22	–7	–1
15%	–43	–17	–3	–17	–5	–1
10%	–30	–12	–2	–11	–3	0
5%	–16	–6	–1	–5	–2	0
0%	0	0	0	0	0	0
–5%	18	6	1	5	1	0
–10%	37	12	2	10	3	0
–15%	59	17	3	15	4	1
–20%	81	23	4	19	5	1
–25%	104	28	4	24	6	1
–30%	129	34	5	27	7	1

We also modeled five changes in the expected catch (+20%, +10%, –10%, –20%, and –30%) using Equation 6 and the trip attributes from Table 28. The averages are weighted by the number of days each participant fished in 1997. Figure 18 depicts changes in the probability that an average sport fisher would take a sportfishing trip as a function of percentage changes in the expected catch.

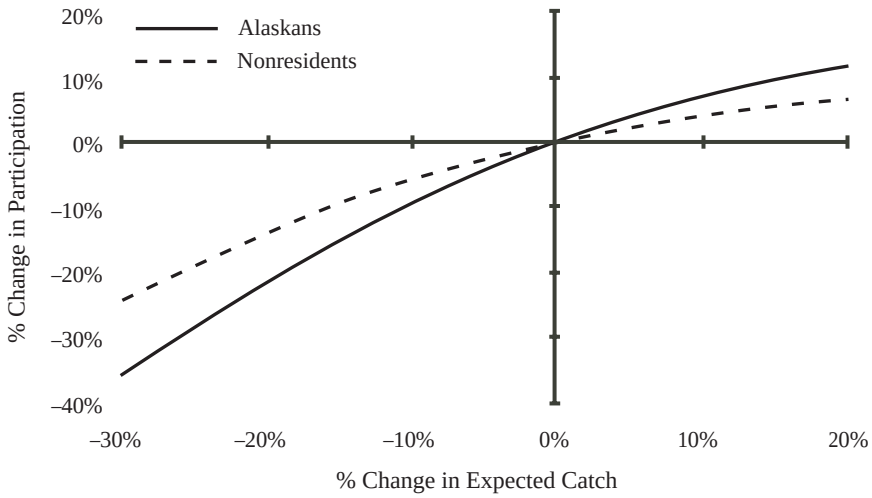


Figure 18. Percentage change in the probability that the average sport fisher will participate as a function of changes in expected catch. (All other trip attributes are set at the survey mean levels reflected in Table 28.)

Applying the probabilities represented in Figure 18 to the population of sport fishers provides estimates of percentage changes in the number of sportfishing-days in the lower and central Cook Inlet salmon and halibut sport fisheries (Table 32).

Table 32. Percentage changes in days fished in response to changes in catch, with ±90% confidence bounds.

	Alaskans (local and non-local)			Nonresidents		
	Mean	–90%	+90%	Mean	–90%	+90%
Change in Catch	%Δ in days fished					
–30%	–34.90	–18.28	–53.27	–24.60	–16.70	–33.43
–20%	–21.16	–10.22	–34.41	–13.96	–8.77	–19.90
–10%	–9.32	–4.35	–16.26	–5.82	–3.46	–8.93
0%	0	0	0	0	0	0
+10%	6.97	2.92	13.56	3.99	1.97	7.08
+30%	11.97	4.86	23.91	6.64	2.97	12.64

Because the point estimates of percentage changes in the number of sportfishing-days are highly nonlinear, the 90% confidence intervals were simulated following Krinsky and Robb [1986], using 10,000 Monte Carlo draws. These confidence intervals are reported in Table 32 and depicted in Figures 19 and 20 for Alaskan residents and nonresidents, respectively.

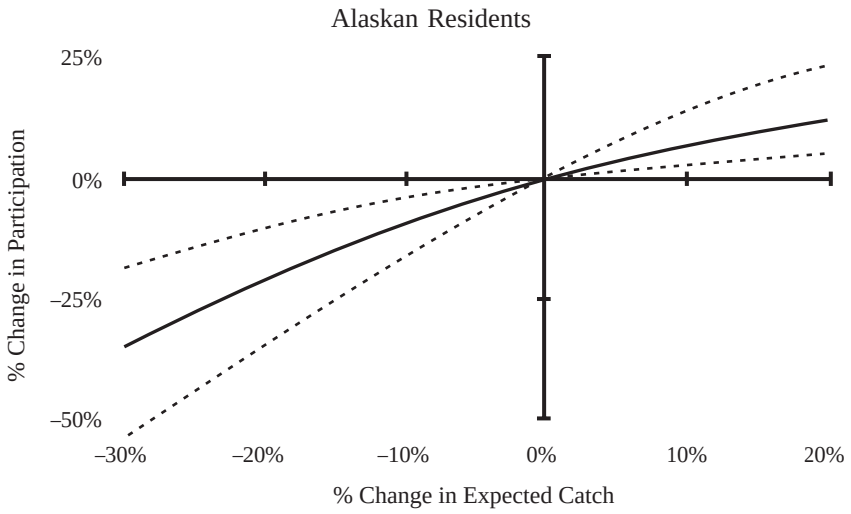


Figure 19. The mean (solid line) and 90% confidence intervals (dotted lines) on the % change in *Alaskan* resident sportfishing-days as a function of % changes in expected catch. (All other trip attributes are set at the survey mean levels reflected in Table 28.)

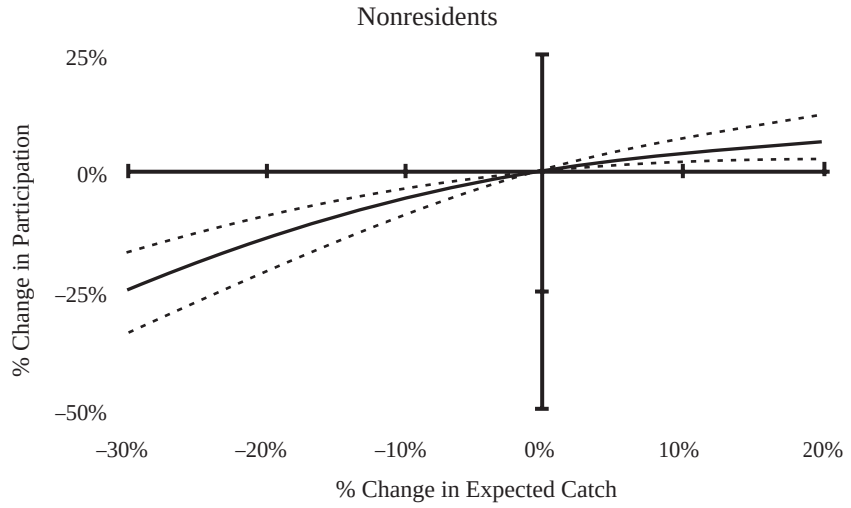


Figure 20. The mean (solid line) and 90% confidence intervals (dotted lines) on the % change in *nonresident* sportfishing-days as a function of % changes in expected catch. (All other trip attributes are set at the survey mean levels reflected in Table 28.)

These results suggest, for example, that a 10% reduction in expected catch will lead to a 9.32% reduction in the probability that the average Alaskan who participated in the 1997 or 1998 lower and central Cook Inlet salmon or halibut sport fishery would take a halibut or salmon sportfishing trip to lower and central Cook Inlet and a 5.82% reduction in the corresponding probability for the average nonresident. When these probabilities are applied to the population of sport fishers, they suggests that a 10% reduction in

catch can be expected to result in a 9.32% reduction in halibut and salmon sportfishing-days in lower and central Cook Inlet by Alaskans and a 5.82% reduction in the number of nonresident sportfishing-days. The 90% confidence intervals (an interval that should contain the true mean 90% of the time) suggest that there is a 90% probability that a 10% reduction in expected catch will reduce the number of sportfishing-days by between 4.35% and 16.26% for Alaskans and between 3.46% and 8.93% for nonresidents (Table 32). If sportfishing catches are proportional to biomass, application of the probabilities represented in Figure 18 to the population of sport fishers provides estimates of percentage changes in the number of sportfishing-days in the lower and central Cook Inlet salmon and halibut sport fisheries (Table 32). Moreover, Table 32 can be interpreted as representing the probable changes in participation that would result from changes in the availability of fish.

Examination of Table 32, and Figures 19 and 20 highlights several important features of the model and results. First, the model exhibits diminishing marginal returns. For example, a 10% increase in expected catch will increase expected participation by 6.97% for Alaskan residents. Increasing expected catch from 110% of the 1997 mean to 120% of the 1997 mean would lead to a smaller incremental participation increase of 5.00% (11.97%−6.97%), etc. Second, nonresidents are less responsive to changes in expected catch than residents. This result is consistent with the widely accepted belief that nonresidents are more strongly motivated by the fishing experience than by the consumptive value of the catch. It is also consistent with Alaskans having greater opportunities for substitution. Third, confidence intervals are narrower for nonresidents than Alaskans, suggesting that nonresidents are more homogenous than residents, and suggesting that greater confidence can be placed in forecasts of changes in nonresident participation than in forecasts of resident participation.

The expected changes in sportfishing-days and 90% confidence intervals, relative to the 1997 fishery conditions are shown for shore, private, and charter fishing modes in Tables 33, 34, and 35, respectively. Table 36 sums the expected changes across fishing modes. Tables 37 and 38 sum the results across residency categories for shore, private, and charter sportfishing modes, and in total. These disaggregations are derived from the percentages reported in Table 32 and the estimates of 1997 days fished reported in Table 3.

Table 33. Changes in days fished from shore in response to changes in catch, with ±90% confidence bounds.

	Locals			Alaskans (non-local)			Nonresidents		
	Mean	−90%	+90%	Mean	−90%	+90%	Mean	−90%	+90%
% Change in Catch	Δ in days fished								
−30%	−4,488	−2,351	−6,851	−1,664	−871	−2,539	−2,510	−1,704	−3,411
−20%	−2,721	−1,314	−4,425	−1,009	−487	−1,640	−1,424	−895	−2,030
−10%	−1,199	−559	−2,091	−444	−207	−775	−594	−353	−911
0%	0	0	0	0	0	0	0	0	0
+10%	896	376	1,744	332	139	646	407	201	722
+20%	1,539	625	3,075	571	232	1,140	677	303	1,290
1997 Effort (Days)		12,861			4,767			10,202	

Table 34. Changes in days fished from private boats in response to changes in catch, with ±90% confidence bounds.

	Locals			Alaskans (non–local)			Nonresidents		
	Mean	–90%	+90%	Mean	–90%	+90%	Mean	–90%	+90%
% Change in Catch	Δ in days fished								
–30%	–9,946	–5,209	–15,181	–12,928	–6,772	–19,733	–6,297	–4,275	–8,557
–20%	–6,030	–2,912	–9,806	–7,839	–3,786	–12,747	–3,573	–2,245	–5,094
–10%	–2,656	–1,240	–4,634	–3,453	–1,611	–6,023	–1,490	–886	–2,286
0%	0	0	0	0	0	0	0	0	0
+10%	1,986	832	3,864	2,582	1,082	5,023	1,021	504	1,812
+20%	3,411	1,385	6,814	4,434	1,800	8,857	1,700	760	3,235
1997 Effort (Days)		28,498			37,044			25,597	

Table 35. Changes in days fished from charter boats in response to changes in catch, with ±90% confidence bounds.

	Locals			Alaskans (non–local)			Nonresidents		
	Mean	–90%	+90%	Mean	–90%	+90%	Mean	–90%	+90%
% Change in Catch	Δ in days fished								
–30%	–2,624	–1,374	–4,005	–6,944	–3,637	–10,600	–12,588	–8,546	–17,106
–20%	–1,591	–768	–2,587	–4,210	–2,034	–6,847	–7,143	–4,488	–10,183
–10%	–701	–327	–1,222	–1,854	–866	–3,235	–2,978	–1,771	–4,570
0%	0	0	0	0	0	0	0	0	0
+10%	524	220	1,019	1,387	581	2,698	2,042	1,008	3,623
+20%	900	365	1,798	2,382	867	4,758	3,398	1,520	6,468
1997 Effort (Days)		7,518			19,898			51,171	

Table 36. Changes in days fished in response to changes in catch, with ±90% confidence bounds.

	Locals			Alaskans (non–local)			Nonresidents		
	Mean	–90%	+90%	Mean	–90%	+90%	Mean	–90%	+90%
% Change in Catch	Δ in days fished								
–30%	–17,058	–8,935	–26,037	–21,536	–11,280	–32,872	–21,395	–14,524	–29,074
–20%	–10,342	–4,995	–16,819	–13,058	–6,307	–21,234	–12,141	–7,627	–17,307
–10%	–4,555	–2,126	–7,947	–5,751	–2,684	–10,034	–5,062	–3,009	–7,766
0%	0	0	0	0	0	0	0	0	0
+10%	3,407	1,427	6,628	4,301	1,802	8,368	3,470	1,713	6,157
+20%	5,851	2,375	11,686	7,387	2,999	14,755	5,775	2,583	10,993
1997 Effort (Days)		48,877			61,709			86,970	

Table 37. Changes in days fished in response to changes in catch by sportfishing mode.

	Δ in days fished			
% Change in Catch	Charter	Private	Shore	Total
−30%	−22,344	−29,421	−8,736	−60,501
−20%	−12,945	−17,443	−5,155	−35,543
−10%	−5,533	−7,600	−2,237	−15,369
0%	0	0	0	0
+10%	3,955	5,588	1,636	11,180
+20%	6,681	9,545	2,788	19,013
1997 Effort (Days)	78,587	91,139	27,830	197,556

Table 38. Percentage changes in days fished in response to changes in catch by sportfishing mode.

	% Δ in days fished			
% Change in Catch	Charter	Private	Shore	Total
−30%	−28.4%	−32.3%	−31.4%	−30.6%
−20%	−16.5%	−19.1%	−18.5%	−18.0%
−10%	−7.0%	−8.3%	−8.0%	−7.8%
0%	0.0%	0.0%	0.0%	0.0%
+10%	5.0%	6.1%	5.9%	5.7%
+20%	8.5%	10.5%	10.0%	9.6%
1997 Effort (Days)	78,587	91,139	27,830	197,556

The discussion of these participation-rate simulations has suggested that changes in expected catch rates approximately reflect changes in biomass. While this characterization approximates the constant exploitation yield strategy applied in halibut management, it is less representative of the constant escapement strategy applied to salmon. Moreover, even where there is a close linkage between biomass or abundance and target catches, the allocation among commercial, subsistence, and sport fishers is not invariant. For example, policy makers could distribute all downside risk to the commercial sector, thereby insulating the recreational and subsistence sectors from the effects of population fluctuations. Another likely phenomenon in the long run is that recreational fishers will have increased access to alternative fishing sites (e.g., Valdez, Whittier, Cordova, Kodiak, Dutch Harbor). (Given that Seward is a close substitute for lower Cook Inlet, and that the participation rate model was also based on Seward sport fishers, an implicit assumption is that changes in stock abundance are similar in areas fished from Seward and lower and central Cook Inlet ports. If that is not the case, lower and central Cook Inlet halibut and salmon sport fishers would be likely to substitute a Seward trip and there is likely to be an even larger reduction in fishing participation.) Another assumption in this is that the news of the reduced expected catches is instantaneous. In reality, it may take a while for reduced (increased) expected catches to be realized by the public, delaying the onset of participation rate reductions (increases). Participation reductions may be greater than indicated by the model for expected catch reductions occasioned by anthropogenic environmental damages because perceptions of the impact of the environmental damage may be greater than the actual impact. Finally, this model explicitly assumes a perfectly elastic supply curve for shore, private, and charter trips. While this is true for shore and private trips it is not necessarily true for charter trips. For example, as a short-run response to an environmental disaster that reduced the

desirability of lower and central Cook Inlet sportfishing trips, charter operators might choose to reduce their prices (discounted trips). To the extent that this occurs, the model will overestimate changes in participation.

Figures 21, 22 and 23 represent the effect of changes in expected catch of halibut, chinook, and coho on Alaskan and nonresident participation decisions.

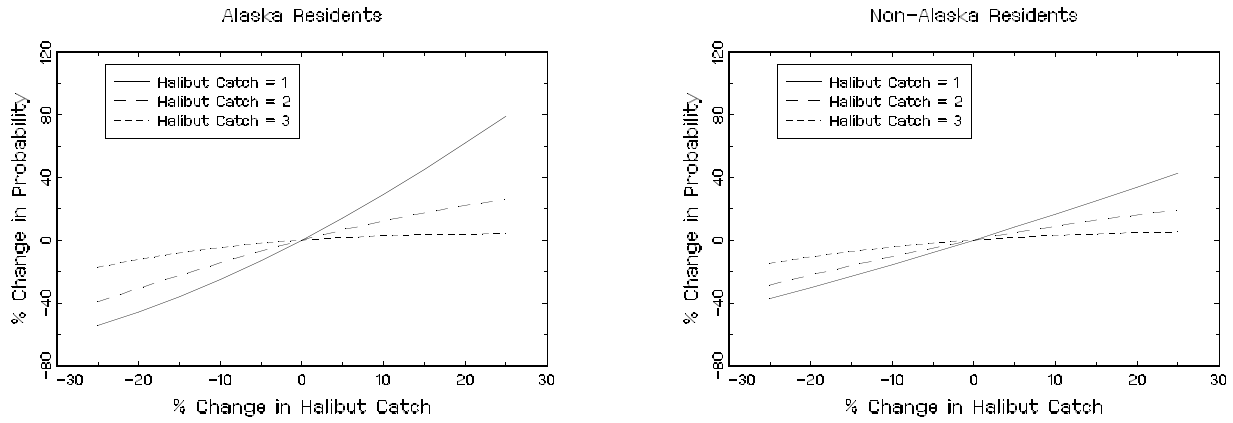


Figure 21. Percentage change in the probability that the average sport fisher will participate as a function of changes in the expected catch of halibut. (Halibut size set at 35 pounds, fishing costs set at $100, and the catch of all other species set to zero.)

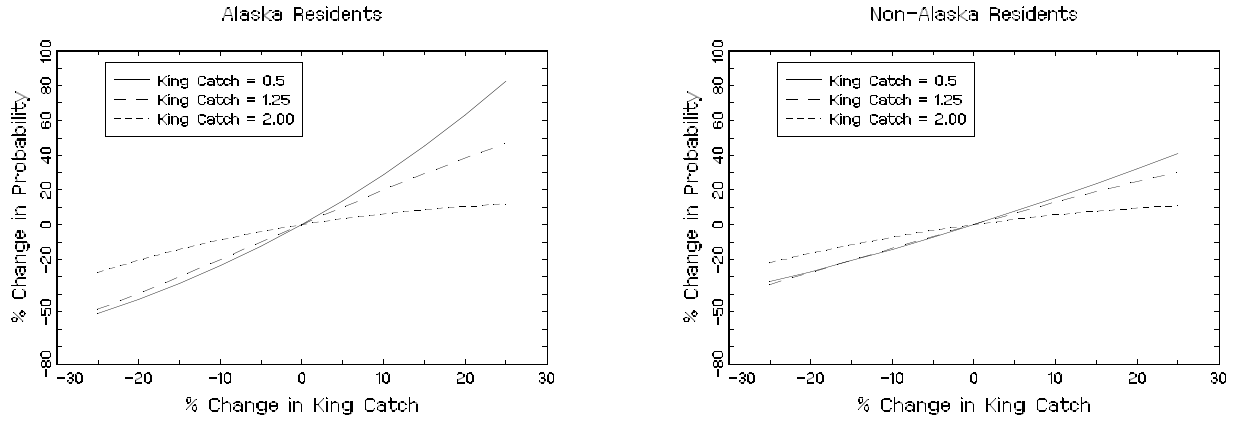


Figure 22. Percentage change in the probability that the average sport fisher will participate as a function of changes in the expected catch of chinook salmon. (Chinook size set at 30 pounds, fishing costs set at $100, and the catch of all other species set to zero.)

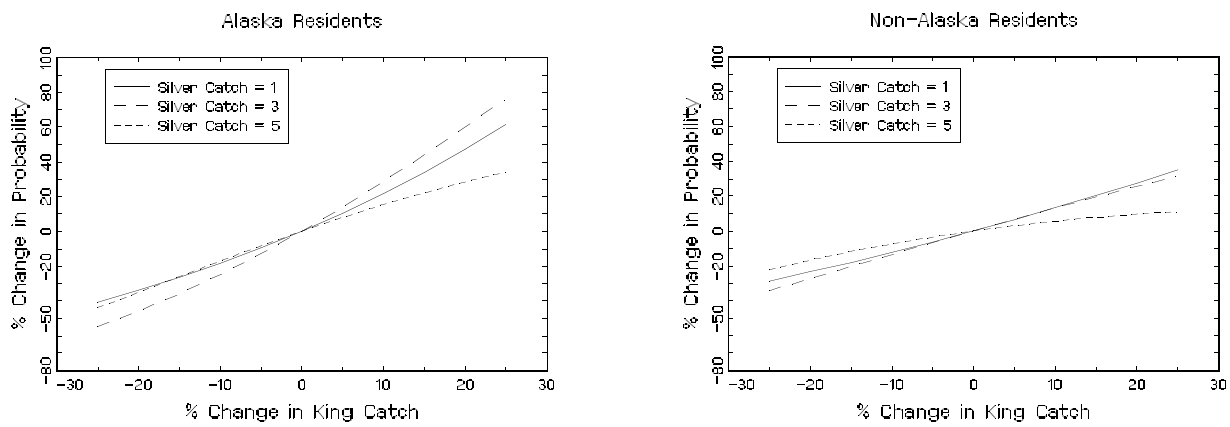


Figure 23. Percentage change in the probability that the average sport fisher will participate as a function of changes in the expected catch of coho salmon. (Coho size set at 7 pounds, fishing costs set at $100, and the catch of all other species set to zero.)

Compensating variations

The expected level of economic welfare of a fishing trip with attributes x can be calculated from our participation rate, econometric model by employing formulas similar to those presented in Hanemann [1999]. let the expected maximum utility from each choice occasion be represented by $M = \mathrm{E}\{\max(u_1, u_0)\}$, where $u_1 = v_1 + e_1$ denotes the utility received by taking a fishing trip and $u_0 = v_0 + e_0$ denotes the utility received from not taking a fishing trip. The economic welfare associated with the choice occasion is therefore $CV = -M/\pi_p$, where CV represents the compensating variation welfare measure 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 constant in our econometric model, this welfare measure is also the equivalent variation welfare measure.

Using standard probability theory, M is calculated by evaluating

(7) $$M = \int_{-\infty}^{+\infty}\int_{-\infty}^{v_0+e_0-v_1}(v_0+e_0)\phi(e_0,e_1)\,de_1 de_0 + \int_{-\infty}^{+\infty}\int_{-\infty}^{v_1+e_1-v0}(v_1+e_1)\phi(e_0,e_1)\,de_0 de_1$$

where $\phi(\bullet)$ is the bivariate normal probability density function.

If we normalize the utility of not taking a trip such that $u_0 = 0$, the the trip will only be taken when $v_1 + e_1 \geq 0$, and M can be evaluated by

(8) $$M = \int_{-v_1}^{+\infty}(v_1+e_1)\phi(e_1)\,de_1 = v_1\Phi(v_1) + \phi(v_1)\ .$$

Note that the lower limit of integration ensures that a trip will be taken if $v_1 + e_1 \geq 0$.

The individual's estimated compensating variation is given by

(9) $$\hat{c}_{ij} = -M_{ij}\,/\hat{\pi}_p$$

where $\hat{c}_{ij}^{\bullet}$ is the compensating variation for person *i* and trip *j*. the weighted average compensating variation across all individuals is

$$\hat{C}_j^{\bullet} = \sum_{i=1}^{n}\left(\hat{c}_{ij}\, d_{ij}\, \Phi\left(\hat{u}_{ij}\right)\right) \Big/ \sum_{i=1}^{n}\left(d_{ij}\, \Phi\left(\hat{u}_{ij}\right)\right) \tag{10}$$

where d_{ij} is the individual's total number of lower and central Cook Inlet salmon and halibut sportfishing-days fished as reported by ADF&G in 1997 (therefore $d_{ij}\Phi(\hat{u}_{ij})$ is the individual's days fished for a trip *j* with corresponding attributes).

The estimated compensating variation is then

$$\hat{C}_B^{\bullet} = \hat{c}_B^{\bullet}\, D_B\left(1 + \%\Delta\, Participation_{\alpha}\right) \tag{11}$$

where D_B 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 for the baseline 1997 season.

Changes in compensating variations will then be calculated as

$$\hat{C}_{\Delta}^{\bullet} = \hat{C}_B^{\bullet} - \hat{C}_S^{\bullet} \tag{12}$$

the estimated difference between the baseline trip $\hat{C}_B^{\bullet}$, the compensating variation for all participants, and the simulated trip $\hat{C}_S^{\bullet}$ compensating variation for all participants.

Average estimated daily compensating variation with confidence intervals is reported in Table 39 and totals are reported in Table 40 and shown in Figure 24.

Table 39. Compensating variations response to changes in catch, with ±90% confidence bounds.*

	Alaskans (local and non-local)			Nonresidents		
Change in Catch	Mean	–90%	+90%	Mean	–90%	+90%
–30%	$35.51	$16.45	$65.52	$64.56	$44.46	$89.74
–20%	$49.43	$25.27	$83.10	$83.62	$58.16	$114.03
–10%	$64.63	$35.46	$102.40	$102.08	$72.94	$137.23
0%	$80.83	$45.75	$121.63	$118.88	$84.90	$157.22
+10%	$95.86	$57.79	$140.50	$133.30	$98.40	$171.64
+20%	$110.68	$68.97	$158.14	$144.85	$110.05	$183.76

*The 90% confidence intervals were simulated following Krinsky and Robb [1986], using 10,000 Monte Carlo draws.

Table 40. Changes in compensating variation in response to changes in expected catches.

Simulated Change to Expected Catch		Mean CV per Day	Sportfishing-days	Total CV	Change in Total CV
–30%	Locals	$35.51	31,672	$1,124,503	–$2,802,007
	Alaskans (non–local)	$35.51	39,986	$1,419,726	–$3,537,637
	Nonresidents	$64.56	65,397	$4,221,858	–$6,116,949
	Total		137,055	$6,766,087	–$12,456,593
–20%	Locals	$49.43	38,534	$1,904,791	–$2,021,719
	Alaskans (non–local)	$49.43	48,651	$2,404,868	–$2,552,494
	Nonresidents	$83.62	74,828	$6,257,338	–$4,081,469
	Total		162,013	$10,566,997	–$8,655,683
–10%	Locals	$64.63	44,320	$2,864,537	–$1,061,973
	Alaskans (non–local)	$64.63	55,956	$3,616,583	–$1,340,780
	Nonresidents	$102.08	81,911	$8,361,115	–$1,977,692
	Total		182,187	$14,842,235	–$4,380,445
0%	Locals	$80.83	48,877	$3,926,510	$0
	Alaskans (non–local)	$80.83	61,709	$4,957,363	$0
	Nonresidents	$118.88	86,970	$10,338,807	$0
	Total		197,556	$19,222,680	$0
+10%	Locals	$95.86	52,281	$5,011,515	$1,085,005
	Alaskans (non–local)	$95.86	66,007	$6,327,221	$1,369,859
	Nonresidents	$133.30	90,447	$12,056,188	$1,717,382
	Total		208,736	$23,394,925	$4,172,245
+20%	Locals	$110.68	54,727	$6,056,510	$2,130,000
	Alaskans (non–local)	$110.68	69,095	$7,646,565	$2,689,202
	Nonresidents	$144.85	92,748	$13,434,175	$3,095,369
	Total		216,569	$27,137,250	$7,914,571

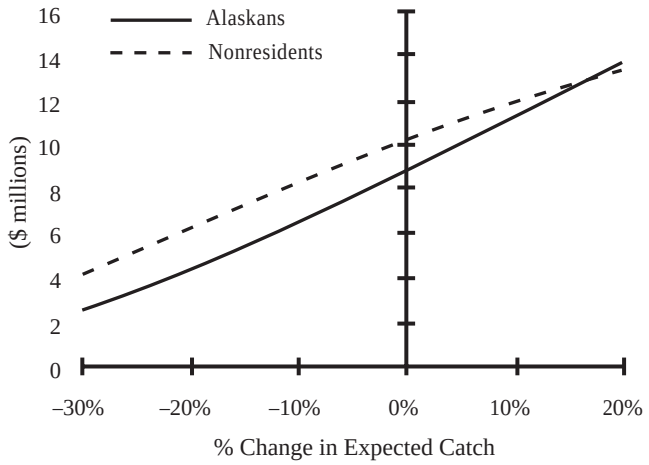


Figure 24. The effect of increases/decreases in expected catch on the magnitude of total compensating variations.

The estimated daily average compensating variations are $80.33 for Alaskans and $118.88 for nonresidents. Total compensating variations are $19.2 million ($10.3 million for nonresidents and $8.9 million for residents). To simulate the changes in compensating variation, when expected fishery attributes change, the expected number of sport fishers predicted by Equation 6 were multiplied against the simulated average compensating variation (Table 39).

For a 10% decrease in expected sportfishing catches of halibut and salmon the estimated industry compensating variation for the lower and central Cook Inlet sports fishery declines from $19.2 to $14.8 million. At 20% and 30% declines in expected catch, compensating variations decline to $10.6 and $6.8 million, respectively. These large decreases are due to a reduction in the number of participants accompanied by a decrease in the compensating variations for the remaining participants, reflecting the decrease in the quality of their trip. Percentage-wise, in all cases, the compensating variations decrease faster for residents than nonresidents, reflecting differential access to substitute activities or differences in the relative import of consumptive and non-consumptive aspects of sportfishing (Figure 25). For example, for a 20% decrease in expected harvest, the compensating variations of Alaskan residents decrease by 51% while nonresident compensating variations drop only 39%.

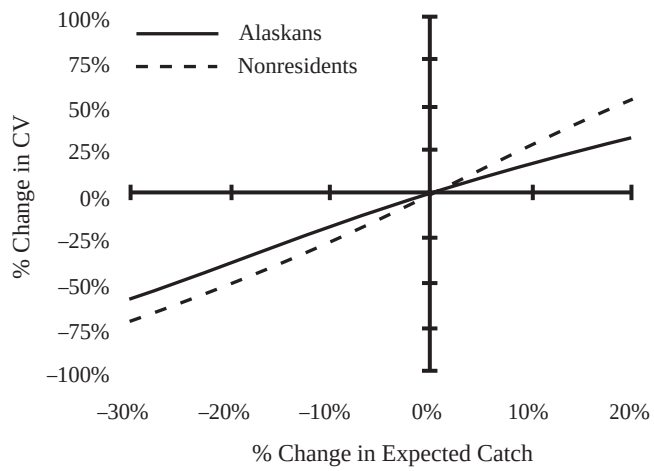


Figure 25. Percentage change in compensating variations as a function of percentage changes in expected catch.

5. Input–Output Model

Economic impact analysis and input–output

In addition to developing a methodology for evaluating the effect of changes in sportfishing trip attributes on participation rates, Section 4 provides estimates of the corresponding changes in the compensating variation (net benefit) that accrues to sport fishers. Although changes in participation affect a multitude of economic agents beyond the participants, these effects are not generally examined in net benefit assessments because they are subsumed in the primary market demand, provided that secondary markets are not distorted. Nevertheless, identification of the downstream monetary impacts helps reveal how benefit changes are distributed among regions and economic sectors.

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. Since 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 might at times imply very disproportional allocations among stakeholders. In contrast with net benefit measures which do not identify the distributional or fairness consequences of alternative policies, economic impact analyses track and identify impacts in revenue, income and employment terms. For a more detailed discussion on the differences and appropriate uses of cost–benefit and economic impact analyses, see Edwards [1994] and Steinback [1999].

Economic impact analyses are expenditure-based measures of impact assessment. That is, they use changes in the monetary value of exchanges to measure the impact of alternative states (trip attributes, policy settings, etc.). Economic impact modeling has taken several forms that vary in complexity and degree of grounding in economic theory. Generally, there is a give and take between theoretical rigor on the one hand and usefulness in real world applications on the other; the level of detail necessary for policy related issues renders the more complex modeling processes prohibitively costly and cumbersome. For this reason, input–output models (I–O) have emerged as the most commonly applied method for measuring regional economic impacts in the damage assessment and policy arenas.

I–O models are attractive because prepared data and software are available and relatively low cost. However, the ready availability of general models and standard data has occasionally led to hasty and ill-formulated analyses that have been subject to deserved criticism. Archer [1984] provides examples of the misuse of I–O results and the misleading policy implications that ensue. Caution must be exercised in the interpretation of I–O model results. Consequently, it is important that the reader be familiar with the assumptions and limitations of I–O modeling. Readers who are unfamiliar with I–O are directed to the Appendix to Section 5 for a review of the theoretical underpinnings of I–O.

It cannot be overemphasized that economic impact analyses are not intended to elicit net benefits. They are instead useful for delineating intra- and inter-regional economic linkages and for illustrating how shocks to one or more economic sectors affect the output of commodities, services, employment, and income. The nature of the impacts that are generated by I–O models comes from the persistent effect of expenditures as money circulates through an economy. (See Appendix to Section 5 for a more detailed discussion of the multiplier effect.)

Input–output model

The I–O framework is based on identifying sectors of regional economies through their usage of inputs in the production process and the subsequent distribution of output throughout the economy. Relationships are measured by the value of exchanges of goods and services among economic sectors within the region, imports or exports from other regions, and final demand by households, government entities, and other economic agents. The annual values of these exchanges are the data used in the I–O model (Figure 26).

From \ To		Purchasing Sectors					Local Final Demand				
		1	…	j	…	n	Households	Private Investment	Government	Exports	Total Gross Outputs
Producing Sectors	1	X_{11}	…	X_{1j}	…	X_{1n}	C_1	I_1	G_1	E_1	X_1
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	i	X_{i1}	…	X_{ij}	…	X_{in}	C_i	I_i	G_i	E_i	X_i
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	n	X_{n1}	…	X_{nj}	…	X_{nn}	C_n	I_n	G_n	E_n	X_n
Labor		L_1	…	L_j	…	L_n	L_C	L_I	L_G	L_E	L
Other Value Added		V_1	…	V_j	…	V_n	V_C	V_I	V_G	V_E	V
Imports		M_1	…	M_j	…	M_n	M_C	M_I	M_G		M
Total Gross Outlay		X_1	…	X_j	…	X_n	C	I	G	E	X

Figure 26. Sample input–output transactions table [Richardson 1972].

I–O models have been used for impact analyses of development projects and government policy changes. For example, I–O models have been used to characterize the regional impact of changes in National Forest harvest policies [Summers and Birss 1991], federal grazing policies [Geier and Holland 1991], community development strategies [Geier et al. 1994], federal land use decisions [Fawson and Criddle 1994], and the impacts of guided sport fisheries off New England [Steinback 1999]. I–O models have also been used to model the Alaska statewide economy [Logsdon et al. 1977; Weddelton 1986], to determine management impacts of commercial fisheries on rural communities [Natcher 1996], and to describe the economic significance of Alaska's sport fisheries [NPFMC 1997; ISER 1999].

We selected IMPLAN [Olson and Lindall 1997] and the most commonly used I–O model as a base. IMPLAN includes 21 economic and demographic variables for 528 industrial sectors for all U.S. counties (and boroughs). The IMPLAN database is built from employment and income data sets including County Business Patterns, ES 202, and the Regional Economic Information System. In cases where there are disclosure problems, IMPLAN uses national averages as estimates for income and employment. IMPLAN is recognized as the best source of U.S. secondary regional economic data. Nevertheless, 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 generated by recreational fishing. This module utilizes IMPLAN generated response coefficients and secondary regional economic data as inputs. 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. This is because 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. [1999b]. The operating cost data required for modeling charter operations were drawn from NPFMC [1997] and updated in the groundtruthing process.

Application of the IMPLAN database and model

In contrast to manufacturing sectors, which are well represented in IMPLAN, retail sectors are highly aggregated. Because impacts associated with changes in sportfishing-related expenditures are primarily retail, tracking them requires disaggregation of some of the IMPLAN sectors. Moreover, only 138 of IMPLAN's 528 sectors are represented in the Kenai Peninsula Borough.

While aggregating two or more I–O sectors into one is straightforward, there are many ways to disaggregate one sector into two or more. For example, charter trip payments are included in IMPLAN's Amusement and Recreation Services sector. Without information describing the intermediate demand components associated with charters, it is not possible to know how to correctly adjust the vector of technical coefficients. While it might be tempting to represent the new "Charter" sector with a vector of technical coefficients that is a simple fraction of the Amusement and Recreation sector, doing so would render the technical coefficients matrix singular and prevent the model from finding a solution.

Bushnell and Hyle [1985], Wolsky [1984], and Gillen and Guccione [1990] suggest approaches that directly modify the technical coefficients matrix. Jensen [1997] and Steinback [1999] note instead that running an impact scenario in IMPLAN that mirrors that sector's purchases can simulate the intermediate demand effects of the aggregated sector. The former is technically preferable, but requires reprogramming of IMPLAN's social accounting matrices to reflect the characteristics of the disaggregated subsector. By including the new sector within the model, the changes are noted within the use (absorption), byproducts, and final demand matrices. Regional purchase coefficients and value-added features are likewise constructed for the new sector. On the other hand, the impact scenario option is much less tedious. Using IMPLAN's front end, a demand shock is executed with components (events) that mirror the proportions of the simulated sector's production function. The resulting impacts can then be used to calculate response coefficients (normal multipliers). (See Appendix to Section 5 for a technical discussion on multipliers.) However, because the new subsector is not explicitly defined in the IMPLAN model, there is no opportunity for it to play a role in the intermediate demand of other sectors within the model, thus leading to possible underestimation of the actual multiplier effect. We used the first approach to represent charter operations and the second to represent expenditures by sport fishers.

