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Alaska Angler Survey: Use and Valuation Estimates for 1996, with a Focus on Arctic Grayling Fisheries in Region III

by
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Alaska Department of Fish and Game **Division of Sport Fish**

SYMBOLS AND ABBREVIATIONS

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used in Division of Sport Fish Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications without definition. All others must be defined in the text at first mention, as well as in the titles or footnotes of tables and in figures or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
mideye-to-fork	MEF
minute (angular)	‘
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	“
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

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ABSTRACT

A social and economic analysis was designed to estimate net economic values for sport fishing in six areas of Region III: Tanana drainage, Seward Peninsula, Northwest Alaska, Haul Road/Koyukuk waters, North Slope waters, and Yukon/Kuskokwim waters. In particular the study focused on fishing trips and anglers targeting Arctic grayling *Thymallus arcticus*. A second goal of the study was to estimate changes in visitation to fishing sites which would result from the implementation of alternative regulations. In addition to these primary goals, information on angler and trip characteristics, trip expenditures, and preferences for alternative fishing experiences was collected. Five populations of anglers who purchased Alaska sport fishing licenses in 1996 were surveyed: Seward Peninsula residents, Northwest Alaska residents, residents of the remainder of Region III exclusive the previous two populations, Region I and II residents, and nonresidents. A total 8,112 surveys were mailed. Of this number 403 surveys were returned as undeliverable. Of the remaining 7,709 surveys successfully delivered, 2,826 completed surveys were returned, for a 36.7% response rate.

The dichotonous choice contingent valuation method was used to estimate anglers' net economic value for their most recent Region III fishing trip. An examination of the estimated models and mean net economic value estimates derived from these models showed two clear and consistent patterns: 1) nonresidents value their fishing trips to Region III significantly more highly than do Region III residents; and, 2) fishing trips in Region III on which grayling are the primarily targeted species are valued much the same as the Region III fishing trips targeting non-grayling species, primarily salmon *Oncorhynchus sp*.

The estimated net economic value per fishing trip to any area for all species was $590.84 (SE = 23.40) for nonresidents, $274.78 (SE = 38.72) for Northwest Alaska residents, $192.25 (SE = 29.97) for Region I and II residents, $149.69 (SE = 11.95) for Seward Peninsula residents and $121.86 (SE = 7.22) for the remainder of Region III residents. Overall, 1996 sport fishing for all species in Region III is estimated to have a total net economic value of $28,809,984 (SE = 1,186,914). Of this total, approximately 34% is attributable to nonresident fishing trips. The 1996 total net economic value of sport fishing for grayling in Region III is at least $8.0 million, and likely close to $8.5 million. Estimated total net economic values for all species and specifically for grayling were generated for the Tanana area and Chena River. Estimated average expenditures per fishing trip was highest for nonresidents ($2,151.96 per trip) followed by Region I and II residents ($429.38 per trip). The benefit/cost ratio for Region III grayling research and management in FY97 was at least 21; for the Tanana area, the benefit/cost ratio was 5.4 in FY97.

Sample populations showed many similarities in their graying fishing experience preferences. In general, there was a strong preference by Region III sport fishing license holders for catching and releasing large grayling in a wilderness setting.

All proposed regulation changes for the Chena, Nome, and Delta Clearwater rivers would lead to small to moderate increases in angler trips. Consistently across models, over three-fourths of respondents said that the proposed regulation changes would have no effect on the number of trips they would take to the rivers. This suggests that of the variables influencing angler trips, fishing regulations at the three rivers specified in this study may play a minor role.

Key Words: nonmarket economic analysis, net economic value, contingent valuation, contingent behavior, sport fishing, Arctic grayling, Alaska.

1.0 INTRODUCTION

This report provides a social and economic analysis of current and alternative conditions for sport fishing in Region III, Alaska in 1996 (Figure 1). In particular this report focused on fishing trips and anglers specifically targeting Arctic grayling *Thymallus arcticus* (hereafter referred to as grayling) on their Region III fishing trips. This study was completed under a contract between Bioeconomics, Inc. of Missoula, MT and the State of Alaska Department of Fish and Game (ADF&G), Sport Fish Division.

Figure 1.-Map of Region III, Alaska in 1996.

This study had two primary goals. The first was estimation of the net economic value[1] or NEV that sport users of Region III waters place on fishing experiences at these waters. The NEV of a trip is the amount of money a person would be willing to pay to take the trip in addition to what they actually did pay. NEVs are recommended by the U.S. Water Resources Council (1983) for use in benefit/cost analysis, and evaluation of land use questions such as instream flow allocation. NEVs have also been used in litigation involving natural resource damages (Duffield 1997). Objectives in fishery-specific management plans in Region III state that, in addition to managing for sustainable harvests and maintaining access, public benefits will outweigh management costs. Thus, the intent of the first study goal was to estimate public benefits in terms of NEVs in order to calculate the benefit/cost ratio for program evaluation and planning. The method employed to provide NEV estimates was contingent valuation modeling.

In Alaska, public opinion is important to shaping fisheries management policy. But, because fisheries management must address multiple, sometimes conflicting objectives, and adhere to governing mandates, there is a need to periodically evaluate policy for its influence on public welfare. The second primary goal of the study was to estimate changes in visitation to fishing sites that would result from the implementation of alternative fishing regulations. For example, what would be the overall social welfare change resulting from ADF&G altering gear regulations or bag limits for sport fishing on certain waters? Trip frequency is used in this study as one indicator of public welfare. The method employed to provide estimates of changes in trip frequency was contingent behavior modeling. Sport Fish Division goals are to conserve wild stocks, provide for diverse sport fishing opportunities, and to optimize social and economic benefits from recreational fisheries. The question relating to the study's second goal was: can an optimization be performed? The few management options available to Sport Fish Division are generally limited to stocking, regulation, access and site facility alternatives.

In addition to these two primary goals, information was collected on respondent and fishing trip characteristics, trip expenditures, and preferences for alternative fishing experiences.

2.0 THEORY

2.1 Contingent Valuation Methodology

The contingent valuation method (CVM) uses survey techniques to determine the values which people would place on traditionally nonmarket goods and services if markets did exist for these commodities. In this study, the nonmarket commodities being measured through the use of contingent valuation are fishing trips in Region III. Well established markets for sport fishing on public lands in Alaska do not exist. Therefore, the basic problem to be faced in determining the economic value of fishing trips to this region is one of measuring these nonmarket values. Contingent valuation has been widely applied (Cummings et al. 1986, Mitchell and Carson 1989) and is recognized by the U.S. Water Resources Council (1983) as an appropriate method. This approach has also been designated in federal guidelines (U.S. Department of Interior 1986, 1991) as a best available procedure for valuation of damages arising in superfund natural resource damage cases. The contingent valuation method has been employed numerous times to inform state and federal agency decision makers on resource issues. In Montana, the CVM has been

[1] The net economic value is also called the willingness to pay or consumer surplus; these terms are equivalent.

used by the state fish and wildlife agency to value coldwater fishing on all major fisheries in the state (Duffield et al. 1987); to examine the relationship between congestion and fishing values on the Bighorn River (Duffield and Neher 1994); and to estimate appropriate market-level prices for nonresident big game hunting permits (Duffield 1997). Additionally, federal agencies have used CVM to inform decision makers in several large-scale Environmental Impact Statements on wildlife issues such as wolf reintroduction to Yellowstone National Park (U.S. Fish and Wildlife Service 1994), and reintroduction of grizzlies to central Idaho and western Montana (U.S. Fish and Wildlife Service 1997).

The essence of the CVM approach is to ask individuals their willingness to pay (WTP) contingent on a hypothetical situation. The application of the CVM involves three elements: 1) a description of the resource which is to be valued; 2) the "payment vehicle," or method by which the respondent will pay for the resource; and, 3) the "question format" or specific method by which the value of the resource will be elicited. We will discuss how each of these elements is addressed in turn.

In the Alaska Region III grayling survey, anglers were asked to place a value on their most recent open water fishing trip to a Region III water. The "payment vehicle," or method by which respondents were asked to place a value on their recreational experience was an increase in travel costs to the site. The use of increased travel costs as a payment vehicle has been used extensively in CVM studies and has the advantage of being relatively neutral. Other possible payment vehicles, such as site access fees or increased taxes, may elicit a "no" response from the respondent, not because they would not pay the amount, but because they are fundamentally opposed to increased taxes or site fees.

The third feature of all CVM applications is the method by which the resource value is elicited from respondents. There are several basic genres of CVM elicitation techniques including open-ended CVM questions and dichotomous choice CVM questions. In the open-ended CVM respondents are asked what the maximum amount they would be willing to pay for a good or resource would be. In the dichotomous choice method, respondents are asked a simple "yes" or "no" question: whether they would pay a specified amount for the specified good or resource. This study utilized the dichotomous choice CVM. The dichotomous choice question format has the advantage of presenting respondents with a simple yes or no decision on whether the described "economic good" is worth the dollar amount asked. This type of decision making is similar to the decisions we make every day when we decide to buy, or not buy, goods and services based on the qualities of the goods and services and also upon their price.

While the dichotomous choice method has the advantage of being easily implemented and similar in design to other economic decisions we make each day, it has the disadvantage of being relatively difficult to calculate welfare measures from the survey responses. A detailed discussion of the calculation of welfare measures from dichotomous choice question responses is included in Appendix A.

2.2 Contingent Behavior Methodology

Contingent behavior questions ask respondents to predict how their behavior would change given a hypothesized change in the attributes of (for example) a fishing trip. In this study respondents were asked how their visitation patterns to the Chena, Nome, and Delta Clearwater rivers would change if alternative fishing regulations for grayling were adopted for those waters. Appendix B

provides a detailed discussion of the motivation for and literature associated with contingent behavior modeling methods.

3.0 METHODS

In May through July 1997, a mail survey was administered to resident and nonresident anglers holding 1996 Alaska sport fishing licenses. The design and administration of this survey are discussed in the following sections.

3.1 Population Sampling Design

The scope of the Alaska Region III grayling survey was ambitious given the resources available for the survey implementation. The survey was ideally designed to estimate NEVs for six geographic areas within Region III (Tanana drainage, Seward Peninsula, Northwest Alaska, Haul Road/Koyukuk waters, North Slope waters, and Yukon/Kuskokwim waters). Given the constraints of sample size, however, a more realistic objective was to obtain value estimates for the more heavily used of these areas. Additionally, it was hoped that final sample sizes would be large enough to estimate NEVs for nonresidents, and Region I (southeast Alaska) and II (southcentral Alaska) residents as well as for Region III residents. A final objective was to estimate region-wide or water-specific NEVs for trips specifically targeting grayling.

Five specific populations were sampled in this survey effort (Table1).

(1) Seward Peninsula license holders

In order to maximize the probability of receiving sufficient survey responses to estimate a Seward Peninsula fishing trip value, all 1996 sport fishing license holders (1,105) in the towns of Nome and Unalakleet were surveyed.

(2) Northwest Alaska license holders

Similarly, all 1996 sport fishing license holders (258) in the towns of Kotzebue, Noatak, and Ambler were surveyed in an attempt to estimate the NEV for trips to this area of Region III.

(3) Remainder of Region III license holders

The largest strata of the survey was the angling population of Region III exclusive of the censused towns listed in (1) and (2) above. A random sample of 4,000 1996 license holders in this area of Region III was drawn and sampled.

(4) Lower 49, Canadian, and foreign anglers

This population was problematic in that it is a very large population yet only a small proportion of the population likely fished in Region III. The result of this low participation rate is that a very large number of nonresident license holders would need to be surveyed to ensure receiving responses from enough anglers who had fished in Region III to allow the estimation of a valuation model.

In an effort to sidestep this problem of low participation rates in Region III angling, the sampled population was narrowed to those nonresident anglers who bought their 1996 licenses in

Region III. The assumption made in this sampling decision was that nonresidents who actually purchased their licenses in Region III are much more likely to have fished in Region III than those nonresidents who purchased their licenses in Regions I or II. The assumption was also made that those nonresidents who purchased licenses in Region III and fished in Region III were not significantly different from those nonresidents who purchased licenses in Regions I or II and then fished in Region III in terms of the value they attach to their Region III fishing experiences. A random sample of 2,000 of these nonresident anglers who bought 1996 licenses in Region III was drawn and these individuals were surveyed.

(5) Region I and Region II resident anglers

The same problems existed with sampling Region I and II anglers as was faced with nonresident anglers. That is, Region I and II anglers are a very large population with likely very low participation rates for fishing in Region III. As with the nonresident population, the target population was narrowed to only those Region I and II residents who bought their 1996 licenses in Region III. All anglers in this sample were surveyed (749).

One limitation of the sampling strategy employed in this study was that the sample pool for Alaska residents only included those individuals holding 1996 sport fishing licenses. Those residents over 60 years of age holding permanent identification cards (PIDs) were not included in the pool. While this study did survey a number of Alaska residents over 60, this population would be larger if PID holders were included. Total angler trip estimates used in this study were estimated by ADF&G and do include PID holders.

Table 1.-Summary of sampled populations.