A model of the average charter operation's purchasing pattern was constructed using data obtained by NPFMC [1997, 2000] as well as discussions with local experts and members of industry during fieldwork conducted for this study. Standard Industrial Classification codes for the corresponding inputs were translated to the IMPLAN sectoral scheme (see Appendix to Section 5) and a production function was estimated for the 1997 charter sector sales value of $10.4 million reported in Table 23. The estimated average production function for the marine charter sector is reported in Table 41. These technical coefficients were applied to the baseline charter sales data presented in Table 24. For a more detailed accounting of the individual expense categories, corresponding Standard Industrial Classification codes and translation to the IMPLAN sectoral scheme, the reader is referred to the Appendix to Section 5.

Table 41. Parameters values for the estimated average production function for the marine charter sector.

Expense Category	Coefficient	Expense Category	Coefficient	Value Added Category	Coefficient
Advertising	0.0410	Medical	0.0015		
Bait	0.0133	Office Supplies	0.0135	Employee Compensation	0.1147
Computer Total	0.0066	Professional Services	0.0098	Proprietor Income	0.1949
Contract Services	0.0035	Repair/Maint/Tools/Supplies	0.0130	OPTI	0.0339
Dues	0.0139	Subscriptions	0.0018	Indirect Business Tax	0.0306
Electronic Supplies	0.0004	Total Boat Maintenance	0.0132	(Sales Tax)	
Entertainment	0.0009	Total Borough Tax	0.0369		
Federal Income Tax	0.0416	Total Insurance	0.0392		
Fuel & Lubrication	0.1356	Total Licenses	0.0243		
Gear Replacement	0.0216	Total Travel	0.0181		
Groceries	0.0008	Total Truck Expenses	0.0178		
Hull Repair	0.0054	Total Utilities	0.0380		
Interest Paid (Boat)	0.0542	Trade Shows	0.0214		
Moorage & Boat Storage	0.0182	Work Gear/Client Supplies	0.0202		
		Total Absorption Coefficient	0.6259	Value Added Coefficient	0.3741

For the other expenditure categories reported in Section 3, impact scenarios were run in IMPLAN to generated response coefficients. These response coefficients and those developed for the charter operation sector were included in $FISH, a stand-alone recreational module (see Appendix B [software manual] or Hamel et al. [2001]). Where data limitations prevented construction of original production functions, the model defaults to the values reported for input coefficients in Jensen [1997]. Table 42 lists the production recipes used for each of the sportfishing expenditure categories in Section 3 that take place on the Kenai Peninsula, and thus affect local economic impacts.

Table 42. Absorption sectors and coefficients for sportfishing expenditure categories.

Expenditure Category	IMPLAN Sector #	IMPLAN Sector Name	Coefficient
Transportation, Food & Lodging			
Auto or Truck Fuel	451	Automotive dealers & service stations	1.00
Groceries	450	Food stores	0.75
	455	Miscellaneous retail	0.25
Lodging	463	Hotels and lodging places	1.00
Restaurant & Bar	454	Eating & drinking	1.00
Fishing Expenditures			
Boat Fuel, Lubricants & Repairs	393	Boat building and repairing	0.10
	448	Building materials & gardening	0.05
	451	Automotive dealers & service stations	0.70
	455	Miscellaneous retail	0.10
	482	Miscellaneous repair shops	0.05
Charter & Guide Fees		Table 41	
Fish Processing or Packaging	98	Prepared fresh or frozen fish or seafood	1.00
Fishing Derby Entry Fees	503	Business associations	1.00
Fishing Gear	98	Prepared fresh or frozen fish or seafood	0.15
	421	Sporting and athletic goods, n.e.c.	0.05
	449	General merchandise stores	0.20
	455	Miscellaneous retail	0.50
Haul Out & Moorage Fees	435	Motor freight transport and warehousing	0.10
	436	Water transportation	0.45
	451	Automotive dealers & service stations	0.10
	473	Equipment rental and leasing	0.15
	479	Automobile repair and services	0.20

To be useful, impact models should be linked to a demand model for the activity in question. While an accurately groundtruthed impact model may appropriately predict the consequences of a specified demand shock for recreational fishing, it will be of limited value without a quantified relationship between the sportfishing-related demand for goods and services and variations in fishery conditions. It is essential to know the set of circumstances that lead to a specific demand shock so that the impact model can serve more as a tool for evaluating the effects of policies and/or simulated environmental change instead of just as an academic exercise in assessing arbitrary levels of demand.

The participation rate model developed in Section 4 provides the linkage between the impact model, $FISH, and variations in fishing conditions. $FISH generates estimates of economic activity on the western Kenai Peninsula of increased/decreased angler spending and expresses these in terms of output (sales), income, employment, and other value-added variables. Changes in these expenditures are driven by changes in participation, which are determined by changes in trip attributes (e.g., fish catch and size, and trip cost) modeled in Section 4. We apply percentage changes in effort level, by residency and fishing mode, on a one-to-one basis to the baseline sportfishing-day expenditures reported in Table 25. 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.

6. Impact Simulations

The simulations in Section 4 examine the influence of changes in trip attributes on the magnitude of net benefits that accrue to recreational fishers. In addition, changes in the number of sportfishing trips taken in lower and central Cook Inlet affect the level of economic activity on the Kenai Peninsula, within Alaska, and ultimately the nation. This section combines the participation rate simulations of Section 4 with the regional economic model introduced in Section 5 to explore the economic impacts to the western Kenai Peninsula from potential changes to the attributes of Cook Inlet salmon and halibut sportfishing trips.

The impact simulations are based on trip attributes and potential changes to exploitable biomass examined in Section 4. The simulations begin with the decision of the average sport fisher to participate in a fishery when environmental conditions or regulatory changes are perceived to affect expected catch. The input–output model includes nine categories of sport fishers: three residency categories (local, non-local Alaskans, and nonresidents) and three sportfishing modes (charter, private, shore). These nine sportfishing categories are represented by nine distinct expenditure patterns in the I–O model.

The baseline trip attributes are reported in Table 28, which summarizes the average fishing cost, average catches, and average weights for Alaskan and nonresident fishing trips during 1997–98. The simulated changes to participation are reported Tables 37 and 38.

Baseline expenditures

Economic impacts of the lower and central Cook Inlet salmon and halibut sport fisheries on the western Kenai Peninsula depend on the portion of sportfishing expenditures spent in the region. Avid sport fishers might base their decision to take a trip to the Kenai Peninsula Borough on the expected quality of the lower and central Cook Inlet salmon or halibut sportfishing opportunity. Other visitors may be less motivated by sportfishing and may choose to take a Kenai Peninsula trip, spending money locally on food, lodging, and other recreational activities, regardless of the expected quality of the sportfishing experience. Because this economic impact analysis is intended to isolate the monetary effects of changes

in participation in lower and central Cook Inlet marine sport fisheries, it is important that we only use those expenditures directly attributable to sportfishing. The model applies the assumptions about the effects of cancellation of the sportfishing component of the trip developed in Table 22 and the corresponding estimates of 1997 expenditures attributed directly to saltwater fishing reported in Table 23.

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. We begin by summing the totals spent on the "Fishing (Kenai)" and "Other (Kenai)" categories from Table 23, to obtain an estimate of total spending, $28.5 million. This value can be regarded as a measure of the economic magnitude of the marine sport fishery in terms of sales, or in the lexicon of regional economic analysis, "output". Economic significance is a description of the level of economic activity associated with the activity or industry in question [ISER 1999]. However, this measure is likely to be comprised of a significant amount of spending by local residents, which needs to be netted out before consideration of impacts of changed spending patterns. It is assumed that local residents will substitute spending on other regional recreational activities for their foregone sportfishing expenditures; hence their contribution to economic significance is disregarded for purposes of impact analysis (see discussion in Section 5).

Subtracting the spending of Kenai area residents (Tables 61, 62, and 63 in the Appendix to Section 3) from the total expenditures attributable to the lower and central Cook Inlet sport fisheries leaves a remainder of $25.0 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, see Table 43).

Table 43. Total Kenai Peninsula area expenditures by Alaskans (non-local) and nonresidents that can be attributed directly to lower and central Cook Inlet halibut or salmon sportfishing trips [Lee et al. 1999a].

	Expenditures ($)	
	Fishing Expenditures	Other Expenditures
Auto fuel		2,208,331
Auto/RV rentals		
Lodge		3,061,159
Groceries		2,443,248
Restaurant & Bar		1,996,927
Charter	9,518,445	
Gear	1,658,566	
Processing	2,202,291	
Derby	171,082	
Boat Fuel	1,279,407	
Haul/Moorage	433,374	
Total	15,263,165	9,709,665

Increases in the amount of new money spent locally will stimulate economic activity whereas decreased spending by non-locals leads to a reduction in economic activity. Variations in spending by non-locals are driven by the changes in effort predicted by the participation rate model. For every percentage change in effort measured by reduced or increased sportfishing-days, there is a proportional change in daily expenditures across each of the nine combinations of residency and sportfishing mode. The changed expenditures are summed and multiplied by the response coefficients developed in Section 5 to generate estimates of the economic impact of regulatory or environmentally induced changes in fishing trip attributes. The impacts can be examined in terms of output (direct, indirect, induced, total), employment, employee earnings, proprietors' income, personal income, other income, indirect taxes, and value added.

Simulations

We examined six scenarios: a continuation of the status quo; 10, 20, and 30% decreases in catch; and 10 and 20% increases in catch. The results are presented in Tables 44–53, below and in the Appendix to Section 6 (Tables 76–80). These tables report estimated changes to the 10 aggregated direct expenditure categories surveyed in Lee et al. [1999b]. The direct, indirect, induced, and total expenditure changes are reported for output, personal income, and employment along with a final demand array of 26 local sectors impacted. The 26 local sectors included in the final demand array represent aggregations of the 528 IMPLAN sectors, and their assignment to elements of the demand array is detailed in the Appendix to Section 5. Total output effects (the sum of direct, indirect, and induced effects) for each of the nine sportfishing categories are listed in the total local impact row. The Appendix to Section 6 includes additional detail on the impacts on employee compensation, proprietor's income, indirect business taxes, other property type income, and total value added.

While the six scenarios that we modeled represent a broad range of changes in sportfishing opportunity, evaluation of the risk and expected outcome of particular environmental damage scenarios may require consideration of specifically tailored scenarios. Therefore, we have developed a spreadsheet-based program (and user manual) to accompany this report (see Appendix B [software manual] or Hamel et al. [2001]). Analysts will be able to use the program to examine different simulation scenarios over residency categories and sportfishing modes. An example of the output from this software for an expected 10% decrease in lower and central Cook Inlet sportfishing catches of salmon and halibut is shown in Figures 27–31.

The simulation model data input form is initialized with 1997 mean trip attributes (Table 29). Users can vary sportfishing catch rates, average fish size and trip costs, and focus the analysis on charter, private vessel, or shore-based sportfishing modes.

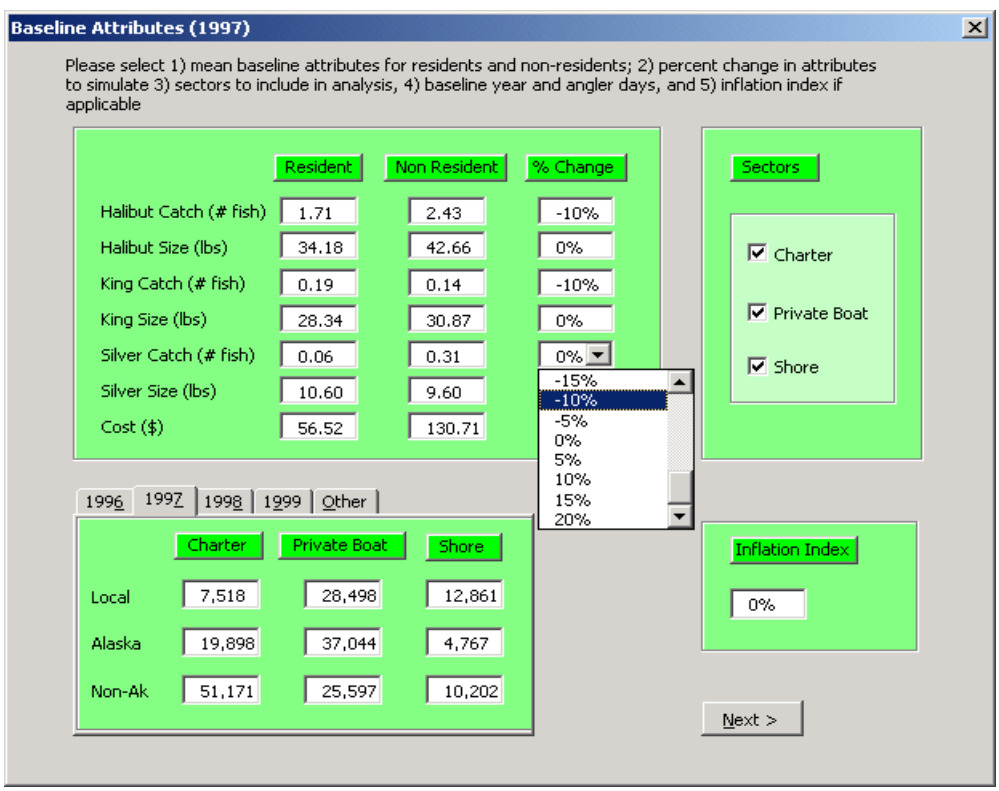
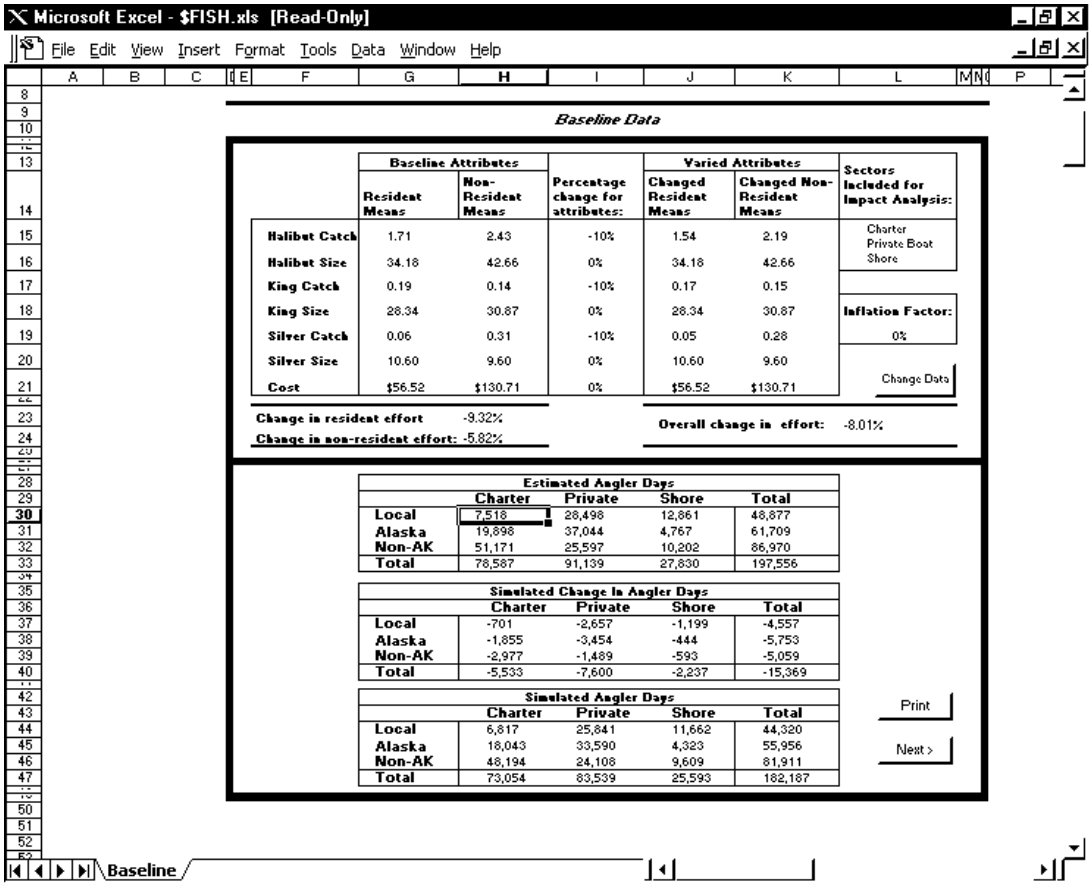


Figure 27. Example simulation model data input interface associated with a 10% decrease in expected catch.

These user-selected trip attributes fuel the simulation's estimates of economic impacts and compensating variation. The screen represented in Figure 28 reconfirms the trip attributes specified by the user and reports estimates of the changes in fishing effort relative to the 1997 fishery.



Baseline Data

	Baseline Attributes: Resident Means	Baseline Attributes: Non-Resident Means	Percentage change for attributes:	Varied Attributes: Changed Resident Means	Varied Attributes: Changed Non-Resident Means
Halibut Catch	1.71	2.43	-10%	1.54	2.19
Halibut Size	34.18	42.66	0%	34.18	42.66
King Catch	0.19	0.14	-10%	0.17	0.15
King Size	28.34	30.87	0%	28.34	30.87
Silver Catch	0.06	0.31	-10%	0.05	0.28
Silver Size	10.60	9.60	0%	10.60	9.60
Cost	$56.52	$130.71	0%	$56.52	$130.71

Sectors Included for Impact Analysis: Charter, Private Boat, Shore

Inflation Factor: 0%

Change Data

Change in resident effort -9.32%

Change in non-resident effort: -5.82%

Overall change in effort: -8.01%

Estimated Angler Days

	Charter	Private	Shore	Total
Local	7,518	28,498	12,861	48,877
Alaska	19,898	37,044	4,767	61,709
Non-AK	51,171	25,597	10,202	86,970
Total	78,587	91,139	27,830	197,556

Simulated Change In Angler Days

	Charter	Private	Shore	Total
Local	-701	-2,657	-1,199	-4,557
Alaska	-1,855	-3,454	-444	-5,753
Non-AK	-2,977	-1,489	-593	-5,059
Total	-5,533	-7,600	-2,237	-15,369

Simulated Angler Days

	Charter	Private	Shore	Total
Local	6,817	25,841	11,662	44,320
Alaska	18,043	33,590	4,323	55,956
Non-AK	48,194	24,108	9,609	81,911
Total	73,054	83,539	25,593	182,187

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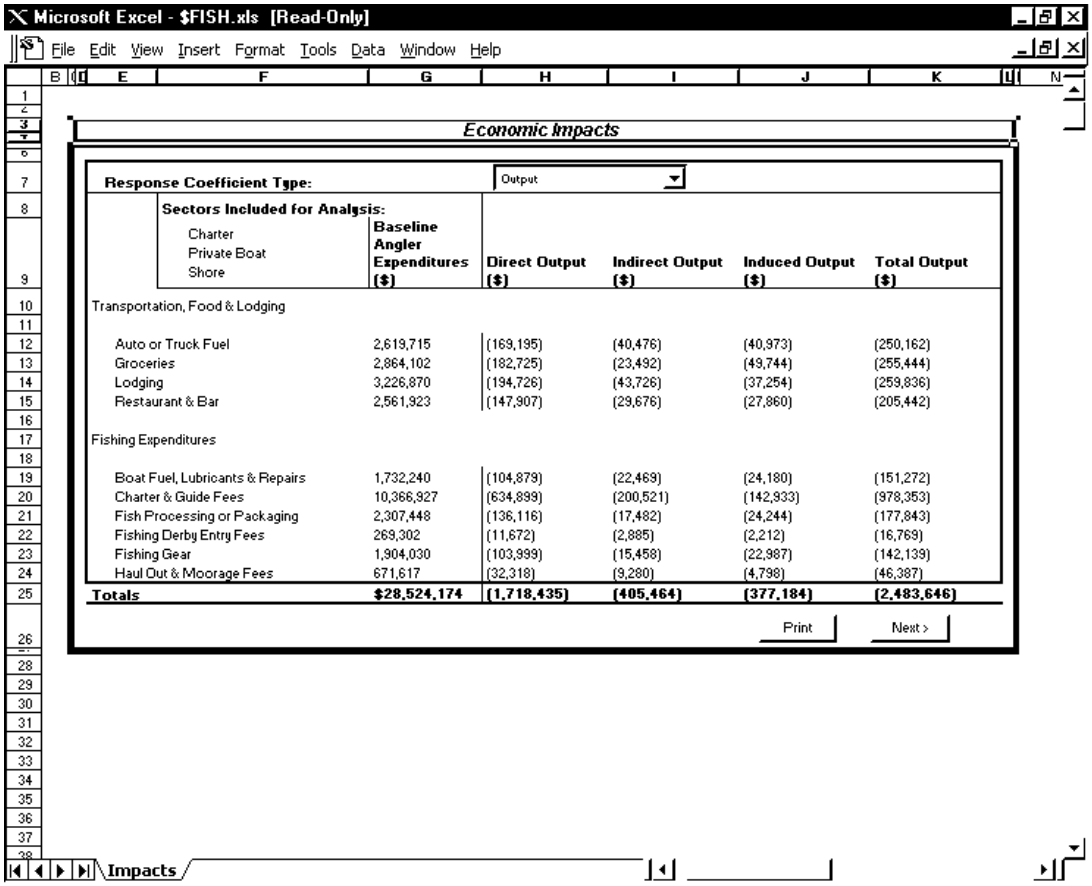
Figure 28. Example simulation screen showing changes in participation and sportfishing-days associated with a 10% decrease in expected catch.

The simulation results suggest that if lower and central Cook Inlet halibut and salmon sportfishing catches are reduced by 10% and average catch size remains constant, resident and nonresident participation will be reduced by –9.32% and –5.82%, respectively (Table 32 and Figure 28). That is, the number of lower and central Cook Inlet region sportfishing-days will diminish by 15,369 from the 1997 baseline of 197,556 days.

The screen represented in Figure 29 reports the direct, indirect, induced, and output impacts associated with the user-specified scenario. Employment, income, and other value-added impacts can also be displayed.



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Economic Impacts

Response Coefficient Type: Output

Sectors Included for Analysis: Charter, Private Boat, Shore	**Baseline Angler Expenditures ($)**	**Direct Output ($)**	**Indirect Output ($)**	**Induced Output ($)**	**Total Output ($)**
Transportation, Food & Lodging					
Auto or Truck Fuel	2,619,715	(169,195)	(40,476)	(40,973)	(250,162)
Groceries	2,864,102	(182,725)	(23,492)	(49,744)	(255,444)
Lodging	3,226,870	(194,726)	(43,726)	(37,254)	(259,836)
Restaurant & Bar	2,561,923	(147,907)	(29,676)	(27,860)	(205,442)
Fishing Expenditures					
Boat Fuel, Lubricants & Repairs	1,732,240	(104,879)	(22,469)	(24,180)	(151,272)
Charter & Guide Fees	10,366,927	(634,899)	(200,521)	(142,933)	(978,353)
Fish Processing or Packaging	2,307,448	(136,116)	(17,482)	(24,244)	(177,843)
Fishing Derby Entry Fees	269,302	(11,672)	(2,885)	(2,212)	(16,769)
Fishing Gear	1,904,030	(103,999)	(15,458)	(22,987)	(142,139)
Haul Out & Moorage Fees	671,617	(32,318)	(9,280)	(4,798)	(46,387)
Totals	**$28,524,174**	**(1,718,435)**	**(405,464)**	**(377,184)**	**(2,483,646)**

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Impacts

Figure 29. Example simulation screen showing regional economic impacts associated with a 10% decrease in expected catch.

Direct output reflects the amount of increased or decreased spending of new money for each sportfishing expense category. For example, reading across the line labeled “Auto or Truck Fuel”, there is a baseline expenditure of $2.62 million spent in the shore, private, and charter sportfishing modes in 1997 that was directly attributable to the lower and central Cook Inlet sport fisheries (Figure 29 and Table 44). The reduction in sportfishing effort associated with a 10% decrease in sportfishing catches will lead to decreases in fishing and non-fishing expenditures. For example, the direct effect on automotive fuel sales is a $169,195 reduction (direct impact). As fuel sales decline, fuel retail outlets decrease their local purchases of inputs from other sectors by $40,476 (the indirect effect), and households with members employed by these sectors spend $40,973 less on local goods and services (the induced effect). Taken together, the total impact on the Kenai Peninsula region economy that is attributable to the change in automotive fuel sales that results from a 10% reduction in expected lower and central Cook Inlet marine sportfishing catches is $250,162.

The screen represented in Figure 30 disaggregates the economic impacts into 26 final demand categories for each of the impact classes (output, employment, personal income, etc).

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Impacts by Final Demand Category

Final Demand Category	Output (Sales) ($)	Employment (Jobs)	Employee Compensation ($)	Proprietor's Income ($)	Personal Income ($)	Other Property Type Income	Indirect Business Taxes ($)	Value Added ($)
Banking/Credit Services	(31,880)	(0)	(6,722)	(288)	(7,010)	(5,005)	(4,069)	(16,084)
Business/Labor Associations	(23,175)	(0)	(10,087)	-	(10,087)	-	(264)	(10,352)
Civic/Religious Assoc.	(3,195)	(0)	(1,792)	-	(1,792)	-	(0)	(1,792)
Communications	(29,334)	(0)	(6,196)	(716)	(6,912)	(4,784)	(999)	(12,695)
Eating & Drinking Places	(184,141)	(5)	(58,315)	(14,266)	(72,581)	(8,856)	(4,946)	(86,383)
Education	(3,183)	(0)	(1,285)	(195)	(1,480)	-	-	(1,480)
Fabrics/Apparel	(4,024)	(0)	(1,618)	(218)	(1,837)	(643)	(478)	(2,957)
Food Processing	(324,195)	(7)	(133,624)	(22,068)	(155,692)	(23,687)	(15,125)	(194,504)
Health Care	(51,766)	(1)	(22,706)	(9,927)	(32,633)	(4,634)	(654)	(37,921)
Hotels & Lodging	(190,341)	(4)	(59,374)	(20,689)	(80,063)	(18,159)	(8,695)	(106,917)
Household Furnishings	(3,224)	(0)	(1,316)	(580)	(1,896)	(323)	(336)	(2,555)
Household Industry	(10)	(0)	(10)	-	(10)	-	-	(10)
Housing	(72,985)	(1)	(2,850)	284	(2,565)	(16,599)	(13,539)	(32,704)
Insurance	(5,962)	(0)	(1,929)	(263)	(2,192)	(149)	(668)	(3,009)
Motor Vehicles	(352,598)	(7)	(150,583)	(25,308)	(175,891)	(26,491)	(22,084)	(224,466)
Other Local Purchases	(372,246)	(21)	(51,619)	(92,388)	(144,007)	(44,318)	(4,398)	(192,723)
Personal Services	(54,127)	(1)	(15,210)	(11,597)	(26,807)	(4,920)	(459)	(32,186)
Petroleum Products	(16,919)	(0)	(1,236)	(157)	(1,393)	(744)	(2,134)	(4,271)
Publications/Paper	(14,307)	(0)	(5,141)	(402)	(5,543)	(4,347)	(68)	(9,957)
Recreation Activities	(386,555)	(16)	(36,618)	(120,305)	(156,924)	(41,445)	(3,758)	(202,127)
Retail Trade	(187,403)	(6)	(79,768)	(30,034)	(109,802)	(20,027)	(15,536)	(145,365)
State/Local Services	(19,431)	(0)	(7,074)	-	(7,074)	(3,144)	(8)	(10,226)
Transportation Services	(55,998)	(0)	(9,412)	(1,709)	(11,121)	(2,706)	(1,981)	(15,808)
U.S. Postal Service	(14,161)	(0)	(9,531)	-	(9,531)	1,471	-	(8,060)
Utilities	(48,382)	(0)	(9,074)	(916)	(9,990)	(13,755)	(1,901)	(25,647)
Wholesale Trade	(34,103)	(0)	(13,816)	(373)	(14,189)	(2,176)	(2,324)	(18,689)
Total Local Impacts	$ (2,483,646)	(72)	$ (696,906)	$ (352,115)	$ (1,049,021)	$ (245,440)	$ (104,426)	$ (1,398,887)

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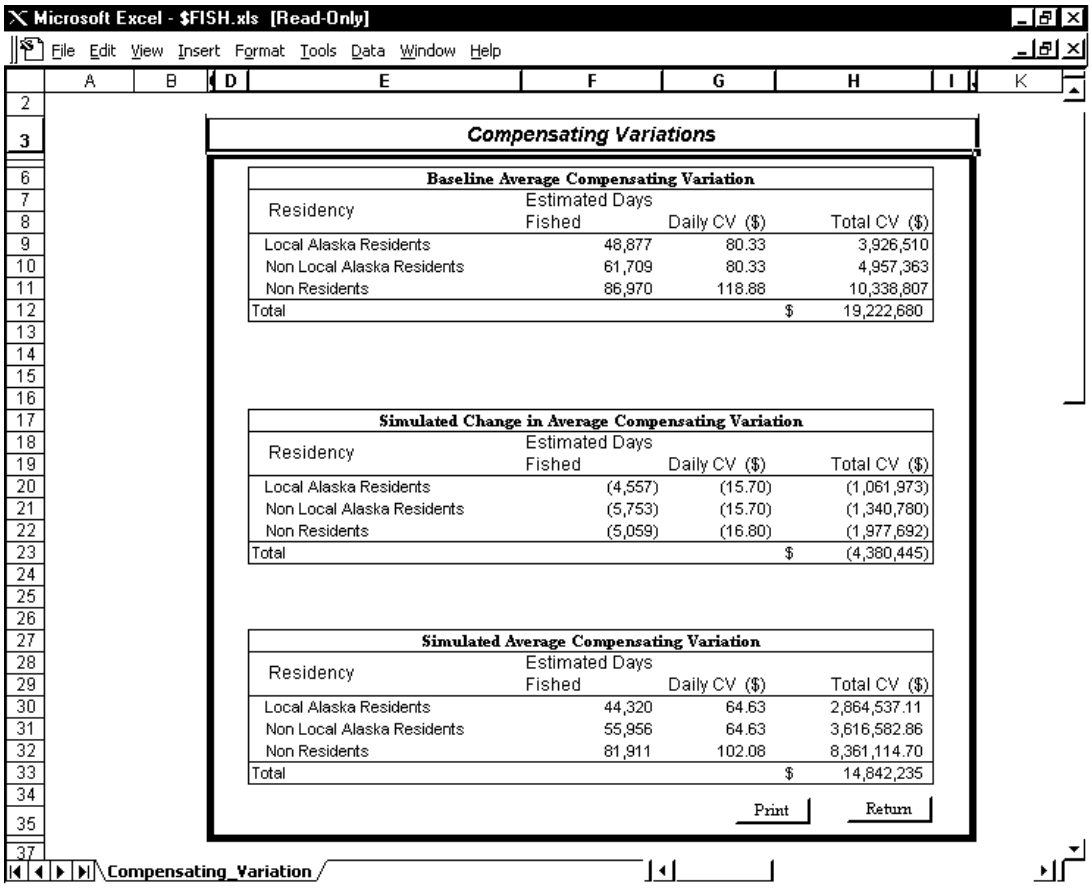
Final_Demands

Figure 30. Example simulation screen showing final demand category impacts associated with a 10% decrease in expected catch.

While the direct effect represents a loss of $169,195 to the automotive fuel sector, the amounts of the indirect and induced effects are distributed across the 528 IMPLAN industry sectors. We have summarized the IMPLAN sectors into 26 categories of the final demand array. Note that sum of total output impacts in Figure 30, –$2,483,646, equals the sum of the total output column in Table 45 as well as the corresponding columns in Figure 29 and Table 44. The individual row entries under the output column of Figure 30 (Table 45) show how each demand category is impacted by changes in sportfishing expenditures. Results in the output column of Figure 30 indicate that businesses making up the Recreation Activities category are hardest hit in terms of foregone sales revenues (–$386,555), followed by the Other Local Purchases category (–$372,246), and the Motor Vehicles category (–$352,598). In terms of employment, (Figure 30 column 3), the largest number of jobs are lost in Other Local Purchases category (21), followed by Recreation Activities (25), and Food Processing (13). The largest losses in personal income (Figure 31 column 6), arise in the Motor Vehicles category (–$175,891), with similar magnitude losses in Recreation Activities (–$156,924), and Food Processing (–$155,692).

The screen represented by Figure 31 contrasts compensating variations under the user-specified scenario with the 1997 baseline.



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Compensating Variations

Baseline Average Compensating Variation

Residency	Estimated Days Fished	Daily CV ($)	Total CV ($)
Local Alaska Residents	48,877	80.33	3,926,510
Non Local Alaska Residents	61,709	80.33	4,957,363
Non Residents	86,970	118.88	10,338,807
Total			$ 19,222,680

Simulated Change in Average Compensating Variation

Residency	Estimated Days Fished	Daily CV ($)	Total CV ($)
Local Alaska Residents	(4,557)	(15.70)	(1,061,973)
Non Local Alaska Residents	(5,753)	(15.70)	(1,340,780)
Non Residents	(5,059)	(16.80)	(1,977,692)
Total			$ (4,380,445)

Simulated Average Compensating Variation

Residency	Estimated Days Fished	Daily CV ($)	Total CV ($)
Local Alaska Residents	44,320	64.63	2,864,537.11
Non Local Alaska Residents	55,956	64.63	3,616,582.86
Non Residents	81,911	102.08	8,361,114.70
Total			$ 14,842,235

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Compensating_Variation

Figure 31. Example simulation screen showing compensating variations associated with a 10% decrease in expected catch.

Figure 31 (see also Table 39) suggests that with a 10% decrease in the expected sportfishing catch of lower and central Cook Inlet halibut and salmon, the estimated compensating variation for the Cook Inlet saltwater sport fishers declines from $19.2 to $14.8 million. This loss in consumer surplus comes from a loss of $1.1 million for local fishermen, $1.3 million for other Alaskans, and $2.0 million for nonresidents.

Tables 44 and 45 report the impacts of a 10% reduction in lower and central Cook Inlet halibut and salmon sportfishing catches. Tables 46 through 53 respectively, report on the output (direct, indirect, induced, total), employment, earnings, income, taxes, and value-added impacts of –20%, –30%, +10%, and +20% changes in lower and central Cook Inlet halibut and salmon sportfishing catches.

Table 44. Regional economic impacts of a 10% decrease in lower and central Cook Inlet sportfishing catches.

Response Coefficient	Baseline Expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Industry Output					
Auto or Truck Fuel	2,619,715	−169,195	−40,476	−40,973	−250,162
Groceries	2,864,102	−182,725	−23,492	−49,744	−255,444
Lodging	3,226,870	−194,726	−43,726	−37,254	−259,836
Restaurant & Bar	2,561,923	−147,907	−29,676	−27,860	−205,442
Boat Fuel, Lubricants & Repairs	1,732,240	−104,879	−22,469	−24,180	−151,272
Charter & Guide Fees	10,366,927	−634,899	−200,521	−142,933	−978,353
Fish Processing or Packaging	2,307,448	−136,116	−17,482	−24,244	−177,843
Fishing Derby Entry Fees	269,302	−11,672	−2,885	−2,212	−16,769
Fishing Gear	1,904,030	−103,999	−15,458	−22,987	−142,139
Haul Out & Moorage Fees	671,617	−32,318	−9,280	−4,798	−46,387
TOTAL	28,524,174	−1,718,435	−405,464	−377,184	−2,483,646
Personal Income					
Auto or Truck Fuel	2,619,715	−85,860	−11,710	−16,329	−113,899
Groceries	2,864,102	−111,829	−6,628	−19,825	−138,282
Lodging	3,226,870	−75,233	−13,556	−14,850	−103,639
Restaurant & Bar	2,561,923	−58,299	−8,100	−11,105	−77,504
Boat Fuel, Lubricants & Repairs	1,732,240	−51,048	−6,532	−9,637	−67,217
Charter & Guide Fees	10,366,927	−261,270	−79,389	−56,976	−397,635
Fish Processing or Packaging	2,307,448	−51,501	−6,233	−9,662	−67,397
Fishing Derby Entry Fees	269,302	−4,491	−821	−887	−6,200
Fishing Gear	1,904,030	−50,054	−4,685	−9,161	−63,900
Haul Out & Moorage Fees	671,617	−8,924	−2,512	−1,913	−13,349
TOTAL	28,524,174	−758,510	−140,165	−150,346	−1,049,021
Employment					
Auto or Truck Fuel	2,619,715	−3	−0	−1	−5
Groceries	2,864,102	−5	−0	−1	−6
Lodging	3,226,870	−4	−1	−1	−5
Restaurant & Bar	2,561,923	−4	−0	−0	−5
Boat Fuel, Lubricants & Repairs	1,732,240	−2	−0	−0	−3
Charter & Guide Fees	10,366,927	−35	−3	−2	−41
Fish Processing or Packaging	2,307,448	−3	−0	−0	−4
Fishing Derby Entry Fees	269,302	−0	−0	−0	−0
Fishing Gear	1,904,030	−3	−0	−0	−3
Haul Out & Moorage Fees	671,617	−0	−0	−0	−1
TOTAL	28,524,174	−60	−6	−7	−72

Table 45. Final demand impacts of a 10% decrease in lower and central Cook Inlet sportfishing catches.

Final Demand Category	Output ($)	Jobs	Employee Earnings ($)	Proprietors Income ($)	Personal Income ($)	Other Income ($)	Indirect Taxes ($)	Value Added ($)
Banking/Credit Services	−31,880	−0	−6,722	−288	−7,010	−5,005	−4,069	−16,084
Business/Labor Assoc	−23,175	−0	−10,087	—	−10,087	—	−264	−10,352
Civic/Religious Assoc	−3,195	−0	−1,792	—	−1,792	—	−0	−1,792
Communications	−29,334	−0	−6,196	−716	−6,912	−4,784	−999	−12,695
Eating & Drinking Places	−184,141	−5	−58,315	−14,266	−72,581	−8,856	−4,946	−86,383
Education	−3,183	−0	−1,285	−195	−1,480	—	—	−1,480
Fabrics/Apparel	−4,024	−0	−1,618	−218	−1,837	−643	−478	−2,957
Food Processing	−324,195	−7	−133,624	−22,068	−155,692	−23,687	−15,125	−194,504
Health Care	−51,766	−1	−22,706	−9,927	−32,633	−4,634	−654	−37,921
Hotels & Lodging	−190,341	−4	−59,374	−20,689	−80,063	−18,159	−8,695	−106,917
Household Furnishings	−3,224	−0	−1,316	−580	−1,896	−323	−336	−2,555
Household Industry	−10	−0	−10	—	−10	—	—	−10
Housing	−72,985	−1	−2,850	284	−2,565	−16,599	−13,539	−32,704
Insurance	−5,962	−0	−1,929	−263	−2,192	−149	−668	−3,009
Motor Vehicles	−352,598	−7	−150,583	−25,308	−175,891	−26,491	−22,084	−224,466
Other Local Purchases	−372,246	−21	−51,619	−92,388	−144,007	−44,318	−4,398	−192,723
Personal Services	−54,127	−1	−15,210	−11,597	−26,807	−4,920	−459	−32,186
Petroleum Products	−16,919	−0	−1,236	−157	−1,393	−744	−2,134	−4,271
Publications/Paper	−14,307	−0	−5,141	−402	−5,543	−4,347	−68	−9,957
Recreation Activities	−386,555	−16	−36,618	−120,305	−156,924	−41,445	−3,758	−202,127
Retail Trade	−187,403	−6	−79,768	−30,034	−109,802	−20,027	−15,536	−145,365
State/Local Services	−19,431	−0	−7,074	—	−7,074	−3,144	−8	−10,226
Transportation Services	−55,998	−1	−9,412	−1,709	−11,121	−2,706	−1,981	−15,808
U.S. Postal Service	−14,161	−0	−9,531	—	−9,531	1,471	—	−8,060
Utilities	−48,382	−0	−9,074	−916	−9,990	−13,755	−1,901	−25,647
Wholesale Trade	−34,103	−0	−13,816	−373	−14,189	−2,176	−2,324	−18,689
Total Local Impacts	−2,483,646	−72	−696,906	−352,115	−1,049,021	−245,440	−104,426	−1,398,887

Table 46. Regional economic impacts of a 20% decrease in lower and central Cook Inlet sportfishing catches.

Response Coefficient	Baseline Expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Industry Output					
Auto or Truck Fuel	2,619,715	−391,826	−93,735	−94,886	−579,332
Groceries	2,864,102	−424,332	−54,553	−115,518	−593,203
Lodging	3,226,870	−456,540	−102,516	−87,342	−609,192
Restaurant & Bar	2,561,923	−343,976	−69,015	−64,791	−477,782
Boat Fuel, Lubricants & Repairs	1,732,240	−241,095	−51,652	−55,584	−347,741
Charter & Guide Fees	10,366,927	−1,495,608	−472,361	−336,702	−2,304,671
Fish Processing or Packaging	2,307,448	−323,900	−41,601	−57,692	−423,192
Fishing Derby Entry Fees	269,302	−27,416	−6,777	−5,197	−39,390
Fishing Gear	1,904,030	−246,891	−36,696	−54,570	−337,435
Haul Out & Moorage Fees	671,617	−75,097	−21,564	−11,150	−107,789
TOTAL	28,524,174	−4,026,681	−950,469	−883,431	−5,819,726
Personal Income					
Auto or Truck Fuel	2,619,715	−198,837	−27,118	−37,816	−263,771
Groceries	2,864,102	−259,695	−15,391	−46,039	−321,125
Lodging	3,226,870	−176,385	−31,782	−34,816	−242,983
Restaurant & Bar	2,561,923	−135,582	−18,838	−25,827	−180,246
Boat Fuel, Lubricants & Repairs	1,732,240	−117,349	−15,016	−22,153	−154,518
Charter & Guide Fees	10,366,927	−615,464	−187,014	−134,215	−936,693
Fish Processing or Packaging	2,307,448	−122,552	−14,832	−22,993	−160,376
Fishing Derby Entry Fees	269,302	−10,549	−1,929	−2,084	−14,563
Fishing Gear	1,904,030	−118,827	−11,121	−21,748	−151,697
Haul Out & Moorage Fees	671,617	−20,737	−5,837	−4,445	−31,019
TOTAL	28,524,174	−1,775,977	−328,877	−352,136	−2,456,990
Employment					
Auto or Truck Fuel	2,619,715	−8	−1	−2	−11
Groceries	2,864,102	−12	−1	−2	−14
Lodging	3,226,870	−8	−1	−2	−11
Restaurant & Bar	2,561,923	−9	−1	−1	−11
Boat Fuel, Lubricants & Repairs	1,732,240	−5	−1	−1	−7
Charter & Guide Fees	10,366,927	−82	−8	−6	−96
Fish Processing or Packaging	2,307,448	−8	−0	−1	−9
Fishing Derby Entry Fees	269,302	−0	−0	−0	−1
Fishing Gear	1,904,030	−7	−0	−1	−8
Haul Out & Moorage Fees	671,617	−1	−0	−0	−1
TOTAL	28,524,174	−140	−13	−15	−168

Table 47. Final demand impacts of a 20% decrease in lower and central Cook Inlet sportfishing catches.

Final Demand Category	Output ($)	Jobs	Employee Earnings ($)	Proprietors Income ($)	Personal Income ($)	Other Income ($)	Indirect Taxes ($)	Value Added ($)
Banking/Credit Services	−74,735	−1	−15,756	−674	−16,430	−11,736	−9,539	−37,706
Business/Labor Assoc	−54,391	−1	−23,668	—	−23,668	—	−619	−24,288
Civic/Religious Assoc	−7,482	−0	−4,195	—	−4,195	—	−0	−4,196
Communications	−68,657	−0	−14,504	−1,676	−16,179	−11,210	−2,342	−29,731
Eating & Drinking Places	−428,819	−11	−135,801	−33,222	−169,023	−20,623	−11,518	−201,165
Education	−7,455	−0	−3,010	−457	−3,466	—	—	−3,466
Fabrics/Apparel	−9,449	−0	−3,801	−513	−4,314	−1,510	−1,122	−6,946
Food Processing	−762,723	−17	−313,359	−51,796	−365,155	−55,442	−35,304	−455,901
Health Care	−121,247	−2	−53,182	−23,252	−76,433	−10,854	−1,531	−88,819
Hotels & Lodging	−446,209	−9	−139,188	−48,501	−187,689	−42,569	−20,384	−250,642
Household Furnishings	−7,557	−0	−3,086	−1,359	−4,444	−758	−788	−5,990
Household Industry	−23	−0	−23	—	−23	—	—	−23
Housing	−170,550	−1	−6,659	665	−5,995	−38,789	−31,639	−76,422
Insurance	−13,992	−0	−4,527	−617	−5,145	−349	−1,567	−7,061
Motor Vehicles	−818,837	−16	−349,615	−58,796	−408,412	−61,563	−51,270	−521,244
Other Local Purchases	−875,074	−49	−121,125	−217,542	−338,668	−104,118	−10,337	−453,122
Personal Services	−126,530	−3	−35,550	−27,113	−62,663	−11,503	−1,073	−75,239
Petroleum Products	−39,630	−0	−2,896	−367	−3,263	−1,743	−4,998	−10,004
Publications/Paper	−33,430	−1	−12,004	−937	−12,941	−10,147	−158	−23,245
Recreation Activities	−909,969	−38	−86,101	−283,388	−369,489	−97,623	−8,853	−475,964
Retail Trade	−439,959	−15	−187,309	−70,444	−257,753	−47,012	−36,477	−341,243
State/Local Services	−45,476	−1	−16,560	—	−16,560	−7,356	−18	−23,933
Transportation Services	−131,076	−1	−22,028	−3,999	−26,027	−6,331	−4,638	−36,996
U.S. Postal Service	−33,257	−0	−22,383	—	−22,383	3,455	—	−18,928
Utilities	−113,148	−0	−21,221	−2,143	−23,364	−32,159	−4,445	−59,968
Wholesale Trade	−80,052	−1	−32,432	−876	−33,307	−5,108	−5,456	−43,871
Total Local Impacts	−5,819,726	−168	−1,629,983	−827,008	−2,456,990	−575,046	−244,077	−3,276,113

Table 48. Regional economic impacts of a 30% decrease in lower and central Cook Inlet sportfishing catches.

Response Coefficient	Baseline Expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Industry Output					
Auto or Truck Fuel	2,619,715	−668,091	−159,824	−161,787	−987,801
Groceries	2,864,102	−725,914	−93,325	−197,619	−1,014,806
Lodging	3,226,870	−789,860	−177,363	−151,111	−1,053,963
Restaurant & Bar	2,561,923	−589,468	−118,270	−111,031	−818,770
Boat Fuel, Lubricants & Repairs	1,732,240	−407,429	−87,287	−93,932	−587,650
Charter & Guide Fees	10,366,927	−2,601,838	−821,743	−585,744	−4,009,325
Fish Processing or Packaging	2,307,448	−570,020	−73,212	−101,530	−744,761
Fishing Derby Entry Fees	269,302	−47,536	−11,750	−9,011	−68,298
Fishing Gear	1,904,030	−433,335	−64,408	−95,779	−592,254
Haul Out & Moorage Fees	671,617	−128,567	−36,917	−19,089	−184,536
TOTAL	28,524,174	−6,962,057	−1,644,100	−1,526,632	−10,062,164
Personal Income					
Auto or Truck Fuel	2,619,715	−339,031	−46,237	−64,479	−449,747
Groceries	2,864,102	−444,266	−26,329	−78,760	−549,355
Lodging	3,226,870	−305,163	−54,987	−60,235	−420,385
Restaurant & Bar	2,561,923	−232,345	−32,282	−44,259	−308,886
Boat Fuel, Lubricants & Repairs	1,732,240	−198,310	−25,375	−37,436	−261,121
Charter & Guide Fees	10,366,927	−1,070,693	−325,340	−233,488	−1,629,521
Fish Processing or Packaging	2,307,448	−215,674	−26,102	−40,464	−282,240
Fishing Derby Entry Fees	269,302	−18,291	−3,345	−3,614	−25,250
Fishing Gear	1,904,030	−208,562	−19,519	−38,172	−266,253
Haul Out & Moorage Fees	671,617	−35,502	−9,993	−7,609	−53,104
TOTAL	28,524,174	−3,067,837	−569,509	−608,517	−4,245,863
Employment					
Auto or Truck Fuel	2,619,715	−14	−2	−3	−18
Groceries	2,864,102	−20	−1	−3	−24
Lodging	3,226,870	−14	−2	−3	−19
Restaurant & Bar	2,561,923	−15	−1	−2	−19
Boat Fuel, Lubricants & Repairs	1,732,240	−8	−1	−2	−11
Charter & Guide Fees	10,366,927	−143	−13	−10	−167
Fish Processing or Packaging	2,307,448	−13	−1	−2	−16
Fishing Derby Entry Fees	269,302	−1	−0	−0	−1
Fishing Gear	1,904,030	−12	−1	−2	−14
Haul Out & Moorage Fees	671,617	−1	−0	−0	−2
TOTAL	28,524,174	−242	−23	−27	−292

Table 49. Final demand impacts of a 30% decrease in Cook Inlet sportfishing catches.

Final Demand Category	Output ($)	Jobs	Employee Earnings ($)	Proprietors Income ($)	Personal Income ($)	Other Income ($)	Indirect Taxes ($)	Value Added ($)
Banking/Credit Services	−129,280	−1	−27,251	−1,166	−28,417	−20,310	−16,502	−65,229
Business/Labor Assoc	−94,216	−2	−40,987	—	−40,987	—	−1,071	−42,058
Civic/Religious Assoc	−12,925	−0	−7,248	—	−7,248	—	−1	−7,248
Communications	−118,545	−1	−25,049	−2,893	−27,942	−19,383	−4,049	−51,373
Eating & Drinking Places	−736,034	−19	−233,092	−57,023	−290,115	−35,398	−19,770	−345,284
Education	−12,879	−0	−5,199	−789	−5,988	—	—	−5,988
Fabrics/Apparel	−16,376	−1	−6,588	−889	−7,478	−2,618	−1,946	−12,042
Food Processing	−1,324,922	−30	−542,294	−89,727	−632,021	−95,734	−60,760	−788,515
Health Care	−209,530	−4	−91,905	−40,181	−132,086	−18,757	−2,646	−153,490
Hotels & Lodging	−771,884	−15	−240,777	−83,901	−324,678	−73,638	−35,262	−433,577
Household Furnishings	−13,073	−0	−5,338	−2,350	−7,688	−1,311	−1,364	−10,362
Household Industry	−39	−0	−39	—	−39	—	—	−39
Housing	−293,928	−2	−11,477	1,146	−10,331	−66,849	−54,526	−131,706
Insurance	−24,235	−0	−7,842	−1,069	−8,911	−604	−2,715	−12,230
Motor Vehicles	−1,400,837	−28	−597,943	−100,633	−698,577	−105,407	−87,679	−891,662
Other Local Purchases	−1,518,683	−85	−209,766	−378,262	−588,028	−180,564	−17,936	−786,528
Personal Services	−218,158	−5	−61,283	−46,753	−108,036	−19,840	−1,848	−129,724
Petroleum Products	−68,490	−0	−5,004	−634	−5,639	−3,012	−8,638	−17,289
Publications/Paper	−57,609	−1	−20,666	−1,613	−22,280	−17,464	−271	−40,015
Recreation Activities	−1,581,775	−65	−149,463	−492,977	−642,440	−169,812	−15,399	−827,651
Retail Trade	−762,361	−26	−324,651	−121,934	−446,585	−81,457	−63,215	−591,256
State/Local Services	−78,513	−1	−28,599	—	−28,599	−12,693	−30	−41,322
Transportation Services	−226,345	−2	−38,035	−6,903	−44,937	−10,926	−8,011	−63,875
U.S. Postal Service	−57,649	−1	−38,801	—	−38,801	5,990	—	−32,811
Utilities	−195,183	−1	−36,609	−3,696	−40,305	−55,455	−7,667	−103,426
Wholesale Trade	−138,695	−1	−56,190	−1,517	−57,707	−8,850	−9,453	−76,010
Total Local Impacts	−10,062,164	−292	−2,812,096	−1,433,767	−4,245,863	−994,091	−420,758	−5,660,712

Table 50. Regional economic impacts of a 10% increase in Cook Inlet sportfishing catches.

Response Coefficient	Baseline Expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Industry Output					
Auto or Truck Fuel	2,619,715	122,820	29,382	29,743	181,595
Groceries	2,864,102	132,104	16,984	35,963	184,677
Lodging	3,226,870	138,790	31,165	26,552	185,196
Restaurant & Bar	2,561,923	106,702	21,409	20,098	148,209
Boat Fuel, Lubricants & Repairs	1,732,240	76,953	16,486	17,742	110,993
Charter & Guide Fees	10,366,927	449,274	141,895	101,144	692,312
Fish Processing or Packaging	2,307,448	94,825	12,179	16,890	123,894
Fishing Derby Entry Fees	269,302	8,295	2,051	1,572	11,918
Fishing Gear	1,904,030	72,718	10,808	16,073	99,387
Haul Out & Moorage Fees	671,617	23,343	6,703	3,466	33,505
TOTAL	28,524,174	1,225,825	289,061	269,242	1,771,687
Personal Income					
Auto or Truck Fuel	2,619,715	62,327	8,500	11,854	82,681
Groceries	2,864,102	80,849	4,791	14,333	99,973
Lodging	3,226,870	53,621	9,662	10,584	73,868
Restaurant & Bar	2,561,923	42,058	5,843	8,012	55,913
Boat Fuel, Lubricants & Repairs	1,732,240	37,456	4,793	7,071	49,319
Charter & Guide Fees	10,366,927	184,882	56,178	40,318	281,378
Fish Processing or Packaging	2,307,448	35,878	4,342	6,731	46,952
Fishing Derby Entry Fees	269,302	3,192	584	631	4,406
Fishing Gear	1,904,030	34,999	3,276	6,406	44,680
Haul Out & Moorage Fees	671,617	6,446	1,814	1,382	9,642
TOTAL	28,524,174	541,708	99,784	107,320	748,812
Employment					
Auto or Truck Fuel	2,619,715	2	0	1	3
Groceries	2,864,102	4	0	1	4
Lodging	3,226,870	3	0	0	3
Restaurant & Bar	2,561,923	3	0	0	3
Boat Fuel, Lubricants & Repairs	1,732,240	2	0	0	2
Charter & Guide Fees	10,366,927	25	2	2	29
Fish Processing or Packaging	2,307,448	2	0	0	3
Fishing Derby Entry Fees	269,302	0	0	0	0
Fishing Gear	1,904,030	2	0	0	2
Haul Out & Moorage Fees	671,617	0	0	0	0
TOTAL	28,524,174	42	4	5	51

Table 51. Final demand impacts of a 10% increase in lower and central Cook Inlet sportfishing catches.

Final Demand Category	Output ($)	Jobs	Employee Earnings ($)	Proprietors Income ($)	Personal Income ($)	Other Income ($)	Indirect Taxes ($)	Value Added ($)
Banking/Credit Services	22,727	0	4,793	205	4,998	3,566	2,901	11,465
Business/Labor Assoc	16,492	0	7,181	—	7,181	—	189	7,369
Civic/Religious Assoc	2,282	0	1,279	—	1,279	—	0	1,280
Communications	20,962	0	4,426	512	4,938	3,412	713	9,063
Eating & Drinking Places	132,578	3	41,986	10,271	52,257	6,376	3,561	62,194
Education	2,273	0	918	139	1,057	—	—	1,057
Fabrics/Apparel	2,862	0	1,151	155	1,306	457	340	2,102
Food Processing	229,856	5	95,205	15,703	110,908	16,925	10,853	138,685
Health Care	36,950	1	16,207	7,086	23,293	3,308	467	27,068
Hotels & Lodging	135,688	3	42,326	14,749	57,074	12,945	6,199	76,218
Household Furnishings	2,298	0	938	413	1,351	230	240	1,822
Household Industry	7	0	7	—	7	—	—	7
Housing	52,279	0	2,041	(204)	1,838	11,890	9,698	23,426
Insurance	4,243	0	1,373	187	1,560	106	475	2,141
Motor Vehicles	254,909	5	108,900	18,286	127,186	19,132	15,972	162,290
Other Local Purchases	264,244	15	36,744	65,419	102,163	31,490	3,123	136,775
Personal Services	38,750	1	10,891	8,301	19,192	3,520	329	23,042
Petroleum Products	12,076	0	882	112	994	531	1,523	3,048
Publications/Paper	10,249	0	3,687	288	3,975	3,119	48	7,143
Recreation Activities	273,825	11	25,986	85,136	111,122	29,332	2,660	143,114
Retail Trade	133,300	4	56,720	21,393	78,114	14,246	11,049	103,410
State/Local Services	13,887	0	5,054	—	5,054	2,249	5	7,308
Transportation Services	40,010	0	6,726	1,221	7,947	1,935	1,415	11,297
U.S. Postal Service	10,068	0	6,776	—	6,776	(1,046)	—	5,730
Utilities	34,614	0	6,492	656	7,147	9,846	1,360	18,353
Wholesale Trade	24,262	0	9,829	265	10,095	1,548	1,654	13,296
Total Local Impacts	1,771,687	51	498,518	250,294	748,812	175,116	74,774	998,702

Table 52. Regional economic impacts of a 20% increase in lower and central Cook Inlet sportfishing catches.

Response Coefficient	Baseline Expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Industry Output					
Auto or Truck Fuel	2,619,715	208,716	49,930	50,543	308,596
Groceries	2,864,102	224,131	28,815	61,016	313,328
Lodging	3,226,870	234,132	52,574	44,793	312,418
Restaurant & Bar	2,561,923	180,879	36,291	34,070	251,240
Boat Fuel, Lubricants & Repairs	1,732,240	131,323	28,134	30,276	189,411
Charter & Guide Fees	10,366,927	755,685	238,670	170,125	1,164,480
Fish Processing or Packaging	2,307,448	158,468	20,353	28,226	207,047
Fishing Derby Entry Fees	269,302	13,978	3,455	2,650	20,082
Fishing Gear	1,904,030	121,711	18,090	26,901	166,347
Haul Out & Moorage Fees	671,617	39,590	11,368	5,878	56,824
TOTAL	28,524,174	2,068,612	487,681	454,478	2,989,775
Personal Income					
Auto or Truck Fuel	2,619,715	105,916	14,445	20,144	140,504
Groceries	2,864,102	137,170	8,129	24,318	169,617
Lodging	3,226,870	90,457	16,299	17,855	124,611
Restaurant & Bar	2,561,923	71,295	9,906	13,581	94,782
Boat Fuel, Lubricants & Repairs	1,732,240	63,919	8,179	12,066	84,164
Charter & Guide Fees	10,366,927	310,975	94,493	67,815	473,283
Fish Processing or Packaging	2,307,448	59,958	7,257	11,249	78,464
Fishing Derby Entry Fees	269,302	5,378	984	1,063	7,425
Fishing Gear	1,904,030	58,579	5,482	10,721	74,783
Haul Out & Moorage Fees	671,617	10,932	3,077	2,343	16,352
TOTAL	28,524,174	914,580	168,250	181,155	1,263,986
Employment					
Auto or Truck Fuel	2,619,715	4	1	1	6
Groceries	2,864,102	6	0	1	7
Lodging	3,226,870	4	1	1	6
Restaurant & Bar	2,561,923	5	0	1	6
Boat Fuel, Lubricants & Repairs	1,732,240	3	0	1	4
Charter & Guide Fees	10,366,927	42	4	3	48
Fish Processing or Packaging	2,307,448	4	0	0	4
Fishing Derby Entry Fees	269,302	0	0	0	0
Fishing Gear	1,904,030	3	0	0	4
Haul Out & Moorage Fees	671,617	0	0	0	1
TOTAL	28,524,174	71	7	8	86

Table 53. Final demand impacts of a 20% increase in lower and central Cook Inlet sportfishing catches.

Final Demand Category	Output ($)	Jobs	Employee Earnings ($)	Proprietors Income ($)	Personal Income ($)	Other Income ($)	Indirect Taxes ($)	Value Added ($)
Banking/Credit Services	38,342	0	8,086	346	8,432	6,015	4,894	19,341
Business/Labor Assoc	27,803	1	12,108	—	12,108	—	318	12,426
Civic/Religious Assoc	3,852	0	2,160	—	2,160	—	0	2,160
Communications	35,399	0	7,473	864	8,337	5,758	1,203	15,299
Eating & Drinking Places	224,564	6	71,116	17,398	88,514	10,800	6,032	105,346
Education	3,837	0	1,550	235	1,785	—	—	1,785
Fabrics/Apparel	4,824	0	1,939	261	2,200	770	572	3,542
Food Processing	386,928	9	160,583	26,472	187,055	28,580	18,358	233,993
Health Care	62,371	1	27,357	11,961	39,318	5,584	788	45,689
Hotels & Lodging	228,915	5	71,406	24,882	96,289	21,839	10,457	128,585
Household Furnishings	3,877	0	1,583	697	2,280	389	404	3,073
Household Industry	12	0	12	—	12	—	—	12
Housing	88,369	1	3,450	(344)	3,106	20,098	16,393	39,597
Insurance	7,154	0	2,315	316	2,630	178	801	3,610
Motor Vehicles	432,480	9	184,786	31,017	215,803	32,446	27,104	275,352
Other Local Purchases	445,035	25	61,954	110,065	172,018	53,055	5,260	230,333
Personal Services	65,486	2	18,407	14,027	32,435	5,948	557	38,940
Petroleum Products	20,383	0	1,489	189	1,678	896	2,571	5,145
Publications/Paper	17,324	0	6,236	487	6,723	5,276	82	12,081
Recreation Activities	460,775	19	43,759	143,204	186,963	49,339	4,474	240,776
Retail Trade	224,686	8	95,594	36,081	131,675	24,014	18,623	174,312
State/Local Services	23,452	0	8,533	—	8,533	3,799	9	12,341
Transportation Services	67,561	1	11,358	2,063	13,421	3,268	2,389	19,078
U.S. Postal Service	16,967	0	11,420	—	11,420	(1,763)	—	9,657
Utilities	58,482	0	10,967	1,108	12,075	16,638	2,299	31,012
Wholesale Trade	40,898	0	16,569	447	17,016	2,610	2,787	22,413
Total Local Impacts	2,989,775	86	842,210	421,776	1,263,986	295,537	126,376	1,685,900

In considering these impacts, the analyst must take into account the assumptions and caveats discussed in Section 5 underlying the use of input–output analysis. These include, but are not limited to, the potential for upwardly biased estimates for induced effects and employment impacts, because of the assumed linear relationship between production and labor inputs. This assumption is less likely to be true for labor than it is for other factors of production, and it assumes that resources are available to satisfy increased demand without input price increases or input substitution. Kenai Peninsula employment patterns are subject to a substantial seasonal effect typical throughout coastal Alaska, with a large seasonal influx of migrant labor. The induced multiplier effect for certain expenditures will tend to be smaller the greater the proportion of imported labor, since itinerant workers consume local goods and services only while inhabiting the region. The analyst needs to take this unaccounted for leakage into consideration when commenting on the economic impact of alternatives.

Summary of results

The simulation model results can be summarized graphically to illustrate the relationship between changes in lower and central Cook Inlet sportfishing catches of halibut and salmon and regional economic impacts. Figure 32 illustrates the relationship between changes in sportfishing catches and total output.

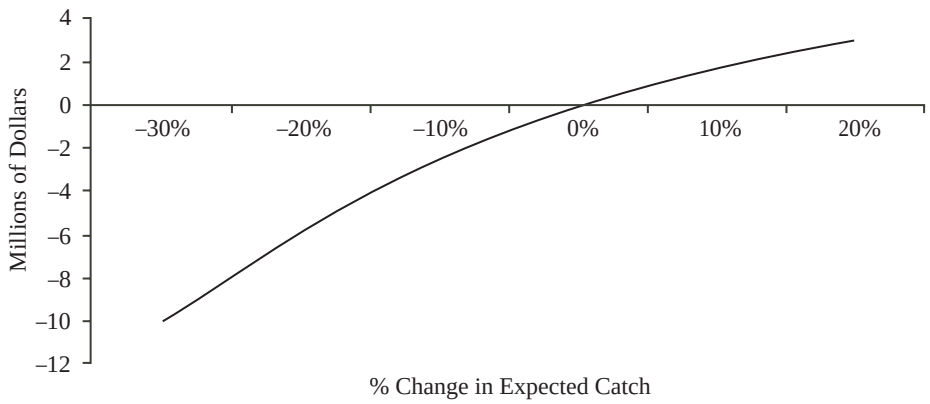

Figure 32. Industry output impacts from changes in expected catches of salmon and halibut in the lower and central Cook Inlet sport fisheries.

Figure 33 provides a corresponding representation of the relationship between changes in catch and changes in personal income.

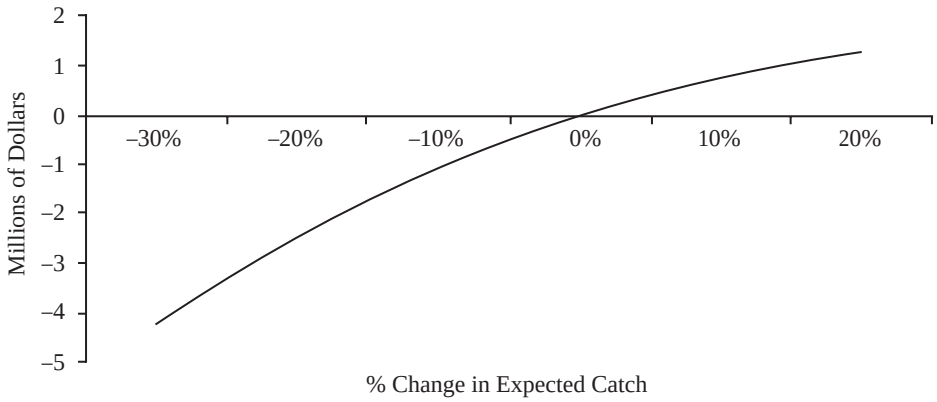

Figure 33. Personal income impacts from changes in expected catch of salmon and halibut in the lower and central Cook Inlet sport fisheries.

The expected changes to employment for given changes to expected sportfishing catch of salmon and halibut are represented in Figure 34.

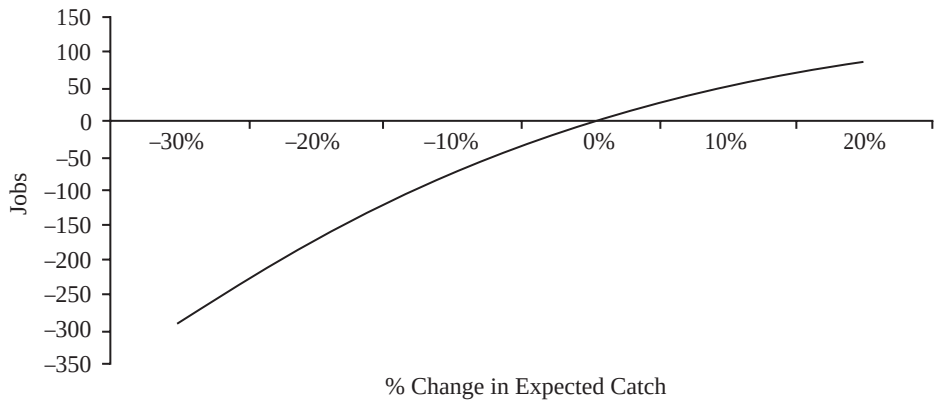

Figure 34. Employment impacts from changes in expected catch of salmon and halibut in the lower and central Cook Inlet sport fisheries.

It is evident in each of these figures that the impact is nonlinear and that the marginal impact declines as catch increases. That is, there is a larger decline in expenditures and jobs when moving from a 20% decrease to a 30% decrease in expected catch than when moving from a 20% increase to a 10% increase. This result is consistent with the principle of declining marginal utility where utility, and therefore participation, increases at a decreasing rate as the average individual sport fisher becomes more successful.

7. Conclusions

The Cook Inlet Planning Area includes and abuts productive commercial, subsistence, and sport fishing grounds. OCS exploration, development and production activities could affect the productivity of these fisheries, the quality of recreation opportunities, and the demand for tourism-related services. Sportfishing provides non-monetary benefits to participants and monetary benefits to tourism-related businesses. This study and a companion study, funded in part by Alaska Sea Grant, develop estimates of the net economic benefits that accrue to participants in the lower and central Cook Inlet salmon and 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.

Results from a survey of Kenai Peninsula area marine recreational fishers [Lee et al. 1999b] were used to develop a predictive model of participation rate changes and, in conjunction with a regional input–output model, to measure the net benefits (compensating variations) to sport fishers and the regional economic impact of marine sportfishing on the Kenai Peninsula economy. The baseline trip, patterned on the 1997 mean trip, is reported along with five sample levels of changes in expected harvests that may result from natural stock dynamic processes, changes in allocation between commercial, subsistence, and sport fishers, changes in catch limits, or environmental damage resulting from minerals exploration, development, production, or transportation activities. A computer simulation model, the Cook Inlet Region Marine Sportfishing Economic Assessment, and an accompanying user manual have been developed as part of this project as a tool for MMS and other resource managers (see Appendix B [software manual] or Hamel et al. [2001]).

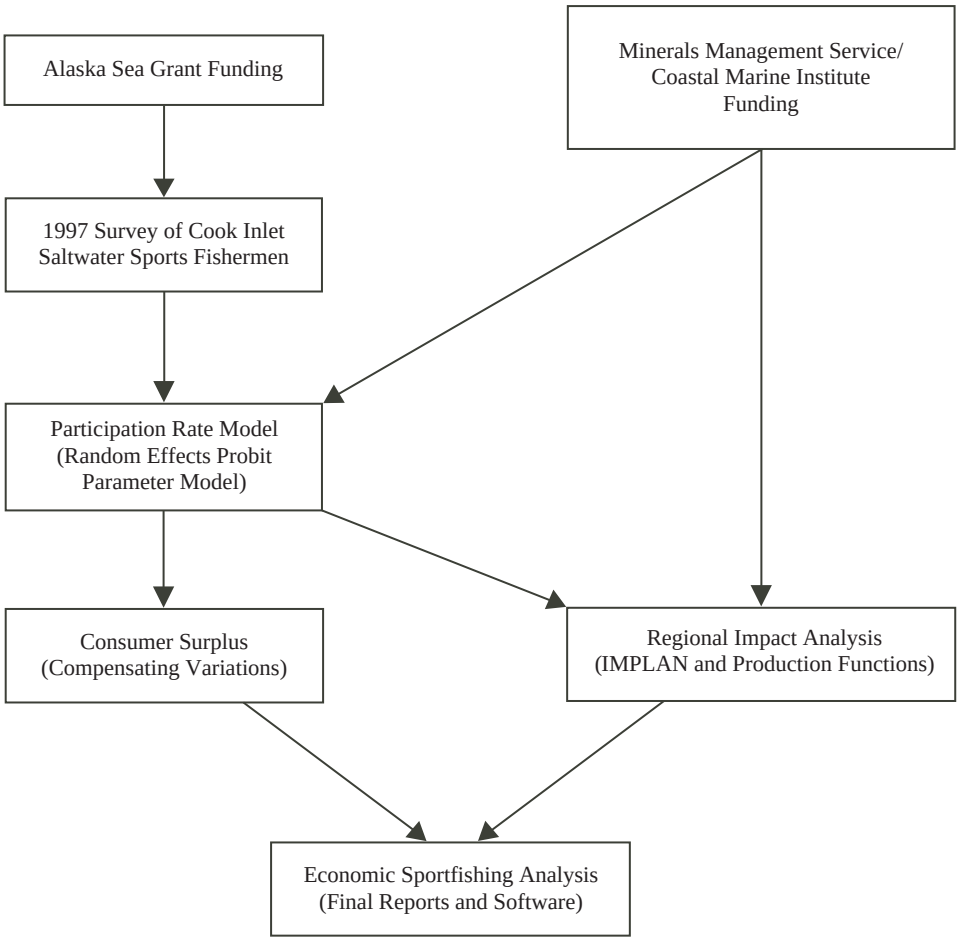

Figure 35. Extramural funding sources and their relationship to components of the lower and central Cook Inlet sportfishing analyses.

Figure 35 provides a schematic representation of the relationship between extramural funding sources used to support this study, major components of the analysis, and this report. The Alaska Sea Grant project funded a 1998 survey of 4,000 (2,640 completed) individuals who purchased Alaska fishing licenses in 1997 [Lee et al. 1999b]. Data generated by that survey were used to estimate a model of the relationship between the probability that a typical lower or central Cook Inlet sport fisher will take a trip given trip cost, and catch (species, size, number). The resulting random utility theory model, estimated using a binary probit estimation technique, allowed for declining marginal utility as well as the interactions between salmon and halibut catches. The participation rate model is used specifically to predict changes in participation given changes in expected catch that may result from changes in biomass (abundance) or changes in catch limits.

The estimated change in the probability of the mean 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 catches 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 the net benefits, which are a measure of economic efficiency, impact analysis is a measure of distribution. 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 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. 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 of sportfishing that was undertaken in this study.

Figures 36 and 37 provide a graphical representation of our analytic approach and the implicit assumptions behind the model.

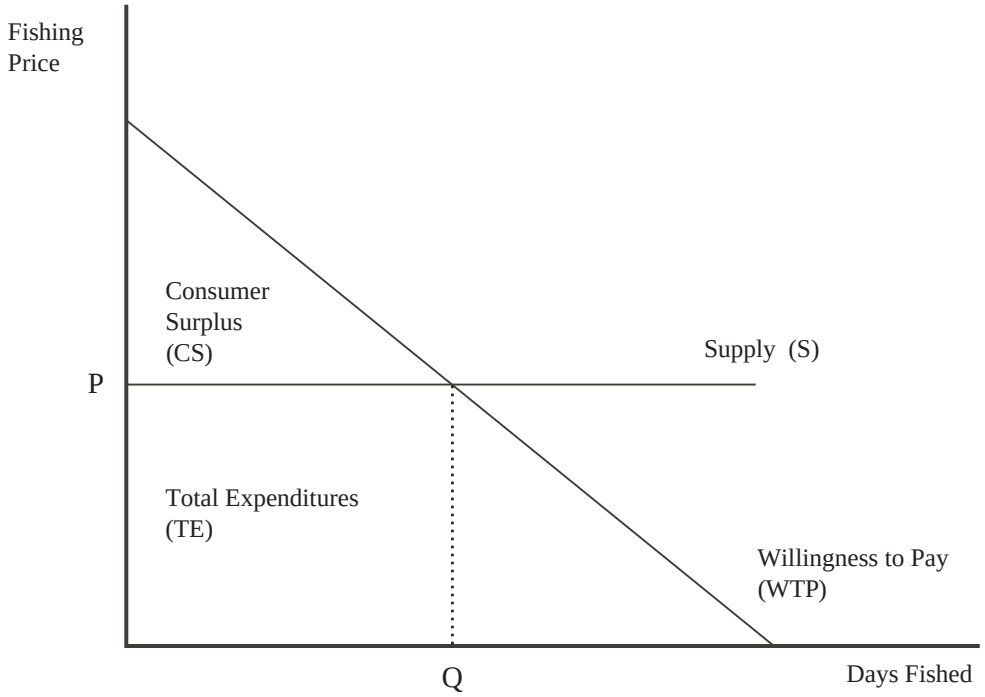

Figure 36. Willingness to pay, consumer surplus, and total expenditures.