Population of 1996 Sport Fishing License Holders Sampled	Type of Sample	Sample Size
Seward Peninsula (Nome, Unalakleet)	Census	1,105
Northwest Alaska (Kotzebue, Noatak, Ambler)	Census	258
Remainder of Region III	Random	4,000
Nonresidents (lower 49 / Canada / foreign) who bought licenses in Region III	Random	2,000
Region I and II residents who bought licenses in Region III	Census	749
Total		8,112

3.2 Survey Design and Administration

The survey instrument (see Appendix C) was designed cooperatively by Bioeconomics and ADF&G personnel. The final survey contained four sections. Section I asked the respondents several general questions about their fishing patterns and their visitation to Region III waters during 1996 in particular. Section II focused the questioning on the Region III water most recently fished by the respondent. Questions in this section asked about the specifics of that trip, fish species targeted and caught, and the anglers' assessment of the quality of this trip. This section also included the contingent valuation question used in estimating the NEV of trips to the waters. Section III asked questions on the respondents' preferences for fishing regulations on

specific Region III waters as well as how their visitation to the Chena, Nome, and Delta Clearwater rivers would change under alternative fishing regulations. Section IV asked respondents a number of demographic questions.

After the survey was developed it was pretested during the month of May, 1997 on a randomly drawn sample of 200 anglers from the 1996 license file. The purpose of this pretest was to 1) test the effectiveness of the wording and question sequencing of the survey instrument, and 2) to determine what the top bid level for the contingent valuation question should be. Several wording changes to the survey were made as a result of the pretest responses and the top bid level was set at $500 for Alaska residents and $1,000 for nonresidents for the final survey administration.

The administration of the survey was by ADF&G personnel and followed a modified Dillman methodology (Dillman 1978). A survey was mailed on June 6, 1997 to the sample of 1996 license holders. After two weeks (June 18-19) a reminder postcard was sent to all potential respondents (see Appendix C). Finally, nonrespondents were sent a second copy of the survey on July 22, 1997.

3.3 Response Rate

A total of 8,112 anglers' names and addresses were included in the survey sample. Of this number, 403 surveys (5%) were returned as undeliverable. Of the remaining 7,709 surveys that were successfully delivered to anglers, 2,826 completed surveys were returned by the end of the survey process. The resulting response rate to the survey was therefore 36.7%.

4.0 RESULTS

4.1 General Fishing and Socioeconomic Statistics

The Alaska grayling survey asked several questions about general fishing habits and socioeconomic characteristics. In general, all statistics in this report are presented specifically for each population (Seward Peninsula, Northwest Alaska, the remainder of Region III, nonresidents, and Region I and II residents). An attempt was made to examine differences between foreign nonresident respondents and lower 49 nonresident respondents. However, the number of verifiable foreign respondents was less than 10 and thus precluded any statistically valid examination of this sub-population. Table 2 shows many similarities in general fishing characteristics between the populations. Respondents from the remainder of Region III, however, appear to fish fewer days per year than respondents from the other samples and areas. It should also be noted that Northwest Alaska residents and nonresidents were less likely to fish specifically for grayling than were respondents from the other three sampling strata. Nonresidents were about 10 years older (average of 52.1 years), were comprised of a higher percentage of males, and indicated a higher percentage of income in the $125,000 + bracket than respondents in the remaining four populations (Table 3).

4.2 Site-Specific Statistics and Trip Characteristics

The grayling survey presented each respondent with a series of alternative fishing trip attributes. Respondents were asked to rate their preference for each attribute on a scale of 1 to 5 with 1 being least preferred and 5 being most preferred. The statistics presented in Table 4 are the percentage of respondents in each sample strata who rated the attribute as either a 4 or a 5. There

are many similarities across populations (Table 4). Respondents in all populations strongly preferred fishing in a wilderness setting to fishing an easily accessible site near a road.

Catching and releasing grayling was strongly preferred by all populations to catching and keeping grayling. Also, catching fewer large-sized grayling was strongly preferred to catching more smaller grayling. Having good trail access and more developed camping facilities was more preferred by nonresidents and the remainder of Region III residents than residents of the Seward Peninsula or Northwest Alaska. In general there is a strong preference by Region III sport fishing license holders for catching and releasing large grayling in a wilderness setting (Table 4).

Table 5 shows the average number of open water fishing trips per year respondents from each population made to each of the waters included in the grayling survey. The bolded entries in Table 5 indicate those waters that are in the same area as the sampled population. Thus, Tanana River drainage streams are highlighted for the remainder of Region III residents, Seward Peninsula streams for Seward Peninsula residents, and the Northwest/Kotzebue streams for Northwest residents. Not surprisingly, these populations had much higher visitation rates to streams in their own areas than to those in other areas. Anglers traveled to the Chena River more frequently (average of 2.46 trips) than other fishing sites in the Tanana drainage. It is interesting that the group of anglers who reported the most frequent trips to the Haul Road/Koyukuk, North Slope, and Yukon/Kuskokwim area waters were residents of Regions I and II. Resident anglers

Table 2.-General fishing characteristics of respondents to the grayling survey, by population, Region III, 1996.

Statistic	Respondent population[a]				
	Seward Peninsula	Northwest	Non-residents	Remainder of Region III	Regions I & II
Average years fished in life	24.1	26.3	31.3	23.1	23.6
Average number of days fished per year	27.2	28.5	28	19.7	26.8
Percent who specifically fish for grayling	31.1	13.8	18.5	39.7	35.2
Percent who sportfished in 1996	91.0	91.6	93.5	84.5	85.7
Sample size[b]	376	66	795	1,355	186

[a] 48 additional surveys could not be identified with a particular population.

[b] Sample sizes for individual statistics vary from reported overall sample size. This is due to varying response rates on individual questions.

Table 3.-Socioeconomic characteristics of respondents to the Region III grayling survey, by population, 1996.

Statistic	Respondent Populations				
	Seward Peninsula	Northwest	Nonresidents	Remainder of Region III	Regions I & II
Average age (years)	42.1	40.5	52.1	40.9	40.4
Percent Male	70.3	79.4	82.6	70.7	76.1
Average years of formal schooling attended	13.9	14.6	14.6	14.1	13.7
1996 household income before taxes					
Percent less than $20,000	10.0	8.2	6.2	13.4	14.0
Percent $20,000-$39,999	21.0	6.6	21.5	19.3	13.4
Percent $40,000-$69,999	32.8	34.4	33.0	37.4	34.7
Percent $70,000-$124,999	32.6	45.9	27.1	25.1	31.4
Percent over $125,000	3.6	4.9	12.2	4.8	6.7

Table 4.-Percent of respondents who preferred alternative fishing experiences, by population[a].

Statistic	Respondent population				
	Seward Peninsula	Northwest[b]	Non-residents	Remainder of Region III	Regions I & II
Fishing easily accessible site near a road	28.6	8.3	32.1	35.9	31.2
Fishing in a wilderness setting	78.0	92.3	71.6	69.5	75.4
Catching and keeping grayling	19.3	16.7	11.4	25.4	24.7
Catching and releasing grayling	51.4	58.4	63.3	51.8	55.9
Catching large-sized but fewer grayling	57.1	66.6	52.4	58.2	61.1
Catching more but smaller grayling	8.9	0.0	11.9	10.7	10.4
Having good trail access to fishing waters	28.9	16.6	45.8	42.7	35.4
Having more developed camping facilities	14.7	8.3	23.8	25.5	14.0

[a] Table statistics represent the percentage of respondents in each population who rated the fishing experience either a "4", or "5" on a scale of 1-5 with 1 being least preferred and 5 being most preferred.

[b] Note the sample size for the Northwest Alaska population is relatively small and thus statistics for this group should be interpreted with caution.

Table 5.-Average reported fishing trips to Region III waters by population, 1996.

Fishing Site	Respondent population				
	Seward Peninsula	Northwest[a]	Non-residents[b]	Remainder of Region III	Regions I & II[b]
Tanana River drainage					
Chena River	.02	.02	.60	**2.46**	.83
Chatanika River	.01	.02	.16	**.91**	.28
Salcha River	.00	.00	.20	**.79**	.22
Delta Clearwater River	.01	.00	.11	**.49**	.07
Goodpaster River	.00	.04	.01	**.29**	.07
Tangle Lakes/River	.01	.02	.09	**.32**	.14
Fielding Lake	.00	.00	.05	**.15**	.06
Piledriver Slough	.25	.00	.14	**.84**	.25
Other Tanana waters	.22	.06	.33	**1.85**	.58
Haul Rd/Koyukuk waters	0.09	0	0.13	**0.2**	1.48
North Slope waters	.01	0.36	.05	**0.1**	0.68
Northwest/Kotzebue	0.04	**8.85**	0.1	0.04	0.14
Norton Sound / Nome					
Nome River	**6.90**	.09	.07	.03	.09
Snake River	**2.64**	.02	.03	.03	.05
Pilgrim River	**1.94**	0	.01	.03	.04
Sinuk River	**1.25**	0	.01	.01	.10
Fish/Niukluk Rivers	**2.43**	0	.03	.0	.05
Other Norton waters	**4.62**	.69	.03	.02	.38
Yukon/Kuskokwim area	0.03	0	0.23	**0.56**	1.47

[a] Note that averages for this area are based on small sample sizes and should be interpreted cautiously.

[b] Averages for nonresidents and Regions I and II anglers apply only to those anglers from these groups who bought their licenses in Region III and thus are not applicable for the overall populations of nonresidents and Regions I and II anglers.

in Northwest Alaska took by far more fishing trips (average of 8.85 trips) than anglers in other populations.

Section II of the grayling survey asked respondents a number of questions on the fish species they targeted on their most recent trip, the number and size of grayling they caught, and the overall rating of their angling experience on their most recent trip (Table 6). A much higher percentage of nonresidents, Regions I and II residents, and remainder of Region III residents specifically targeted grayling than did Seward Peninsula and Northwest residents. Table 6 also shows that a strong majority of the grayling caught by all populations are released rather than kept, and that between a quarter and a third of respondents reported catching grayling over 15 inches in length. Northwest Alaskans and nonresidents reported the highest percentage of fishing experiences rated above average or excellent.

Table 6.-Fishing trip experiences and quality ratings from respondents to the grayling survey, Region III, 1996.

Statistic	Respondent Population				
	Seward Peninsula	Northwest	Nonresidents	Remainder of Region III	Regions I & II
Fishing for salmon	70.4%	18.1%	30.9%	16.6%	8.0%
Fishing for grayling	5.4%	5.5%	19.1%	30.1%	23.2%
Average number of grayling caught	2.7	4.2	8.7	4.4	5.1
Average number kept	0.3	0.6	0.6	0.6	0.4
Respondents who caught grayling over 15 inches	24.0%	29.2%	28.0%	23.3%	32.6%
Above average fishing experience[a]	26.2%	49.0%	44.9%	23.8%	38.7%
Average number of people in party	2.9	3.1	3.6	3.1	3.0

[a] Those respondents who rated the overall quality of their fishing experience as either a 4 or 5 on a scale of 1 to 5 with 1 being poor and 5 being excellent.

4.3 Trip Expenditures

In the final questions of Section II of the survey, respondents were asked how much money they spent in a number of expenditure categories on their recent trip to the study waters. Table 7 shows the average reported expenditures by category for each of the five populations. Nonresidents who fished in Region III spent significantly more per trip than did all other sample populations ($2,152 per trip). Additionally, Regions I and II anglers spent significantly more per trip ($429) fishing in Region III than did the three Region III populations.

When expenditures and net economic values are added together, the sum is termed gross NEV. This measures the gross total value associated with an activity. Gross NEV may correspond roughly to the market price for a package fishing trip including all expenses. Gross values are

not appropriate for valuing a site since they include many other goods and services utilized on a fishing trip such as gasoline and food.

4.4 Net Economic Value per Trip

Section II of the survey concluded by asking respondents two questions designed to elicit information on how much their most recent fishing trip was worth to them. The first question simply asked anglers if their most recent trip was worth more to them than they actually spent on the trip. In general, over 75% of respondents felt that their most recent fishing trip to Region III was worth more than they spent on the trip. The second question asked anglers to provide

Table 7.-Average expenditures per trip by category and respondent population.

Expenditure category[b]	Respondent population				
	Seward Peninsula	Northwest[a]	Non-residents	Remainder of Region III	Regions I & II
Travel	$48.52	$155.98	$922.63	$55.05	$166.46
Food	$37.96	$56.32	$290.47	$41.57	$75.25
Lodging	$27.50	$5.33	$412.96	$23.81	$38.28
Equipment	$34.30	$39.57	$212.44	$34.43	$110.25
Other expenses	$18.72	$11.79	$313.46	$27.57	$39.14
Total expenditures	$167.00	$268.99	$2,151.96	$182.43	$429.38

[a] Note that averages for this area are based on small sample sizes and should be interpreted cautiously.

[b] Total reported trip expenditures greater than $10,000 were excluded from calculations.

information on their NEV for their most recent angling experience. Specifically, the valuation questions asked:

> Was this trip worth more than what you actually spent? (Yes or No)
>
> If YES, Would you still have made the trip if your share of the expenses had been $_____ more?

The bid amount asked in this question was varied across respondents and consisted of one of six or seven bid levels (10, 25, 50, 100, 200, and 500 dollars for Alaska residents and 10, 25, 50, 100, 200, 500, and 1,000 dollars for nonresidents). The responses to this question were analyzed for many alternative population groupings in order to estimate the truncated mean NEV for a fishing trip. The distribution of yes responses to the individual bid levels in the current trip contingent valuation question is generally consistent with the hypothesis that the percentage of yes answers will drop as the bid level is increased.