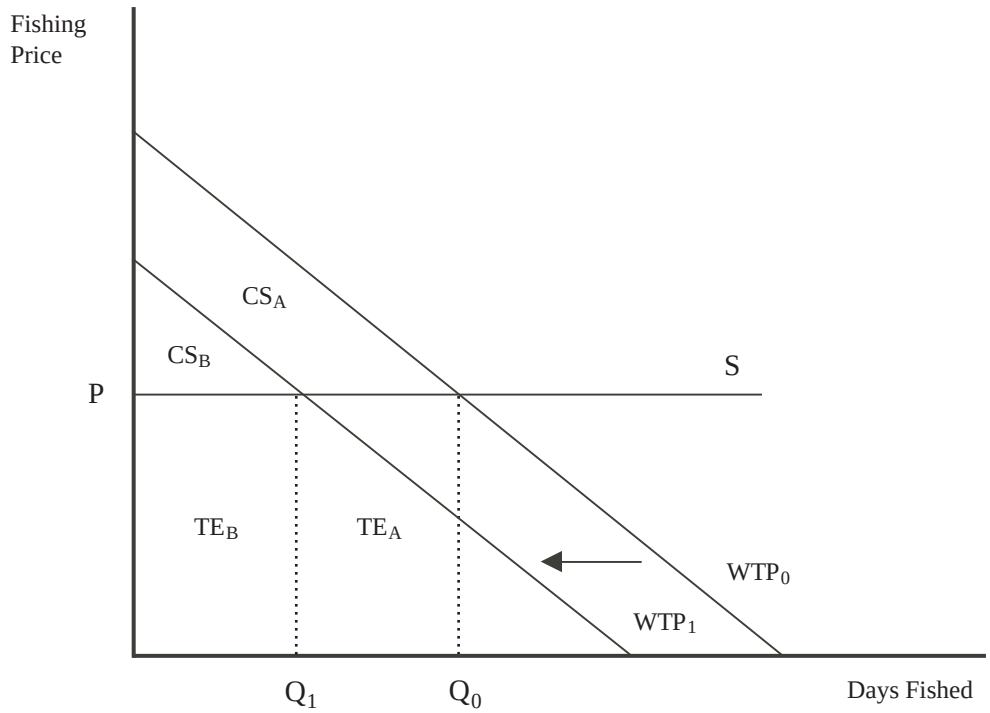

Figure 37. Effect of a decrease in willingness to pay on consumer surplus and total expenditures.

Figure 36 shows a demand curve for fishing trips before the change. The vertical axis measures the price of the fishing trip and quantity is in days fished. The total expenditures are measured as *PQ* or the rectangle labeled Total Expenditures. The consumer surplus is the area below the willingness to pay curve (*WTP*) and above the price of the trip (*P*). Figure 37 shows an example of an inward shift in a trip possibly caused by the reduction in expected catch. Here, for any given price, the number of trips taken is reduced.

When the demand curve for fishing trips shifts inward (from WTP_0 to WTP_1), the total expenditures are reduced from $TE = TE_A + TE_B$ to TE_B. As to their local impact this will depend on what is being measured. There will be redistribution away from industries most benefiting from the sport fishing, especially as fishing participation, which was bringing in new money into the region, decreases. The total impact, as far as expenditures go, to the Kenai Peninsula will depend on the change in participation for changes in environmental conditions that affect expected catches as well as the amount of new money that was coming into the region due to the marine sportfishing effort.

A simplistic view of consumer surplus is that it will 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. In our measurements of consumer surplus, we net out the income effect, and use the compensating variation measurement of consumer surplus as shown in Figure 38.

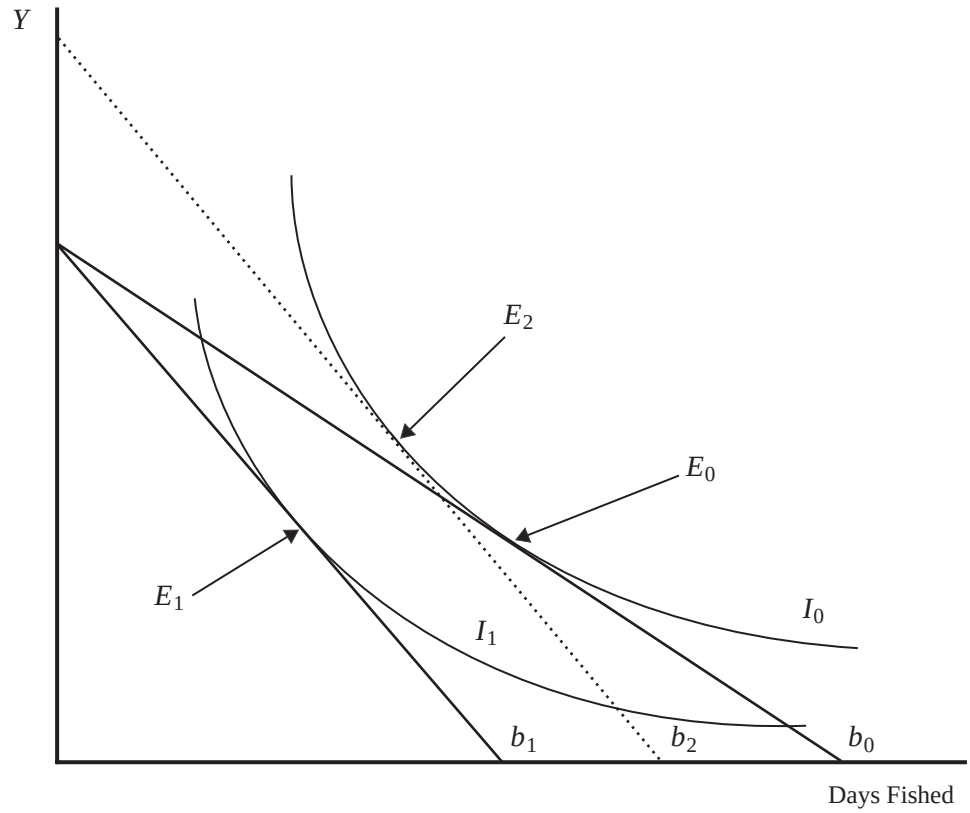

Figure 38. Compensating variation.

For example, in Figure 38 the price of a fishing day has been decreased vis-à-vis the price of all other goods (Y). The budget line rotates back from b_0 to b_1. The consumer is made worse off as her utility decreases from I_0 to I_1. The expenditure needed to bring the consumer 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. (It should be noted that Figures 36 and 37 depict perfectly elastic supply curves. The implication of this assumption is discussed at greater length below.)

We have presented the results of five simulated changes to the fishery conditions from the mean 1997 fishing trip. The expected catch was increased by 10 and 20% of the baseline fishery averages and decreased by 10, 20, and 30% of the baseline averages. The resulting changes in compensating variations and total expenditure impacts to the Kenai are reported in Section 6 and summarized in Table 54, where they are aggregated across residency category and sportfishing mode.

Table 54. Changes in compensating variations (CV) and regional economic impacts in response to changes in catch.

% Change in Catch	% Change in Participation	Change in Mean Total CV ($)	Change in Output (Sales) ($)	Change in Personal Income ($)	Change in Employment (Jobs)
–30%	–31.30%	–12,456,593	–10,062,164	–4,245,863	–292
–20%	–21.16%	–8,655,683	–5,819,726	–2,456,990	–168
–10%	–8.01%	–4,380,445	–2,483,646	–1,049,021	–72
0%	0	0	0	0	0
+10%	5.85%	4,172,245	1,771,687	748,812	51
+20%	9.97%	7,914,571	2,989,775	1,263,986	86

The results indicate, for example, that for a 10% decrease in expected salmon and halibut landings, net benefits to sport fishers will decrease by $4.4 million. The regional impacts, for the selected measures, indicate that there will be a $2.5 million decrease of direct, indirect, and induced output expenditures in the Kenai Peninsula region, which will result in a decrease of $1.0 million in personal expenditures and a loss of 72 jobs. In the case of all impacts, the higher the catch rates the smaller the marginal change in impact. This is due to the fact that there is a declining marginal value of additional fish catches and, therefore, the change in participation rates diminishes as the catch rates increase and vice versa.

Limitations of the results and the need for future research

In any large-scale economic study, there is a trade-off between economic realism and cost in terms of money and time. However, no study can completely capture all of the economic values as the studies are limited by their explicit and implicit economic assumptions and data limitations. In this study, where there was very little precedence for applied analysis (although plenty of theoretical work), much of the applied work was new territory. Looking back over the project, some things worked out very well and others could have been improved. This section is written to help the reader to understand the limitations of this study and to help future studies improve on our approach and analysis.

In the survey, we asked about the respondents' expenditure patterns on the fishing trip. However, if we had to do the survey over again, we would have asked a question(s) to ascertain if the travelers would have made the trip (or the same length trip) to the Kenai had they not been fishing. In the Appendix to Section 3 we use a question that asked the sport fisher's primary purpose of the trip along with a set of assumptions (Tables 58 and 59) to estimate the amount of expenditures that were solely due to the fishing aspect of the trip, that is, Kenai Peninsula area expenditures that would have been made if the fishing portion of the trip were cancelled. However, had we asked this question directly, we would not have needed to rely on assumptions to model respondents' behavior.

In the participation model, when estimating the 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* (see Figure 36). In other words, we assume that supply is perfectly inelastic. While this assumption is appropriate for shore and private trips, it is probably incorrect for charter trips. 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-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 unrealistic in the short run. If there is an upward sloping supply curve for charters then there would still be a loss inefficiency for the charter

industry when there is an environmental change; however, it would come from producer surplus not from consumer surplus. 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 results than short-run results especially with respect to income distribution. For shore and private vessels this is not a factor.

Finally, a complete examination of economic efficiency would estimate producer surplus at all levels. This was outside of the scope of this study and therefore losses to consumers in terms of net benefits may underestimate total losses. Future work may want to include an estimation of the producer surpluses.

8. Acknowledgements

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We are also grateful for information provided by the Kenai, Seward, and Homer Chambers of Commerce, Becky Hultberg and Craig Layman (Kenai Peninsula Borough Economic Development District), Sheri Hobbs (City of Homer), John Williams (former Kenai Peninsula Borough mayor), Tim Evers (Deep Creek Charter Association), Frank Libal (Anchor Point Charter Association), Robert Ward (Homer Charter Association), Karl Kircher (Kenai Peninsula Fishermen's Association), Theo Matthews (United Cook Inlet Drifters Associations), Al Howe (Alaska Department of Fish and Game), Nancy and John Hillstrand (Coal Point Trading Co.), Kurt Eriksson (National Bank of Alaska, Soldotna), Doug Coughenower (Alaska Sea Grant Marine Advisory Program), and Emmett Trimble, Simone Klutts, Vicki Stik, and Tom Boedeker.

9. Study Products

Publications

Criddle, K.R., J.A. Greenberg, H. Geier, C. Hamel, M. Herrmann, S.T. Lee and C.E. Lewis. 1998. An economic assessment of the marine sport fisheries in lower Cook Inlet, p. 5–12. *In* University of Alaska Coastal Marine Institute Annual Report No. 4. OCS Study MMS 98–0062, University of Alaska Fairbanks.

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Hamel, C., M. Herrmann, T.S. Lee, K.R. Criddle and H. Geier. Linking sportfishing trip attributes, participation decisions, and regional economic impacts in Lower and Central Cook Inlet, Alaska. Working paper, University of Alaska Fairbanks. Submitted to The Annuals of Regional Science.

Herrmann, M., K.R. Criddle and C. Hamel. An economic evaluation of the demand for marine sport fisheries in the Lower Cook Inlet. Working Paper. Being prepared for Marine Resource Economics.

Herrmann, M., T.S. Lee, K.R. Criddle and C. Hamel. Results of a survey of participants in the Lower and Central Cook Inlet halibut and salmon sport fishery. Working paper, University of Alaska Fairbanks. Alaska Fisheries Research Bulletin (under review).

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Presentations

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Hamel, C., M. Herrmann, T.S. Lee, C. Hamel and K.R. Criddle. 2000. An economic discussion of the marine sport fisheries in Lower Cook Inlet. Presented at the tenth meeting of the International Institute of Fisheries Economics and Trade, Corvallis, Oregon, 10–24 July 2000.

Herrmann, M., K.R. Criddle, S.T. Lee and Charles Hamel. 2000. An economic evaluation of the demand for marine sport fisheries in the Lower Cook Inlet. Presentation at the 2000 Alaska Chapter American Fisheries Society Meeting, Fairbanks, 13–16 November 2000.

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APPENDIX A

Appendix to Section 3. Total Expenditures

Adjustments made to total expenditure estimates for multipurpose trips
Total expenditures assuming that some trip expenditures cannot be attributed to fishing

Appendix to Section 4. Estimated Trip Attributes by Sportfishing Mode, Residency, Target Species, and Region

Appendix to Section 5. Input–Output

- Input–output theory
  - The transactions table
  - Multipliers
  - Ratio multipliers and response coefficients
  - Assumptions and limitations
- Specific changes to the baseline model
  - The Kenai–Nikiski model
  - The Homer model
  - The Anchor Point and Ninilchik model
  - Soldotna and balance of northern Kenai Peninsula model
- IMPLAN baseline data

Appendix to Section 6. Impact Analysis

Appendix to Section 3. Total Expenditures

Adjustments made to total expenditure estimates for multipurpose trips

Section 3 reports results based on calculations adjusted to account for the fact that there are many reasons that a visitor may visit the Kenai Peninsula. Because some trips are multipurpose, changes in fishing opportunity will not result in one-for-one changes in the number of visitor days to the Kenai Peninsula. This appendix presents the assumptions and calculations used to adjust the estimated response of visitor days to changes in the number of days spent fishing in Cook Inlet. The primary reasons that a Kenai saltwater fishing trip was taken are reported in Table 55.

Table 55. Primary purpose of visit to the Kenai Peninsula for lower and central Cook Inlet halibut and salmon sport fishers (*by trip*) [Lee et al. 1999a].

n = 408	Alaskans	Nonresidents
Fishing for halibut or salmon in Cook Inlet	87.9%	43.0%
Visit/Vacation Alaska	2.9%	24.4%
Kenai area freshwater fishing	1.7%	12.0%
Visit relatives	5.2%	11.2%
Business	1.2%	3.7%
Saltwater/Freshwater fishing	0.0%	2.5%
Visit friends	1.2%	0.4%
Cruise Ship		1.2%
Hunting		1.7%

However, there is a difference between the total amount of *trips* identified by trip purpose and the total amount of trip fishing *days* identified by trip purpose. Table 56 summarizes the percent of total trip *fishing days* attributable to the primary purpose of the trip.

Table 56. Primary purpose of visit to the Kenai Peninsula for lower and central Cook Inlet halibut and salmon sport fishers (*by fishing days*) [Lee et al. 1999a].

n = 408	Alaskans (less locals)	Nonresidents
Fishing for halibut or salmon in Cook Inlet	89.5%	51.0%
Visit/Vacation Alaska	2.6%	23.2%
Kenai area freshwater fishing	0.9%	8.8%
Visit relatives	4.9%	10.1%
Business	1.4%	2.9%
Saltwater/Freshwater fishing	0.0%	2.2%
Visit friends	0.7%	0.5%
Cruise Ship		0.7%
Hunting		0.7%

It is assumed that if the fishing trip is cancelled that all of the Kenai fishing days would be cancelled. More pertinent to the calculations of total trip days spent on the *Kenai* are the days spent on the Kenai by trip purpose. These values are reported in Table 57.

Table 57. Primary purpose of visit to the Kenai Peninsula for lower and central Cook Inlet halibut and salmon sport fishers (*by fishing days*) [Lee et al. 1999a].

n = 408	Alaskans (less locals)	Nonresidents
Fishing for halibut or salmon in Cook Inlet	80.3%	34.1%
Visit/Vacation Alaska	5.9%	25.6%
Kenai area freshwater fishing	1.2%	14.5%
Visit relatives	7.2%	19.7%
Business	1.9%	2.6%
Saltwater/Freshwater fishing	0.0%	1.9%
Visit friends	3.4%	0.6%
Cruise Ship	0.0%	0.4%
Hunting	0.0%	0.5%

Table 58 summarizes the assumptions made in the main report (Table 22) for adjustments to the percent of the days spent on the Kenai, and in other parts of Alaska, due to changes in Cook Inlet fishing trip days. For example, nonresidents whose main trip purpose was to visit relatives made up 11.2% of the total *trips* but 19.7% of the *total days spent on the Kenai*. This is presumably due to longer visits to the Kenai for nonresidents visiting relatives than for those making a trip just to fish.

Table 58. Assumed effects of the cancellation of the saltwater fishing portion of the Kenai Peninsula trip.

Main Purpose of Trip	Alaskans (non-local) and other U.S.
Fishing for halibut or salmon in Cook Inlet	Cancel entire trip
Visit/Vacation Alaska	Cancel Kenai trip replace these days with days in other parts of Alaska
Kenai area freshwater fishing	Still take full trip
Visit relatives	Reduce days spent in Kenai and Alaska by amount of days lost saltwater fishing
Business	Still take full trip
Saltwater/Freshwater fishing	Reduce days spent in Kenai and Alaska by amount of days lost saltwater fishing
Visit friends	Still take full trip
Cruise Ship	No observations
Hunting	No observations

The assumptions in Table 58 result in the following percentages of the trip due to the fishing component as reported in Table 59.

Table 59. Assumed net effect of the cancellation of the saltwater fishing portion of the Kenai Peninsula saltwater fishing trip on all days applied to the Appendix to Section 3.

Main Purpose of Trip	Kenai Portion	Alaska Portion (net Kenai)
Fishing for halibut or salmon in Cook Inlet	–100%	–100%
Visit/Vacation Alaska	–100%	+ Kenai Portion
Kenai area freshwater fishing	0%	0%
Visit relatives	– Fishing Days	– Fishing Days
Business	0%	0%
Saltwater/Freshwater fishing	– Fishing Days	– Fishing Days
Visit friends	0%	0%
Cruise Ship	0%	NA
Hunting	0%	NA

Table 60 is a reproduction of Table 22.

Table 60. Estimated reduction in visitation rates for a 100% reduction in fishing effort (days) [Lee et al. 1999a].

	Locals	Alaskans	Nonresidents
Fishing Reduction	100%	100%	100%
Kenai Living Expense Reduction	100%	89.5%	64.0%
Alaska Living Reduction (net Kenai)	100%	57.3%	23.8%

For illustration we use the nonresident Kenai living reduction values. The 64.0% number is interpreted as 64.0% of the total days spent on the Kenai by nonresidents having been directly related to the Kenai saltwater fishing component of the trip (i.e., if the trip had not been taken these days would not have been spent on the Kenai). Therefore, when a fishing trip is reduced 1 day, 0.64 days spent by nonresidents on the Kenai Peninsula[14] will be lost.

Sample Calculation: reduction in nonresident expenditures on Kenai region living expenses is equal to $34.1\% + 25.6\% + 10.1\% \left(557/1587\right) + 2.2\% \left(557/1587\right) = 64.0\%$, where 557 is the number of nonresident days reported in the survey spent fishing, 1,587 is the number of days reported living on the Kenai, and 557 is the number of nonresident days reported living on the Kenai.

Total expenditures assuming that some trip expenditures cannot be attributed to fishing

Table 61. Total expenditures by local residents fishing for halibut and salmon from the lower and central Cook Inlet shore that are attributed directly to the saltwater halibut and salmon fishing trip [Lee et al. 1999a].

	Days					Expenditures ($)				
n = 34	Ratio	% of Total	Total Days	Adjusted Days	$/Day	Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	Total
Days Fished	1.000	6.5%	12,861	12,861						
Days spent on Kenai[1]	1.290		16,591	16,591						
Days spent in Alaska[2]	0.000									
Auto					7.82		129,739			129,739
RV										
Lodge					3.15		52,261			52,261
Groceries					8.00		132,726			132,726
Restaurant & Bar					10.74		178,184			178,184
Charter										
Gear					2.14	27,523				27,523
Processing										
Derby										
Boat Fuel										
Haul										
Total						27,523	492,909			520,432

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

[14] It is possible that the saltwater trips on the Cook Inlet side could be replaced by saltwater trips out of Seward thus redistributing the Kenai Peninsula expenditures from west to east.

Table 62. Total expenditures by local residents fishing for halibut and salmon from private boats in lower and central Cook Inlet that are attributed directly to the saltwater halibut and salmon fishing trip [Lee et al. 1999a].

n = 34	Ratio	Days			$/Day	Expenditures ($)				Total
		% of Total	Total Days	Adjusted Days		Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	
Days Fished	1.000	14.4%	28,498	28,498						
Days spent on Kenai[1]	1.000		28,498	28,498						
Days spent in Alaska[2]	0.000									
Auto					7.82		222,854			222,854
RV										
Lodge					3.15		89,769			89,769
Groceries					8.00		227,984			227,984
Restaurant & Bar					10.74		306,069			306,069
Charter										
Gear					7.12	202,906				202,906
Processing					0.92	26,218				26,218
Derby					0.36	10,259				10,259
Boat Fuel					15.89	452,833				452,833
Haul					8.36	238,243				238,243
Total						930,460	846,676			1,777,135

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 63. Total expenditures by local residents fishing for halibut and salmon from charter boats in lower and central Cook Inlet that are attributed directly to the saltwater halibut and salmon fishing trip [Lee et al. 1999a].

n = 34	Ratio	Days			$/Day	Expenditures ($)				Total
		% of Total	Total Days	Adjusted Days		Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	
Days Fished	1.000	3.8%	7,518	7,518						
Days spent on Kenai[1]	1.000		7,518	7,518						
Days spent in Alaska[2]	0.000									
Auto					7.82		58,791			58,791
RV										
Lodge					3.15		23,682			23,682
Groceries					8.00		60,144			60,144
Restaurant & Bar					10.74		80,743			80,743
Charter					112.86	848,481				848,481
Gear					2.00	15,036				15,036
Processing					10.50	78,939				78,939
Derby					11.70	87,961				87,961
Boat Fuel										
Haul										
Total						1,030,417	223,360			1,253,777

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 64. Total expenditures by Alaskans (non-local) fishing for halibut and salmon from the lower and central Cook Inlet shore that are attributed directly to the saltwater halibut and salmon fishing trip [Lee et al. 1999a].

n = 7	Ratio	Days			$/Day	Expenditures ($)				Total
		% of Total	Total Days	Adjusted Days		Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	
Days Fished	1.00	2.4%	4,767	4,767						
Days spent on Kenai[1]	1.03		4,910	4,394						
Days spent in Alaska[2]	0.06		286	164						
Auto					14.57		64,027		2,388	66,415
RV										
Lodge					3.86		16,963		633	17,595
Groceries					12.43		54,623		2,037	56,660
Restaurant & Bar					3.43		15,073		562	15,635
Charter										
Gear					4.50	16,089		5,363		21,452
Processing										
Derby										
Boat Fuel										
Haul										
Total						16,089	150,686	5,363	5,620	177,757

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 65. Total expenditures by Alaskans (non-local) fishing for halibut and salmon from private boats in lower and central Cook Inlet that are attributed directly to the saltwater halibut and salmon fishing trip [Lee et al. 1999a].

n = 73	Ratio	Days			$/Day	Expenditures ($)				Total
		% of Total	Total Days	Adjusted Days		Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	
Days Fished	1.00	18.8%	37,044	37,044						
Days spent on Kenai[1]	1.45		53,714	48,074						
Days spent in Alaska[2]	0.00									
Auto					12.99		624,479			624,479
RV					0.39				18,749	18,749
Lodge					6.20		298,058			298,058
Groceries					14.44		694,186			694,186
Restaurant & Bar					9.58		460,547			460,547
Charter										
Gear					5.53	153,640		51,213		204,853
Processing					2.33	86,313				86,313
Derby					0.18	6,668				6,668
Boat Fuel					31.53	875,998		291,999		1,167,997
Haul					5.48	203,001				203,001
Total						1,325,620	2,077,271	343,213	18,749	3,764,852

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 66. Total expenditures by Alaskans (non-local) fishing for halibut and salmon from charter boats in lower and central Cook Inlet that are attributed directly to the saltwater halibut and salmon fishing trip [Lee et al. 1999a].

n = 85	Ratio	Days			$/Day	Expenditures ($)				Total
		% of Total	Total Days	Adjusted Days		Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	
Days Fished	1.00	10.1%	19,898	19,898						
Days spent on Kenai[1]	1.73		34,424	30,809						
Days spent in Alaska[2]	0.52		10,347	5,929						
Auto					15.81		487,091		93,734	580,826
RV					3.97				145,849	145,849
Lodge					21.19		652,844		125,631	778,476
Groceries					13.76		423,933		81,580	505,513
Restaurant & Bar					13.95		429,787		82,707	512,493
Charter					116.40	2,316,127				2,316,127
Gear					3.58	53,426		17,809		71,235
Processing					7.14	142,072				142,072
Derby					2.13	42,383				42,383
Boat Fuel										
Haul										
Total						2,554,008	1,993,655	17,809	529,503	5,094,974

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 67. Total expenditures by nonresidents fishing for halibut and salmon from the lower and central Cook Inlet shore that are attributed directly to the saltwater halibut and salmon fishing trip [Lee et al. 1999a].

n = 8	Ratio	Days			$/Day	Expenditures ($)				Total
		% of Total	Total Days	Adjusted Days		Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	
Days Fished	1.00	5.2%	10,202	10,202						
Days spent on Kenai[1]	2.00		20,404	13,059						
Days spent in Alaska[2]	1.15		11,732	2,792						
Auto					9.34		121,967		26,080	148,047
RV					28.91				458,248	458,248
Lodge					14.83		193,658		41,410	235,068
Groceries					7.47		97,547		20,858	118,406
Restaurant & Bar					10.20		133,197		28,481	161,679
Charter										
Gear					20.00	204,040				204,040
Processing					9.62	98,143				98,143
Derby					0.95	9,692				9,692
Boat Fuel										
Haul										
Total						311,875	546,370		575,077	1,433,323

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 68. Total expenditures by nonresidents fishing for halibut and salmon from private boats in lower and central Cook Inlet that are attributed directly to the saltwater halibut and salmon fishing trip [Lee et al. 1999a].

n = 28	Ratio	Days			$/Day	Expenditures ($)				Total
		% of Total	Total Days	Adjusted Days		Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	
Days Fished	1.00	13.0%	25,597	25,597						
Days spent on Kenai[1]	2.92		74,743	47,836						
Days spent in Alaska[2]	1.02		26,109	6,214						
Auto					7.81		373,597		48,531	422,127
RV					2.92				157,825	157,825
Lodge					7.83		374,553		48,655	423,208
Groceries					10.72		512,798		66,613	579,412
Restaurant & Bar					6.65		318,107		41,323	359,430
Charter										
Gear					17.12	438,221				438,221
Processing					7.87	201,448				201,448
Derby					1.65	42,235				42,235
Boat Fuel					15.76	403,409				403,409
Haul					9.00	230,373				230,373
Total						1,315,686	1,579,056		362,947	3,257,688

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Table 69. Total expenditures by nonresidents fishing for halibut and salmon from charter boats in lower and central Cook Inlet that are attributed directly to the saltwater halibut and salmon fishing trip [Lee et al. 1999a].

n = 173	Ratio	Days			$/Day	Expenditures ($)				Total
		% of Total	Total Days	Adjusted Days		Fishing (Kenai)	Other (Kenai)	Fishing (Alaska)	Other (Alaska)	
Days Fished	1.00	25.9%	51,171	51,171						
Days spent on Kenai[1]	2.03		103,877	66,481						
Days spent in Alaska[2]	2.86		146,349	34,831						
Auto					8.08		537,169		281,435	818,605
RV					18.92				1,916,831	1,916,831
Lodge					22.94		1,525,082		799,025	2,324,107
Groceries					9.93		660,160		345,873	1,006,033
Restaurant & Bar					9.63		640,216		335,423	975,639
Charter					140.75	7,202,318				7,202,318
Gear					15.50	793,151				793,151
Processing					32.72	1,674,315				1,674,315
Derby					1.37	70,104				70,104
Boat Fuel										
Haul										
Total						9,739,888	3,362,627		3,678,587	16,781,103

[1] Includes days fished.
[2] Excludes days spent on the Kenai Peninsula.

Appendix to Section 4. Estimated Trip Attributes by Sportfishing Mode, Residency, Target Species, and Region

Table 70. Kenai Peninsula trip attributes [Lee et al. 1999a].

			Including Seward-based Trips				Excluding Seward-based Trips			
			Charter and Private		Charter only		Charter and Private		Charter only	
			All	Halibut	All	Halibut	All	Halibut	All	Halibut
Alaskans			n=328	n=154	n=141	n=76	n=223	n=121	n=100	n=56
	Halibut	Retained	0.66	1.20	1.13	1.40	0.72	1.22	1.22	1.38
		Released	0.75	1.42	1.36	1.78	0.98	1.72	1.79	2.22
		Total Caught	1.40	2.62	2.49	3.18	1.71	2.94	3.01	3.61
		Average Weight (lbs.)	33.57	33.13	33.63	33.52	34.18	33.38	33.78	33.54
	Chinooks	Retained	0.07		0.11		0.08		0.13	
		Released	0.08		0.07		0.11		0.11	
		Total Caught	0.15		0.18		0.19		0.24	
		Average Weight (lbs.)	29.00		27.50		28.34		26.00	
	Coho	Retained	0.18		0.24		0.05		0.11	
		Released	0.05		0.05		0.01		0.01	
		Total Caught	0.23		0.29		0.06		0.12	
		Average Weight (lbs.)	9.84		9.54		10.60		10.00	
Nonresidents			n=381	n=164	n=263	n=133	n=271	n=124	n=192	n=98
	Halibut	Retained	0.92	1.28	1.11	1.37	1.04	1.40	1.19	1.45
		Released	1.15	1.62	1.44	1.72	1.40	1.92	1.66	2.01
		Total Caught	2.07	2.90	2.55	3.09	2.43	3.33	2.85	3.45
		Average Weight (lbs.)	42.07	41.82	43.08	43.98	42.66	41.41	43.02	43.41
	Chinooks	Retained	0.09		0.10		0.11		0.12	
		Released	0.06		0.08		0.04		0.04	
		Total Caught	0.16		0.19		0.14		0.15	
		Average Weight (lbs.)	29.42		29.93		30.87		31.41	
	Coho	Retained	0.21		0.21		0.13		0.12	
		Released	0.17		0.14		0.18		0.18	
		Total Caught	0.38		0.34		0.31		0.29	
		Average Weight (lbs.)	9.22		9.68		9.60		10.31	

Appendix to Section 5. Input–Output

Input–output theory[15]

The transactions table

An examination of the structure and foundation of input–output begins with the transactions table, a matrix of identified industrial sectors for the economy under consideration (e.g., Figure 39 [duplicates Figure 26 in body of report]). The transactions table depicts the amount of goods and services required from each producing sector to fulfill final demand as well as the value of the inputs each sector purchases from all others toward the production of a unit of output for a specified period of time. In their production of goods or services, firms must purchase inputs from other producing sectors, and these purchases make up intermediate demand. Final demand includes household consumption, private investment requirements, public (government) demand, and net exports. The production by firms and the supply of labor by households fulfill the "requirements" of both final and intermediate demand, and the exchanges reveal the reliance of one industry upon the rest. Mapping these inter-industry relationships forms the basis for the transactions table and provides static description of the economy. Subject to some arguably limiting assumptions, hypothetical changes in demand can be fed into the model to predict impacts.

From \ To		Purchasing Sectors					Local Final Demand				
		1	…	j	…	n	Households	Private Investment	Government	Exports	Total Gross Outputs
Producing Sectors	1	X_{11}	…	X_{1j}	…	X_{1n}	C_1	I_1	G_1	E_1	X_1
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	i	X_{i1}	…	X_{ij}	…	X_{in}	C_i	I_i	G_i	E_i	X_i
	⋮	⋮		⋮		⋮	⋮	⋮	⋮	⋮	⋮
	n	X_{n1}	…	X_{nj}	…	X_{nn}	C_n	I_n	G_n	E_n	X_n
Labor		L_1	…	L_j	…	L_n	L_C	L_I	L_G	L_E	L
Other Value Added		V_1	…	V_j	…	V_n	V_C	V_I	V_G	V_E	V
Imports		M_1	…	M_j	…	M_n	M_C	M_I	M_G		M
Total Gross Outlay		X_1	…	X_j	…	X_n	C	I	G	E	X

Figure 39. Sample input–output transactions table [Richardson 1972].

The components of Figure 39 can be expressed as a system of linear equations:

$$
\begin{aligned}
X_1 &= x_{1,1} + x_{1,2} + \ldots + x_{1j} + \ldots + x_{1n} + C_1 + I_1 + G_1 + E_1 \\
X_2 &= x_{2,1} + x_{2,2} + \ldots + x_{2j} + \ldots + x_{2n} + C_2 + I_2 + G_2 + E_2 \\
&\bullet \\
&\bullet \\
X_i &= x_{i1} + x_{i2} + \ldots + x_{ij} \ldots + x_{in} + C_i + I_i + G_i + E_i \\
&\bullet \\
&\bullet \\
X_n &= x_{n1} + x_{n2} + \ldots + x_{nj} + \ldots + x_{nn} + C_n + I_n + G_n + E_n
\end{aligned}
\tag{13}
$$

[15] This section draws on Archer [1977], Miller and Blair [1985], and Richardson [1972].

which can be compactly written as:

$$X_i = \sum_{i=1}^{n} x_{ij} + \left(C_i + I_i + G_i + E_i\right) \tag{14}$$

for all i, where X_i is the gross output of sector i, x_{ij} is the i-th industrial demand by the j-th industry, C_i is consumption, or household demand for the i-th output, I_i is private investment in the i-th output, G_i is government purchases of the i-th output, and E_j is the level of net exports of the i-th output.

Reading across the first row of Figure 39, purchasing sectors S_1 through S_n each require some portion of producing sector S_1's output, $x_{1,1}$ through x_{1n} respectively, as inputs for their own production process. The model assumes that final demand provides the impetus for initial changes in production, and that changes in intermediate (or intersectoral) demand follow from the additional inputs required to fulfill S_1's initial output changes. The sum of these final and intermediate demand requirements, X_1, is the total output from sector S_1.

Because the entire economy's industrial sectors can be considered in either their producing or purchasing roles, the input requirements for S_1 from all other industrial sectors can be found in the first column of Figure 39. Inputs which cannot be satisfied locally within the region are treated as imports, and these, along with the other inputs described above, sum to sector S_1's total gross outlay, X_1.

The transactions table not only depicts the trade flows for a selected economy, but also provides the means for identifying regional trade imbalances, and ultimately allows for the calculation of expressions of potential impact arising from changes in demand. Consider the ratio formed by dividing any of the x_{ij} entries by its corresponding total gross outlays, X_j. The resulting input coefficient is the proportion that x_{ij} comprises of all of that particular sector's purchases. Taking the sum of all column elements of the local demand components (C_i, I_i, or G_i) except for imports, and dividing by the total outlay for each category can form a similar measure for local demand, the regional purchase coefficient. This ratio can be interpreted as the proportion of local demand purchased locally [Olson and Lindall 1997].

Given the deterministic nature of the relationships represented by the transactions table, a change in demand for one sector will have a predictable, industry-wide effect on changes in output. Drawing from a numerical example will further clarify this point and serve to introduce the following section on multipliers. Table 71 represents a transactions table for a two-sector economy, industries S_1 and S_2. Of the value-added components of final demand, only household consumption is included to facilitate the illustration.

Table 71. Simplified transactions table for a hypothetical regional economy [adapted from Archer 1977].

		Purchasing Sectors				
		Industry 1	Industry 2	Local Household Expenditure	Exports	Gross Output
Producing Sectors	Industry 1	100	320	200	380	1,000
	Industry 2	300	640	300	360	1,600
	Value Added	200	160	100	540	1,000
	Imports	400	480	400		1,280
	Gross Outlay	1,000	1,600	1,000	1,280	4,880

In order to produce $1,000 worth of output, Industry 1 purchases $100, $300, $200, and $400 worth of goods and services from itself, sector S_2, the labor market, and imports respectively, for a total outlay of $1,000. Note that the balance of final outlays and output implies zero accounting profits in this example. However, in a complete input–output model such as IMPLAN, accounting profits form a sectoral component within the value-added category, and the equivalence between outlays and output is maintained [Olson and Lindall 1997]. Forming the

ratio for each of the four inter-industry input requirements to their corresponding gross outlays produces a 2×2 matrix of input coefficients, **A**:

(15) $$A = \begin{pmatrix} 100/1000 & 320/1600 \\ 300/1000 & 340/1600 \end{pmatrix} = \begin{pmatrix} 0.1 & 0.2 \\ 0.3 & 0.4 \end{pmatrix}$$

The Direct Requirements (**A**) matrix describes a "production recipe" for each industry [Hastings and Brucker 1993]. In other words, the a_{ij} entries specify the proportion of each input, relative to all other inputs, needed for a purchasing sector to produce a unit of output. Hence, each column of **A** describes a linear production function for one of the two purchasing sectors in this example.