As described above in Section 3.2, the sampling and survey design allowed for the possibility of estimating many subsample models of NEV. The ability to estimate meaningful subsample models was dependent on sample size. Tables 8a through 13b show the estimated bivariate logistic regression models of NEV and mean NEV estimates for all subsamples of interest with adequate sample sizes. In general, models reported in these tables that had sample sizes below approximately 60 were included only if all estimated parameters were significant at the 90th

Table 8a.-Bivariate current trip models of net economic value for a fishing trip to any area in Region III, by population, for all species, 1996.

Variable / statistic	Respondent population				
	Seward Peninsula	Northwest	Non-residents	Remainder of Region III	Regions I & II
Intercept	3.7180	8.8859	5.5309	4.8520	6.0153
SE	0.5581	2.8425	0.6444	0.3714	1.2671
(t-stat)	(6.662)	(3.772)	(8.583)	(13.063)	(4.747)
Ln (BID)	-0.8107	-1.4890	-0.7521	-1.1043	-1.1358
SE	0.1183	0.5309	0.1128	0.0839	0.2551
(t-stat)	(6.854)	(2.805)	(6.669)	(13.170)	(4.452)
Chi-square degrees of freedom	4	4	5	5	4
Chi-square	2.75	3.79	2.81	6.26	4.67
P-statistic	0.6	0.44	0.73	0.28	0.32
Sample size	278	49	456	742	88

Table 8b.-Estimates of adjusted mean net economic value for a fishing trip to any area in Region III, by population, for all species, 1996.

Population	Mean NEV[a] (standard error)[b]	Percent of respondents with NEV greater than expenses	Adjusted mean NEV per trip
Seward Peninsula	$190.45 (15.20)	78.6%	$149.69 (11.95)
Northwest	$332.26 (46.82)	82.7%	$274.78 (38.72)
Nonresidents	$724.07 (28.68)	81.6%	$590.84 (23.40)
Remainder of Region III	$153.86 (9.11)	79.2%	$121.86 (7.22)
Regions I and II	$247.43 (38.57)	77.7%	$192.25 (29.97)

[a] Mean NEV measures are truncated means, truncated at the highest bid level.

[b] Standard errors are based on 200 bootstrap iterations following the methodology of Duffield and Patterson (1991).

Table 9a.-Bivariate current trip models of net economic value for a fishing trip to any area in Region III, by population and targeted species, 1996.

	Respondent Population			
	Nonresident		Remainder of Region III	
Variable / Statistic	Grayling	Non-grayling Species[a]	Grayling	Non-grayling Species[b]
Intercept	5.7642	5.2493	4.9310	4.7148
SE	1.2483	0.7279	0.4700	0.6035
(t-stat)	(4.6174)	(7.2118)	(10.4914)	(7.812)
Ln(BID)	-0.8448	-0.6877	-1.0953	-1.1185
SE	0.2189	0.1282	0.1054	0.1376
(t-stat)	(3.8601)	(5.3638)	(10.3870)	(8.130)
Chi-square degrees of freedom	5	5	5	5
Chi-square statistic	2.92	1.84	2.97	13.26
P-statistic	0.71	0.87	0.71	0.02
Sample size	109	354	467	275

[a] Salmon (51.0%), jack chinook salmon which are frequently misidentified as rainbow trout (M. Doxey, ADF&G, Fairbanks, personal communication) (13.0%), and northern pike (9.1%) were the primary species indicated for "non-grayling" fishing trips.

[b] Salmon (32.9%), northern pike (17.4%), and jack chinook salmon which are frequently misidentified as rainbow trout (M. Doxey, ADF&G, Fairbanks, personal communication) (15.9%) were the primary species indicated for "non-grayling" fishing trips.

Table 9b.-Estimates of adjusted mean net economic value for a fishing trip to any area in Region III, by population, and targeted species, 1996.

Population	Mean NEV[a] (standard error)[b]	Percent of respondents with NEV greater than expenses	Adjusted mean NEV per trip
Nonresident grayling	$653.90	85.5%	$559.08
	(58.63)		(50.13)
non-grayling species	$746.49	80.4%	$600.18
	(30.90)		(24.84)
Remainder of Region III grayling	$152.33	80.9%	$123.24
	(18.46)		(14.93)
non-grayling species	$164.03	78.2%	$128.27
	(13.38)		(10.46)

[a] Mean NEV measures are truncated means, truncated at the highest bid level.

[b] Standard errors are based on 200 bootstrap iterations following the methodology of Duffield and Patterson (1991).

Table 10a.-Bivariate current trip models of net economic value for trips to specific areas in Region III, by population, for all species, 1996.

Variable / Statistic	Respondent population: Trips to Seward Pen., by Seward Pen. Residents	Trips to Tanana area by Nonresidents	Trips to Tanana, by Remainder of Region III Residents
Intercept	3.6569	6.1197	4.9613
SE	0.6689	1.0318	0.4796
(t-stat)	(5.467)	(5.930)	(10.345)
Ln(BID)	-0.8195	-0.9115	-1.1765
SE	0.1438	0.1804	0.1113
(t-stat)	(5.699)	(5.052)	(10.570)
Chi-square degrees of freedom	4	5	5
Chi-square statistic	3.95	4.13	9.4
P-statistic	0.41	0.53	0.09
Sample size	190	180	454

Table 10b.-Estimates of adjusted mean net economic value for a fishing trip to specific areas in Region III, by population for all species, 1996.

Population	Mean NEV[a] (standard error)[b]	Percent of respondents with NEV greater than expenses	Adjusted mean NEV per trip
Trips to Seward Pen., By Seward Pen. Residents	$178.60 (18.45)	80.0%	$142.88 (14.76)
Trips to Tanana area by Nonresidents	$649.39 (47.75)	80.7%	$524.06 (38.53)
Trips to Tanana, by Remainder of Region III Residents	$133.38 (9.67)	77.5%	$103.37 (7.49)

[a] Mean NEV measures are truncated means, truncated at the highest bid level.

[b] Standard errors are based on 200 bootstrap iterations following the methodology of Duffield and Patterson (1991).

Table 11a.-Bivariate current trip models of net economic value for trips to the Tanana area in Region III, by population, for trips specifically targeting grayling, 1996.

	Respondent Population	
Variable / Statistic	Trips to Tanana area by Nonresidents	Trips to Tanana, by Remainder of Region III Residents
Intercept	5.4552	4.6325
SE	(1.4929)	(0.6659)
(t-stat)	(3.65)	(6.96)
Ln(BID)	-0.8352	-1.1308
SE	(0.2669)	(0.1539)
(t-stat)	(-3.13)	(-7.35)
chi-square degrees of freedom	5	5
chi-square statistic	1.70	13.29
p-statistic	0.8885	0.0208
Sample size	67	224

Table 11b.-Estimates of adjusted mean net economic value for a fishing trip to the Tanana area in Region III, by population, for trips specifically targeting grayling, 1996.

Population	Mean NEV [a] (standard error)[b]	Percent of respondents with NEV greater than expenses	Adjusted mean NEV per trip
Trips to Tanana area by Remainder of Region III Residents	$125.25 (15.36)	85.5%	$107.09 (13.13)
Trips to Tanana area by Nonresidents	$601.74 (75.47)	91.0%	$547.58 (68.68)

[a] Mean willingness to pay measures are truncated means, truncated at the highest bid level.

[b] Standard errors are based on simulation using 10,000 iterations following the methodology of Krinsky and Robb (1986).

Table 12a.-Bivariate current trip models of net economic value for a fishing trip to individual rivers in Region III, by population, for all species, 1996.

	Water fished / *Population sampled*					
Variable / Statistic	Chena River *Nonresident*	Chena River *Remainder of Region III*	Nome River *Seward Pen.*	Chatanika River *Remainder of Region III*	Salcha River *Remainder of Region III*	Delta Clear-water River *Remainder of Region III*
Intercept	5.8435	4.0947	3.5156	6.3017	6.2142	5.7775
SE	1.3356	0.6554	0.9133	1.5616	1.6957	1.8498
(t-stat)	(4.375)	(6.248)	(3.850)	(4.035)	(3.665)	(3.123)
Ln (BID)	-0.8635	-1.0556	-0.8674	-1.4065	-1.3709	-1.4512
SE	0.2318	0.1592	0.2089	0.3480	0.3796	0.4510
(t-stat)	(3.724)	(6.630)	(4.153)	(4.041)	(3.611)	(3.217)
Chi-square degrees of freedom	5	5	4	4	4	5
Chi-square statistic	5.99	2.61	7.04	4.85	6.4	1.78
P-statistic	0.31	0.76	0.13	0.3	0.17	0.88
Sample size	92	185	89	65	55	39

Table 12b.-Estimates of adjusted mean net economic value for a fishing trip to individual rivers in Region III, by population, for all species, 1996.

Water fished/ *Population*	Mean NEV [a] (standard error) [b]	Percent of respondents with NEV greater than expenses	Adjusted mean NEV per trip
Chena River / *Nonresident*	$629.73 (64.49)	81.2%	$511.34 (52.37)
Chena River / *Remainder of Region III*	$114.06 (16.29)	77.4%	$88.28 (12.61)
Nome River / *Seward Peninsula*	$142.52 (24.90)	74.2%	$105.75 (18.48)
Chatanika River / *Remainder of Region III*	$156.84 (32.23)	73.6%	$115.43 (23.72)
Salcha River / *Remainder of Region III*	$190.06 (49.18)	77.0%	$146.35 (37.87)
Delta Clearwater River /*Remainder of Region III*	$106.40 (40.52)	76.2%	$81.08 (30.88)

[a] Mean NEV measures are truncated means, truncated at the highest bid level.

[b] Standard errors are based on 200 bootstrap iterations following the methodology of Duffield and Patterson (1991).

Table 13a.-Bivariate current trip models of net economic value for a fishing trip to individual rivers in Region III, by population, for trips specifically targeting grayling, 1996.

	Water Fished / *population sampled*					
	Chena River / *Nonresident*		Chena River / *Remainder of Region III*		Chatanika River / *Remainder of Region III*	
Variable / Statistic	Grayling	Non-grayling Species[a]	Grayling	Non-grayling Species[b]	Grayling	Non-grayling Species[c]
Intercept	5.5662	6.1371	3.5818	4.5142	5.9825	6.2185
SE	2.0127	1.8099	0.9244	0.9482	2.2130	2.2191
(t-stat)	(2.7659)	(3.3912)	(3.8743)	(4.7603)	(2.7037)	(2.8018)
Ln(BID)	-0.8118	-0.9125	-1.0250	-1.0598	-1.3766	-1.3365
SE	0.3581	0.3092	0.2276	0.2263	0.4787	0.5138
(t-stat)	(2.2672)	(2.9513)	(4.505)	(4.6840)	(2.876)	(2.6019)
Chi-square degrees of freedom	5	5	5	4	4	4
Chi-square statistic	5.15	4.28	3.44	2.19	6.08	4.94
P-statistic	0.40	0.51	0.63	0.70	0.19	0.30
Sample size	37	55	94	91	34	31

[a] Salmon (49.1%), jack chinook salmon which are frequently misidentified as rainbow trout (M. Doxey, ADF&G, Fairbanks, personal communication) (14.5%), and northern pike (9.1%) were the primary species indicated for "non-grayling" fishing trips on the Chena River by nonresidents.

[b] Salmon (45.1%), jack chinook salmon which are frequently misidentified as rainbow trout (M. Doxey, ADF&G, Fairbanks, personal communication) (15.4%) and northern pike (9.9%) were the primary species indicated for "non-grayling" fishing trips on the Chena River by remainder of Region III residents.

[c] Pike (37.8%) and salmon (27.6%) were the primary species indicated for "non-grayling" fishing trips on the Chatanika River by remainder of Region III residents.

Table 13b.-Estimates of adjusted mean net economic value for a fishing trip to individual rivers in Region III, by population, for trips specifically targeting grayling, 1996.

Water Fished/ *Population*	Mean NEV [a] (standard error)[b]	Percent of respondents with NEV greater than expenses	Adjusted mean NEV per trip
Chena River / *Nonresident* Grayling	$596.11 (131.19)	81.0%	$482.85 (106.19)
Chena River / *Nonresident* Non-grayling Species	$630.12 (81.59)	81.4%	$512.92 (66.41)
Chena River / *Remainder of Region III* Grayling	$100.22 (24.63)	77.9%	$78.07 (19.19)
Chena River / *Remainder of Region III* Non-grayling Species	$142.85 (25.22)	76.9%	$109.85 (19.39)
Chatanika River / *Remainder of Region III* Grayling	$149.27 (40.39)	77.8%	$116.13 (31.42)
Chatanika River / *Remainder of Region III* Non-grayling Species	$201.81 (71.46)	69.4%	$140.06 (49.59)

[a] Mean NEV measures are truncated means, truncated at the highest bid level.