To further simplify the exercise, we can reduce household expenditures and exports into the general heading of final demand by rewriting Equation 13 so that total output X and final demand Y are 2×1 column vectors and **A** is the 2×2 Direct Requirements matrix. That is,

(16) $$X = \mathbf{A}X + Y$$

For the example, Equation 16 becomes

(17) $$\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} 0.1 & 0.2 \\ 0.3 & 0.4 \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 200 & 380 \\ 300 & 360 \end{pmatrix} = \begin{pmatrix} 0.1 & 0.2 \\ 0.3 & 0.4 \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 580 \\ 660 \end{pmatrix}$$

Solving for final demand, Y, and simplifying through use of the identity matrix (**I**) results in

(18) $$IX - \mathbf{A}X = Y$$

or $$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} - \begin{pmatrix} 0.1 & 0.2 \\ 0.3 & 0.6 \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} 580 \\ 660 \end{pmatrix}$$

which can be rewritten as

(19) $$(\mathbf{I} - \mathbf{A})X = Y$$

or $$\begin{pmatrix} 0.9 & -0.2 \\ -0.3 & 0.6 \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} 580 \\ 660 \end{pmatrix}$$

Solving for X by inverting (**I** – **A**) produces the multiplier form of the original system:

(20) $$X = (\mathbf{I} - \mathbf{A})^{-1} Y$$

$$\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} 0.9 & -0.2 \\ -0.3 & 0.6 \end{pmatrix}^{-1}\begin{pmatrix} 580 \\ 660 \end{pmatrix} = \begin{pmatrix} 1.25 & 0.42 \\ 0.62 & 1.87 \end{pmatrix}\begin{pmatrix} 580 \\ 660 \end{pmatrix} = \begin{pmatrix} 1000 \\ 1600 \end{pmatrix}$$

where $(\mathbf{I} - \mathbf{A})^{-1}$, the Leontieff inverse or Total Requirements matrix, can be interpreted as the proportion of any change in final demand by which output would have to respond to fulfill such a change. In other words, given the relationships gleaned from the transactions table, an exogenous monetary infusion (diffusion) modeled as an increase (decrease) in final demand will have the following successive effect on production:

$$\Delta X = (\mathbf{I} - \mathbf{A})^{-1} \Delta Y \tag{21}$$

The multipliers contained in the Total Requirements matrix gauge the potential productivity associated with potential demand changes. To clarify this, solving for the Total Requirements matrix and substituting into the form of Equation 21 gives

$$\begin{pmatrix} \Delta X_1 \\ \Delta X_2 \end{pmatrix} = \begin{pmatrix} 1.25 & 0.42 \\ 0.62 & 1.87 \end{pmatrix} \begin{pmatrix} \Delta Y_1 \\ \Delta Y_2 \end{pmatrix} \tag{22}$$

Suppose that household expenditures for product 1 increased by 15 units while non-local demand for product 2 diminishes so that 5 units less were exported. The Total Requirements matrix offers a simultaneous solution to the above system and we see that output of X_1 would increase by 16.65 units while production of X_2 would drop by 0.05 units:

$$\begin{pmatrix} \Delta X_1 \\ \Delta X_2 \end{pmatrix} = \begin{pmatrix} 1.25 & 0.42 \\ 0.62 & 1.87 \end{pmatrix} \begin{pmatrix} 15 \\ -5 \end{pmatrix} = \begin{pmatrix} 16.65 \\ -0.05 \end{pmatrix} \tag{23}$$

The impact of other combinations of changes in the demand for one or both goods can be explored, subject to limitations and assumptions discussed later.

Multipliers

Output Multiplier—The above example outlined a procedure for deriving the basic *output* multiplier, one of several categories of indices that serve to gauge a regional economy's potential response to exogenous changes. Because the a_{ij} entries of the Leontieff inverse matrix, $(\mathbf{I} - \mathbf{A})^{-1}$, encompass the degree of inter-industry linkage among all sectors as well as the initial intra-sectoral response to demand changes, their values can be thought of as comprising two separate effects. The first, or *direct* effect, regards the unitary response with which a sector's output rises or falls to fulfill a new demand requirement. In other words, as demand for X_i increases by one unit, sector S_i responds by producing one more unit of output. That is, the direct effect is the "production changes associated with the immediate effects of final demand changes" [Olson and Lindall 1997]. However, in producing that one additional unit, sector S_i must increase its purchase of inputs, thus prompting a rise in intermediate demand for the goods and services of other industries through its incurred outlays. As these other industries respond by mounting their respective production levels, they propagate another round of intermediate demand associated with their incremental purchases of factors. To the extent that some of these factors happen to be units of X_i, a new series of endogenously determined demand for sector S_i's output is touched off, etc. These incremental additions to the original and unitary multiplier constitute the *indirect* effect. That is, the indirect effects are "the changes in inter-industry purchases as they respond to the new demands of the directly affected industries" [Olson and Lindall 1997].

Returning to the example, again consider the a_{ij} elements of the Total Requirements matrix from Equation 21

$$\begin{pmatrix} \Delta X_1 \\ \Delta X_2 \end{pmatrix} = \begin{pmatrix} 1.25 & 0.42 \\ 0.62 & 1.87 \end{pmatrix} \begin{pmatrix} \Delta Y_1 \\ \Delta Y_2 \end{pmatrix} \tag{24}$$

While the example was expressed in physical units of goods or services in the previous section, it will now be discussed in monetary values, as this is typically the fashion in which model results are reported. Let demand for good X_1 increase by one dollar while holding the demand for X_2 constant so that $\Delta Y_1 = 1$ and $\Delta Y_2 = 0$. Equation 22 becomes:

$$\begin{pmatrix} \Delta X_1 \\ \Delta X_2 \end{pmatrix} = \begin{pmatrix} 1.25 & 0.42 \\ 0.62 & 1.87 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \begin{pmatrix} 1.25 \\ 0.62 \end{pmatrix} \tag{25}$$

Remembering that the first entry ($a_{1,1} = 1.25$) signifies that a unit change in the demand for good X_1 (or $\Delta Y_1 = 1$) will affect \$1.25 worth of good X_1 from sector S_1, and also keeping in mind that the direct effect is unitary, we can subtract 1 from 1.25 to back out the indirect effect. In this example 0.25 dollars worth of X_1 are produced to satisfy the various rounds of indirect demands associated with the initial change in final demand for X_1. Even though final demand for good X_2 remained constant, the inter-industry dependence between sectors S_1 and S_2 necessitates the additional production of good X_2 to fulfill sector S_1's input requirements. The value of good X_2's production necessary to fulfill the requirements of the \$1 demand change for good X_1 is 0.62, the $a_{2,1}$ element. This amount is made up entirely of indirect (inter- and intra-sectoral) effects as no exogenous change in demand for X_2 occurred, so that summing it with the 0.25 dollars worth of indirect effect from X_1 gives us a total indirect effect of 0.87. At this point it should be apparent that the total (direct plus indirect) output multiplier effect for sector S_1 can be obtained simply by summing the a_{n1} entries of the $(\mathbf{I} - \mathbf{A})^{-1}$ matrix. Similarly, if we wanted to determine the dollar value of the total effects attributable to a dollar's worth of increased final demand for good X_2, then we would sum the a_{n2} elements. Generally then, the output multiplier for good X_j can be stated as:

$$O_j = \sum_{i=1}^{n} \alpha_{ij} \tag{26}$$

where n is the number of industrial sectors with intermediate demand requirements.

While the simple output multiplier captures inter-industry (indirect) interactions, it reveals nothing about the relationship between production changes and household income and consumption expenditures. In fact, as long as labor is a factor for the production processes modeled above, then additional payments to households would, in theory, stimulate increased spending. Similar to the indirect effects discussed above, increased consumption translates into increased demand for all other goods and services. The addition this component makes to the output multiplier is called an *induced* effect. By augmenting the **A** matrix in Equation 15 to include the Value Added/Household Expenditure row and column of Table 71, consumer spending can be treated endogenously as another industrial sector for deriving output multipliers. Input coefficients for households are arrived at in the same way as they were for sectors S_1 and S_2, by dividing each input requirement by its respective gross outlay, thereby extending the production functions by the household requirements:

$$\mathbf{A}^* = \begin{pmatrix} 0.1 & 0.2 & 0.2 \\ 0.3 & 0.4 & 0.3 \\ 0.2 & 0.1 & 0.1 \end{pmatrix} \tag{27}$$

Inversion of $\mathbf{A}^*$ yields the following Total Requirements matrix:

$$\left(\mathbf{I} - \mathbf{A}^*\right)^{-1} = \begin{pmatrix} 1.40 & 0.55 & 0.50 \\ 0.91 & 2.12 & 0.91 \\ 0.41 & 0.36 & 1.32 \end{pmatrix} \tag{28}$$

By simulating a change in demand of one dollar's worth of good X_1 as we did earlier with the closed model, we can derive an output multiplier which includes the direct, indirect, and induced effects. ΔY^* will now be a 3×1 vector, with $\Delta Y_1 = 1$ and all other elements equal to zero. As before, pre-multiplying the demand vector by the Leontieff inverse gives the value of the total output resulting from a one-dollar change in final demand for X_1, which in this case is 2.72. Alternatively, summing the elements of the first column of the $(\mathbf{I} - \mathbf{A}^*)^{-1}$ matrix yields the same results, revealing a general form for deriving the total effects multiplier parallel to that of Equation 26 for the direct and indirect effects:

$$O_j^* = \sum_{i=1}^{n+1} \alpha_{ij}^* \tag{29}$$

The *total output* multiplier represented above contains all three effects of industrial production. Simply subtracting from the total the sums of the direct and indirect effects can isolate the induced values of output produced in response to inter- and intra-industrial payments to households. That is, the induced effect is $O_1^* - O_1$. For the above example, $O_1 = 1.87$ (from the closed model) and $O_1^* = 2.72$, then we can see that 0.85 dollars worth of output effected across both sectors by a one dollar increase in demand for X_1 is attributable to the household receipts and expenditures.

The two other principal categories of multipliers predict income and employment responses to exogenous change. There are many variants of the income and employment multipliers that will be presented below. Moreover, these multipliers can be stated in ratio form to emphasize their relative magnitude. The purpose and usefulness of these ratio multipliers has been debated contentiously in the literature, and will be briefly described towards the end of this section.

Income Multiplier—Output multipliers describe the "structural interdependence between each sector and the rest of the economy"; however, policymakers and constituents who look to economic impact analyses for policy direction are usually more concerned with the effects on income and/or employment [Richardson 1972]. Income multipliers "translate" output responses triggered by demand changes into measures of new income created [Miller and Blair 1985]. Based on the labor input coefficients derived from augmenting the **A** matrix with respect to households (i.e. treating households endogenously within the Direct Requirements matrix), we can estimate the amount of value from additional output realized as income. The initial effect of a change in demand upon household income can also be derived from each industry's production function (i.e. columns of the $\mathbf{A}^*$ matrix). Consider that each dollar's worth of exogenous spending for good X_i is met with a dollar's worth of direct production from sector S_1, and recall that the input coefficients within the production functions describe the proportion of each dollar's worth of outlays disbursed to factors.

Reading down the first column of the $\mathbf{A}^*$ matrix, for each dollar's worth of X_1 produced, sector S_1 makes 0.20 dollar's worth of payments to household income. Hence, 0.2 can be interpreted as the direct multiplier effect for income associated with demand changes for good X_1, or more generally speaking, a_{n+1j}^* is the direct income effect for any X_j sector.

$$\mathbf{A}^* = \begin{pmatrix} 0.1 & 0.2 & 0.2 \\ 0.3 & 0.4 & 0.3 \\ 0.2 & 0.1 & 0.1 \end{pmatrix} \tag{30}$$

Of course, identifying a direct income effect by itself does not suffice the rigors of even a simple impact analysis, for the exhaustive derivation of the output multipliers above informed us that inter-industry demands spawn indirect income effects as well. Naturally, any indirect effects from backward linked industries will involve payments to labor. To obtain an estimate for the combined direct and indirect income effects, we need to transform respective output values into values paid out as income. Since both output effects fall under the values of each entry in the $(\mathbf{I} - \mathbf{A})^{-1}$ matrix, summing over the products of each household coefficient, a_{n+1j}^*, multiplied by its respective output multiplier effect, a_{ij}, produces the direct and indirect income multipliers.

For example, to compute the direct and indirect multiplier effect on income of a dollar's worth of additional demand for good X_1, we make a column vector out of the column elements of the $(\mathbf{I} - \mathbf{A})^{-1}$ matrix corresponding to sector S_1, and pre-multiply by a row vector of the first two $n + 1$ labor input coefficients from $\mathbf{A}^*$ to obtain:

$$H_1 = \begin{pmatrix} a^*_{n+1,1} & a^*_{n+1,2} \end{pmatrix} \begin{pmatrix} \alpha_{1,1} \\ \alpha_{2,1} \end{pmatrix} = \begin{pmatrix} 0.2 & 0.1 \end{pmatrix} \begin{pmatrix} 1.25 \\ 0.62 \end{pmatrix} = 0.312 \tag{31}$$

where H_1 is the direct and indirect household income effect resulting from a change in demand for good X_1. In more general terms then, the household income multiplier can be expressed as:

$$H^*_j = \sum_{i=1}^{n} \left(a^*_{n+1j}\right)\left(\alpha_{ij}\right) \tag{32}$$

The justifications for having derived induced effects for output multipliers in the previous section are founded on the theoretical notion that increased payments made to suppliers of labor continue to circulate through the economy as households make additional expenditures. Analogously, induced effects for income multipliers can be derived from an augmentation of the Leontieff inverse, $(\mathbf{I} - \mathbf{A}^*)^{-1}$, in which household consumption and labor supply are endogenously treated. Now instead of taking the products of the a_{n+1i} entries with the corresponding column multipliers for sector S_j from the open $(\mathbf{I} - \mathbf{A})^{-1}$ matrix, we multiply the former by the same sector's multipliers in the closed model. The total income multiplier inclusive of induced effects is denoted as:

$$H^*_j = \sum_{i=1}^{n} \left(a^*_{n+1i}\right)\left(\alpha^*_{ij}\right) \tag{33}$$

There are variations of the income multiplier that have been designed to adjust for overstatements resulting from the structural form above. Essentially, the assumption that consumer spending rises both linearly and homogeneously with increased income inflates estimates of the induced effect. The manner in which more sophisticated multipliers compensate for the overstatement will be discussed later.

Employment Multipliers—Policymakers are often interested in considering the distributional effects of income increases as they pertain to population changes and employment patterns in general. An analogous measure to the income multiplier can be described in terms of the physical employment necessary to fuel the labor requirements prompted by exogenous demand changes. This presumption is acceptable so long as a consistent relationship is assumed between the "value of output of a sector and [physical] employment in that sector" [Miller and Blair 1985]. If we know the number of persons employed in each industry, then input coefficients expressed as units of employment can be determined and then substituted for the labor input coefficients in the $\mathbf{A}^*$ matrix. Caution is warranted here as it is for each of the previous multipliers. The interpretation of this labor/output relationship is that it describes the number of jobs necessary to fulfill the labor component of the production mix for a dollar's worth of output. For our continuing example, assume that sector S_1 employs six workers while S_2 utilizes four and households employ two (as domestic services). Using the notation e_i to denote number of workers per i-th sector, then $e_1 = 6$, $e_2 = 4$, and $e_3 = 2$. To convert these values into employment coefficients, we divide each by its corresponding outlays, denoting the operation as $w^*_{n+1i} = e_i/X_i$. Substituting the resulting w^*_{n+1i} values for the a^*_{n+1i} entries, our $\mathbf{A}^*$ matrix becomes:

$$\mathbf{A}^{\mathbf{w}} = \begin{pmatrix} 0.1 & 0.2 & 0.2 \\ 0.3 & 0.4 & 0.3 \\ 0.006 & 0.0025 & 0.001 \end{pmatrix} \tag{34}$$

Multiplying the first two w^*_{n+1i} entries by their corresponding a_{ij} elements of the closed $(\mathbf{I} - \mathbf{A})^{-1}$ matrix gives us the direct and indirect multiplicative effects for employment (E_j):

$$E_j = \sum_{i=1}^{n} \left(w^*_{n+1i}\right)\left(\alpha_{ij}\right) \tag{35}$$

As with the income multipliers, the direct and indirect components can be isolated from the total by recalling that the direct effects are revealed in the row vector culled from the $(n + 1)$ row of the $\mathbf{A}^*$ matrix. To see this we can simulate a unitary demand change for good X_2 and compute the employment multiplier:

$$E_2 = \begin{pmatrix} w^*_{3,1} & w^*_{3,2} \end{pmatrix} \begin{pmatrix} \alpha_{1,2} \\ \alpha_{2,2} \end{pmatrix} = \begin{pmatrix} 0.006 & 0.003 \end{pmatrix} \begin{pmatrix} 0.4 \\ 1.87 \end{pmatrix} = 0.008 \tag{36}$$

This means that every dollar's worth of output of good X_2 creates 0.008 jobs, or by extension, that a job will be created somewhere in the economy as a consequence of each \$125 worth of output from sector S_2. Subtracting the direct effect from the combined direct and indirect effects of E_2 gives 0.008 – 0.0024 = 0.0056, the indirect component.

In order to capture any induced effects from household spending, we would repeat the exercise with the closed $(\mathbf{I} - \mathbf{A}^*)^{-1}$, and multiply all three of the converted employment coefficients by the a^*_{ij} entries instead of the α_{ij} elements. Doing so generates multipliers inclusive of household spending for output and income. The operation is represented as:

$$E^*_j = \sum_{i=1}^{n} \left(a^*_{n+1i}\right)\left(\alpha^*_{ij}\right) \tag{37}$$

Each of the categories of multipliers provides predictive measures of impact for any combination of final demand changes for goods and services. By manipulating the components of intermediate (intersectoral) demand, assumptions can be imposed on the role of household earnings and expenditures throughout the regional economy. As we have seen repeatedly, the effects of increased household incomes associated with direct and indirect production responses can be omitted from the calculation of multipliers or included as an induced effect by simply augmenting the Leontieff inverse with the household's technical coefficients. While the open model understates the total impacts due to the omission, the augmented model probably overstates induced effects because of the assumed homogeneity in consumption. Although demarcating the range of possible impacts attributed to household spending by comparing results from both procedures is one possible solution to this limitation, it is an unimaginative way of bypassing the inherent theoretical problems underlying the model's structure. Refinements in the methodology have been developed to solve for overstatement of the induced effects that stem from the unrealistic construction of homogeneous consumption functions, thus imparting a more representative effect more in line with consumer choice theories. These adjustment techniques are described below.

Compensated Induced Effects—It was pointed out in the discussion on assumptions and caveats that the very traits which render input–output so appealing also frustrate its ability to adhere to some of the more fundamental principles of economics. Restricting production and consumption functions to linear forms is imposing enough without the added assumption of homogeneity. A function is homogeneous (of degree one) when it can be shown that a doubling of inputs results in a doubling of outputs. This is demonstrated with the following production example where quantity q, is a function of inputs X_n:

(38) $$q = f(X_1, X_2, \ldots X_n)$$

and we multiply all inputs by a constant λ, so that

(39) $$f(\lambda X_1, \lambda X_2, \ldots, \lambda X_3) = f(X_1, X_2, \ldots, X_n)$$

then for any linear specification, *k* will be equal to 1. In other words, outputs increase in the same proportion as inputs, bearing on the constant returns to scale characteristic introduced earlier [Nicholson 1995]. Though limiting in its treatment of real world production scenarios where diminishing returns and input substitution are likely to exist, these assumptions may be relaxed for short-term predictive purposes. On the other hand, it is difficult to envision a case where a doubling of income leads to a doubling of consumption for all goods and services, yet this is exactly what induced multiplier effects convey, leading to inevitable overestimation.

Moore and Petersen [1955] developed an approach to approximate induced effects by estimating linear community-wide consumption functions for each sector, of the form $C_i=a+bY_i$. In this case, Y_i is the direct and indirect income associated with final demand for X_i. Therefore, ΔC_i will equal ΔY_i. Instead, Miernyk et al. [1967] estimate aggregate linear consumption functions for several income classes, and then combine these to simulate a non-linear function through a stepwise functional form. The slope of this function declines over larger values of income and thus behaves in a more theoretically appealing manner than does the linear, homogeneous approach. However, both approaches are costly in terms of data requirements. Not only are income levels and consumption patterns necessary for the "cost center" sources (i.e. sport fishers in this study), they are also needed for all consumers in the study region. Data collection efforts for I–O models are typically exhausted by the mere solicitation of consumer expenditures and production features for the sectors of primary interest when secondary sources of data are unavailable.

Ratio multipliers and response coefficients

A great deal of confusion has emerged around the interpretation and misinterpretation of the multipliers developed in the previous section, and much of the I–O literature has been devoted to treatment of these issues. The multipliers discussed above were derived for predicting the effects of exogenous changes in demand for output, income, and employment. This is the form of the multiplier used for estimating impacts, and depending on the source cited, can be referred to as the "normal" multiplier [Archer 1977], "Keynesian" multiplier [Archer 1984], or "response coefficient" [Bushnell and Hyle 1985; Rose et al. 1981; Jensen 1997]. The "ratio multiplier" is a very different but widely applied concept. While the normal multiplier describes the total effects of a dollar change in demand, the ratio multiplier is an expression that relates the degree of internal linkage for the sector in question by establishing the proportion by which total effects exceed direct effects. The ratio multiplier, also referred to as the "conventional" or "traditional" multiplier [Bushnell and Hyle 1985], is formulated simply by dividing the total effects of the normal multiplier by the direct effect. For a Type I ratio multiplier, the total effects are comprised of the sum of the direct and indirect effects, and for Type II, the induced component is also included.

A simple example will help to illustrate how the ratio multiplier is calculated and to shed light on its significance as a policy tool. Recall the income multiplier developed earlier and that the value for the direct and indirect effects was 0.312 dollars (Equation 31). To obtain the Type I ratio multiplier, we divide the sum of the direct and indirect effects by the direct effect: $0.312 \div 0.20 = 1.56$. Confusion among inexperienced practitioners of input–output has probably arisen from the misuse of the term "multiplier" to describe what is in fact an index of internal linkage or economic self-sufficiency. It is not intended as a multiplicative factor for predictive impact modeling, but its widespread erroneous use in this manner has sparked much controversy over the use of impact modeling in general [Archer 1977]. Instead, the ratio multiplier describes the degree of internal linkage and relative magnitude of the indirect effect, which is useful for comparisons among sectors in conjunction with other information. Even if one sector's ratio multiplier is substantially greater than another's, the analyst needs to consider the circumstances that could lead to misleading interpretations. For example, a large ratio multiplier might be more a function of a particularly small direct effect (denominator for the ratio multiplier) than the overall significance of the direct and induced effects as compared with those for other sectors. In other words, sectors with the highest ratio multipliers

do not necessarily yield the highest impacts. It is important to assess the amount of exogenous sales (demand change), which are required to generate an initial unit of direct income [Archer 1977; Bushnell and Hyle 1985], and the normal multipliers take this standardization into account, making cross-sectoral comparisons possible.

Ratio multipliers have been dismissed as meaningless on their own for predictive impact purposes and are instead used to gauge degrees of self-sufficiency among distinct economies of a given area. The impacts derived for this study rely on the induced normal multipliers, and are referred to as response coefficients in the accompanying software package.

Assumptions and limitations

Input–output models have gained favor among regional economists and other analysts because of the relative operational simplicity and low cost associated with available pre-packaged programs. Even when considerable work is involved in building an original model, linear algebra provides simpler mathematical framework than is available for sophisticated alternatives. However, these conveniences come at the expense of certain limitations inherent in the restrictive assumptions underlying the model's design. Despite these limitations, an understanding of the caveats can help the analyst overcome the weaknesses. The following discussion is adapted from Archer [1977] and Olson and Lindall [1997].

Unlike actual economies, input–output models are static in form because: 1) constant returns to scale are assumed; 2) there is implied supply elasticity in all sectors and absence of supply constraints; 3) relative prices are constant and commodity input structure is fixed; 4) sector output is homogenous; and 5) industry technology is fixed.

Because of the linear production specification for all industrial sectors, increased production requires the purchase of inputs in exactly the same proportions regardless of magnitude. I–O also assumes that the only limiting factor on production is the level of demand, implying that marginal costs are constant and that firms have unlimited access to inputs. Therefore, returns to scale are constant over the entire range of production possibilities. Since relative prices are fixed, I–O models operate under the assumption that resources have no opportunity costs so that changes in demand affect production without altering the mix of commodities and services. Finally, the fixed technology assumption states that the same technology is used to produce all of an industry's products, and that technology is static.

These limitations become increasingly binding the greater the simulated change in the impact analysis. Although real world production relationships are most probably non-linear, it is not unreasonable to approximate these with linear specifications for small changes from the starting point. On the other hand, simulations that involve drastic changes from the means are likely to have poor predictive abilities. Determining acceptable levels for demand shocks to I–O models relies on intuition and qualitative assessments of the industries in question. As a general rule, practitioners of I–O should have less confidence in results the further the impact scenario deviates from the baseline conditions.

Specific changes to the baseline model

The regional economic modeling system IMPLAN has not been used as extensively in Alaska as it has in other U.S. regions. One reason is that Alaska is large and sparsely populated. In addition, most of the population is concentrated in Anchorage (Southcentral), Fairbanks (Interior), Juneau (Southeast), and the Kenai Peninsula. In the rest of Alaska, populations are very small, isolated from each other, and may have more direct links to distant urban centers such as Seattle than they do to proximate communities. Many of Alaska's industries (oil, fisheries, tourism) operate with little connection to local economies. In fact, much of the labor force is imported, residing out-of-state for much of each year. Thus, Alaska's economy differs from the U.S. economy in general.

Before IMPLAN is used for impact analysis in a community in Alaska, it must be modified to accurately reflect the local economy. Economically small regions are difficult to model because of the problem of data masked to ensure confidentiality [Geier et al. 1994]. While REIS data is often used elsewhere, disclosure problems and a lack of self-

employment data in REIS renders it unsuitable for many Alaskan industries. Consequently, community research is the most efficient and accurate method to gather the data to regionalize the IMPLAN model.

The first step is to identify the study area. We combined Seward with other areas of the Kenai Peninsula Borough that also did not participate materially in the lower Cook Inlet sport fisheries and identified four other sub-regions of the Kenai Peninsula Borough that had their own regional identities. We defined these five areas by zip code and ordered IMPLAN databases for each area. The five areas had populations ranging from 2,755 to 17,212. Four of the zip code areas were to be included in the model for impact analysis.

To structure our interviews, we used the Output, Value Added, and Employment report (OVE). We targeted persons who were identified to us by the Kenai Peninsula Borough Economic Development District as being familiar with their local communities. They included mayors, borough- and city-council persons, real estate agents, Chamber of Commerce directors, and bankers. We interviewed at least three local informed experts in each community to "groundtruth" a line-by-line (sector-by-sector) review of the OVE report.

The five regional economies were very different from each other. The northern part of the Kenai Peninsula Borough was dominated by the oil industry, and included most of the wholesale and retail sales activity. Commercial and sport fishing activities were distributed throughout the borough, with regional differences in operation by commercial guiding industries, and also among the commercial fishers by gear type. Logging and related industries were also unevenly distributed, with very real regional differences in operation. Sand and gravel mining industries were concentrated in the south central part of the borough. The use of zip codes to define discrete subareas contributed to the accuracy of our final model, as it should in any area where the IMPLAN databases need to be corrected.

Individual sectors of the five IMPLAN models were adjusted to reflect information provided by the informed experts. In addition, the models were adjusted to reflect Alaska Department of Labor ES202 data. However, even this data did not provide sufficient detail for commercial fishing, guided/charter sportfishing, or bed and breakfasts. Because these industries may have a significant amount of unreported income and employment, we conducted a second round of interviews with actual participants.

The ES202 data was particularly helpful for fish processing and large-scale tourism oriented industries. The ES202 data was also useful for examining the seasonality of different industries. We used the data to construct a peak seasonal employment model. While the peak seasonal model employment figures exceeded the original IMPLAN numbers, we felt that a peak seasonal employment model would provide a more accurate measure of the effect of most impact scenarios.

The mean Alaska unemployment rate (1990–1997) has shown a 3.7% seasonal variation between the months of January/February (lowest) to August (highest). The Kenai Peninsula Borough seasonal variation has exceeded 10% during the same time period, due to its reliance on recreation and the commercial fishing. However, what was not captured by the unemployment rate is the seasonal variation of the size of the labor force. The average low labor force occurs in December/January, and the high generally falls in July. The average (1990–1997) high is 23,842, while the average low is 19,159; an average difference is approximately 24%. This shows the seasonality of the labor force much more clearly than the unemployment rate. However, we must be mindful that this does not reflect proprietors and non-unemployment insurance covered employees, like the commercial fishing industry, and the sportfishing guide/charter industry. So, the employment numbers should be even higher than they are because of the large amount of summer employment that does not appear in State data. Much of this employment is nonresidential. Commercial fishing, fish processing, guiding, and seasonal industries tied to tourism and natural resources account for much of the nonresidential employment.

Nonresidential employment, of course, leads to different household consumption patterns. Many nonresident employees on the Kenai Peninsula Borough are college students recruited from in state and from out of state. They tend to minimize expenditures and transfer a large part of their incomes to locations outside the Kenai Peninsula Borough.

We attempted to remedy employment data shortcomings in the commercial fishing sector through the use of ADF&G data for crew licenses and commercial fishing permits, and through our interviews with industry

representatives. Thus, we were able to estimate and verify the accuracy of our estimates for employment in the commercial fishing and guided/charter sportfishing industries. We also used data from several representative guides to construct production functions for the three sectors that we assigned to those guides: Homer, Deep Creek, and Kenai River. We further estimated employment and constructed another production function for the sport fish-processing sector using informed interviewees.

Another sector that was underestimated by IMPLAN models for the Kenai Peninsula Borough was the Hotels and Lodging sector. Bed and breakfast inns are a recent addition to this sector in the Kenai Peninsula Borough, and most are seasonally operated and do not appear in employment statistics because of the structure of the firms in the sector. Thus, we had to estimate an increase in this sector also. This was done solely through the first round of interviews with community experts. It was not possible to estimate a new production function, but the amount of proprietors and other property income should be adjusted upwards from the existing rations to reflect the higher number of owner/operators in these businesses relative to other business in the Hotels and Lodgings sector.

Commercial fishing, Hotels and Lodging, and other existing sectors were changed before the zip codes were aggregated. Thus, to construct the overall Kenai Peninsula Borough model for analysis of the lower Cook Inlet sport fisheries, four models were constructed and their data was corrected using the IMPLAN editor for the sectors where there were only employment number changes. After correction, the four zip code models were aggregated using Microsoft Access and a spreadsheet. The SA Industry Data tables for the four zip code models were imported into the spreadsheet for aggregation. After aggregation, the revised table was imported back into Access for use in IMPLAN.

The Kenai–Nikiski model

The first model is for the Kenai–Nikiski area. Expert interviews were held with John Williams, former Borough Mayor, Becky Hultberg from the Borough Economic Development Office, and Rick Ross and Laura Measles of the Kenai Chamber of Commerce. The model had 92 sectors from IMPLAN. The expert interviews and correlation of the model with other data sources including the agricultural statistics publication from USDA, the Kenai Peninsula Borough School District employment roster, and other miscellaneous sources yielded the following changes.

Agriculture and Agricultural Services—Sector 3, Ranch Fed Cattle, was doubled for employment and all income components. This was indicated by 3 out of 4 experts, and validated by Agricultural Statistics. The other agricultural sectors, 6, 9, 13, 18, and 23, were not changed. Sector 27, Landscape and Horticultural Services, was increased from 6 to 24 because of the ES202 numbers with a like increase in all other components.

Mining—Sectors 31 and 37 were zeroed-out as there was no evidence of either gold or coal mining in the Kenai–Nikiski area. Sector 38, Natural Gas and Crude Petroleum, was considered to be fully disclosed in the ES202 report, and was adjusted to 307.

Construction—Only two construction sectors 48 and 49 were adjusted according to ES202 numbers and expert opinion. The other sectors were accepted as IMPLAN presented them by the experts and were not significantly different from the ES202 numbers.

Manufacturing—Sector 133, Logging Camps and Contractors, was expanded according to expert opinion from 3 to 15 employees. Sector 174, Newspapers, was adjusted down from 127 to 100 due to ES202 data. Sector 202, Nitrogenous and Phosphoric Fertilizers, was adjusted from 320 to 351 employees. Sector 210, Petroleum Refining, was acceptable. Sector 244, Ready-Mixed Concrete, was also okay. Sector 282, Fabricated Structural Metal, deserves some comment. The APC module facility was left out of this model as the date of most data was prior to its opening. Sector 354, Industrial Machines Not Elsewhere Classified, was specified in the ES202 numbers. Sector 393, Boat Building and Repair, was added with 5 employees.

Transportation and Public Utilities—Sector 434, Local, Interurban Passenger Transit, was added with 10 employees according to expert interviews. Sector 435, Motor Freight Transport and Warehousing, was cut from 91 employees to 60. This was calculated from both ES202 numbers and also expert interviews. Sector 436, Water Transportation, was seen by experts as a seasonal industry, and it was not represented accurately by IMPLAN or ES202, so it was

doubled from 11 to 22 employees. Sector 437, Air Transportation, was increased to 124, the seasonal high from the ES202 files. Experts agreed that it should be higher than IMPLAN's 70, but were unable to pin an exact number. Sector 438, Pipelines except Natural Gas, was increased from 0 to 4 employees according to ES202 files. Sector 439, Arrangement of Passenger Transportation, was adjusted from 12 to 15 according to expert interviews as well as collaborating evidence from ES202. Sector 443, Electric Services, was adjusted from 98 to 67 in accordance with the ES202 files. Sector 446 was adjusted down from 39 to 34.

Wholesale and Retail Trade—Wholesale and retail trade sectors were adjusted according to the ratios in ES202 files and then individually corrected according to expert opinion. Sector 447, Wholesale Trade, was adjusted from 180 to 350 according to ES202. Sector 448, Building Materials and Gardening, retail, was adjusted down from 64 to 25 with deference to ES202 and experts. Sector 449, General Merchandise Stores, was reduced from 327 to 250 with reference to ES202 and expert opinion. Sector 451, Automotive Dealers & Service Stations, was adjusted from 119 to 200 according to expert opinion. Sector 453, Furniture and Home Furnishings Stores, was adjusted from 12 to 8 according to ES202 and expert opinion.

Finance, Insurance, and Real Estate—Sector 456, Banking, was adjusted from 68 to 57 according to ES202. Sector 457, Credit Agencies, was adjusted from 70 to 18 according to ES202 and expert opinion. Sector 459, Insurance Carriers, was adjusted from 1 to 10 according to ES202. Sector 462, Real Estate, was adjusted from 74 to 45 according to expert opinion.

Services—Sector 471, Photo-Finishing, Commercial Photography, was adjusted from 30 to 10 according to expert opinion. Sector 472, Services to Buildings, was adjusted from 144 to 100 according to expert opinion. Sector 479, Automobile Repair and Services, was adjusted from 64 to 50 according to expert opinion. Sector 480, Electrical Repair Shops, was adjusted from 1 to 12 according to ES202 and expert opinion. Sector 483, Motion Pictures, was adjusted from 59 to 45 according to ES202 and expert opinion. Sector 484, Theatrical Producers, Bands, Etc., was adjusted from 1 to 10 according to expert opinion. Sector 485, Bowling Alleys and Pool Halls, was adjusted from 19 to 10 according to expert opinion. Sector 498, Job Training and Related Services, was adjusted from 5 to 10 according to expert opinion and ES202. Sector 503, Business Associations, was adjusted from 5 to 8 according to ES202. Sector 504, Labor and Civic Organizations, was adjusted from 212 to 76 according to ES202. Sector 505, Religious Organizations, was adjusted from 7 to 140, according to ES202. Sector 506, Engineering, Architectural Services, was adjusted from 52 to 26 according to expert opinion. Sector 508, Management and Consulting Services, was adjusted from 25 to 20 according to expert opinion.

Government—Sector 511, State and Local Electric Utilities, was adjusted from 2 to 0 according to expert opinion and ES202. Sector 513, U.S. Postal Service, was adjusted from 25 to 33 according to ES202. Sector 519, Federal Government – Military, was adjusted from 121 to 2 according to ES202. Sector 520, Federal Government – Non-Military, was adjusted from 102 to 137 according to ES202. Sector 522, State & Local Government – Education, was adjusted from 370 to 379 according to the Kenai Borough School District Employment numbers. Sector 523, State & Local Government – Non-Education, was adjusted from 485 to 806 according to ES202.

The Homer model

The sector-by-sector correction of the Homer/Seldovia model was completed with input from Derotha Ferraro, Homer Chamber of Commerce, and Shari Hobbs, Homer Mayor's office. Also taken into account were the ES202 files from Alaska Department of Labor. When there was not agreement between interview subjects, their answers were averaged. In sectors where ES202 data was relatively complete, these data were used. Absent any conflicting information, IMPLAN database numbers were accepted as the best estimates.