[b] Standard errors are based on 200 bootstrap iterations following the methodology of Duffield and Patterson (1991).

percentile or greater. Models not meeting this level of significance due to insufficient samples are not reported. The estimated bootstrapped standard errors of the mean NEV estimates are estimated based on the procedures suggested by Duffield and Patterson (1991), and are also reported below.

The final models of NEV are presented in six pairs of tables (Tables 8a and b through 13a and b). These tables report the estimated model parameters, as well as the mean NEV estimates based on these models. Each of the six pairs of NEV tables contains a (a) table reporting the estimated model parameters and goodness-of-fit statistics, and a (b) table reporting the estimated truncated mean NEV estimate (truncated at the maximum bid level per the discussion in Appendix A). Also included in the (b) tables are the adjusted mean NEV estimates. These estimates are adjusted for the percent of respondents in each model who said that their most recent trip was not worth more than they spent on it. Those giving this response were not asked the CVM question, and thus their "zero" NEV must be factored into the NEV estimate for those other respondents who all had a positive NEV. Therefore, the adjusted mean NEV estimate includes all respondents, those with a positive and those with a zero NEV. Associated with the adjusted mean NEV estimates are bootstrapped standard errors which are calculated under the assumption that the percent of respondents in the targeted population with a zero NEV is constant. The standard errors in the b tables, 8 to 13, are computed using a standard variance formula. The first set of tables, 8a and 8b, show the estimates for each of the five populations considering all trips taken to Region III.

The estimated coefficients for these models are all significant at the 95% level of confidence. For the chi-square coefficient the null hypothesis is one of general association (i.e., the estimated model fits the logistic functional form). With a p statistic greater than 0.05, the model fits the data at the 95% confidence level; with a $p < 0.05$, the null hypothesis is rejected and the model does not fit particularly well.

Of particular interest in this study is the question of whether Region III fishing trips that specifically target grayling are valued differently than those trips targeting species other than grayling. Tables 9a and 9b show estimated models and mean NEV estimates for fishing trips made by the nonresident and remainder of Region III populations in which grayling were the primarily targeted species. Additionally, these tables show models and estimates for trips by these strata where non-grayling species were targeted. Only the nonresident and remainder of Region III resident models had adequate sample sizes to provide reliable NEV measures and estimated models. The estimated mean NEV for trips on which grayling are the primary targeted species are very similar to those for trips targeting non-grayling. The “non-grayling” species identified by respondents was primarily salmon. From creel surveys, it has been observed that jack chinook salmon are frequently misidentified as rainbow trout (M. Doxey, ADF&G, Fairbanks, personal communication). This is clearly the case for the Chena River, where rainbow trout do not occur, yet were listed as targeted. Northern pike are the second-most targeted non-grayling species following salmon. Given the estimates and associated standard errors, it appears that most Region III residents, as well as nonresident anglers, value fishing for grayling in Region III nearly as highly as they value fishing trips targeting nongrayling species, comprised primarily of salmon**.**

Tables 10a and 10b show estimated models and mean NEV measures for trips to specific areas of Region III for all species. Models with an adequate number of observations included one for

trips made by Seward Peninsula residents to Seward Peninsula, trips by nonresidents to the Tanana area, and trips by remainder of Region III residents to the Tanana area. In general, average NEV measures for the area specific trips made by these populations closely follow the NEV estimates for these populations to all Region III waters. This was expected as a large portion of the Region III trips made by residents of the Seward Peninsula (for instance) were made to streams on the Seward Peninsula. Thus these trips dominate the NEV calculations for Seward Peninsula resident trips to all Region III waters.

Tables 11a and 11b show estimated models and mean NEV measures for trips to the Tanana area specifically targeting grayling. Of the six geographic areas, only the Tanana had sufficient observations for estimating the NEV for trips targeting grayling. Of the populations sampled, only nonresidents and remainder of Region III residents had adequate sample sizes for Tanana grayling NEV models. While the model for the remainder of Region III population does not fit particularly well, the estimated coefficients are highly significant.

Tables 12a and b, and 13a and b show the results of water-specific NEV modeling. Water-specific models of NEV were estimated for the Chena, Nome, Chatanika, Salcha, and Delta-Clearwater rivers for trips targeting any species, and for the Chena and Chatanika rivers for trips targeting grayling. Examination of Tables 12b and 13b show that trips to the Chena and Chatanika rivers which target grayling are not valued significantly different from the set of all trips to these waters. This finding is consistent with that reported in Tables 8b and 9b.

In summary, an examination of the models and mean NEV estimates reported in Tables 8a through 13b show two clear and consistent patterns:

1. nonresidents value their fishing trips to Region III significantly more highly than do Region III residents. This is consistent with the findings of many other recreational NEV studies; and,
2. fishing trips in Region III on which grayling are the targeted species are valued much the same as the Region III fishing trips targeting non-grayling species – primarily salmon.

4.5 Total Net Economic Value Estimates

4.5.1 Total Trip Estimates

The ADF&G conducts an annual survey of sport fishing trips in the state however, estimates of trips reported in the statewide harvest survey (Howe et al. *In press*) are for household-trips. Estimates of angler-trips per household trip for the five populations were approximated following the equations documented in Appendix D. The annual statewide harvest survey does not directly estimate angler use by species, therefore, estimates of grayling angler-trips were used from this survey.

4.5.2 Total Estimated Net Economic Value of Fishing Trips to Study Waters

The NEV per trip estimates shown in Tables 8a and 8b can be used in conjunction with annual trip estimates derived by ADF&G (shown in Table 14) to estimate the total annual NEV of sport fishing for all species in Region III (Table 15).

Overall, 1996 sport fishing for all species in Region III is estimated to have a total NEV of approximately $28.8 million. Of this total, approximately 33.9% is attributable to nonresident

fishing trips. Of the 66.1% of estimated value attributable to Alaska residents, 7.4% is from Region I and II anglers fishing in Region III, and the remaining 58.7% is from Region III residents angling within the region.

The NEV per trip estimates shown in Table 9b can be used in conjunction with annual trip estimates targeting grayling derived by this survey (shown in Table 14) to estimate the total annual NEV of sport fishing for grayling of two populations in Region III (Table 15). In 1996, the total NEV for grayling fishing in Region III by nonresidents was $2.2 million and for the remainder of Region III resident population was $5.8 million, 22.6% and 37.8%, respectively, of their total NEV for sport fishing for all species in Region III. Because models could not be developed within established criteria for Seward Peninsula, northwest and Regions I and II residents specifically targeting grayling, a total NEV of sport fishing for grayling in Region III could not be estimated, however, the total is at least $8 million. Assuming that the fraction of total species valuation designated for grayling is roughly similar among resident populations (1/3), then the total NEV for grayling for all populations is likely close to $8.5 million in 1996.

Table 14.-Estimates of sport fishing trips to Region III for angler populations, 1996.

Sample Population	Estimated angler-trips (standard error)[a]	Estimated percent grayling fishing trips[b]	Estimated total grayling fishing trips[c]
Seward Peninsula Residents	8,618 (627)	5.6	483
Northwest Alaska Residents	841 (183)	5.8	49
Remainder of Region III Residents	126,310 (2,678)	37.4	47,240
Nonresidents	16,531 (701)	23.9	3,951
Regions I and II Residents	11,077 (639)	33.3	3,692
Total	163,377		55,415

[a] Howe et al. (*In press*)

[b] Derived from this survey.

[c] Product of 1996 angler-trip estimates and estimates of percent grayling fishing trips.

Table 15.-Estimated total net economic value of sport fishing in Region III for all species and for grayling, 1996.

Population	Total Estimated Net Economic Value for All Species (Standard Error)[a]	Total Estimated Net Economic Value for Grayling [b]
Seward Peninsula Residents	$1,290,028 (139,538)	--
Northwest Alaska Residents	$231,090 (60,325)	--
Remainder of Region III Residents	$15,392,137 (968,783)	$5,821,858
Nonresidents	$9,767,176 (566,963)	$2,208,925
Regions I and II Residents	$2,129,553 (354,496)	--
Total of all subgroups	$28,809,984 (1,186,914)	☜ $8,030,783 [c]

[a] Product of NEV in Table 8b and angler-trips in Table 14.

[b] Product of NEV in Table 9b and grayling trips in Table 14. Only estimates for two populations could be derived for grayling.

[c] Total is at least $8.0 million. Assuming that the fraction of total species valuation designated for grayling is roughly similar among resident populations (1/3), then the total NEV for grayling for all populations is likely close to $8.5 million.

Three populations generated 117,911 trips to sport fish in the Tanana area in 1996: remainder of Region III residents (89.6%), nonresidents (7.1%) and Region I and II residents (3.3%; Howe et al. *In press*). However, only NEVs per trip were generated for the first two populations (see Table 10b); too few Region I and II residents were sampled in this survey to estimate their NEV per trip to the Tanana area. Although few in number (3,840), omitting the estimated trips taken by Region I and II residents to the Tanana area in 1996 would undervalue total NEV for the Tanana area. Therefore, to get a measure of total NEV in the Tanana closer to the true value, Region I and II trips were conservatively valued the same as remainder of Region III residents for all species ($103.37) and grayling ($107.09) and included in the calculation of total NEV for the Tanana area. These inferred NEVs per trip are conservative because for any area in Region III, Region I and II residents have higher NEVs per trip than the remainder of Region III population (see Table 8b), although not significantly so. The total NEV for sport fishing for all species in the Tanana area was estimated at $15.7 million in 1996 (Table 16), which represents 54.6% of the total estimated regional NEV of $28.8 million. The total NEV for sport fishing for grayling in the Tanana area was estimated at $3.5 million in 1996 (Table 17).

Three populations generated 28,261 trips to sport fish in the Chena River in 1996: remainder of Region III residents (91.7%), nonresidents (7.6%) and Region I and II residents (0.7%; Howe et al. *In press*). Only NEVs per trip were generated for the first two populations (see Table 12b). Although few in number (192) omitting the estimated trips taken by Region I and II residents to the Chena River in 1996 would undervalue total NEV for the river. Therefore, to get a measure of total NEV for all species in the Chena River closer to the true value, Region I and II trips were conservatively valued the same as remainder of Region III residents for all species ($88.28) and grayling ($78.07) and included in the calculation of total NEV for the Chena River. The total NEV for sport fishing for all species in the Chena River was estimated at $3.4 million in 1996 (Table 16), which represents 21.7% of the total estimated NEV for the Tanana area ($15.7 million) and 11.8% of the total estimated NEV for the region ($28.8 million). The total NEV for sport fishing for grayling in the Chena River was estimated at $1.1 million in 1996 (Table 17) which is 31.8% of the total estimated NEV for grayling in the Tanana area.

Table 16.-Estimated net economic value of sport fishing for all species in the Tanana area, and specifically in the Chena River, 1996.

Residency	Estimated angler trips[a]	NEV/Trip	Total NEV
Tanana Area			
Remainder of Region III Residents	105,682	$103.37[b]	$10,924,348
Nonresidents	8,389	$524.06[b]	$4,396,339
Region I and II Residents	3,840	$103.37[d]	❿ $398,208
Total	117,911	--	$15,718,895
Chena River			
Remainder of Region III Residents	25,915	$88.28[c]	$2,287,776
Nonresidents	2,154	$511.34[c]	$1,101,426
Region I and II Residents	192	$88.28[c]	❿ $16,950
Total	28,261	--	$3,406,152

[a] Howe et al. (*In press*)

[b] NEVs from Table 10b.

[c] NEVs from Table 12b.

[d] NEV for the Region I and II population is assumed at least that estimated for the remainder of Region III population.

Table 17.-Estimated net economic value of sport fishing for grayling in the Tanana area, and specifically in the Chena River, 1996.

Residency	Estimated angler trips [a]	Percent trips targeting grayling [b]	NEV/Trip	Total NEV
Tanana Area				
Remainder of Region III Residents	105,682	20.5	$107.09 [c]	$2,320,105
Nonresidents	8,389	24.5	$547.58 [c]	$1,125,277
Region I and II Residents	3,840	20.5	$107.09 [e]	❿ $84,280
Total	117,911			$3,529,662
Chena River				
Remainder of Region III Residents	25,915	35.3	$78.07 [d]	$714,184
Nonresidents	2,154	38.7	$482.85 [d]	$402,697
Region I and II Residents	192	35.3	$78.07 [e]	❿ $5,309
Total	28,261		--	$1,122,190

[a] Howe et al. (*In press*)

[b] Calculated from the use survey (Howe and Fleischman *In prep*); populations are reported as nonresident and resident only.

[c] NEVs from Table 11b.

[d] NEVs from Table 13b.

[e] NEV for the Region I and II population is assumed at least that estimated for the remainder of Region III population.

4.5.2 Benefit/Cost Ratios

The cost basis was limited to those activities relating to research and management of grayling fisheries in Region III (Table 18). Management costs were estimated from the proportion of time spent by individual managers on grayling management by geographic area. Not included are indirect costs associated with supervision and administration.

Benefit/cost ratios were examined for the entire region, and for the Tanana area[2]. The majority (❿75%) of research and management funds expended on grayling occur in the Tanana area because this area supports the greatest angling pressure for grayling. The estimated benefit/cost ratio for grayling in the Tanana area was 5.4 in FY97. Although the total estimated NEV for grayling in Region III could not be estimated due to small numbers of observations in three populations, nevertheless if one sums the total NEV for the remainder of Region III and

[2] Cost accounting procedures are established to provide sufficient assessment of research and management costs on an area basis, however these procedures are not sufficiently detailed to give costs on a river basis.

nonresident populations ($8.0 million) and divides by the regional costs, the estimated benefit/cost ratio for grayling in Region III was at least 21 in FY 97. Obviously, the benefits of Region III's grayling research and management program outweigh the costs to a high degree.

Table 18.-The cost basis used to evaluate the benefit/cost ratio for program planning relating to grayling research and management in Region III and in the Tanana area, for fiscal year 1997.

Budget Component	FY97
Total Region III	
Research	$288,000
Management [a]	$78,200
Total	$366,200
Tanana Area	
Research	$241,900
Management	$49,800
Total	$267,100

[a] Computed from the estimated amount of time each of four area managers normally spend on grayling management within their respective areas per fiscal year (total allocation x percentage of time). These estimated percentages are: lower Tanana-20%, upper Tanana-22%, northwest-10%, AYK-20%.

4.7 Stated Preferences for Various Management Options

In section III of the survey, respondents were asked their preferences for various management options for grayling fishing in area waters. The statistics presented in Table 19 represent the percentage of respondents who rated a particular management option as a 4 or a 5 on a 1 to 5 scale with 1 being least preferred and 5 being most preferred.

Table 19.-Percent of respondents who preferred alternative options for grayling fishery management in areas of Region III, 1996.

Management action	Respondent population[a]				
	Seward Peninsula	Northwest[b]	Non-residents	Region III	Regions I & II
Options for Tanana drainage streams					
Status Quo	34.10%	50.00%	46.40%	42.00%	49.40%
Catch and release only	50.00%	45.50%	48.50%	48.70%	41.30%
Most frequently cited stream for catch and release (number of times cited)	--[c]	--	Chena R. (11)	Chena R. (124)	Chena R. (10)
Manage streams for harvest	39.40%	10.00%	31.00%	42.20%	50.20%
Most frequently cited stream for harvest (number of times cited)	--	--	Chena R. (11)	Chena R. (98)	Chena R. (7)
Options for Dalton Highway streams					
Status Quo	32.30%	44.40%	45.50%	41.30%	43.40%
Harvest 1 fish per day, no size limit	34.60%	25.00%	36.80%	29.20%	34.00%
Catch and release only	40.70%	66.70%	45.90%	32.60%	27.30%
Options for Seward Peninsula streams					
Status Quo	60.90%	68.80%	53.50%	42.20%	50.80%
Catch and release only	33.80%	26.70%	51.00%	29.60%	31.40%
Most frequently cited stream for catch and release (number of times cited)	Nome R. (30)	--	--	--	--
Manage streams for harvest	40.90%	26.70%	27.50%	25.70%	27.60%
Most frequently cited stream for harvest (number of times cited)	Nome R. (29)	--	--	--	--

[a] Statistics represent the percentage of respondents who rated a particular management option as most preferred (a “4” or a “5”).

[b] Statistics for the Northwest area are based on a small number of responses and should be interpreted cautiously.

[c] Cells marked with dashes had less than five observations and are thus omitted.

There seems to be fairly strong support for a range of management actions. Those respondents from the remainder of Region III were divided nearly evenly between preferences for managing for harvest (42.2%), and managing as catch and release (48.7%) on Tanana drainage streams. For this population, the most frequently cited stream for catch and release management was the Chena River (cited 124 times). On the other hand, the Chena was also the most frequently cited Tanana drainage stream for management for harvest (cited 98 times). Thus, there are conflicting preferences for management, nearly evenly divided, for managing grayling in Tanana waters. Residents on the Seward Peninsula favor managing streams for harvest (40.9%); however, catch and release management for grayling is preferred by 33.8%. The Nome River was the most frequently cited stream for both catch and release management (cited 30 times) and for harvest management (cited 29 times). Nonresident anglers consistently preferred catch and release management over harvest management. Preference for status quo management is rated high by residents in both Tanana (42.0%) and especially Seward Peninsula (60.9%) areas.

4.8 Analysis of Contingent Behavior Responses

Respondents were asked to predict how their visitation to specific waters would change under certain regulation alternatives for the Chena, Nome, and Delta Clearwater rivers (Questions 19-22). On occasion respondents will include a letter or write comments in the margins of the survey relating their opinions on a particular question in more detail or on another topic. Appendix E is a summary of respondent comments grouped by topic.

The first contingent behavior question (Question 19) asked anglers how three proposed changes to the current catch and release regulation for grayling in the Chena River would affect their visitation to the Chena River. Nearly a quarter of respondents (23%) said they would not fish for grayling on the Chena River regardless of regulation changes. A large majority (77.7-87.5%) of respondents indicated that there would be no change in their number of trips taken to the Chena River under the hypothetical changes (Figures 2a-2c)[3]. The approximately 10-20% of remaining respondents indicated a preference for catch and release regulations but also indicated they would change the number of trips taken under alternative management options. These last responses are not inconsistent (an analogous statement might, for example, be "I do not support a cut in capital gains tax rates, but if enacted, I would take advantage of those lower rates"), but they do present fisheries managers with two slightly different ways to evaluate policy: based on preferences for various management options, and estimated changes in fishing trips.

Overall, it is estimated that regulations allowing for harvest of one fish per day would lead to a 16.3% increase in visitation from the remainder of Region III population. Harvest of two fish, one over 15 inches would lead to a 28.7% increase, and maintaining catch and release on the upper river but opening the lower river to harvest would lead to a 10.7% increase. It should be noted that 30.1% of respondents stated that any increases to area waters from regulation changes would come at the cost of trips to other waters. Among respondents, 48.1% stated that they

[3] Those respondents who checked the box "I would not fish for grayling on the Chena River regardless of regulation changes" were logically assumed to have no changes in visitation under the three options. For those who checked the box "I support continued catch and release grayling fishing on the Chena River to further boost population numbers," two possible actions were taken. If the respondent checked this box and entered no trip estimates in parts 1, 2, or 3 it was assumed that that individual would not change the number of trips taken under each of the options. If, however, the respondent checked this box *and* also wrote in a change in number of trips in parts 1, 2, or 3, then the responses were left as the respondent wrote them.

supported continued catch and release on the Chena River to further boost grayling population numbers (Table 20).

Table 20.-Responses to management options for grayling fishing on the Chena River for the remainder of Region III respondents[a] (standard errors are in parentheses).

	Harvest 1 fish per day, no size limit	Harvest 2 fish per day, 1 over 15 inches	Catch and release with lower river open to harvest
Average reported increase in number of trips per year under new regulations	0.47 (0.09)	0.83 (0.17)	0.31 (0.07)
Estimated percent increase in number of trips per year under new regulations	16.3%	28.7%	10.7%
Sample size	716	741	686
Average reported number of trips per year to the Chena River for all species		2.89	
Respondents who support continued catch and release regulations on the Chena River		48.1%	
Respondents who would not fish for grayling on the Chena River regardless of regulations		23.0%	

[a] Exclusive of responses from Seward Peninsula and Northwest Alaska.

The second contingent behavior question (Question 20) asked anglers how three proposed changes to the current closure to any grayling fishing in the Nome River would affect their visitation to the Nome River. Over a third of respondents (36.6%) said they would not fish for grayling on the Nome River regardless of regulation changes (Table 21). A large majority (87.9-93.2%) of respondents indicated there would be no change in their number of trips taken to the Nome River under the hypothetical changes (Figures 3a-3c)[4]. The remaining respondents indicated a preference for grayling closure but also indicated they would change the number of trips taken under alternative management strategies.

Overall, it is estimated that regulations allowing for harvest of one fish per day would lead to a 6.0% increase in visitation from Seward Peninsula residents to the Nome River (the Nome River already sees heavy use by area residents fishing for other species of fish). Harvest of two fish, one over 15 inches would lead to a 9.1% increase and instituting catch and release regulations

[4] Those respondents who checked the box "I would not fish for grayling on the Nome River regardless of regulation changes" were logically assumed to have no changes in visitation under the three options. Those respondents who checked the box "I support continued grayling closure on the Nome River to further boost population numbers," two possible actions were taken. If the respondent checked this box and entered no trip estimates in parts 1, 2, or 3 then it was assumed that individual would not change the number of trips taken under each of the options. If, however, the respondent checked this box *and* also wrote in change in number of trips estimates in parts 1, 2, or 3, then the responses were left as the respondent wrote them.

would lead to a 6.8% increase (Table 21). It should be noted that 27.8% of respondents in this population stated that any increases to area waters from regulation changes would come at the cost of trips to other waters. Among respondents, 47.8% stated that they supported continued closure of grayling fishing on the Nome River to further boost population numbers (Table 21).

Table 21.-Responses to management options for grayling fishing on the Nome River for Seward Peninsula respondents (standard errors are in parentheses).

	Harvest 1 fish per day, no size limit	Harvest 2 fish per day, 1 over 15 inches	Catch and release only
Average reported increase in number of trips per year under new regulations	0.43 (0.13)	0.65 (0.16)	0.49 (0.18)
Estimated percent increase in number of trips per year under new regulations	6.0%	9.1%	6.8%
Sample size	252	262	251
Average reported number of trips per year to the Nome River for all species		7.18	
Respondents who support continued closure of Nome R. grayling fishing		47.8%	
Respondents who would not fish for grayling on the Nome River regardless of regulations		36.6%	

The third contingent behavior question (Question 21) asked anglers how the implementation of a catch and release regulation for grayling in the Delta Clearwater River would affect their visitation to the Delta Clearwater River. Over a third of respondents (37.8%) said they would not fish for grayling on the Delta Clearwater River regardless of regulation changes (Table 22). A large majority (86.9%) of respondents indicated there would be no change in their number of trips taken to the Delta Clearwater River under the hypothetical change (Figure 4). It is estimated that visitation to the Delta Clearwater River would increase by 23% under catch and release regulations. The relative size of the standard error on the estimated change in the annual number of trips per respondent is quite large, however, and thus this estimate should be interpreted with caution. It should also be noted that 30.1% of respondents in this population stated that any increases to area waters from regulation changes would come at the cost of trips to other waters.

Table 22.-Responses to management options for grayling fishing on the Delta Clearwater River for the remainder of Region III [a] respondents.

	Catch and release only (potential for more and bigger fish)
Average reported change in number of trips per year under new regulations	0.13 (0.07)
Estimated percent change in number of trips per year under new regulations	23.0%
Sample size	620
Average reported number of trips per year to the Delta Clearwater River	0.57
Respondents who would not fish for grayling on the Delta Clearwater River regardless of regulations	37.8%

[a] Exclusive of responses from Seward Peninsula and Northwest Alaska.

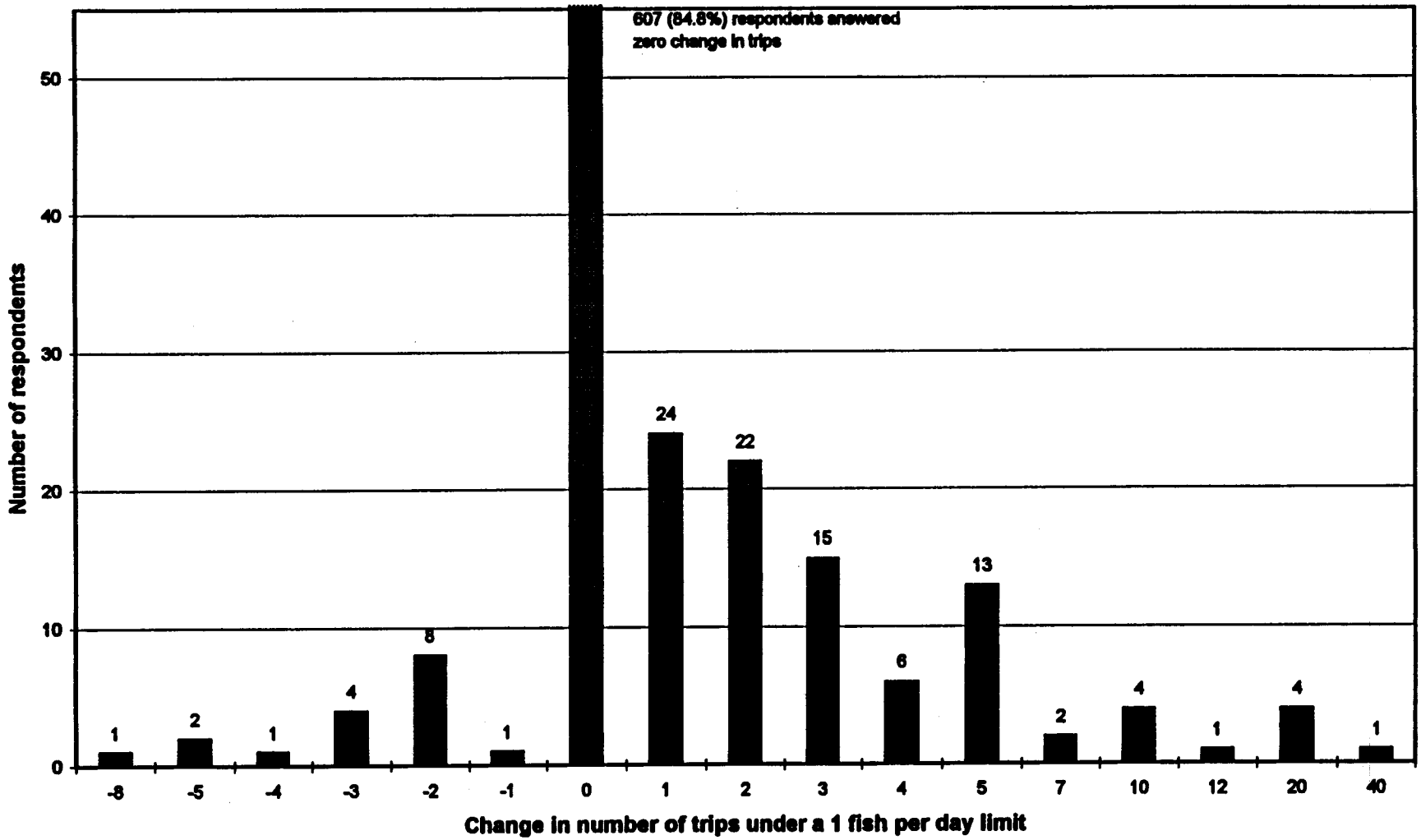

Figure 2a.-Reported change in number of trips to the Chena River under a 1 fish per day limit.