Construction Sectors—Sector 48, New Residential Structures, was adjusted from 16 employees to 76, averaged according to expert opinions. Sector 50, New Utility Structures, was increased from 9 to 30 employees according to expert opinion. Sector 54, New Government Facilities, was increased from 9 to 30, also according to expert opinion. Sector 55, Maintenance and Repair Residential, average expert opinion increased employment from 11 to 61. Sector 56, Maintenance and Repair of Other Facilities, was decreased from 91 to 45 according to expert opinion.

Manufacturing Sectors—Sector 67, Canned Fruits and Vegetables, was averaged according to expert opinion from 1 to 26. Sector 98, Prepared Fresh and Frozen Seafoods was adjusted from 345 to 246 according to ES202 seasonal high. Sector 128, Canvas Products, was increased from 6 employees to 26, on advice from expert (D). Sector 133, Logging Camps and Logging Contractors, was increased from 44 to 100 according to expert opinion. Sector 144, Prefabricated Wood Buildings, was increased from 1 to 4 employees according to expert opinion. Sector 174, Newspapers, was decreased from 29 to 20 according to expert opinion. Sector 176, Book Publishing, was increased from 1 employee to 10 according to average expert opinion. Sector 179, Commercial Printing, increased from 4 to 9 according to average expert opinion. These numbers also cross-referenced closely with ES202 data. Sector 241, Pottery Products, was added with 2 employees according to expert opinion and ES202 data. Sector 311, Construction Machinery and Equipment, was added because it was indicated in the ES202 files. Sector 354, Industrial Machines, was decreased from 39 to 3 according to ES202 files. Sector 393, Boat Building and Repair, was increased from 1 to 50 by average expert opinion. Sector 415, Jewelry, Precious Metal, was increased from 12 to 25 because of ES202 data and an allowance for workers not covered by unemployment insurance.

Transportation and Communication Service Sectors—The service sectors exhibited the greatest variation from IMPLAN numbers because the industries contain lots of proprietor's income and thus non-UI reported employment. Sector 434, Local, Interurban Transport, was increased from 6 employees to 16 according to expert opinion. Sector 436, Water Transportation was increased from 124 to 134 because of expert opinion and ES202 evidence of higher employment. Sector 437, Air Transportation, was increased from 44 to 75 due to expert opinion. Sector 439, Arrangement of Passenger Transportation, was adjusted from 16 to 26 according to expert opinion. Sector 441, Communications, Except Radio and TV, was adjusted from 3 to 4 according to ES202. Sector 442, Radio and TV Broadcasting, was adjusted from 30 to 18 according to ES202. Sector 443, Electric Services, was adjusted from 92 to 75 according to ES202.

Retail Trade—Sector 448, Building Materials and Gardening Supplies, was adjusted from 43 to 63 according to ES202 and allowing for proprietors. Sector 451, Automotive Dealers and Service Stations, was adjusted from 50 to 56 according to ES202. Sector 452, Apparel and Accessory Stores, was adjusted from 6 to 12 according to expert opinion. Sector 453, Furniture and Home Furnishings Store, was adjusted from 11 to 14 according to ES202 files. Sector 454, Eating and Drinking Establishments, employment was adjusted from 281 to 500 according to ES202, plus an added approximation of proprietors.

*Finance, Insurance, and Real Estat*e—Sector 456, Banking, was adjusted from 49 to 36 according to expert opinion. Sector 460, Insurance Agents and Brokers, was adjusted from 43 to 16 according to expert opinion and ES202. Sector 463, Hotels and Lodging Places, was adjusted from 151 to 250 according to expert opinion, ES202, and allowing for operators.

Services—Sector 464, Laundry, Cleaning, and Shoe Repair, was adjusted from 38 to 20 according to expert opinion. Sector 466, Beauty and Barber Shops, was adjusted from 9 to 25 according to expert opinion. Sector 468, Miscellaneous Personal Services, was adjusted from 8 to 20 according to average expert opinion. Sector 470, Other Business Services, was adjusted from 22 to 20 according to expert opinion. Sector 471, Photo-Finishing, Commercial Photography, was adjusted from 60 to 35 according to average expert opinion. Sector 472, Servicesto Buildings, was adjusted from 30 to 12 according to estimates from ES202. Sector 479, Automobile Repair and Services, was adjusted from 53 to 31 according to ES202. Sector 482, Miscellaneous Repair Shops, was adjusted from 2 to 10 according to expert opinion. Sector 484, Theatrical Producers, Bands, Etc., was adjusted from 1 to 30 according to average expert opinion. Sector 488, Amusement and Recreation Services, was adjusted from 159 to 200 by consensus expert opinion. Sector 489, Membership Sports and Recreation Clubs, was adjusted from 54 to 15 according to expert opinion. Sector 492, Hospitals, was adjusted from 190 to 219 according to ES202. Sector 493, Other Medical and Health Services, was adjusted from 42 to 15 according to expert opinion. Sector 494, Legal Services, was adjusted from 16 to 24 according to expert opinion. Sector 498, Job Training and Related Services, was adjusted from 2 to 4 according to ES202. Sector 499, Child Day Care Services, was adjusted from 13 to 20 according to consensus expert opinion. Sector 500, Social Services, was adjusted from 54 to 94 according to ES202 and expert opinion. Sector 501, Residential Care, was adjusted from 5 to 15 according to ES202 and expert opinion. Sector 502, Other Nonprofit Organizations, was adjusted from 4 to 28 according to ES202. Sector 503, Business Associations, was adjusted from 3 to 11 according to ES202. Sector 504, Labor and Civic Organizations, was adjusted from 42 to 56 according to ES202. Sector 505, Religious Organizations, was adjusted from 12 to 20

according to expert opinion. Sector 506, Engineering and Architectural Services, was adjusted from 16 to 8 according to ES202.

Government—Sector 513, U.S. Postal Service, was adjusted from 19 to 2. Sector 522, State and Local Government – Education, was adjusted from 279 to 278 according to the Kenai Peninsula Borough School District Employment catalog. Sector 523, State and Local Government – Non-Education, was adjusted from 366 to 118 according to ES202.

The Anchor Point and Ninilchik model

The documentation for the communities of Ninilchik and Anchor Point relied mainly upon the expert testimony of three people recommended by the Kenai Peninsula Borough Economic Development District: one who was considered expert for both communities; one considered expert in Anchor Point; and, one for Ninilchik. They were, respectively, real estate agent Emmett Trimble, business owner Simone Klutts, and business owner Vicki Stik. They were presented with the value added and employment report from the IMPLAN zip code model and asked to determine the accuracy of all sectors. Following is a discussion of the sectors that were changed from the original IMPLAN zip code model for Anchor Point and Ninilchik.

Agriculture—Sector 3, Ranch Fed Cattle, was changed from 0 to 3 according to expert opinion with additional data from the Alaska Agricultural Statistics. Sector 7, Hogs, Pigs, and Swine, was adjusted from 0 to 1 according to expert opinion and additional documentation from the Alaska Agricultural Statistics. Sector 8, Other Meat Animal Products, was adjusted from 0 to 7 according to expert opinion and additional documentation from the Alaska Agricultural Statistics. Sector 9, Miscellaneous Livestock, was adjusted from 2 to 10 according to expert opinion and additional documentation from the Alaska Agricultural Statistics. Sector 13, Hay and Pasture, was adjusted from 2 to 13 according to expert opinion and additional documentation from the Alaska Agricultural Statistics. Sector 23, Greenhouse and Nursery Products, was adjusted from 1 to 7 according to expert opinion.

Mining—Sector 41, Sand and Gravel, was adjusted from 2 to 50 according to expert opinion.

Construction—Sector 48, New Residential Structures, was adjusted from 7 to 21 according to expert opinion. Sector 54, New Government Facilities, was adjusted from 4 to 20 according to expert opinion. Sector 55, Maintenance and Repair, Residential, was adjusted from 2 to 15 according to expert opinion. Sector 56, Maintenance and Repair Other Facilities, was adjusted from 19 to 11 according to expert opinion.

Manufacturing—Sector 133, Logging Camps and Logging Contractors, was adjusted from 37 to 50 according to expert opinion. Sector 134, Sawmills and Planing Mills, General, was adjusted from 0 to 4 according to expert opinion. Sector 144, Prefabricated Wood Buildings, was adjusted from 1 to 3. Sector 244, Ready-Mixed Concrete, was adjusted from 0 to 5 according to expert opinion. Sector 275, Cutlery, was adjusted from 1 to 0 according to expert opinion. Sector 393, Fabricated Structural Metal, was adjusted from Boat Building and Repair, was adjusted from 4 to 13 according to expert opinion.

Transportation and Public Utilities—Sector 435, Motor Freight Transport and Warehousing, was adjusted from 2 to 6 according to expert opinion. Sector 436, Water Transportation, was adjusted from 7 to 10 according to expert opinion. Sector 433, Electric Services, was adjusted from 0 to 65 according to ES202. Sector 445, Water Supply and Sewerage Systems, was adjusted from 0 to 12 according to expert opinion.

Wholesale and Retail Trade—Sector 447, Wholesale Trade, was adjusted from 8 to 16 according to expert opinion and ES202. Sector 449, General Merchandise Stores, was adjusted from 5 to 25 according to expert opinion and ES202. Sector 450, Food Stores, was adjusted from 8 to 72 according to ES202. Sector 451, Automotive Dealers & Service Stations, was adjusted from 8 to 20 according to expert opinion. Sector 454, Eating & Drinking, was adjusted from 64 to 100 according to expert opinion. Sector 455, Miscellaneous Retail, was adjusted from 10 to 26 according to expert opinion. Sector 463, Hotel and Lodging Places, was adjusted from 23 to 55 according to expert opinion.

Services—Sector 472, Services to Buildings, was adjusted from 0 to 3 according to expert opinion. Sector 473, Equipment Rental and Leasing, was adjusted from 0 to 2 according to expert opinion. Sector 479, Automobile Repair and Services, was adjusted from 6 to 12 according to expert opinion. Sector 482, Miscellaneous Repair Shops, was adjusted from 2 to 6 according to expert opinion. Sector 499, Child Day Care Services, was adjusted from 3 to 12 according to expert opinion. Sector 504, Labor and Civic Organizations, was adjusted from 9 to 20 according to ES202. Sector 505, Religious Organizations, was adjusted from 0 to 10 according to expert opinion.

Government—Sector 513, U.S. Postal Service, was adjusted from 6 to 12 according to expert opinion. Sector 520, Federal Government – Non-Military, was adjusted from 24 to 48 according to expert opinion and ES202. Sector 522, State and Local Government – Education, was adjusted from 87 to 55 according to the Kenai Peninsula School District Personnel List. Sector 523, State & Local Government – Non-Education, was adjusted from 114 to 28 according to ES202. Sector 525, Domestic Services, was adjusted from 8 to 13 according to expert opinion.

Soldotna and balance of northern Kenai Peninsula model

The documentation for these communities relies mainly upon the expert testimony of Kurt Eriksson, National Bank of Alaska Soldotna, and Tom Boedeker. They were presented with the value added and employment report from the IMPLAN zip code model and asked to determine the accuracy of all sectors. Following is a discussion of the sectors that were changed from the original IMPLAN zip code model for Soldotna.

Agriculture—Sector 3, Ranch Fed Cattle, was adjusted from 1 to 2 according to Alaska Agricultural Statistics. Sector 7, Hogs, Pigs, and Swine, was adjusted from 1 to 3 according to Alaska Agricultural Statistics and expert opinion. Sector 22, Forest Products, was adjusted from 1 to 6 according to expert opinion. Sector 23, Greenhouse and Nursery Products, was adjusted from 11 to 13 according to expert opinion. Sector 27, Landscape and Horticultural Services, was adjusted from 8 to 11 according to expert opinion.

Construction—Sector 48, New Residential Structures, was adjusted from 51 to 204 according to expert opinion. Sector 49, New Industrial and Commercial Buildings, was adjusted from 194 to 291 according to expert opinion. Sector 50, New Utility Structures, was adjusted from 29 to 20 according to expert opinion and ES202. Sector 51, New Highways and Streets, was adjusted from 103 to 130 according to expert opinion. Sector 53, New Mineral Extraction Facilities, was adjusted from 197 to 25 according to expert opinion. Sector 54, New Government Facilities, was adjusted from 31 to 25 according to expert opinion. Sector 55, Maintenance and Repair, Residential, was adjusted from 12 to 25 according to expert opinion.

Manufacturing—Sector 67, Canned Fruits and Vegetables, was adjusted from 1 to 0. Sector 79, Bread, Cake, and Related Products, was adjusted from 0 to 5 according to ES202. Sector 133, Logging Camps and Logging Contractors, was adjusted from 1 to 60 according to expert opinion and ES202. Sector 140, Structural Wood Members, was adjusted from 0 to 9 according to ES202. Sector 144, Prefabricated Wood Buildings, was adjusted from 0 to 30 according to ES202 and expert opinion. Sector 242, Concrete Block and Brick, was adjusted from 3 to 30 according to ES202 and expert opinion. Sector 244, Ready-Mixed Concrete, was adjusted from 0 to 23 according to ES202. Sector 275, Cutlery, was adjusted from 2 to 3 according to expert opinion. Sector 337, Industrial Furnaces and Ovens, was adjusted from 0 to 7 according to ES202. Sector 392, Shipbuilding and Repair, was adjusted from 0 to 3 according to ES202. Sector 393, Boat Building and Repair, was adjusted from 1 to 5 according to ES202 and expert opinion.

Transportation and Public Utilities—Sector 435, Motor Freight Transport and Warehousing, was adjusted from 15 to 50 according to ES202 and expert opinion. Sector 436, Water Transportation, was adjusted from 0 to 50 according to ES202. Sector 437, Air Transportation, was adjusted from 18 to 36 according to ES202 and expert opinion. Sector 439, Arrangement of Passenger Transportation, was adjusted from 12 to 19 according to ES202 and expert opinion. Sector 440, Transportation Services, was 2 to 15 according to expert opinion and ES202. Sector 441, Communications, Except Radio and TV, was adjusted from 51 to 54 according to ES202. Sector 443, Electric Services, was adjusted from 3 to 5 according to expert opinion and ES202. Sector 444, Gas Production and Distribution, was adjusted from 10 to 22 according to ES202. Sector 446, Sanitary Services and Steam Supply, was adjusted from 21 to 26 according to expert opinion.

Wholesale and Retail Trade—Sector 447, Wholesale Trade, was adjusted from 109 to 130 according to expert opinion. Sector 448, Building Materials & Gardening, was adjusted from 69 to 90 according to ES202 and expert opinion. Sector 449, General Merchandise Stores, was adjusted from 64 to 213 according to ES202 averaged with Sector 450. Sector 450, Food Stores, was adjusted according to ES202 averaged with Sector 449. Sector 451, Automotive Dealers & Service Stations, was adjusted from 207 to 278 according to ES202 and expert opinion. Sector 452, Apparel & Accessory Stores, was adjusted from 62 to 31 according to ES202 and expert opinion. Sector 453, Furniture & Home Furnishings Store, was adjusted from 51 to 45 according to expert opinion. Sector 454, Eating & Drinking, was adjusted from 416 to 430 according to ES202 and expert opinion.

Finance, Insurance, and Real Estate—Sector 456, Banking, was adjusted from 95 to 60 according to expert opinion and ES202. Sector 457, Credit Agencies, was adjusted from 70 to 35 according to expert opinion. Sector 462, Real Estate, was adjusted from 190 to 350 according to expert opinion. Sector 463, Hotels and Lodging Places, was adjusted from 439 to 470 according to expert opinion.

Services—Sector 464, Laundry, Cleaning, and Shoe Repair, was adjusted from 53 to 60 according to expert opinion. Sector 468, Miscellaneous Personal Services, was adjusted from 18 to 36 according to expert opinion. Sector 470, Other Business Services, was adjusted from 15 to 25 according to ES202 and expert opinion. Sector 472, Services to Buildings, was adjusted from 120 to 125 according to expert opinion. Sector 473, Equipment Rental and Leasing, was adjusted from 42 to 47 according to expert opinion. Sector 476, Detective and Protective Services, was adjusted from 11 to 25 according to ES202. Sector 477, Automobile Renting and Leasing, was adjusted from 5 to 10 according to expert opinion. Sector 478, Automobile Parking and Car Wash, was adjusted from 7 to 9 according to expert opinion. Sector 480, Electrical Repair Service, was adjusted from 13 to 25 according to expert opinion. Sector 481, Watch, Clock, Jewelry, and Furniture Repair, was adjusted from 8 to 15 according to expert opinion. Sector 482, Miscellaneous Repair Shops, was adjusted from 14 to 25 according to expert opinion. Sector 483, Motion Pictures, was adjusted from 19 to 40 according to expert opinion and ES202. Sector 484, Theatrical Producers, Bands, etc., was adjusted from 2 to 20 according to expert opinion. Sector 489, Membership Sports and Recreation Clubs, was adjusted from 0 to 7 according to ES202. Sector 490, Doctors and Dentists, was adjusted from 246 to 200 according to ES202 and expert opinion. Sector 492, Hospitals, was adjusted from 407 to 376 according to ES202. Sector 494, Legal Services, was adjusted from 19 to 35 according to expert opinion. Sector 495, Elementary and Secondary Schools, was adjusted from 76 to 28 according to ES202. Sector 497, Other Educational Services, was adjusted from 14 to 20 according to expert opinion. Sector 499, Child Day Care Services, was adjusted from 71 to 80 according to expert opinion. Sector 500, Social Services, was adjusted from 29 to 60 according to ES202. Sector 502, Other Nonprofit Organizations, was adjusted from 1 to 50 according to expert opinion. Sector 503, Business Associations, was adjusted from 32 to 20, according to ES202 and expert opinion. Sector 504, Labor and Civic Organizations, was adjusted from 42 to 15 according to ES202. Sector 505, Religious Organizations, was adjusted from 38 to 22 according to ES202 and expert opinion. Sector 506, Engineering, Architectural Services, was adjusted from 32 to 44 according to ES202 and expert opinion. Sector 507, Accounting, Auditing and Bookkeeping, was adjusted from 65 to 75 according to expert opinion. Sector 508, Management and Consultant Services, was adjusted from 11 to 37 according to ES202.

Government—Sector 511, State and Local Utilities, was adjusted from 4 to 0 according to expert opinion. Sector 513, U.S. Postal Service, was adjusted from 37 to 31 according to ES202. Sector 522, State & Local Government – Education, was adjusted from 542 to 491 according to the Kenai Peninsula Borough School Employment Roster. Sector 523, State & Local Government – Non-Education was adjusted from 711 to 370 according to ES202 and expert opinion. Sector 525, Domestic Services, was adjusted from 53 to 150 according to expert opinion.

IMPLAN baseline data

Table 72. General IMPLAN model information: household numbers and mean household income by zip code based subarea.

	Household Income									
	< 5K	5–10K	10–15K	15–20K	20–30K	30–40K	40–50K	50–70K	70K+	Total
Kenai–Nikiski: *2,730 sq miles, 11,753 residents*										
Number of households	140	225	300	265	566	556	489	1,076	900	4,517
Soldotna: *4,645 sq miles, 17,212 residents*										
Number of households	208	334	445	392	836	822	722	1,590	1,330	6,678
Anchor Point–Ninilchik: *570 sq miles, 2,755 residents*										
Number of households	33	53	71	63	134	131	115	254	212	1,065
Homer–Seldovia: *15,275 sq miles, 8,864 residents*										
Number of households	111	179	238	209	446	438	385	848	709	3,563
Total: 23,220 sq miles, 40,584 residents										
Total household income	957,660,984									
Number of households	15,823									
Mean household income	60,523									

Table 73. Output, value added, and employment in the study area. (All variables except employment are in millions of dollars.)

IMPLAN Sectors	IMPLAN Sector Names	Industry Output	Employment	Employee Compensation	Proprietor Income	Other Property Income	Indirect Business Tax
1	Dairy Farm Products	0.187944	2	0.008873	0.068579	0.016712	0.000997
2	Poultry and Eggs	0.091530	1	0.003750	0.000000	0.000000	0.000000
3	Ranch Fed Cattle	0.275775	9	0.011071	0.021687	0.009379	0.001856
4	Range Fed Cattle	0.053206	2	0.005412	0.014569	0.006493	0.001084
6	Sheep, Lambs and Goats	0.037252	6	0.002066	0.010833	0.003794	0.000840
7	Hogs, Pigs and Swine	0.224615	5	0.008297	0.010028	0.006429	0.001436
8	Other Meat Animal Products	0.276773	7	0.072758	0.000000	0.000000	0.000000
9	Miscellaneous Livestock	0.959207	79	0.116454	0.195820	0.184563	0.007455
13	Hay and Pasture	0.548297	56	0.070981	0.115848	0.173175	0.018186
16	Fruits	0.027914	1	0.006775	0.017497	0.017774	0.001851
18	Vegetables	0.323406	5	0.034240	0.085726	0.183228	0.004812
22	Forest Products	0.172417	7	0.139528	0.004870	0.000587	0.001594
23	Greenhouse and Nursery Prod	2.405635	62	0.717508	0.476588	0.723521	0.011568
24	Forestry Products	11.577130	10	4.865414	2.558976	−0.007530	0.000000
25	Commercial Fishing	42.452000	328	1.229000	23.900000	4.244000	2.251000
26	Ag, Forestry, Fishery Services	41.077011	1,773	1.727404	26.952858	0.003782	0.000000
27	Landscape and Horticulture	1.004093	37	0.422339	0.105908	−0.000282	0.000000
31	Gold Ores	0.000000	0	0.000000	0.660145	0.240856	0.544865
37	Coal Mining	3.718044	12	0.951615	0.299479	0.539516	0.212318
38	Natural Gas & Crude Petroleum	152.822403	307	22.286860	0.137410	56.489685	14.959482
41	Sand and Gravel	3.212210	50	1.268353	−0.007175	0.043174	0.010711
48	New Residential Structures	29.888811	357	8.537996	0.429226	1.863657	0.070746
49	New Commercial Building	38.944309	526	18.838739	2.503038	3.644666	0.294197
50	New Utility Structures	6.216228	67	2.441026	0.380190	1.392274	0.052855
51	New Highways and Streets	26.082237	220	7.688272	1.319647	4.484946	0.171331

Table 73. (continued)

IMPLAN Sectors	IMPLAN Sector Names	Industry Output	Employment	Employee Compensation	Proprietor Income	Other Property Income	Indirect Business Tax
53	New Mineral Extract Facilities	12.994324	197	7.598982	3.217901	5.365077	0.006775
54	New Government Facilities	68.016945	89	4.361479	0.538459	7.899123	0.304791
55	Maint and Repair, Residential	13.310281	140	4.298064	0.377638	1.156787	0.044066
56	Maint and Repair Other	52.856743	487	17.167292	3.559559	9.788436	0.407676
57	Maint and Repair Oil and Gas	90.262932	1,001	61.859791	0.350939	14.335698	0.000000
67	Canned Fruits and Vegetables	3.871938	29	0.614613	0.003751	0.137180	0.001938
71	Custom Processors	2.000000	70	0.800000	0.200000	0.100000	0.060000
79	Bread, Cake, and Related Prod	0.873450	5	0.231930	0.000000	0.000000	0.000000
97	Canned and Cured Sea Foods	19.029049	187	6.166262	0.003635	0.048804	0.000452
98	Prep Fresh or Frozen Seafood	150.986221	2,210	67.485901	1.278959	11.340320	0.133431
128	Canvas Products	0.973867	26	0.235391	0.005108	0.013897	0.001569
133	Log Camps and Log Contractors	40.383743	185	5.902300	0.394521	2.350718	0.402403
134	Sawmills and Planing Mills, General	0.610864	4	0.115252	0.000000	0.000000	0.000000
140	Struct Wood Members, N.E.C	0.943434	9	0.223362	0.000000	0.000000	0.000000
144	Prefabricated Wood Buildings	4.747231	37	0.880868	0.005821	0.021417	0.002836
174	Newspapers	6.180384	120	2.589937	0.213493	2.385698	0.032019
176	Book Publishing	0.742320	11	0.080241	0.001241	0.025490	0.000502
179	Commercial Printing	1.354768	19	0.318166	0.018505	0.072990	0.008036
202	Nitrogenous/Phosphatic Fert	173.064163	351	30.661814	0.370143	−27.045559	4.449693
210	Petroleum Refining	214.702698	162	15.687890	1.988441	9.442089	27.079660
241	Pottery Products, N.E.C	0.088042	2	0.044894	0.000000	0.000000	0.000000
242	Concrete Block and Brick	4.743502	30	1.334093	0.010046	0.074518	0.017359
244	Ready-Mixed Concrete	9.934810	72	2.756462	0.143848	0.782699	0.127204
275	Cutlery	0.159396	4	0.036744	0.010349	0.031830	0.001638
282	Fabricated Structural Metal	3.203821	29	0.432957	0.172147	0.152269	0.018704
311	Constr Machinery and Equip	1.113725	5	0.261470	0.000000	0.000000	0.000000
337	Industrial Furnaces and Ovens	0.893648	7	0.298417	0.000000	0.000000	0.000000
354	Industrial Machines N.E.C.	2.171923	23	0.608892	0.555358	0.240587	0.027481
392	Ship Building and Repairing	3.376394	33	1.574052	0.213788	0.243417	0.046895
393	Boat Building and Repairing	7.051503	73	1.857990	0.012647	0.064194	0.006132
415	Jewelry, Precious Metal	1.419027	25	0.156639	0.079401	0.050946	0.001048
429	Signs and Advertising Displays	0.778604	12	0.113154	0.112161	0.027182	0.002605
434	Local Passenger Transit	7.893198	245	2.428647	1.284860	0.878143	0.166940
435	Motor Freight and Warehousing	11.232040	125	2.570351	0.512887	1.415114	0.256128
436	Water Transportation	44.816757	216	6.179594	0.374730	1.280492	1.664185
437	Air Transportation	31.529009	235	5.796894	1.192769	1.202868	1.634800
438	Pipe Lines, Except Natural Gas	3.689872	4	0.314088	0.000000	0.000000	0.000000
439	Arrange Passenger Transport	2.861649	60	0.597810	0.474597	0.154130	0.042740
440	Transportation Services	2.031888	19	0.406091	0.137666	0.060420	0.002804
441	Comm, Except Radio and TV	16.760351	58	3.746234	0.394488	3.636073	0.741086
442	Radio and TV Broadcasting	4.405313	39	0.817810	0.115523	0.225780	0.057319
443	Electric Services	82.985374	212	15.059435	1.683339	29.392427	3.654519
444	Gas Production and Distribution	11.740775	22	1.774055	0.064826	0.990468	0.197956
445	Water Supply and Sewerage Sys	3.337002	20	1.010868	0.053242	-0.092416	0.095043
446	Sanitary Svcs and Steam Supply	10.752735	66	2.273008	0.232119	-0.069645	0.237382
447	Wholesale Trade	65.866585	594	26.684801	0.720415	4.202782	4.489123
448	Building Materials & Gardening	9.605376	178	4.622252	1.275499	0.969955	0.784773
449	General Merchandise Stores	16.499325	570	8.622360	0.431554	1.629006	1.468855
450	Food Stores	28.710424	709	15.445184	2.403192	3.076915	2.332783
451	Auto Dealers & Service Stations	27.294859	554	12.063550	1.839984	1.827780	1.786495
452	Apparel & Accessory Stores	1.703195	57	0.711751	0.100570	0.296371	0.221779
453	Furniture & Furnishings Stores	2.577920	67	1.052588	0.463501	0.258434	0.268881
454	Eating & Drinking	49.705368	1,303	15.741036	3.850855	2.390498	1.335099
455	Miscellaneous Retail	26.310511	916	10.429534	5.154718	2.879325	2.144669
456	Banking	22.788244	153	4.248957	0.170559	4.769254	2.970170
457	Credit Agencies	1.397088	56	0.826004	0.050820	-0.930938	0.172233
458	Security/Commodity Brokers	0.692355	6	0.189772	0.001964	0.031038	0.003271
459	Insurance Carriers	2.993351	19	0.897057	0.000000	-0.048568	0.385362
460	Insurance Agents and Brokers	5.077574	121	2.170830	1.198725	1.035741	0.199595
461	Owner-occupied Dwellings	63.469902	0	0.000000	0.000000	49.113533	14.439820
462	Real Estate	59.470222	484	2.322092	−0.231793	13.525408	11.032242
463	Hotels and Lodging Places	48.233215	949	15.045561	5.242788	4.601468	2.203413
464	Laundry, Clean and Shoe Repair	2.383940	118	0.616307	0.877730	0.101164	0.033621
466	Beauty and Barber Shops	6.076117	221	1.488017	1.784216	0.454235	0.026075
467	Funeral Service and Crematories	0.173871	4	0.044814	0.060830	0.024539	0.001844

Table 73. (continued)

IMPLAN Sectors	IMPLAN Sector Names	Industry Output	Employment	Employee Compensation	Proprietor Income	Other Property Income	Indirect Business Tax
468	Miscellaneous Personal Services	2.507464	64	0.165503	0.112196	0.040140	0.010961
470	Other Business Services	6.096404	118	1.435767	1.469217	1.366750	0.050853
471	Commercial Photography	1.440177	45	0.411984	0.832109	0.423853	0.032656
472	Services To Buildings	5.721159	240	1.695210	2.317784	0.468151	0.063720
473	Equipment Rental and Leasing	6.029505	79	1.180776	1.139670	0.931684	0.115538
475	Comp and Data Processing Svcs	0.777072	14	0.199764	0.227711	0.064139	0.005909
476	Detective and Prot Services	1.363565	37	0.496449	0.386730	0.000055	0.000005
477	Automobile Rental and Leasing	2.150700	31	0.332096	0.156094	0.139188	0.052038
478	Auto Parking and Car Wash	1.494013	29	0.187042	0.103354	0.040793	0.019383
479	Auto Repair and Services	11.391490	164	2.533370	1.695754	2.555129	0.246880
480	Electrical Repair Service	1.668478	39	0.360512	0.060229	0.123321	0.003369
481	Watch, Jewelry and Furn Rep	0.757056	15	0.057039	0.017758	0.006380	0.002910
482	Miscellaneous Repair Shops	4.034085	75	0.835904	0.399239	0.631081	0.032158
483	Motion Pictures	7.606745	98	0.773160	0.513697	0.193725	0.027192
484	Theatrical Producers, Bands Etc.	3.349400	60	0.476570	0.059400	0.013738	0.001119
485	Bowling Alleys and Pool Halls	1.074287	29	0.222815	0.510751	0.037004	0.027859
486	Marine Charter Boats	13.566000	571	1.220000	4.341000	1.492000	0.135000
488	Amusement and Recreation Svcs	37.284000	582	7.336200	4.201100	1.377000	0.182500
489	Sports and Recreation Clubs	0.496839	22	0.137164	0.524819	0.015350	0.013740
490	Doctors and Dentists	22.750988	448	9.543023	4.384151	2.974609	0.367821
491	Nursing and Protective Care	4.694432	109	2.410834	0.961331	0.143430	0.111398
492	Hospitals	46.337612	595	21.923016	9.284808	2.040382	0.267628
493	Other Medical and Health Svcs	14.756278	379	4.474514	1.885687	1.634996	0.107569
494	Legal Services	5.425562	109	2.364611	1.397490	0.636196	0.059121
495	Elem and Secondary Schools	2.231139	61	0.691391	0.251690	0.000000	0.000000
497	Other Educational Services	1.512934	44	0.446580	0.054566	0.000000	0.000000
498	Job Trainings & Related Svcs	0.671499	14	0.461095	0.000000	0.000000	0.000000
499	Child Day Care Services	3.681965	145	1.259075	0.000000	0.425105	0.000000
500	Social Services, N.E.C.	8.426696	264	4.564272	0.000000	0.000000	0.000000
501	Residential Care	1.526296	86	0.997407	0.000000	0.000000	0.000000
502	Other Nonprofit Organizations	3.477053	78	2.093038	0.000000	0.000000	0.000250
503	Business Associations	2.312967	39	0.889984	0.000000	0.000000	0.003417
504	Labor and Civic Organizations	5.971159	167	3.499366	0.000000	0.000000	0.245290
505	Religious Organizations	5.718175	192	2.804364	0.000000	0.000000	0.000000
506	Engineering, Architectural Svcs	3.995126	78	1.518801	0.504536	0.322567	0.011529
507	Acct, Auditing and Bookkeeping	7.432057	166	1.836944	1.207063	0.327323	0.004840
508	Mgm and Consulting Services	5.862024	73	1.901073	0.358412	0.101125	0.026223
509	Res, Devel & Testing Servic	1.401402	32	0.644275	0.153373	0.036986	0.010083
511	State and Local Electric Utilities	0.905821	3	0.201323	0.000000	0.881153	0.000000
512	Oth State and Local Govt Enter	12.811302	58	3.156869	0.000000	3.265979	0.007829
513	U.S. Postal Service	5.594696	78	3.765522	0.000000	−0.581284	0.000000
519	Federal Government – Military	3.733826	270	3.733826	0.000000	0.000000	0.000000
520	Federal Govt – Non-Military	19.982292	412	19.982292	0.000000	0.000000	0.000000
522	State & Local Govt – Education	41.479939	1,203	41.479939	0.000000	0.000000	0.000000
523	State & Local Govt – Non-Educ	60.458088	1,322	60.458088	0.000000	0.000000	0.000000
525	Domestic Services	1.487472	226	1.487472	0.000000	0.000000	0.000000
526	Kenai River Guides	7.167000	259	0.322520	2.293440	0.788370	0.071670
528	Inventory Valuation Adjustment	−1.567368	0	0.000000	0.000000	−2.214494	0.000000
	Total	2,339.530478	27,205	693.376219	147.821938	263.353927	109.173561

Table 74. Charterboat expenditure categories, SIC classification, and IMPLAN sectoral translation.

Charter Operation Expenses	Technical Coefficients	SIC Code	SIC Name	SIC Subcategory	IMPLAN Sectors	IMPLAN Sector Names
Bait	0.0192	5941	Sporting Goods/Bike Shops	Bait & Tackle Shops– Retail	455	Misc Retail
Boat Fuel	0.1922	5541	Gasoline Gas Stations	Marine Gas Stations	451	Auto Dealers & Gas Stat
Boat Ins	0.0483	6331	Fire, Marine, & Cas Ins	Ins Carriers	459	Ins Carriers
Boat Oil	0.0040	5542	Gasoline Stations	Marine Gas Stations	213	Lub Oils & Greases
Booking Agents	0.0540	7999	Amusement & Recreation	Ticket Sales Offices	488	Amusement & Recreation
Brochures	0.0583	2731	Books: Pub/Printing	Pamphlets	176	Book Pub
Cellular Svc	0.0150	4812	Radiotelephone Comm	Cellular Telephone Svcs	441	Comm, Except Radio/TV
Cleaning Supplies	0.0094	5251	Hardware Stores	Hardware Stores – Retail	448	Bldg Mat & Garden Suppl
Comp Hardware	0.0026	5734	Comp/Software Stores		453	Home Furnishing Stores
Comp Software	0.0026	5734	Comp/Software Stores		453	Furnishing Stores
Dues	0.0201	8611	Business Assoc	Trade Assoc	503	Business Assoc
Electronic Supplies	0.0006	5551	Boat Dealers	Marine Supply – Retail	455	Misc Retail
Engine Maint	0.0075	5251	Hardware Stores	Hardware Stores – Retail	451	Auto & Gas Stations
Engine Repair	0.0065	7699	Misc Repair	Engine Repair, Except Auto	482	Misc Repair
Entertainment	0.0013	5812	Eating Places		454	Eating & Drinking
Gear Replacement	0.0313	5551	Boat Dealers	Marine Supply – Retail	455	Misc Retail
Groceries	0.0011	5411	Grocery Stores	Supermarkets, Grocery – Retail	450	Food Stores
Health Ins	0.0031	6321	Accident & Health Ins	Health Ins	459	Ins Carriers
Hull Maint	0.0213	3732	Boat Building & Repairing	Fishing Boats, Small	393	Boat Building & Repairing
Hull Repair	0.0078	3732	Boat Building & Repairing	Fishing Boats, Small	393	Boat Building & Repairing
Interest Paid (Boat)	0.0785	6159	Misc Bus Credit Inst	Credit Institutions, Agricultural	456	Banking
Internet Access	0.0096	4812	Radiotelephone Comms	Cellular Telephone Svcs	441	Comms, Except Radio/TV
Licenses – Other	0.0165	9651	Comm Lic, & Inspection	Prof Occupation Lic & Permit	523	State/Local Govt – Non-Ed
Medical	0.0022	8062	Hospitals		492	Hospitals
Moorage/Boat Storage	0.0523	4493	Marinas	Marinas	436	Water Transportation
Office Supplies	0.0195	5943	Stationary Stores	Pen & Pencil Stores – Retail	455	Misc Retail
Periodicals/Other	0.0005	2741	Misc Pub	Business Svcs Newsletters	178	Misc Pub
Permits	0.0186	9651	Comm Lic & Inspection	Prof Occupation Licensing	523	State/Local Govt – Non-Ed
Postage	0.0112	4311	US Post		513	US Post
Rental Units	0.0131	5610	Real Estate Operators		462	Real Estate
Shop Electric	0.0062	4911	Electric Svcs		511	State/Local Electric Util
Shop Heat Oil	0.0085	5983	Fuel Oil Dealers – Retail		455	Misc Retail
Shop Maint	0.0036	5251	Hardware Stores	Hardware Stores – Retail	448	Bldg Mat & Garden Suppl
Shop Repair	0.0049	5251	Hardware Stores	Hardware Stores – Retail	448	Bldg Mat & Garden Suppl
Maint/Small Tools	0.0030	5251	Hardware Stores	Hardware Stores – Retail	448	Bldg Mat & Garden Suppl
Small Tools	0.0074	5251	Hardware Stores	Hardware Stores – Retail	448	Bldg Mat & Garden Suppl
Subscriptions	0.0035	5963	Direct Sales	Magazine Subscription Sales	455	Misc Retail
Telephone Svc	0.0281	4813	Telephone Comm	Local / Long Distance	441	Comm, Except Radio/TV
Trade Shows	0.0310	7389	Business	Trade Show Arrangement	470	Other Business
Truck Fuel	0.0221	5541	Gasoline Stations	Filling Stations – Retail	451	Auto Dealers & Gas Stat
Truck Ins	0.0052	6321	Accident & Health Ins		459	Ins Carriers
Truck Maint	0.0056	5531	Auto & Home Supply	Auto Parts Dealers – Retail	451	Auto Dealers & Gas Stat
Truck Repair	0.0187	7538	General Auto Repair Shops	Engine Repair, Truck	479	Auto Repair
Visitor Guides	0.0571	2741	Misc Pub	Guides	178	Misc Pub
Client Supplies	0.0292	5251	Hardware Stores	Hardware Stores – Retail	452	Accessory Stores
Workers Comp	0.0052	6331	Fire, Marine, & Cas Ins	Worker's Compensation Ins	459	Ins Carriers
Yellow Pages	0.0321	2741	Misc Pub	Telephone Directories	178	Misc Pub

Table 75. Final demand categories, IMPLAN sector descriptions, and sector numbers [Jensen 1997].