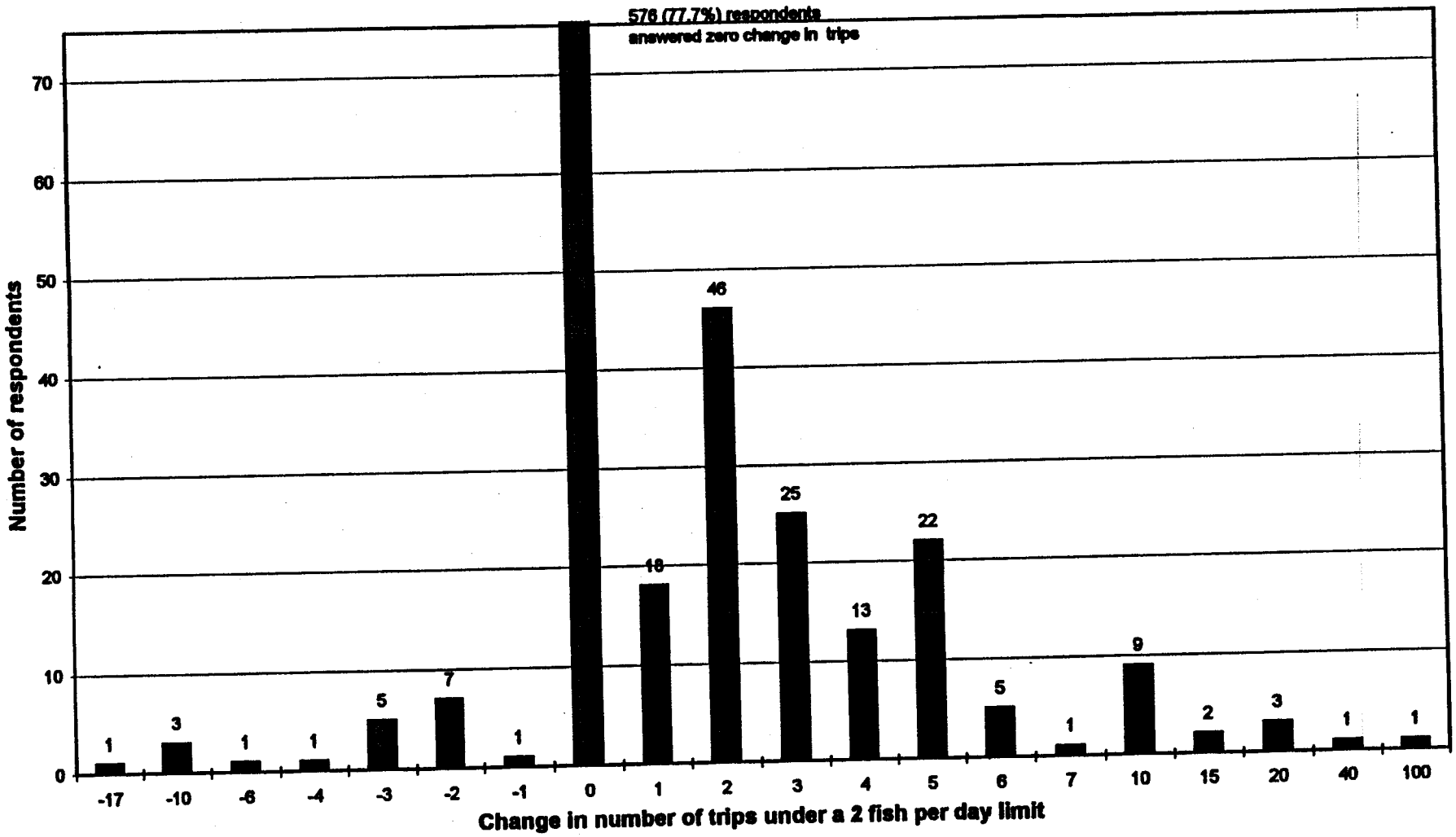

Figure 2b.-Reported change in number of trips to the Chena River under a 2 fish per day limit.

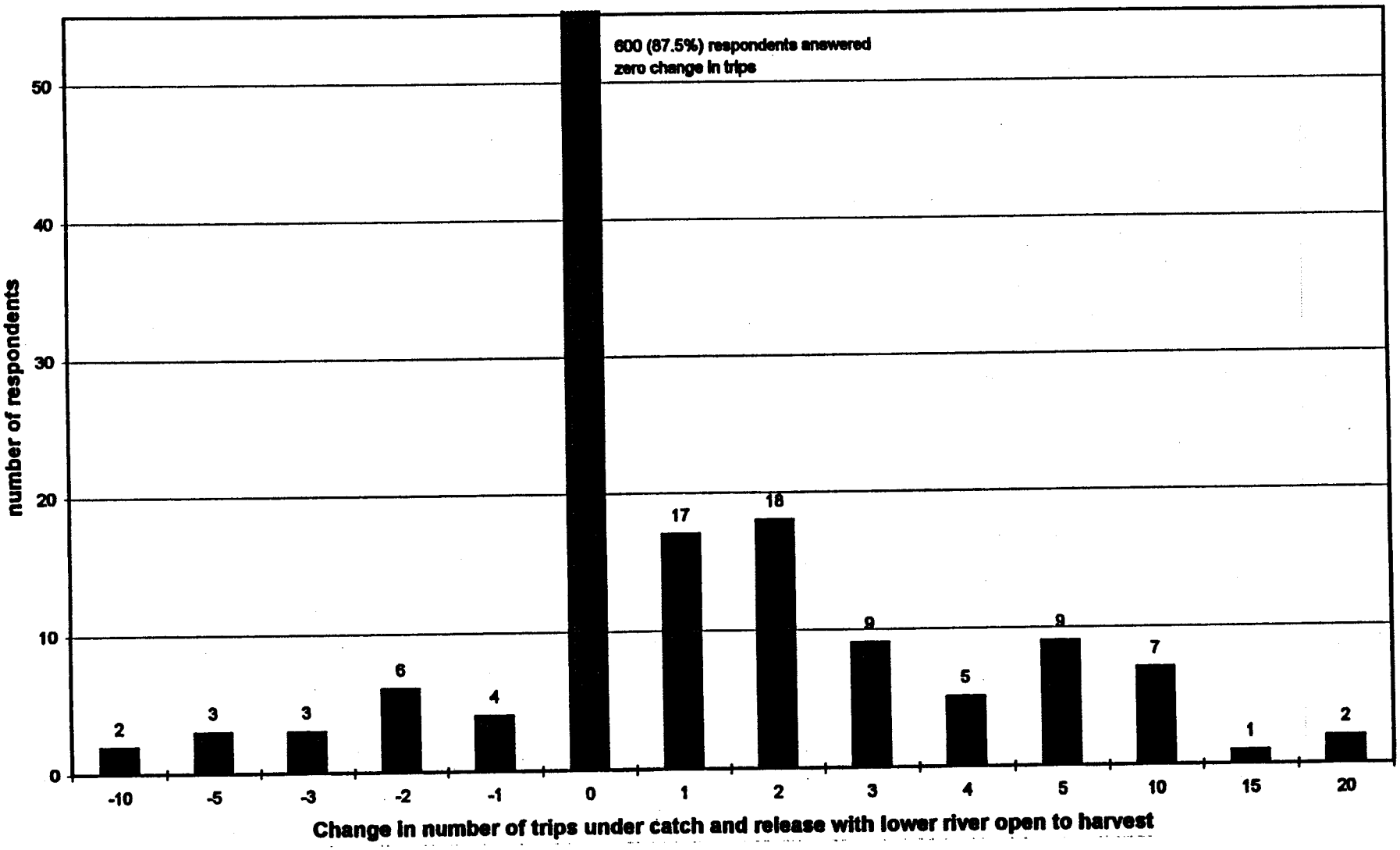

Figure 2c.-Reported change in number of trips to the Chena River under catch and release with lower river open to harvest.

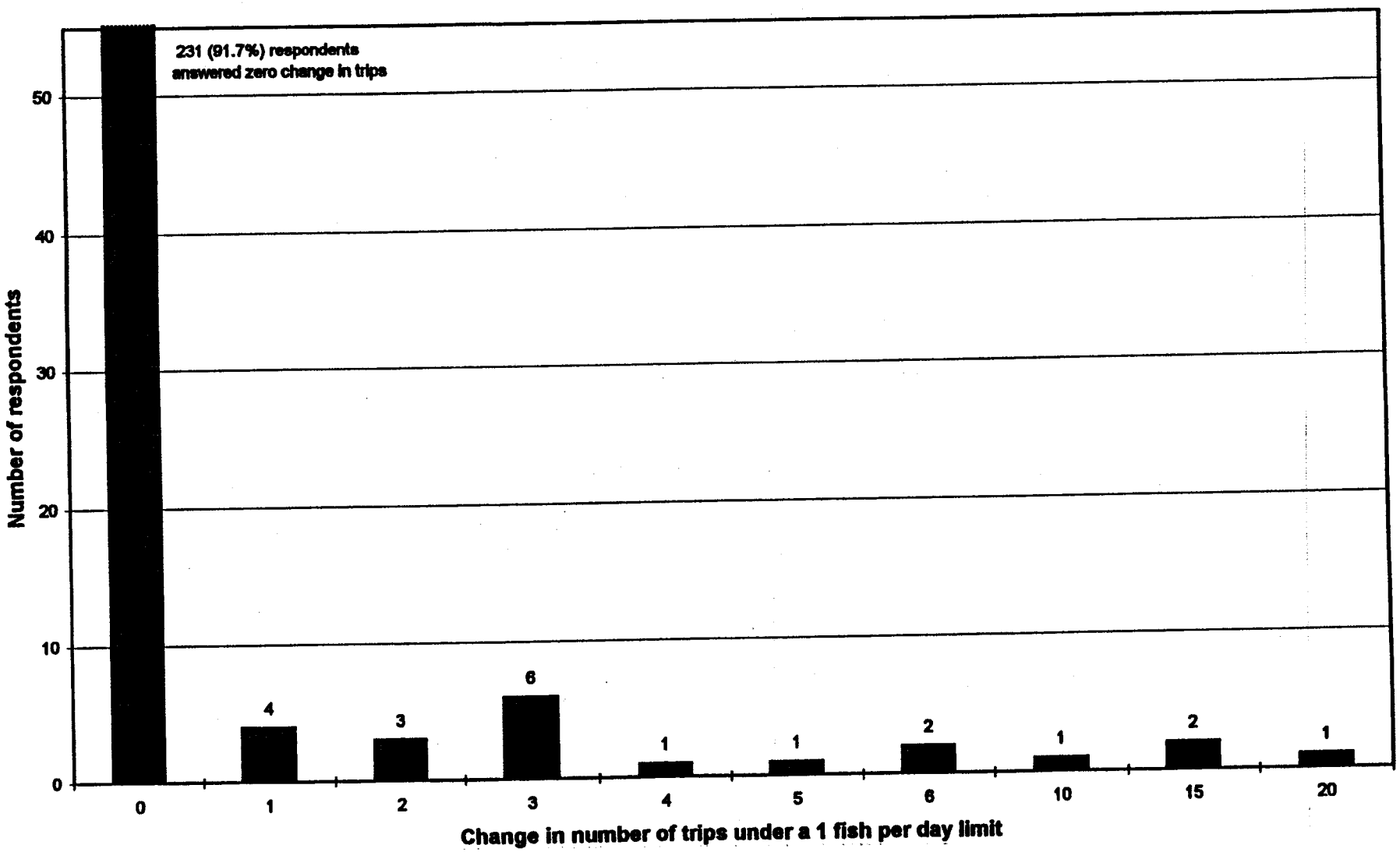

Figure 3a.-Reported change in number of trips to the Nome River under a 1 fish per day limit, by respondents from the Seward Peninsula.

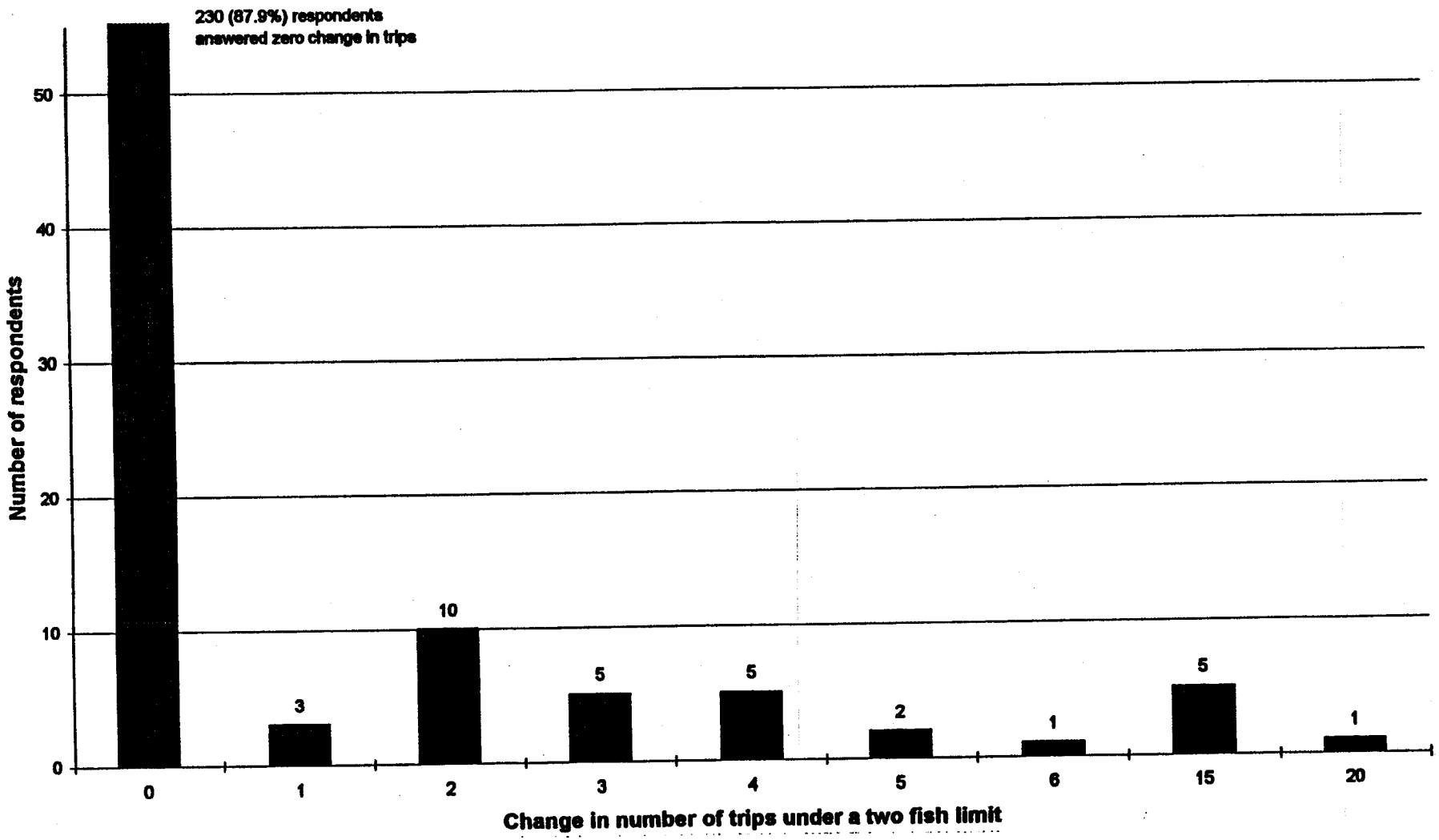

Figure 3b.-Reported change in number of trips to the Nome River under a 2 fish per day limit, by respondents from the Seward Peninsula.

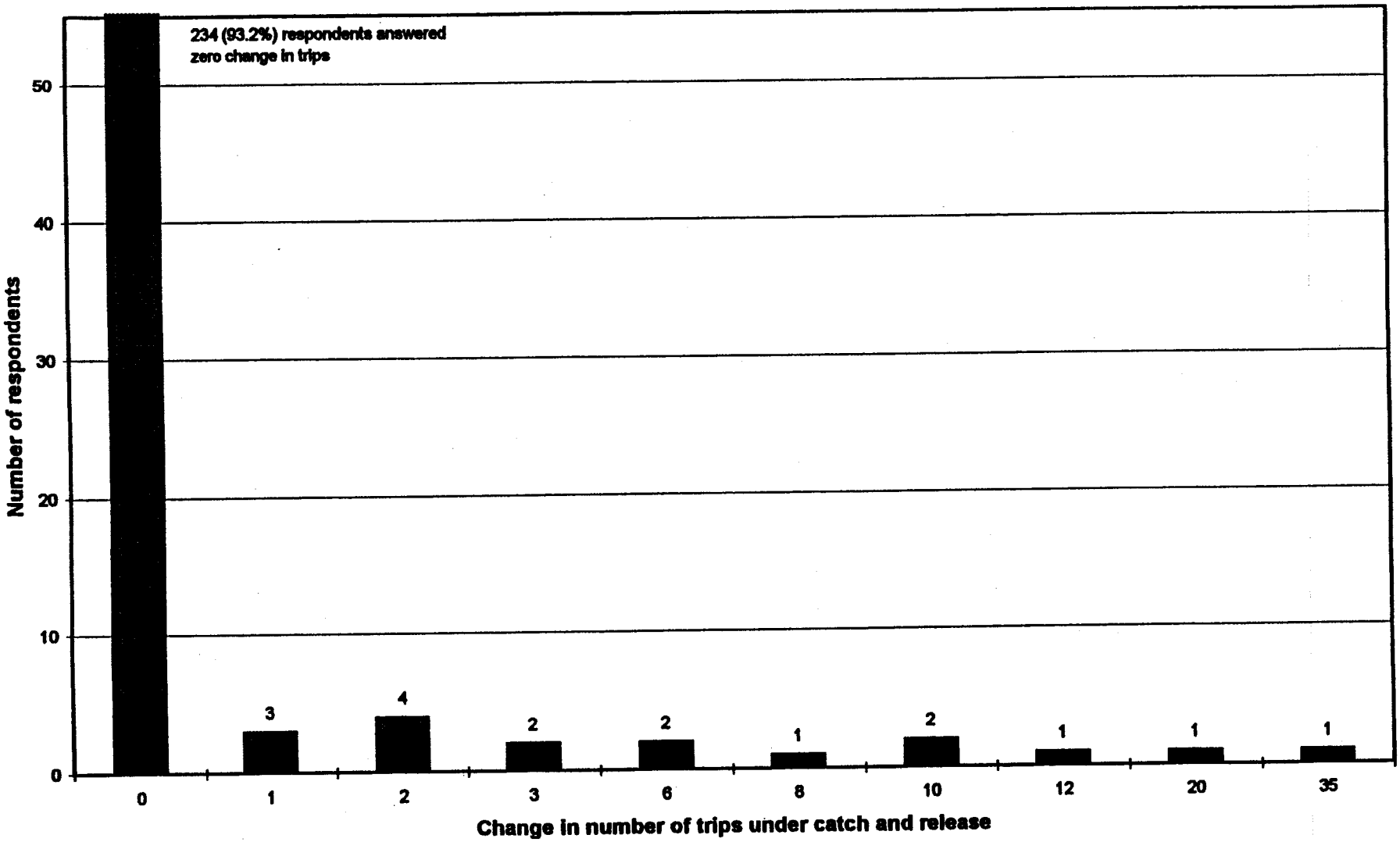

Figure 3c.-Reported change in number of trips to the Nome River under catch and release, by respondents from the Seward Peninsula.

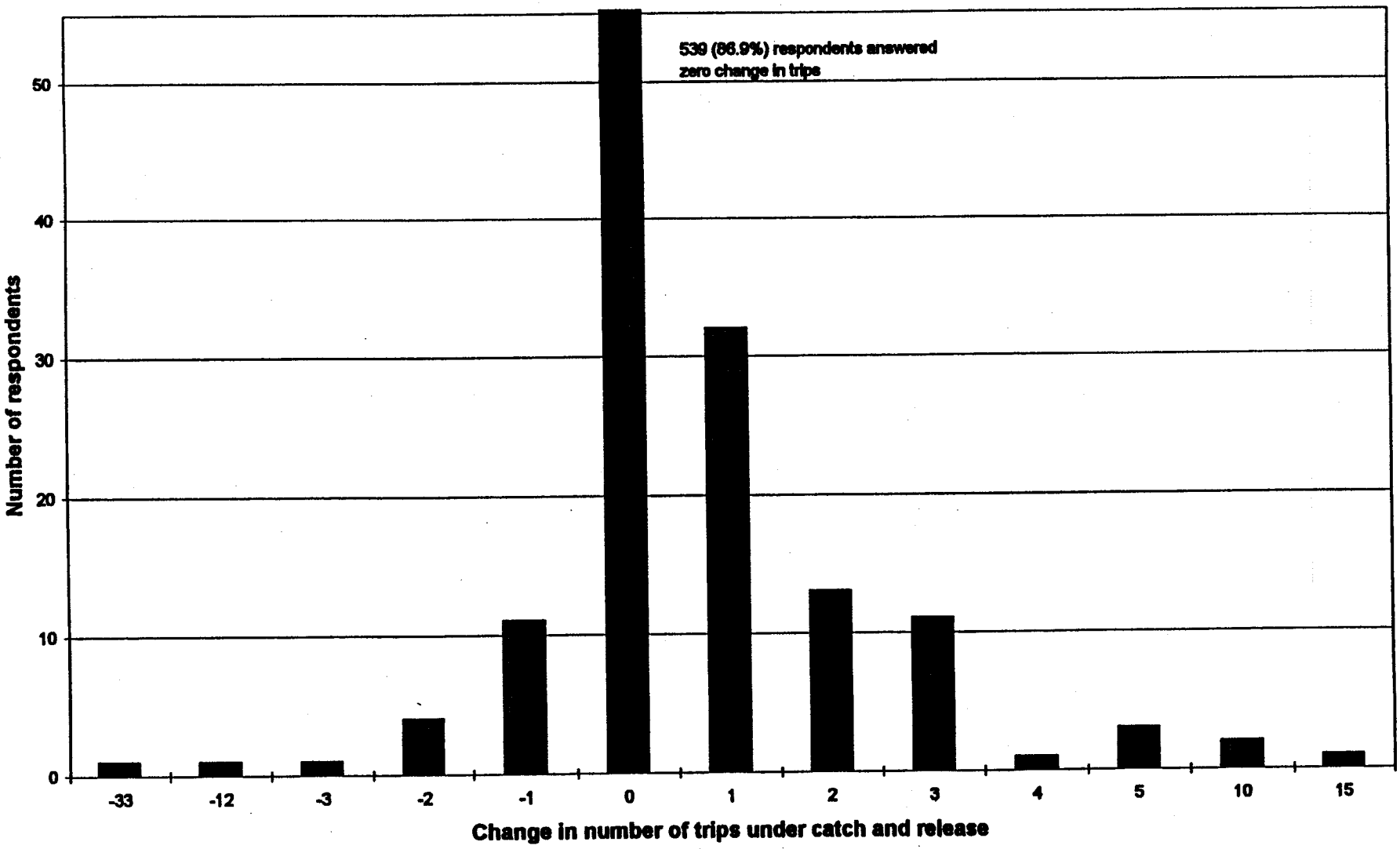

Figure 4.-Reported change in the number of trips to the Delta Clearwater River under catch and release management for grayling.

5.0 DISCUSSION

5.1 Total Net Economic Value of Sport Fishing and Benefit/Cost Analysis

The primary goal of this study was the estimation of public benefits as NEV that anglers of Region III waters place on their sport fishing experiences. Few studies to estimate the nonmarket value of sport fishing trips in Alaska have been conducted. In 1986, Jones and Stokes conducted sport fishing economic studies under contract to ADF&G in southeast and southcentral Alaska (Jones and Stokes 1987). More recently, in 1995 the authors conducted a socioeconomic analysis of major stocked waters in interior Alaska (Duffield et al. 2001).

Non-resident anglers have a higher NEV ($483-$600) for trips than other Alaska anglers (ranging from $81 to $275). This is consistent with the findings of many previous studies of recreational NEV (see for example Duffield and Neher 1994, Duffield et al. 1992, and Duffield 1992). The adjusted mean NEV estimates shown in Table 8b are also quite consistent in magnitude to estimates of the value of cold water fishing in Montana. In a study conducted by Duffield et al. (1992) it was estimated that resident float anglers on the Bitterroot River had a NEV of $48 per trip and non-resident float anglers on the same river had a NEV of $236 per trip. In the same study it was estimated that NEV values on the Big Hole River were $87 per trip for resident float anglers and $540 per trip for non-resident float anglers. In 1994, Duffield and Neher estimated that on the Bighorn River of Montana resident anglers had a NEV of $199 per trip and non-resident anglers had a NEV of $564 per trip. Among Alaska residents, mean NEVs vary considerably, with residents of northwest Alaska valuing their sport fishing trips the greatest.