- *Banking/Credit Services*: Banking (456), Credit Agencies (457), and Security and Commodity Brokers (458).
- *Business/Labor Associations*: Business Associations (503), and Labor and Civic organizations (504).
- *Civic/Religious Associations*: Other Nonprofit organizations (502), and Religious organizations (505).
- *Communications*: Radio and TV Receiving Sets (370), Phonograph Records and Tape (371), Telephone and Telegraph Apparatus (372), Radio and TV Communication Equipment (373), Communications Equipment Not Elsewhere Classified (374), Electron Tubes (375), Printed Circuit Boards (376), Semiconductors and Related Devices (377), Electronic Components Not Elsewhere Classified (378), Communications, Except Radio and TV (441), and Radio and TV Broadcasting (442).
- *Eating and Drinking Places*: Eating and Drinking (454).
- *Education*: Elementary and Secondary Schools (495), Colleges, Universities, Schools (496), Other Educational Services (497), Job Trainings and Related Services (498), and State and Local Government – Education (522).
- *Fabrics/Apparel*: Broad-woven Fabric Mills and Finishing (108), Narrow Fabric Mills (109), Women's Hosiery, Except Socks (110) Hosiery Not Elsewhere Classified (111), Knit Outerwear Mills (112), Knit Underwear Mills (113), Knit Fabric Mills (114), Knitting Mills, Not Elsewhere Classified (115), Yarn Mills and Finishing of Textiles, Not Elsewhere Classified (116), Carpets and Rugs (117), Thread Mills (118), Coated Fabrics, Not Rubberized (119), Tire Cord and Fabric (120), Non-woven Fabrics (121), Cordage and Twine (122), Textile Goods, Not Elsewhere Classified (123), Apparel Made From Purchased Materials (124), Curtains and Draperies (125), House furnishings, Not Elsewhere Classified (126), Textile Bags (127), Canvas Products (128), Pleating and Stitching (129), Automotive and Apparel Trimmings (130), Schiffi Machine Embroideries (131), Fabricated Textile Products, Not Elsewhere Classified (132), Leather Tanning and Finishing (221), Footwear Cut Stock (222), House Slippers (223), Shoes, Except Rubber (224), Leather Gloves and Mittens (225), Luggage (226), Women's Handbags and Purses (227), Personal Leather Goods (228), Leather Goods, Not Elsewhere Classified (229), and Apparel and Accessory Stores (452).
- *Food Processing*: Dairy Farm Products (1), Poultry and Eggs (2), Ranch Fed Cattle (3), Range Fed Cattle (4), Cattle Feedlots (5), Sheep, Lambs and Goats (6), Hogs, Pigs and Swine (7), Other Meat Animal Products (8), Miscellaneous Livestock (9), Food Grains (11), Fruits (16), Tree Nuts (17), Vegetables (18), Sugar Crops (19), Miscellaneous Crops (20), Oil Bearing Crops (21), Meat Packing Plants (58), Sausages and Other Prepared Meats (59), Poultry Processing (60), Creamery Butter (61), Cheese, Natural and Processed (62), Condensed and Evaporated Milk (63), Ice Cream and Frozen Desserts (64), Fluid Milk (65), Canned Specialties (66), Canned Fruits and Vegetables (67), Dehydrated Food Products (68), Pickles, Sauces, and Salad Dressings (69), Frozen Fruits, Juices and Vegetables (70), Custom Processors (71), Flour and Other Grain Mill Products (72), Cereal Preparations (73), Rice Milling (74), Blended and Prepared Flour (75), Wet Corn Milling, (76), Bread, Cake, and Related Products (79), Cookies and Crackers (80), Sugar (81), Confectionery Products (82), Chocolate and Cocoa Products (83), Chewing Gum (84), Salted and Roasted Nuts and Seeds (85), Cottonseed Oil Mills (86), Soybean Oil Mills (87), Vegetable Oil Mills, Not Elsewhere Classified (88), Animal and Marine Fats and Oils (89), Shortening and Cooking Oils (90), Malt Beverages (91), Malt (92), Wines, Brandy, and Brandy Spirits (93), Distilled Liquor, Except Brandy (94), Bottled and Canned Soft Drinks and Water (95), Flavoring Extracts and Syrups, Not Elsewhere Classified (96), Canned and Cured Sea Foods (97), Prepared Fresh or Frozen Fish or Seafood (98), Roasted Coffee (99), Potato Chips and Similar Snacks (100), Manufactured Ice (101), Macaroni and Spaghetti (102), Food Preparations Not Elsewhere Classified (103), and Food Stores (450).
- *Health Care*: Drugs (195), Surgical and Medical Instrument (407), Surgical Appliances and Supplies (408), Dental Equipment and Supplies (409), Doctors and Dentists (490), Nursing and Protective Care (491), Hospitals (492), and Other Medical and Health Services (493).
- *Hotels and Lodging*: Hotels and Lodging Places (463), Household Furnishings, Wood Household Furniture (148), Upholstered Household Furniture (149), Metal Household Furniture (150), Mattresses and Bedsprings (151), Wood TV and Radio Cabinets (152), Household Furniture, Not Elsewhere Classified, (153), Wood Office Furniture (154), Metal Office Furniture (155), Public Building Furniture (156), Wood Partitions and Fixtures (157), Metal Partitions and Fixtures (158), Blinds, Shades, and Drapery Hardware (159), Furniture and Fixtures, Not Elsewhere Classified (160), Vitreous China Food Utensils (238), Fine Earthenware Food Utensils (239), and Furniture and Home Furnishings Stores (453).
- *Household Industry*: Domestic Services (525).
- *Housing*: New Residential Structures (48), Mobile Homes (143), Owner-occupied Dwellings (461), and Real Estate (462).
- *Insurance*: Insurance Carriers (459), Insurance Agents and Brokers (460).
- *Motor Vehicles*: Carburetors, Pistons, Rings, Valves (350), Storage Batteries (379), Electrical Equipment, Not Elsewhere Classified (383), Motor Vehicles (384), Truck and Bus Bodies (385), Motor Vehicle Parts and Accessories (386), Truck Trailers (387), Motorcycles, Bicycles, and Parts (395), Automotive Dealers and Service Stations (451), Automobile Rental and Leasing (477), Automobile Parking and Car Wash (478), and Automobile Repair and Services (479).
- *Other Local Purchases*: Cotton (10), Feed Grains (12), Hay and Pasture (13), Grass Seeds (14), Tobacco (15), Forest Products (22), Greenhouse and Nursery Products (23), Forestry Products (24), Commercial Fishing (25), Iron ores (28), Copper ores (29), Lead and Zinc ores (30), Gold ores (31), Silver ores (32), Ferroalloy ores, Except Vanadium (33), Metal Mining Services (34), Uranium-radium-vanadium ores (35), Metal ores, Not Elsewhere Classified (36), Coal Mining (37), Natural Gas and Crude Petroleum (38), Natural Gas Liquids (39), Dimension Stone (40), Sand and Gravel (41), Clay, Ceramic, Refractory Minerals, Not Elsewhere Classified (42), Potash, Soda, and Borate Minerals (43), Phosphate Rock (44), Chemical, Fertilizer Mineral Mining, Not Elsewhere Classified (45), Nonmetallic Minerals (Except Fuels) Service (46), Misc. Nonmetallic Minerals, Not Elsewhere Classified (47), New Industrial and Commercial Buildings (49), New Utility Structures (50), New Highways and Streets (51), New Farm Structures (52), New Mineral Extraction Facilities (53), New Government Facilities (54), Maintenance and Repair, Residential (55), Maintenance and Repair Other Facilities (56), Maintenance and Repair Oil and Gas Wells (57), Dog, Cat, and Other Pet Food (77), Prepared Feeds, Not Elsewhere Classified (78), Cigarettes (104), Cigars (105), Chewing and Smoking Tobacco (106), Tobacco Stemming and Redrying (107), Logging Camps and Logging Contractors (133), Sawmills and Planing Mills, General (134), Hardwood Dimension and Flooring Mills (135), Special Product Sawmills, Not Elsewhere Classified (136), Millwork (137), Wood Kitchen Cabinets (138), Veneer and Plywood (139), Structural Wood Members, Not Elsewhere

Table 75. (continued)

Classified (140), Wood Containers (141), Wood Pallets and Skids (142), Prefabricated Wood Buildings (144), Wood Preserving (145), Reconstituted Wood Products (146), Wood Products, Not Elsewhere Classified (147), Alkalies and Chlorine (186), Industrial Gases (187), Inorganic Pigments (188), Inorganic Chemicals Not Elsewhere Classified (189), Cyclic Crudes, Intermediate and Industrial organic Chemicals (190), Plastics Materials and Resins (191), Synthetic Rubber (192), Cellulosic Man-made Fibers (193), organic Fibers, Noncellulosic (194), Soap and Other Detergents (196), Polishes and Sanitation Goods (197), Surface Active Agents (198), Toilet Preparations (199), Paints and Allied Products (200), Gum and Wood Chemicals (201), Nitrogenous and Phosphatic Fertilizers (202), Fertilizers, Mixing Only (203), Agricultural Chemicals, Not Elsewhere Classified (204), Adhesives and Sealants (205), Explosives (206), Printing Ink (207), Carbon Black (208), Chemical Preparations, Not Elsewhere Classified (209), Paving Mixtures and Blocks (211), Asphalt Felts and Coatings (212), Tires and Inner Tubes (215), Rubber and Plastics Footwear (216), Rubber and Plastics Hose and Belting (217), Gaskets, Packing and Sealing Devices (218), Fabricated Rubber Products, Not Elsewhere Classified (219), Miscellaneous Plastics Products (220), Glass and Glass Products, Excluding Containers (230), Glass Containers (231), Cement, Hydraulic (232), Brick and Structural Clay Tile (233), Ceramic Wall and Floor Tile (234), Clay Refractories (235), Structural Clay Products, Not Elsewhere Classified (236), Vitreous Plumbing Fixtures (237), Porcelain Electrical Supplies (240), Pottery Products, Not Elsewhere Classified (241), Concrete Block and Brick (242), Concrete Products, Not Elsewhere Classified (243), Ready-mixed Concrete (244), Lime (245), Gypsum Products (246), Cut Stone and Stone Products (247), Abrasive Products (248), Asbestos Products (249), Minerals, Ground or Treated (250), Mineral Wool (251), Non-clay Refractories (252), Nonmetallic Mineral Products, Not Elsewhere Classified (253), Blast Furnaces and Steel Mills (254), Electrometallurgical Products (255), Steel Wire and Related Products (256), Cold Finishing Of Steel Shapes (257), Steel Pipe and Tubes (258), Iron and Steel Foundries (259), Primary Copper (260), Primary Aluminum (261), Primary Nonferrous Metals, Not Elsewhere Classified (262), Secondary Nonferrous Metals (263), Copper Rolling and Drawing (264), Aluminum Rolling and Drawing (265), Nonferrous Rolling and Drawing, Not Elsewhere Classified (266), Nonferrous Wire Drawing and Insulating (267), Aluminum Foundries (268), Brass, Bronze, and Copper Foundries (269), Nonferrous Castings, Not Elsewhere Classified (270), Metal Heat Treating (271), Primary Metal Products, Not Elsewhere Classified (272), Metal Cans (273), Metal Barrels, Drums and Pails (274), Cutlery (275), Hand and Edge Tools, Not Elsewhere Classified (276), Hand Saws and Saw Blades (277), Hardware, Not Elsewhere Classified (278), Metal Sanitary Ware (279), Plumbing Fixture Fittings and Trim (280), Heating Equipment, Except Electric (281), Fabricated Structural Metal (282), Metal Doors, Sash, and Trim (283), Fabricated Plate Work (Boiler Shops) (284), Sheet Metal Work (285), Architectural Metal Work (286), Prefabricated Metal Buildings (287), Miscellaneous Metal Work (288), Screw Machine Products and Bolts, Etc. (289), Iron and Steel Forgings (290), Nonferrous Forgings (291), Automotive Stampings (292), Crowns and Closures (293), Metal Stampings, Not Elsewhere Classified (294), Plating and Polishing (295), Metal Coating and Allied Services (296), Small Arms Ammunition (297), Ammunition, Except For Small Arms, Not Elsewhere Classified (298), Small Arms (299), Other ordnance and Accessories (300), Industrial and Fluid Valves (301), Steel Springs, Except Wire (302), Pipe, Valves, and Pipe Fittings (303), Miscellaneous Fabricated Wire Products (304), Metal Foil and Leaf (305), Fabricated Metal Products, Not Elsewhere Classified (306), Steam Engines and Turbines (307), Internal Combustion Engines, Not Elsewhere Classified (308), Farm Machinery and Equipment (309), Lawn and Garden Equipment (310), Construction Machinery and Equipment (311), Mining Machinery, Except Oil Field (312), Oil Field Machinery (313), Elevators and Moving Stairways (314), Conveyors and Conveying Equipment (315), Hoists, Cranes, and Monorails (316), Industrial Trucks and Tractors (317), Machine Tools, Metal Cutting Types (318), Machine Tools, Metal Forming Types (319), Industrial Patterns (320), Special Dies and Tools and Accessories (321), Power Driven Hand Tools (322), Rolling Mill Machinery (323), Welding Apparatus (324), Metalworking Machinery, Not Elsewhere Classified (325), Textile Machinery (326), Woodworking Machinery (327), Paper Industries Machinery (328), Printing Trades Machinery (329), Food Products Machinery (330), Special Industry Machinery Not Elsewhere Classified (331), Pumps and Compressors (332), Ball and Roller Bearings (333), Blowers and Fans (334), Packaging Machinery (335), Power Transmission Equipment (336), Industrial Furnaces and Ovens (337), General Industrial Machinery, Not Elsewhere Classified (338), Electronic Computers (339), Computer Storage Devices (340), Computer Terminals (341), Computer Peripheral Equipment, (342), Calculating and Accounting Machines (343), Typewriters and Office Machines Not Elsewhere Classified (344), Automatic Merchandising Machine (345), Commercial Laundry Equipment (346), Refrigeration and Heating Equipment (347), Measuring and Dispensing Pumps (348), Service Industry Machines, Not Elsewhere Classified (349), Fluid Power Cylinders and Actuators (351), Fluid Power Pumps and Motors (352), Scales and Balances (353), Industrial Machines Not Elsewhere Classified (354), Transformers (355), Switchgear and Switchboard Apparatus (356), Motors and Generators (357), Carbon and Graphite Products (358), Relays and Industrial Controls (359), Electrical Industrial Apparatus, Not Elsewhere Classified (360), Household Cooking Equipment (361), Household Refrigerators and Freezers (362), Household Laundry Equipment (363), Electric House wares and Fans (364), Household Vacuum Cleaners (365), Household Appliances, Not Elsewhere Classified (366), Electric Lamps (367), Wiring Devices (368), Lighting Fixtures and Equipment (369), Primary Batteries, Dry and Wet (380), Engine Electrical Equipment (381), Magnetic and Optical Recording Media (382), Aircraft (389), Aircraft and Missile Engines and Parts (390), Aircraft and Missile Equipment, (391), Railroad Equipment (394), Complete Guided Missiles (396), Tanks and Tank Components (398), Search and Navigation Equipment (400), Laboratory Apparatus and Furniture (401), Automatic Temperature Controls (402), Mechanical Measuring Devices (403), Instruments To Measure Electricity (404), Analytical Instruments (405), Optical Instruments and Lenses (406), X-Ray Apparatus (410), Electro-medical Apparatus (411), Ophthalmic Goods (412), Watches, Clocks, and Parts (414), Jewelry, Precious Metal (415), Silverware and Plated Ware (416), Jewelers Materials and Lapidary Work (417), Pens and Mechanical Pencils (422), Lead Pencils and Art Goods (423), Marking Devices (424), Carbon Paper and Inked Ribbons (425), Costume Jewelry (426), Fasteners, Buttons, Needles, Pins (427), Brooms and Brushes (428), Signs and Advertising Displays (429), Burial Caskets and Vaults (430), Hard Surface Floor Coverings (431), Manufacturing Industries, Not Elsewhere Classified (432), Transportation Services (440), Electrical Repair Service (480), Watch, Clock, Jewelry and Furniture Repair (481), Miscellaneous Repair Shops (482), Motion Pictures (483), Theatrical Producers, Bands Etc. (484), Bowling Alleys and Pool Halls (485), Racing and Track Operation (487), Amusement and Recreation Services, Not Elsewhere Classified (488), Membership Sports and Recreation Clubs (489), Child Day Care Services (499), Research, Development and Testing Services (509), Federal Electric Utilities (514), Non-comparable Imports (516), Used and Secondhand Goods (518), Federal Government – Military (519), Federal Government – Non-Military (520), Commodity Credit Corporation (521), State and Local Government – Non-Education (523), Rest Of The World Industry (524), Dummy (527), Inventory Valuation Adjustment (528).

Table 75. (continued)

- *Personal Services*, Agricultural, Forestry, Fishery Services (26), Landscape and Horticultural Services (27), Laundry, Cleaning and Shoe Repair (464), Portrait and Photographic Studios (465), Beauty and Barber Shops (466), Funeral Service and Crematories (467), Miscellaneous Personal Services (468), Advertising (469), Other Business Services (470), Photo-finishing, Commercial Photography (471), Services To Buildings (472), Equipment Rental and Leasing (473), Personnel Supply Services (474), Computer and Data Processing Services (475), Detective and Protective Services (476), Legal Services (494), Engineering, Architectural Services (506), Accounting, Auditing and Bookkeeping (507), Management and Consulting Services (508).
- *Petroleum Products*, Petroleum Refining (210), Lubricating Oils and Greases (213), Petroleum and Coal Products, Not Elsewhere Classified (214)
- *Publications/Paper*, Pulp Mills (161), Paper Mills, Except Building Paper (162), Paperboard Mills (163), Paperboard Containers and Boxes (164), Paper Coated and Laminated Packaging (165), Paper Coated and Laminated Not Elsewhere Classified (166), Bags, Plastic (167), Bags, Paper (168), Die-cut Paper and Board (169), Sanitary Paper Products (170), Envelopes (171), Stationery Products (172), Converted Paper Products, Not Elsewhere Classified (173), Newspapers (174), Periodicals (175), Book Publishing (176), Book Printing (177), Miscellaneous Publishing (178), Commercial Printing (179), Manifold Business Forms (180), Greeting Card Publishing (181), Blank books and Loose-leaf Binder (182), Bookbinding and Related (183), Typesetting (184), Plate Making (185).
- *Recreation Activities*, Motor Homes (388), Ship Building and Repairing (392), Boat Building and Repairing (393), Travel Trailers and Camper (397), Photographic Equipment and Supplies (413), Musical Instruments (418), Dolls (419), Games, Toys, and Children's Vehicles (420), Sporting and Athletic Goods, Not Elsewhere Classified (421), Marine Charter Boats (486), Kenai River Guides (526).
- *Retail Trade*, Building Materials and Gardening (448), General Merchandise Stores (449), Miscellaneous Retail (455).
- *State/Local Services*, Social Services, Not Elsewhere Classified (500), Residential Care (501), Other State and Local Government Enterprises (512), Other Federal Government Enterprises (515).
- *Transportation Services*, Transportation Equipment, Not Elsewhere Classified (399), Railroads and Related Services (433), Local, Interurban Passenger Transit (434), Motor Freight Transport and Warehousing (435), Water Transportation (436), Air Transportation (437), Pipe Lines, Except Natural Gas (438), Arrangement Of Passenger Transportation (439), Local Government Passenger Transit (510).
- *U.S. Postal Service*, U.S. Postal Service (513).
- *Utilities*, Electric Services (443), Gas Production and Distribution (444), Water Supply and Sewerage Systems (445), Sanitary Services and Steam Supply (446), State and Local Electric Utilities (511), Scrap (517).
- *Wholesale Trade*, Wholesale Trade (447).

Appendix to Section 6. Impact analysis

Table 76. Regional economic impacts of a 10% decrease in lower and central Cook Inlet sportfishing catches.

Response Coefficient	Baseline expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Employment Compensation					
Auto or Truck Fuel	2,619,715	−74,507	−9,415	−13,087	−97,009
Groceries	2,864,102	−91,501	−5,290	−15,888	−112,680
Lodging	3,226,870	−55,791	−11,027	−11,900	−78,719
Restaurant & Bar	2,561,923	−46,840	−6,827	−8,899	−62,566
Boat Fuel, Lubricants & Repairs	1,732,240	−42,840	−5,300	−7,723	−55,863
Charter & Guide Fees	10,366,927	−58,071	−65,235	−45,659	−168,965
Fish Processing or Packaging	2,307,448	−43,139	−4,538	−7,744	−55,420
Fishing Derby Entry Fees	269,302	−4,491	−685	−712	−5,888
Fishing Gear	1,904,030	−38,655	−3,634	−7,342	−49,632
Haul Out & Moorage Fees	671,617	−6,556	−2,075	−1,533	−10,164
TOTAL	28,524,174	−462,392	−114,026	−120,488	−696,906
Proprietors Income					
Auto or Truck Fuel	2,619,715	−11,353	−2,295	−3,243	−16,890
Groceries	2,864,102	−20,329	−1,337	−3,937	−25,602
Lodging	3,226,870	−19,441	−2,529	−2,950	−24,920
Restaurant & Bar	2,561,923	−11,459	−1,273	−2,206	−14,938
Boat Fuel, Lubricants & Repairs	1,732,240	−8,209	−1,232	−1,914	−11,355
Charter & Guide Fees	10,366,927	−203,199	−14,154	−11,317	−228,670
Fish Processing or Packaging	2,307,448	−8,362	−1,695	−1,919	−11,976
Fishing Derby Entry Fees	269,302	0	−137	−175	−311
Fishing Gear	1,904,030	−11,399	−1,050	−1,819	−14,268
Haul Out & Moorage Fees	671,617	−2,368	−437	−380	−3,185
TOTAL	28,524,174	−296,118	−26,139	−29,858	−352,115
Indirect Business Taxes					
Auto or Truck Fuel	2,619,715	−11,023	−2,595	−2,160	−15,777
Groceries	2,864,102	−14,793	−1,508	−2,622	−18,923
Lodging	3,226,870	−8,171	−2,110	−1,963	−12,243
Restaurant & Bar	2,561,923	−3,973	−1,967	−1,468	−7,408
Boat Fuel, Lubricants & Repairs	1,732,240	−6,112	−1,424	−1,275	−8,811
Charter & Guide Fees	10,366,927	−6,333	−12,177	−7,530	−26,040
Fish Processing or Packaging	2,307,448	−2,470	−943	−1,278	−4,691
Fishing Derby Entry Fees	269,302	−17	−136	−116	−269
Fishing Gear	1,904,030	−6,257	−945	−1,212	−8,414
Haul Out & Moorage Fees	671,617	−1,056	−540	−253	−1,849
TOTAL	28,524,174	−60,205	−24,344	−19,876	−104,426
Other Property Type Income					
Auto or Truck Fuel	2,619,715	−11,355	−7,086	−4,660	−23,100
Groceries	2,864,102	−19,674	−4,227	−5,657	−29,558
Lodging	3,226,870	−17,063	−6,358	−4,236	−27,657
Restaurant & Bar	2,561,923	−7,113	−4,901	−3,168	−15,182
Boat Fuel, Lubricants & Repairs	1,732,240	−7,521	−3,854	−2,750	−14,125
Charter & Guide Fees	10,366,927	−69,849	−19,817	−16,252	−105,917
Fish Processing or Packaging	2,307,448	−5,840	−1,909	−2,757	−10,507
Fishing Derby Entry Fees	269,302	0	−361	−251	−612
Fishing Gear	1,904,030	−8,853	−2,460	−2,614	−13,927
Haul Out & Moorage Fees	671,617	−3,235	−1,074	−546	−4,855
TOTAL	28,524,174	−150,503	−52,048	−42,890	−245,440
Total Value Added					
Auto or Truck Fuel	2,619,715	−108,238	−21,390	−23,149	−152,777
Groceries	2,864,102	−146,296	−12,363	−28,104	−186,763
Lodging	3,226,870	−100,466	−22,024	−21,048	−143,539
Restaurant & Bar	2,561,923	−69,385	−14,969	−15,741	−100,095
Boat Fuel, Lubricants & Repairs	1,732,240	−64,681	−11,810	−13,661	−90,152
Charter & Guide Fees	10,366,927	−337,452	−111,382	−80,758	−529,592
Fish Processing or Packaging	2,307,448	−59,812	−9,085	−13,698	−82,594
Fishing Derby Entry Fees	269,302	−4,508	−1,318	−1,255	−7,081
Fishing Gear	1,904,030	−65,164	−8,090	−12,987	−86,241
Haul Out & Moorage Fees	671,617	−13,215	−4,126	−2,711	−20,053
TOTAL	28,524,174	−969,217	−216,558	−213,112	−1,398,887

Table 77. Regional economic impacts of a 20% decrease in lower and central Cook Inlet sportfishing catches.

Response Coefficient	Baseline expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Employment Compensation					
Auto or Truck Fuel	2,619,715	−172,546	−21,803	−30,307	−224,656
Groceries	2,864,102	−212,487	−12,286	−36,897	−261,670
Lodging	3,226,870	−130,804	−25,853	−27,901	−184,558
Restaurant & Bar	2,561,923	−108,933	−15,876	−20,697	−145,506
Boat Fuel, Lubricants & Repairs	1,732,240	−98,479	−12,183	−17,754	−128,416
Charter & Guide Fees	10,366,927	−136,795	−153,672	−107,556	−398,024
Fish Processing or Packaging	2,307,448	−102,653	−10,798	−18,427	−131,878
Fishing Derby Entry Fees	269,302	−10,549	−1,608	−1,673	−13,831
Fishing Gear	1,904,030	−91,767	−8,628	−17,430	−117,825
Haul Out & Moorage Fees	671,617	−15,234	−4,823	−3,562	−23,618
TOTAL	28,524,174	−1,080,249	−267,531	−282,203	−1,629,983
Proprietors Income					
Auto or Truck Fuel	2,619,715	−26,291	−5,314	−7,509	−39,114
Groceries	2,864,102	−47,208	−3,105	−9,142	−59,455
Lodging	3,226,870	−45,580	−5,929	−6,916	−58,425
Restaurant & Bar	2,561,923	−26,649	−2,961	−5,130	−34,740
Boat Fuel, Lubricants & Repairs	1,732,240	−18,870	−2,833	−4,399	−26,102
Charter & Guide Fees	10,366,927	−478,669	−33,342	−26,659	−538,669
Fish Processing or Packaging	2,307,448	−19,898	−4,034	−4,566	−28,498
Fishing Derby Entry Fees	269,302	0	−321	−411	−732
Fishing Gear	1,904,030	−27,060	−2,493	−4,319	−33,872
Haul Out & Moorage Fees	671,617	−5,503	−1,015	−883	−7,400
TOTAL	28,524,174	−695,728	−61,346	−69,933	−827,008
Indirect Business Taxes					
Auto or Truck Fuel	2,619,715	−25,527	−6,009	−5,002	−36,537
Groceries	2,864,102	−34,353	−3,502	−6,089	−43,945
Lodging	3,226,870	−19,156	−4,946	−4,602	−28,704
Restaurant & Bar	2,561,923	−9,239	−4,576	−3,414	−17,228
Boat Fuel, Lubricants & Repairs	1,732,240	−14,051	−3,273	−2,930	−20,254
Charter & Guide Fees	10,366,927	−14,918	−28,684	−17,739	−61,341
Fish Processing or Packaging	2,307,448	−5,877	−2,244	−3,041	−11,162
Fishing Derby Entry Fees	269,302	−41	−319	−273	−633
Fishing Gear	1,904,030	−14,855	−2,244	−2,877	−19,976
Haul Out & Moorage Fees	671,617	−2,454	−1,255	−587	−4,297
TOTAL	28,524,174	−140,472	−57,052	−46,554	−244,077
Other Property Type Income					
Auto or Truck Fuel	2,619,715	−26,296	−16,410	−10,791	−53,496
Groceries	2,864,102	−45,687	−9,817	−13,137	−68,641
Lodging	3,226,870	−40,005	−14,907	−9,931	−64,843
Restaurant & Bar	2,561,923	−16,543	−11,398	−7,367	−35,308
Boat Fuel, Lubricants & Repairs	1,732,240	−17,288	−8,860	−6,321	−32,470
Charter & Guide Fees	10,366,927	−164,541	−46,681	−38,283	−249,505
Fish Processing or Packaging	2,307,448	−13,898	−4,543	−6,561	−25,002
Fishing Derby Entry Fees	269,302	0	−849	−590	−1,438
Fishing Gear	1,904,030	−21,017	−5,839	−6,206	−33,062
Haul Out & Moorage Fees	671,617	−7,517	−2,496	−1,268	−11,281
TOTAL	28,524,174	−352,791	−121,801	−100,455	−575,046
Total Value Added					
Auto or Truck Fuel	2,619,715	−250,660	−49,536	−53,609	−353,805
Groceries	2,864,102	−339,735	−28,710	−65,265	−433,711
Lodging	3,226,870	−235,545	−51,636	−49,349	−336,530
Restaurant & Bar	2,561,923	−161,364	−34,812	−36,607	−232,783
Boat Fuel, Lubricants & Repairs	1,732,240	−148,688	−27,149	−31,404	−207,241
Charter & Guide Fees	10,366,927	−794,923	−262,379	−190,238	−1,247,540
Fish Processing or Packaging	2,307,448	−142,327	−21,619	−32,595	−196,540
Fishing Derby Entry Fees	269,302	−10,590	−3,096	−2,947	−16,633
Fishing Gear	1,904,030	−154,699	−19,204	−30,831	−204,734
Haul Out & Moorage Fees	671,617	−30,708	−9,589	−6,300	−46,596
TOTAL	28,524,174	−2,269,239	−507,729	−499,144	−3,276,113

Table 78. Regional economic impacts of a 30% decrease in lower and central Cook Inlet sportfishing catches.

Response Coefficient	Baseline expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Employment Compensation					
Auto or Truck Fuel	2,619,715	−294,203	−37,176	−51,675	−383,055
Groceries	2,864,102	−363,507	−21,018	−63,120	−447,645
Lodging	3,226,870	−226,305	−44,729	−48,271	−319,305
Restaurant & Bar	2,561,923	−186,677	−27,207	−35,468	−249,352
Boat Fuel, Lubricants & Repairs	1,732,240	−166,421	−20,588	−30,002	−217,011
Charter & Guide Fees	10,366,927	−237,976	−267,337	−187,111	−692,423
Fish Processing or Packaging	2,307,448	−180,656	−19,002	−32,429	−232,087
Fishing Derby Entry Fees	269,302	−18,291	−2,789	−2,901	−23,981
Fishing Gear	1,904,030	−161,067	−15,143	−30,592	−206,802
Haul Out & Moorage Fees	671,617	−26,081	−8,256	−6,098	−40,435
TOTAL	28,524,174	−1,861,183	−463,245	−487,668	−2,812,096
Proprietors Income					
Auto or Truck Fuel	2,619,715	−44,828	−9,061	−12,804	−66,693
Groceries	2,864,102	−80,759	−5,312	−15,639	−101,711
Lodging	3,226,870	−78,858	−10,258	−11,965	−101,081
Restaurant & Bar	2,561,923	−45,668	−5,075	−8,791	−59,534
Boat Fuel, Lubricants & Repairs	1,732,240	−31,889	−4,787	−7,434	−44,109
Charter & Guide Fees	10,366,927	−832,717	−58,003	−46,378	−937,097
Fish Processing or Packaging	2,307,448	−35,019	−7,100	−8,035	−50,153
Fishing Derby Entry Fees	269,302	0	−556	−713	−1,269
Fishing Gear	1,904,030	−47,495	−4,376	−7,580	−59,451
Haul Out & Moorage Fees	671,617	−9,421	−1,737	−1,511	−12,669
TOTAL	28,524,174	−1,206,654	−106,264	−120,849	−1,433,767
Indirect Business Taxes					
Auto or Truck Fuel	2,619,715	−43,526	−10,245	−8,528	−62,299
Groceries	2,864,102	−58,769	−5,991	−10,417	−75,177
Lodging	3,226,870	−33,142	−8,558	−7,961	−49,661
Restaurant & Bar	2,561,923	−15,833	−7,841	−5,850	−29,524
Boat Fuel, Lubricants & Repairs	1,732,240	−23,744	−5,531	−4,951	−34,227
Charter & Guide Fees	10,366,927	−25,953	−49,900	−30,860	−106,713
Fish Processing or Packaging	2,307,448	−10,343	−3,949	−5,352	−19,644
Fishing Derby Entry Fees	269,302	−70	−552	−474	−1,097
Fishing Gear	1,904,030	−26,072	−3,939	−5,049	−35,060
Haul Out & Moorage Fees	671,617	−4,202	−2,148	−1,006	−7,356
TOTAL	28,524,174	−241,655	−98,656	−80,448	−420,758
Other Property Type Income					
Auto or Truck Fuel	2,619,715	−44,836	−27,980	−18,399	−91,215
Groceries	2,864,102	−78,157	−16,794	−22,474	−117,425
Lodging	3,226,870	−69,212	−25,791	−17,181	−112,185
Restaurant & Bar	2,561,923	−28,349	−19,533	−12,624	−60,507
Boat Fuel, Lubricants & Repairs	1,732,240	−29,215	−14,973	−10,682	−54,871
Charter & Guide Fees	10,366,927	−286,244	−81,209	−66,599	−434,052
Fish Processing or Packaging	2,307,448	−24,458	−7,995	−11,547	−44,000
Fishing Derby Entry Fees	269,302	0	−1,471	−1,022	−2,494
Fishing Gear	1,904,030	−36,888	−10,249	−10,892	−58,029
Haul Out & Moorage Fees	671,617	−12,869	−4,274	−2,170	−19,313
TOTAL	28,524,174	−610,229	−210,269	−173,593	−994,091
Total Value Added					
Auto or Truck Fuel	2,619,715	−427,393	−84,462	−91,407	−603,262
Groceries	2,864,102	−581,193	−49,114	−111,651	−741,958
Lodging	3,226,870	−407,517	−89,336	−85,378	−582,231
Restaurant & Bar	2,561,923	−276,528	−59,656	−62,733	−398,917
Boat Fuel, Lubricants & Repairs	1,732,240	−251,270	−45,879	−53,070	−350,218
Charter & Guide Fees	10,366,927	−1,382,889	−456,449	−330,947	−2,170,286
Fish Processing or Packaging	2,307,448	−250,476	−38,046	−57,362	−345,885
Fishing Derby Entry Fees	269,302	−18,361	−5,369	−5,110	−28,840
Fishing Gear	1,904,030	−271,522	−33,707	−54,113	−359,342
Haul Out & Moorage Fees	671,617	−52,572	−16,416	−10,785	−79,773
TOTAL	28,524,174	−3,919,721	−878,433	−862,558	−5,660,712

Table 79. Regional economic impacts of a 10% increase in lower and central Cook Inlet sportfishing catches.

Response Coefficient	Baseline expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Employment Compensation					
Auto or Truck Fuel	2,619,715	54,086	6,834	9,500	70,420
Groceries	2,864,102	66,152	3,825	11,487	81,464
Lodging	3,226,870	39,765	7,860	8,482	56,106
Restaurant & Bar	2,561,923	33,791	4,925	6,420	45,136
Boat Fuel, Lubricants & Repairs	1,732,240	31,433	3,889	5,667	40,988
Charter & Guide Fees	10,366,927	41,093	46,162	32,309	119,565
Fish Processing or Packaging	2,307,448	30,053	3,161	5,395	38,609
Fishing Derby Entry Fees	269,302	3,192	487	506	4,185
Fishing Gear	1,904,030	27,029	2,541	5,134	34,704
Haul Out & Moorage Fees	671,617	4,735	1,499	1,107	7,341
TOTAL	28,524,174	331,328	81,183	86,007	498,518
Proprietors Income					
Auto or Truck Fuel	2,619,715	8,241	1,666	2,354	12,261
Groceries	2,864,102	14,697	967	2,846	18,510
Lodging	3,226,870	13,857	1,802	2,102	17,761
Restaurant & Bar	2,561,923	8,267	919	1,591	10,777
Boat Fuel, Lubricants & Repairs	1,732,240	6,023	904	1,404	8,331
Charter & Guide Fees	10,366,927	143,790	10,016	8,008	161,814
Fish Processing or Packaging	2,307,448	5,825	1,181	1,337	8,343
Fishing Derby Entry Fees	269,302	0	97	124	221
Fishing Gear	1,904,030	7,970	734	1,272	9,976
Haul Out & Moorage Fees	671,617	1,711	315	274	2,300
TOTAL	28,524,174	210,380	18,601	21,313	250,294
Indirect Business Taxes					
Auto or Truck Fuel	2,619,715	8,002	1,883	1,568	11,453
Groceries	2,864,102	10,695	1,090	1,896	13,681
Lodging	3,226,870	5,824	1,504	1,399	8,726
Restaurant & Bar	2,561,923	2,866	1,419	1,059	5,344
Boat Fuel, Lubricants & Repairs	1,732,240	4,485	1,045	935	6,465
Charter & Guide Fees	10,366,927	4,481	8,617	5,329	18,427
Fish Processing or Packaging	2,307,448	1,721	657	890	3,268
Fishing Derby Entry Fees	269,302	12	96	83	191
Fishing Gear	1,904,030	4,375	661	847	5,884
Haul Out & Moorage Fees	671,617	763	390	183	1,336
TOTAL	28,524,174	43,223	17,363	14,188	74,774
Other Property Type Income					
Auto or Truck Fuel	2,619,715	8,243	5,144	3,382	16,769
Groceries	2,864,102	14,223	3,056	4,090	21,369
Lodging	3,226,870	12,162	4,532	3,019	19,712
Restaurant & Bar	2,561,923	5,132	3,536	2,285	10,953
Boat Fuel, Lubricants & Repairs	1,732,240	5,518	2,828	2,018	10,364
Charter & Guide Fees	10,366,927	49,427	14,023	11,500	74,950
Fish Processing or Packaging	2,307,448	4,069	1,330	1,921	7,320
Fishing Derby Entry Fees	269,302	0	257	178	435
Fishing Gear	1,904,030	6,190	1,720	1,828	9,738
Haul Out & Moorage Fees	671,617	2,337	776	394	3,507
TOTAL	28,524,174	107,300	37,201	30,615	175,116
Total Value Added					
Auto or Truck Fuel	2,619,715	78,571	15,527	16,804	110,902
Groceries	2,864,102	105,767	8,938	20,319	135,024
Lodging	3,226,870	71,606	15,698	15,002	102,306
Restaurant & Bar	2,561,923	50,055	10,799	11,356	72,210
Boat Fuel, Lubricants & Repairs	1,732,240	47,459	8,665	10,024	66,148
Charter & Guide Fees	10,366,927	238,791	78,818	57,147	374,755
Fish Processing or Packaging	2,307,448	41,668	6,329	9,543	57,539
Fishing Derby Entry Fees	269,302	3,204	937	892	5,033
Fishing Gear	1,904,030	45,564	5,656	9,081	60,302
Haul Out & Moorage Fees	671,617	9,545	2,981	1,958	14,484
TOTAL	28,524,174	692,231	154,347	152,124	998,702

Table 80. Regional economic impacts of a 20% increase in lower and central Cook Inlet sportfishing catches.

Response Coefficient	Baseline expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Employment Compensation					
Auto or Truck Fuel	2,619,715	91,911	11,614	16,144	119,669
Groceries	2,864,102	112,235	6,489	19,489	138,213
Lodging	3,226,870	67,082	13,259	14,309	94,649
Restaurant & Bar	2,561,923	57,282	8,349	10,883	76,514
Boat Fuel, Lubricants & Repairs	1,732,240	53,641	6,636	9,670	69,947
Charter & Guide Fees	10,366,927	69,119	77,646	54,345	201,109
Fish Processing or Packaging	2,307,448	50,223	5,283	9,015	64,521
Fishing Derby Entry Fees	269,302	5,378	820	853	7,052
Fishing Gear	1,904,030	45,239	4,253	8,592	58,085
Haul Out & Moorage Fees	671,617	8,031	2,542	1,878	12,451
TOTAL	28,524,174	560,141	136,891	145,178	842,210
Proprietors Income					
Auto or Truck Fuel	2,619,715	14,005	2,831	4,000	20,835
Groceries	2,864,102	24,935	1,640	4,829	31,404
Lodging	3,226,870	23,375	3,041	3,547	29,962
Restaurant & Bar	2,561,923	14,013	1,557	2,698	18,268
Boat Fuel, Lubricants & Repairs	1,732,240	10,278	1,543	2,396	14,217
Charter & Guide Fees	10,366,927	241,857	16,847	13,470	272,173
Fish Processing or Packaging	2,307,448	9,735	1,974	2,234	13,943
Fishing Derby Entry Fees	269,302	0	164	210	373
Fishing Gear	1,904,030	13,340	1,229	2,129	16,698
Haul Out & Moorage Fees	671,617	2,901	535	465	3,901
TOTAL	28,524,174	354,440	31,359	35,977	421,776
Indirect Business Taxes					
Auto or Truck Fuel	2,619,715	13,598	3,201	2,664	19,463
Groceries	2,864,102	18,145	1,850	3,216	23,211
Lodging	3,226,870	9,824	2,537	2,360	14,721
Restaurant & Bar	2,561,923	4,858	2,406	1,795	9,060
Boat Fuel, Lubricants & Repairs	1,732,240	7,653	1,783	1,596	11,032
Charter & Guide Fees	10,366,927	7,538	14,493	8,963	30,994
Fish Processing or Packaging	2,307,448	2,875	1,098	1,488	5,461
Fishing Derby Entry Fees	269,302	21	162	139	322
Fishing Gear	1,904,030	7,323	1,106	1,418	9,847
Haul Out & Moorage Fees	671,617	1,294	662	310	2,265
TOTAL	28,524,174	73,130	29,297	23,949	126,376
Other Property Type Income					
Auto or Truck Fuel	2,619,715	14,007	8,741	5,748	28,496
Groceries	2,864,102	24,132	5,185	6,939	36,256
Lodging	3,226,870	20,516	7,645	5,093	33,254
Restaurant & Bar	2,561,923	8,699	5,994	3,874	18,567
Boat Fuel, Lubricants & Repairs	1,732,240	9,417	4,826	3,443	17,686
Charter & Guide Fees	10,366,927	83,137	23,587	19,343	126,067
Fish Processing or Packaging	2,307,448	6,800	2,223	3,210	12,232
Fishing Derby Entry Fees	269,302	0	433	301	733
Fishing Gear	1,904,030	10,361	2,879	3,059	16,299
Haul Out & Moorage Fees	671,617	3,963	1,316	668	5,947
TOTAL	28,524,174	181,031	62,828	51,679	295,537
Total Value Added					
Auto or Truck Fuel	2,619,715	133,520	26,387	28,556	188,463
Groceries	2,864,102	179,447	15,164	34,473	229,085
Lodging	3,226,870	120,797	26,481	25,308	172,586
Restaurant & Bar	2,561,923	84,853	18,306	19,250	122,408
Boat Fuel, Lubricants & Repairs	1,732,240	80,989	14,788	17,106	112,882
Charter & Guide Fees	10,366,927	401,650	132,572	96,121	630,344
Fish Processing or Packaging	2,307,448	69,633	10,577	15,947	96,158
Fishing Derby Entry Fees	269,302	5,399	1,579	1,503	8,480
Fishing Gear	1,904,030	76,263	9,467	15,199	100,929
Haul Out & Moorage Fees	671,617	16,189	5,055	3,321	24,565
TOTAL	28,524,174	1,168,741	260,375	256,783	1,685,900

APPENDIX B

The following is the manual that accompanies the software package $FISH and is a reproduction of Hamel et al. [2001]

$FISH

An economic assessment of lower and central Cook Inlet sport fisheries

SOFTWARE MANUAL

April 2001

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The authors are with: 1) North Pacific Fishery Management Council; 2) Department of Economics, University of Alaska Fairbanks; 3) Alaska Fisheries Science Center, National Marine Fisheries Service; and, 4) Department of Economics, Utah State University. Any views expressed are solely those of the authors, and should not be construed as representing those of the institutions by which they are employed. Correspondence should be addressed to Charles Hamel (chuck.hamel@noaa.gov) or Mark Herrmann (ffmlh@uaf.edu). 1. Introduction to $FISH

1. Introduction to $FISH

$FISH is an interactive Microsoft Excel based computer program developed to accompany *An Economic Assessment of the Sport Fisheries for Halibut, and Chinook and Coho Salmon in Lower and Central Cook Inlet* [Herrmann et al. 2001]. This program is designed to explore the economic effects of changes in the attributes of lower and central Cook Inlet sport fisheries for halibut or salmon that might arise from changes in abundance, or regulatory change. The program derives compensating variations (net benefits to sport fishers) and regional economic impacts to the western Kenai Peninsula associated with the perceived angler reaction to modeled changes.

System requirements

$FISH.xls is designed to run in Microsoft Excel for Office 97 or Office 2000 under the Windows 9x, Windows 2000, or Windows NT operating system. A Pentium class PC with at least 64 MB of RAM is recommended. The program is memory and processor intensive and will run best on PCs with a large amount of memory and a fast processor.

Installation

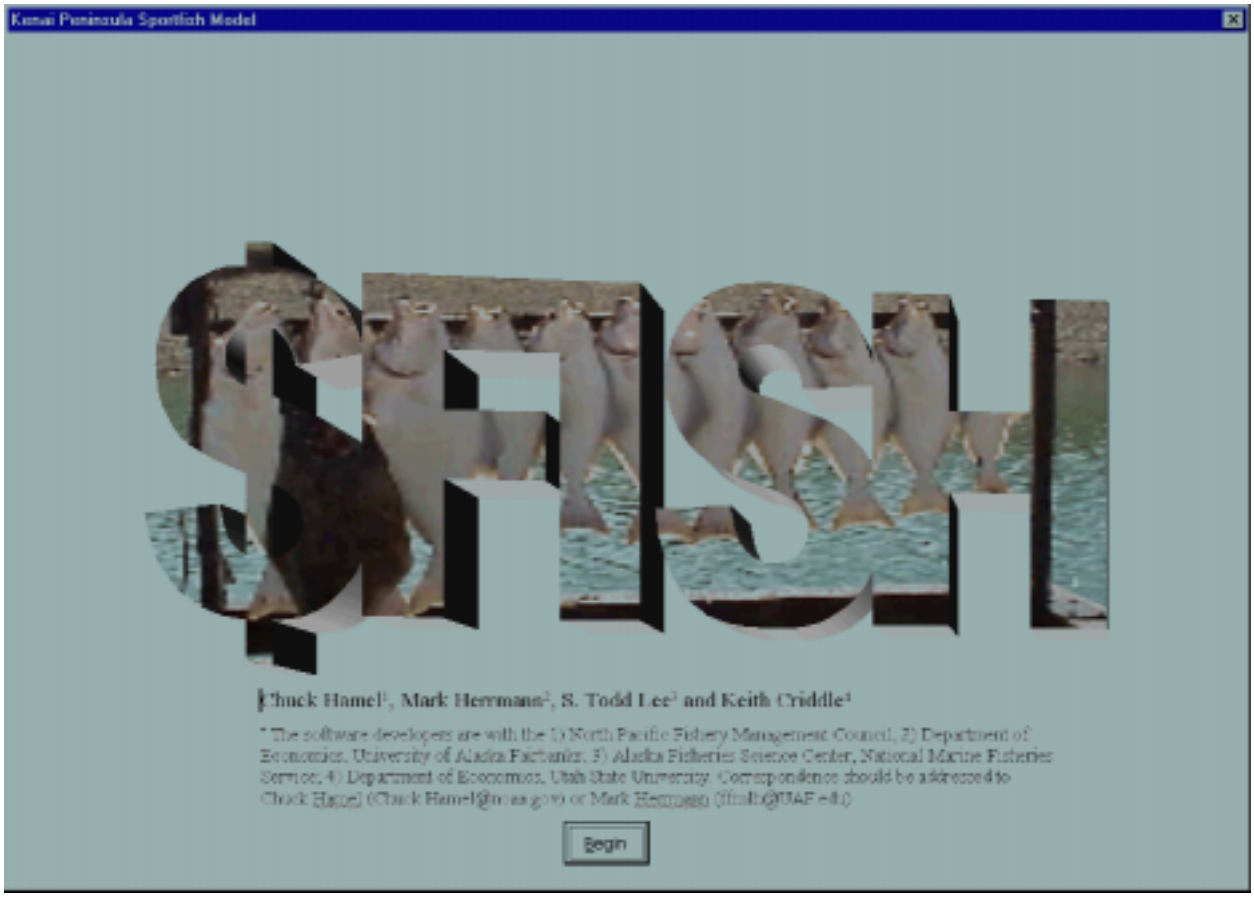
$FISH.xls is distributed as a compressed Microsoft Excel file. Upon extraction, save $FISH.xls to a preferred directory and launch with the standard file open sequence in Microsoft Excel. Depending on options selected during the installation of Microsoft Excel, it may be necessary to copy some drivers into system directories.

2. Operating $FISH

Initial View

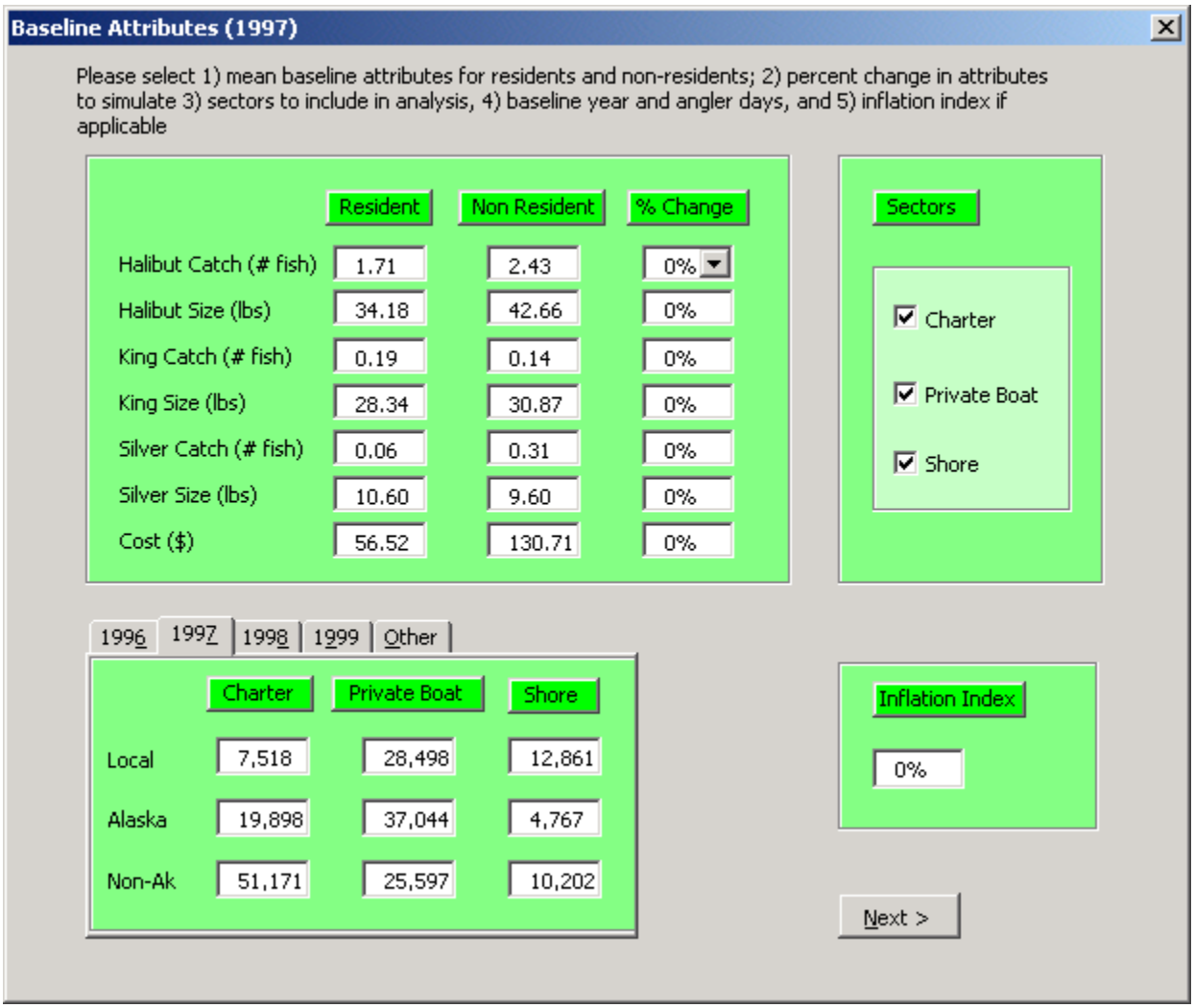
When $FISH.xls is opened, the user may be warned it contains macros. These macros are required for program operation. To run the program, select the Enable Macros button. $FISH.xls is set to open as a password-protected, read-only workbook. Please select the Read only button to continue to launch the application. Additionally, a message box may appear prompting the user to update any information linked to other workbooks. If this message appears, select No.

An opening splash screen will be displayed:



After the Begin button has been selected a form will appear prompting the user to enter: 1) mean catch and weight attributes; 2) the percentage change to apply to the mean attributes; 3) sectors to include in the analysis (i.e. charter, private boat, and shore-based fishing); 4) baseline year and the number of angler days for the year modeled; and 5) an inflation factor to apply to the model's nominal dollar values.

IMPORTANT: The user can select effort values that correspond to the 1996 through 1999 time period, or supplant his or her own values under the "Other" option of the tab strip. However, the estimated angler days expenditures are based on 1997 data, which is the default year for this model. (See Table 1 of Herrmann et al. [2001] for a more detailed representation of Cook Inlet sportfishing effort.)



The Alaska Department of Fish and Game (ADF&G) reported effort levels for 1996–1999 can be selected by clicking on the appropriate years. Or, if "Other" is selected, the user can model for any effort desired by entering new values. Note however, that unless the mean 1997 level attributes are changed, the resulting monetary effects will be based on 1997 level average trip attributes even if the total figures are based on alternative year total effort.

Selecting the Next > button will update the trip attributes and display a worksheet titled *Baseline Data*. Changes in estimated participation are displayed by residency, and the expected participation change in terms of angler days fished for each sector and residency category are also shown. If the baseline data needs to be changed, the user form can be called back by selecting the Change Data button.

This and other worksheets within the model have been programmatically customized for viewing on a 17 inch monitor. If the user needs to make changes to these settings, they can be adjusted by calling the Zoom feature under the View heading of Excel's menu bar.

After entering new data values or accepting the default values, select the Next > button to move to the output worksheets. The Next > button is always located in the bottom right-hand corner of the display. To print the current worksheet the user can select the Print button. On the last page the reader can select Return to return to the *Baseline Data* sheet.

Additional Worksheets

Upon clicking the Next > button from the *Baseline Data* worksheet, the model will generate economic impacts and output them to a worksheet titled *Economic Impacts*. This sheet shows the regional economic impacts resulting from changes in angler spending for the 10 expenditure categories. (See Table 23 of Herrmann et al. [2001] for the corresponding baseline expenditures.) Impacts can be evaluated for sales (output), employment, income, and other value added classes.

A worksheet titled *Impacts by Final Demand Category* shows the same economic impacts distributed among 26 aggregated final demand categories. (See Herrmann et al. [2001] Appendix A.)

The fourth and last worksheet, titled *Compensating Variations*, reports changes to the consumer surplus measurement described in Section 4 of Herrmann et al. [2001]. The baseline compensating variations for the 1997 fishery can be found in Herrmann et al. [2001], Table 39.

Simulations

A variety of baseline simulations can be run using the default data for the lower and centralCook Inlet 1997 sport fishery. To perform a simulation click the Begin button from the initial view or the Change Data button on the *Baseline Data* worksheet to call up the *Baseline Attributes* (1997) user form. All simulation changes are to be made in this display. Whenever changes to the data are to be simulated, click the Next > button on the user form.

% Change

% Change is the most important user-modified input. Changes from the baseline mean expected catches are simulated by selecting the % Change drop down list for the relevant attribute and selecting from the range of percentage changes shown. Catch numbers and weight changes are available in 5% increments over the range −100% to +20%. % Change is bounded by an upper limit of +20% because it is driven by a functional form chosen for damage assessment and reductions in angler activity stemming from policy changes. The range for cost percentage changes is −50% to +50%.

Estimated 1997 Angler Days

The estimated effort used in the Herrmann [2001] study was based on Alaska Department of Fish and Game estimated effort for the Cook Inlet portion of the Kenai Peninsula for 1997. This effort is likely to change over the years and can be altered by entering new effort figures in the lower effort box titled Estimated 1997 Angler Days. (Before making changes to the fishing attributes please read the Appendix [note 1].)

Inflation

The baseline simulation defaults to a 1997-dollar base. To inflate these dollar figures to represent impacts in current dollar terms, enter a percentage value in the Inflation Index text box. For example, if the analyst believes that the dollar has inflated in value by 8.2% since 1997, s/he should enter 8.2% in the Inflation Index box.

Baseline Fishery Data

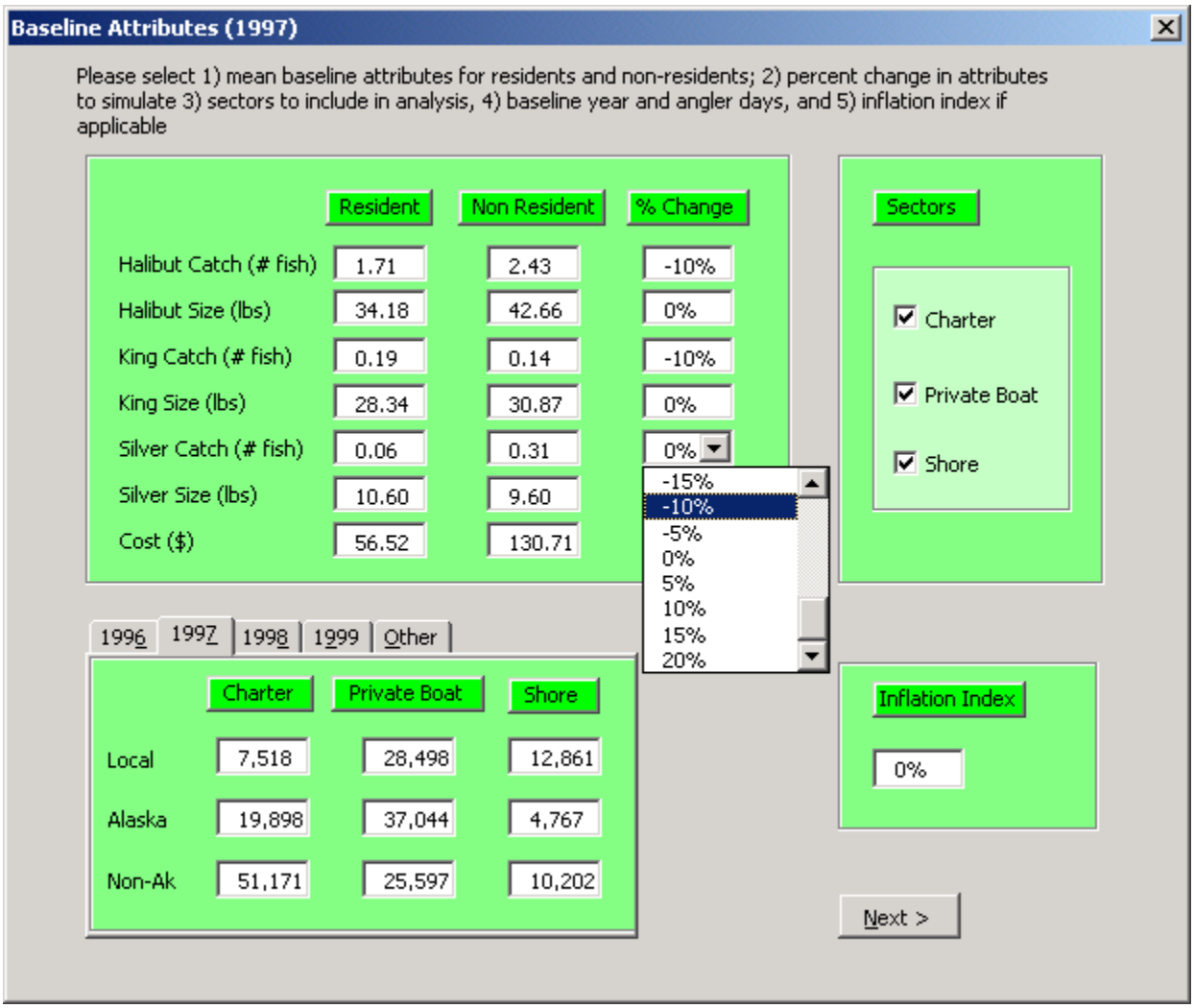
The baseline fishery data is displayed for the 1997 season aggregated across all fishing sectors. This information can be changed to reflect current fishery conditions, data permitting. To change this data click the relevant text box and enter new values. The Alaskan and nonresident values for fish catch, weight, and trip cost need to be changed individually. (Before making changes to the fishing attributes please read the Appendix [note 2].)

Sectors

The initial baseline simulations are for data aggregated across all fishing sectors. If the analyst wishes to evaluate sector specific effects, such as changes to the charter fishery only, s/he can choose the appropriate checkbox. (Before making changes to the fishing attributes please the Appendix [note 2].)

3. An Example

The following example evaluates the economic effects of a simulated decline in expected catch of 10% for both halibut and salmon. This demonstration recreates the scenario and results of values reported in Herrmann et al. [2001]. From the *Baseline Data* window select the Change Data button to call up the *Baseline Attributes* (1997) user form. Select –10% from the drop down lists corresponding to the halibut catch and each of the salmon rows, and make sure that all three sectors are included for analysis (shoreline, private boat, and charter). The *Baseline Attributes* (1997) screen should look like:



After clicking the Next > button, the resulting *Baseline Data* worksheet will look like:

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Baseline Data

	Baseline Attributes		Percentage change for attributes:	Varied Attributes		Sectors Included for Impact Analysis:
	Resident Means	Non-Resident Means		Changed Resident Means	Changed Non-Resident Means	
Halibut Catch	1.71	2.43	-10%	1.54	2.19	Charter Private Boat Shore
Halibut Size	34.18	42.66	0%	34.18	42.66	
King Catch	0.19	0.14	-10%	0.17	0.15	
King Size	28.34	30.87	0%	28.34	30.87	Inflation Factor:
Silver Catch	0.06	0.31	-10%	0.05	0.28	0%
Silver Size	10.60	9.60	0%	10.60	9.60	
Cost	56.52	130.71	0%	$56.52	$130.71	Change Data

Change in resident effort -9.32%
Change in non-resident effort: -5.82%

Overall change in effort: -8.01%

Estimated Angler Days				
	Charter	Private	Shore	Total
Local	7,518	28,498	12,861	48,877
Alaska	19,898	37,044	4,767	61,709
Non-AK	51,171	25,597	10,202	86,970
Total	78,587	91,139	27,830	197,556

Simulated Change In Angler Days				
	Charter	Private	Shore	Total
Local	-701	-2,657	-1,199	-4,557
Alaska	-1,855	-3,454	-444	-5,753
Non-AK	-2,977	-1,489	-593	-5,059
Total	-5,533	-7,600	-2,237	-15,369

Simulated Angler Days				
	Charter	Private	Shore	Total
Local	6,817	25,841	11,662	44,320
Alaska	18,043	33,590	4,323	55,956
Non-AK	48,194	24,108	9,609	81,911
Total	73,054	83,539	25,593	182,187

Print

Next >

Baseline

The model predicts that if the expected catch of halibut and salmon decreases by 10%, resident and nonresident fishing effort (in days) will decrease by 9.32 and 5.82 percent respectively. (See Table 32 in Herrmann et al. [2001].) The effort in angler days is shown below the percentage changes. For the 10% expected reduction in catch it is estimated that sportfishing days will diminish by 15,369 of the 1997 baseline (197,556), for a total of 182,187 days. Estimated changes are disaggregated to fishing sector and residency category.

Clicking the Next > button calls up the following view:

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Economic Impacts

Response Coefficient Type: Output

Sectors Included for Analysis: Charter, Private Boat, Shore	Baseline Angler Expenditures ($)	Direct Output ($)	Indirect Output ($)	Induced Output ($)	Total Output ($)
Transportation, Food & Lodging					
Auto or Truck Fuel	2,619,715	(169,195)	(40,476)	(40,973)	(250,162)
Groceries	2,864,102	(182,725)	(23,492)	(49,744)	(255,444)
Lodging	3,226,870	(194,726)	(43,726)	(37,254)	(259,836)
Restaurant & Bar	2,561,923	(147,907)	(29,676)	(27,860)	(205,442)
Fishing Expenditures					
Boat Fuel, Lubricants & Repairs	1,732,240	(104,879)	(22,469)	(24,180)	(151,272)
Charter & Guide Fees	10,366,927	(634,899)	(200,521)	(142,933)	(978,353)
Fish Processing or Packaging	2,307,448	(136,116)	(17,482)	(24,244)	(177,843)
Fishing Derby Entry Fees	269,302	(11,672)	(2,885)	(2,212)	(16,769)
Fishing Gear	1,904,030	(103,999)	(15,458)	(22,987)	(142,139)
Haul Out & Moorage Fees	671,617	(32,318)	(9,280)	(4,798)	(46,387)
Totals	**$28,524,174**	**(1,718,435)**	**(405,464)**	**(377,184)**	**(2,483,646)**

Print Next >

Impacts

The economic impacts are discussed in greater detail in Herrmann et al. [2001]. The above table includes economic impacts on output from changes in spending for the 10 expenditure sectors queried in the UAF survey. The direct output reflects the amount of increased or decreased spending of new money for each angler expense category. For example, reading across the line labeled "Auto or Truck Fuel", we begin with a total of $2.62 million based on the amount of money spent by sport fishers in the shore, private boat, and charter fishery modes that were directly attributable to the saltwater fisheries in 1997. The effort reductions for residents (9.32%) and nonresidents (5.82%) translate into equivalent reductions in angler day expenditures for each group. This amounts to a decrease in sales of automotive fuels by $169,195, the entry under the "Direct Output" column. As fuel sales decline, fuel retail outlets decrease their local purchases of inputs from other sectors, causing these sectors to also decrease their inputs for a combined indirect effect of $40,476, and households with members employed by these sectors spend less on local goods and services for an induced effect of $40,973. Taken together, the total effect on regional sales (output) caused by the anticipated decreases in sport caught fish and subsequent decline in fuel spending is $250,162.

Selecting the Next > button brings up the *Impacts by Final Demand Category* worksheet, which shows the simulated impacts reported above in terms of 26 final demand categories by each of the impact classes (output, employment, personal income, etc.).

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Impacts by Final Demand Category

Final Demand Category	Output ($Sales) ($)	Employment (Jobs)	Employee Compensation ($)	Proprietor's Income ($)	Personal Income ($)	Other Property Type Income ($)	Indirect Business Taxes ($)	Value Added ($)
Banking/Credit Services	(31,880)	(0)	(6,722)	(288)	(7,010)	(5,005)	(4,069)	(16,084)
Business/Labor Associations	(23,175)	(0)	(10,087)	-	(10,087)	-	(264)	(10,352)
Civic/Religious Assoc.	(3,195)	(0)	(1,792)	-	(1,792)	-	(0)	(1,792)
Communications	(29,334)	(0)	(6,196)	(716)	(6,912)	(4,784)	(999)	(12,695)
Eating & Drinking Places	(184,141)	(5)	(58,315)	(14,266)	(72,581)	(8,856)	(4,946)	(86,383)
Education	(3,183)	(0)	(1,285)	(195)	(1,480)	-	-	(1,480)
Fabrics/Apparel	(4,024)	(0)	(1,618)	(218)	(1,837)	(643)	(478)	(2,957)
Food Processing	(324,195)	(7)	(133,624)	(22,068)	(155,692)	(23,687)	(15,125)	(194,504)
Health Care	(51,766)	(1)	(22,706)	(9,927)	(32,633)	(4,634)	(654)	(37,921)
Hotels & Lodging	(190,341)	(4)	(59,374)	(20,689)	(80,063)	(18,159)	(8,695)	(106,917)
Household Furnishings	(3,224)	(0)	(1,316)	(580)	(1,896)	(323)	(336)	(2,555)
Household Industry	(10)	(0)	(10)	-	(10)	-	-	(10)
Housing	(72,985)	(1)	(2,850)	284	(2,565)	(16,599)	(13,539)	(32,704)
Insurance	(5,962)	(0)	(1,929)	(263)	(2,192)	(149)	(668)	(3,009)
Motor Vehicles	(352,598)	(7)	(150,583)	(25,308)	(175,891)	(26,491)	(22,084)	(224,466)
Other Local Purchases	(372,246)	(21)	(51,619)	(92,388)	(144,007)	(44,318)	(4,398)	(192,723)
Personal Services	(54,127)	(1)	(15,210)	(11,597)	(26,807)	(4,920)	(459)	(32,186)
Petroleum Products	(16,919)	(0)	(1,236)	(157)	(1,393)	(744)	(2,134)	(4,271)
Publications/Paper	(14,307)	(0)	(5,141)	(402)	(5,543)	(4,347)	(68)	(9,957)
Recreation Activities	(386,555)	(16)	(36,618)	(120,305)	(156,924)	(41,445)	(3,758)	(202,127)
Retail Trade	(187,403)	(6)	(79,768)	(30,034)	(109,802)	(20,027)	(15,536)	(145,365)
State/Local Services	(19,431)	(0)	(7,074)	-	(7,074)	(3,144)	(8)	(10,226)
Transportation Services	(55,998)	(0)	(9,412)	(1,709)	(11,121)	(2,706)	(1,981)	(15,808)
U.S. Postal Service	(14,161)	(0)	(9,531)	-	(9,531)	1,471	-	(8,060)
Utilities	(48,382)	(0)	(9,074)	(916)	(9,990)	(13,755)	(1,901)	(25,647)
Wholesale Trade	(34,103)	(0)	(13,816)	(373)	(14,189)	(2,176)	(2,324)	(18,689)
Total Local Impacts	$ (2,483,646)	(72)	$ (696,906)	$ (352,115)	$ (1,049,021)	$ (245,440)	$ (104,426)	$ (1,398,887)

Print Next >

\Final_Demands /

Note that the output change of –$2,483,646 matches the "Total Output" figure under the *Economic Impacts* view shown earlier. The decreased angler spending in the 10 expenditure categories and consequent effects are apportioned across a list of 26 industrial sectors.[17] For example, the decreased angler spending causes a decrease in sales of "Recreational Activities" of $386,555. Consequently, 16 jobs are lost and personal income within this sector declines by $156,924.

[17] These sector aggregations are developed in Jensen [1997].

Selecting the Next > button one last time calls up the *Compensating Variations* worksheet:

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Compensating Variations

Baseline Average Compensating Variation

Residency	Estimated Days Fished	Daily CV ($)	Total CV ($)
Local Alaska Residents	48,877	80.33	3,926,510
Non Local Alaska Residents	61,709	80.33	4,957,363
Non Residents	86,970	118.88	10,338,807
Total			$ 19,222,680

Simulated Change in Average Compensating Variation

Residency	Estimated Days Fished	Daily CV ($)	Total CV ($)
Local Alaska Residents	(4,557)	(15.70)	(1,061,973)
Non Local Alaska Residents	(5,753)	(15.70)	(1,340,780)
Non Residents	(5,059)	(16.80)	(1,977,692)
Total			$ (4,380,445)

Simulated Average Compensating Variation

Residency	Estimated Days Fished	Daily CV ($)	Total CV ($)
Local Alaska Residents	44,320	64.63	2,864,537.11
Non Local Alaska Residents	55,956	64.63	3,616,582.86
Non Residents	81,911	102.08	8,361,114.70
Total			$ 14,842,235

Print Return

Compensating_Variation

Compensating variation is analogous to consumer surplus and represents the net benefits to anglers of fishing. Simply stated, this reflects the difference between the costs anglers would have been willing to pay and what they actually incurred to fish. For a 10% decrease in expected catch of halibut and salmon the estimated compensating variation for the Cook Inlet saltwater sport fishers declines from $19.2 to $14.8 million. This total loss in consumer surplus is estimated to come from a loss of $1,061,973 from local fishermen, $1,340,780 from other Alaskans and $1,977,692 from nonresidents.

To model a new scenario, select the Return button to return to the *Baseline Data* worksheet.

4. Appendix

NOTE 1. Rather than altering the baseline fishery data, changes in expected catch should be simulated by modification of the % Change. The % Change category affects demand while changing the baseline fishery data does not. % Change is used to simulate hypothetical changes to the fishery. The baseline fishery data should reflect actual trip data.

NOTE 2. $FISH was designed based on a "generic" fishing trip using 1997 data. The participation-rate model was not based on a particular fishing mode; that is, when the respondents stated their preferences to whether or not they would have taken a presented trip they were not told that the trip was on board a charter or private vessel or a shoreline trip. To estimate the changes to these three trip modes for simulated changes in catch, weights, or trip price, the same percentage is applied across fishing modes. If a researcher wants to simulate just the charter industry, for instance, a check of just the charter industry will disaggregate these numbers using the "generic" trip attributes. An alternative way of modeling the charter industry is to use fishery characteristics more often found with a charter trip, and then changing the charter fishery attributes to reflect this. These two methods will give different results and need to be discussed within the context of the underlying assumptions.

5. Acknowledgements

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