In 1996, sport fishing for all species in Region III is estimated to have a total NEV of $28.8 million. A large portion of this value is in the Tanana area ($15.7 million); the Chena River, tributary to the Tanana area that flows through Fairbanks, has a total NEV for all sport fishing of $3.4 million.

Sport fishing for grayling in Region III has a total NEV value of at least $8.0 million, and assuming that the fraction of total species valuation designated for grayling is roughly similar among resident populations (1/3), then the total NEV for grayling for all populations in Region III is likely close to $8.5 million in 1996. The estimated total NEV for sport fishing for grayling in the Tanana area is $3.5 million; one third of that value is in the grayling sport fishery in the Chena River ($1.1 million).

The NEV is influenced by changes in site attributes, substitute fishing sites, and the regional wealth. If these factors remain relatively stable, there is no reason to believe that the NEV has changed. Because total net economic benefits is a product of the NEV and angler trips, variability in angler trips plays an important role in the total net economic benefits for sport fishing in Region III.

Objectives in fishery management plans state that, in addition to managing for sustainable harvests and maintaining access, public benefits will outweigh management costs. The problem, then was to estimate public benefits in dollar terms, and to calculate the benefit/cost ratio for program evaluation and planning. Benefit/cost analysis is designed to examine and measure factors that influence efficient allocation or resources and to determine the extent to which a given policy produces net economic gains or losses (Herrick et al. 1994). Since enactment of the Magnuson Act, which requires an analysis of proposed actions in economic and social terms, fishery managers are being asked more often to examine the efficiencies and impacts associated with management actions and program decisions. This study is not intended to be a rigorous analysis of the benefit/cost problem, however will provide managers with guidance in their policy-making.

The benefit/cost ratio for grayling sport fisheries in Region III was at least 21 in FY 97. For the Tanana area, the benefit/cost ratio was 5.4 in FY 97. Obviously, the benefits of Region III's grayling research and management program outweigh the costs to a high degree.

5.2 Stated Changes in Trips

A second goal of the study was to estimate changes in angler trip frequency resulting from hypothetical implementation of regulation changes. Division goals, created in 1992, are to conserve wild stocks, provide for diverse sport fishing opportunities, and to optimize social and economic benefits from recreational fisheries. The question prompting this component of the research was: can we perform an optimization? There is a need to evaluate management policy for its influence on public welfare. The few management options available to the Sport Fish Division include sport fishing regulations. Changes in bag limit, size limit, area closures, and catch and release fishing were examined in this study for their effects on stated trip frequency. Angler trip frequency is one indicator of public welfare, and can be directly tied to changes in total net economic value of a fishery. Predicted changes in angler trips resulting from regulation changes can also be used in the context of a benefit/risk analysis. Benefits (angler trips) accrued or lost as a result of a management change can be weighed against the risks of over- or underutilization of the fishery resource.

The responses to the three contingent behavior questions regarding grayling fishing regulation changes on the Chena, Nome, and Delta Clearwater rivers indicate that all proposed regulation changes would lead to increased visitation on the rivers. On the Chena River it is estimated that visitation would increase between 10.7% and 28.7% under the alternative regulation changes allowing some harvest of grayling on the river. The most liberal option (two fish bag limit, one fish over 15 inches) resulted in the greatest predicted trip increase by remainder of Region III respondents. While overall increases in trips are predicted, negative trips to the Chena River would result as well (Figures 2a-2c), likely from anglers dissatisfied with the hypothesized liberalization of the current harvest management strategy. Additionally, 30% of the overall increase in trips would occur from a transfer of trips from other fishing sites, thus minimizing the net public welfare benefit.

For the Nome River, increases in predicted trips from liberalization of fishing regulations were minimal (less than 10%). Seward Peninsula residents already report heavy use (an average of 7.18 fishing trips per year to the Nome River). In contrast with the hypothesized regulation changes to

the Chena River, no negative trips were predicted by respondents to the Nome River management question.

Finally, on the Delta Clearwater River it is estimated that visitation would increase by 23% under regulations that allowed only catch and release fishing for grayling, thereby increasing the chance of catching more and larger fish. While this option resulted in overall predicted increases in trips, the change in management also resulted in the greatest predicted number of negative trips. Similar to the Chena River management question, the overall predicted increase in trips to the Delta Clearwater River is tempered by the report that 30% of the increase would be at the cost of fishing trips to other waters.

In the case of all of these rivers, however, the estimated percentage changes in visitation come primarily from a relatively small percentage of anglers. Consistently across models, over three fourths of respondents said that the proposed regulation changes would have no effect on the number of trips they would take to the rivers. The ability of managers to influence anglers' decisions to take fishing trips may be overshadowed by more significant variables, such as weather, the anglers' employment and economic situation, and the anglers' motives for initiating a trip. While the ability to influence trip frequency by a majority of anglers using bag limit, size limit, area closure and catch and release fishing does not appear feasible, nevertheless, a fraction of the angling public indicates their visits will be impacted. These anglers, then, influence the marginal net benefits of the sport fisheries facing changes in regulations.

5.3 Angler Preferences for Fishing Experiences

Measuring angler preferences provides valuable input to the manager on whether current management is aligned with anglers' desires (Pollock et al. 1994). Angler preference is another indicator of social welfare. If managers are informed about preferred fishing experiences, and can plan accordingly, the more likely the angler is to give the fishery a higher satisfaction rating. The higher the angler satisfaction rating, the closer the fishery is to a social optimum. In this study, general questions were asked about alternative fishing experiences. The highest rating across respondent populations was given to "fishing in a wilderness setting". Concomitant with this finding is that a low percentage of respondents preferred "having more developed camping facilities". "Catching and releasing grayling" was more preferred by roughly twice as many respondents as "catching and keeping" grayling. Catching larger-sized but fewer grayling was more preferred by roughly five to six times as the option to catch more but smaller grayling. Thus, management strategies that preserve large grayling in a wilderness setting are likely to produce the greatest angler satisfaction, especially for nonresident anglers.

5.4 Angler and Fishing Trip Characteristics

Angler characteristics are useful for understanding angler groups, known as market segments. Market research provides information on resource users, and how to attract those segments with low rates of sport fishing participation. Additionally, angler characteristics can help to explain such variables as fishing motivation.

Residents were somewhat similar in average years fished (23-26 years), number of days fished per year (20-29 days), age (40-42 years), percent male (70-79%), and years of schooling (14). There were disparities in income, with Northwest Alaskans having the most percentages in the two highest income brackets, and the remainder of Region III population having the lowest percentages

in the highest income brackets. Nonresidents on average had fished the longest (31 years), were older (52 years), and were a slightly higher percentage of males (83%) than residents.

Twenty to 30% of nonresidents, the remainder of Region III, and Regions I and II populations specifically target grayling, indicating the importance of grayling to these populations' total sport fishing opportunities. Of grayling caught, few are kept. About twice as many Northwest Alaskans and nonresidents gave their fishing experience a high rating as did residents of Seward Peninsula and the remainder of Region III. There are factors influencing the quality of the fishing experience that are not in the ability of the manager to control, such as weather.

ACKNOWLEDGMENTS

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APPENDIX A. THE DICHOTOMOUS CHOICE CONTINGENT VALUATION MODEL

Appendix A.-The Dichotomous Choice Contingent Valuation Model.

Dichotomous Choice Contingent Valuation

In dichotomous choice, individuals respond "yes" or "no" as to their willingness to pay (WTP) a specific cash amount for a specified commodity or service. The advantages of this approach, as compared to open-ended or bidding game questions formats, have been discussed elsewhere (Boyle and Bishop 1987, Bowker and Stoll 1988). The disadvantage of this approach is that analysis and interpretation are relatively complex, since WTP is inferred rather than observed.

Hanemann (1984) has investigated the theoretical motivation for dichotomous choice models. He provides both a utility difference approach and an alternative derivation based on the relationship of the individual's unobserved true valuation compared to the offered threshold sum (see also Cameron 1988). In the latter, it is assumed that if each individual has a true WTP, then the individual will respond positively to a given bid only if his WTP is greater than the bid. For example, suppose that an individual is confronted with an offered price (t) for access to a given resource or recreational site. The probability of accepting this offer $\pi(t)$, given the individual's true (unobserved) valuation WTP is then:

$$\pi(t) = \Pr(WTP > t) = 1\text{-}F(t) \tag{1}$$

where F is a cumulative distribution function of the WTP values in the population. In the logit model F(.) is the c.d.f. of a logistic variate and in the probit model F(.) is the c.d.f. of a normal variate. The specification of this model can be briefly illustrated for the case where the WTP values are assumed to have a logistic distribution in the population of interest conditional on the value of covariates. A statistical model is developed that relates the probability of a "yes" response to explanatory variables such as the bid amount, preferences, income, and other standard demand shifter type variables. The specific model is:

$$\pi(t, \bar{\chi}) = [1 + \exp(-\alpha t - \tilde{\gamma}' \bar{\chi})]^{-1} \tag{2}$$

where $\pi(t, \tilde{\chi})$ is the probability that an individual with covariate vector $\tilde{\chi}$ is willing to pay the bid amount t. The parameters to be estimated are α and $\tilde{\gamma}'$ (the constant term is included in $\tilde{\chi}$). The equation to be estimated can be derived as:

$$L = 1n[p/(1-p)] = \alpha t + \tilde{\gamma}' \bar{\chi} \tag{3}$$

where L is the "logit" or log of the odds of a "yes" and p are observed response proportions. In application, the logit and probit models are so similar that it is difficult to justify one over the other on the basis of goodness of fit. We choose to work with the logistic specification here because the probit model does not lead to closed-form derivatives. Maximum likelihood estimates of the parameters in equation 3 can be obtained with a conventional logistic regression program. We have utilized SAS (SAS Institute 1988).

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Hanemann (1984) has shown that the linear specification in equation 3 is consistent with utility maximization based on his utility difference motivation. However Cameron (1988) argues that from the standpoint of the threshold motivation, any of a variety of WTP distributions are theoretically plausible. This implies that the choice of functional form for F(.) be based on empirical considerations. Some investigators (e.g., Boyle and Bishop 1987, Bowker and Stoll 1988) have found that WTP distributions are skewed to the right. In these cases, a better estimate may be obtained with a log-logistic model (replacing t in equation 3 with log t).

Because we estimate the distribution of WTP values with dichotomous choice contingent valuation, the question remains as to which parameter of the distribution to use. A variety of welfare measures for dichotomous choice models have been proposed in the literature including a truncated mean (Bishop and Heberlein 1992), the overall mean, and percentiles of the distribution, including the median (Hanemann 1984, 1989). In all cases the distribution of F is assumed to be continuous and nonnegative. As developed below, we utilize the truncated mean and several different percentiles in this application. The truncated mean is defined by:

$$M_T = \int_0^T [1 - F(\chi)]dx \qquad (4)$$

where f(x) is the probability density function of the distribution. The truncated mean has the interpretation of being a mean, but with all values above the truncation point, T, set equal to T. Accordingly, the truncated mean is more conservative than the overall mean, but has a clear interpretation for purposes of aggregation. T is generally set equal to the highest bid offer; as a result the integrand in equation 4 is within the range of observed data. Previous applications indicate that the truncated mean is also much more precisely estimated than the overall mean (Patterson and Duffield 1991).

The p^{th} quantile (100 p^{th} percentile) of the distribution is given by $F^{-1}(p)$. For the log-logistic model, the p^{th} quantile is given by:

$$\eta_p(\overline{\chi}) = \exp(-\tilde{\gamma}'\overline{\chi}/\alpha)[p/(1-P)]^{-1/\alpha} \qquad (5)$$

Of course when p = 0.50 equation 5 provides an estimate of the median. For the case where WTP values are skewed, as demonstrated in previous studies (e.g. Bowker and Stoll 1988), the median and the truncated mean may differ considerably. As Hanemann (1989) has discussed, choice of the welfare measure is a value judgement in that there is an implicit weighing of whose values are to count.

Methods have recently been developed to identify the precision of dichotomous choice based welfare estimates. The procedures utilized in this study is bootstrapping (Efron 1982). Details of the procedure for applying this method to logistic models are described elsewhere (Park et al. 1989; Duffield and Patterson 1991).

APPENDIX B
CONTINGENT BEHAVIOR METHODS

Appendix B.-Contingent behavior methods.

Contingent behavior methods have in common the use of survey questions in which respondents are asked to predict their future behavior contingent on the circumstances described in a given question. There is a very large scientific literature that fits within this general definition, including the use of polls to predict voting behavior and market research (and U.S. Census efforts) to predict consumer purchases.

In the context of resource economics, contingent behavior methods utilize survey data in which respondents are asked how they would change the level of some activity in response to some change in services, such as in the level of an environmental amenity. If the activity can be interpreted in the context of a behavioral model, it may be possible to develop a measure of willingness-to-pay. Contingent behavior is mentioned in many of the texts on economic valuation including Mitchell and Carson (1989), Kopp and Smith (1993), and Freeman (1993). (Freeman refers to the survey questions at issue as contingent activity questions.) Nonetheless, the economic literature on contingent behavior as a specific valuation tool is fairly limited. In the remainder of this brief literature review, the economic literature on contingent behavior and valuation is discussed first, followed by an overview of the much larger related literature on voting behavior and buying intentions. The latter literature is equally relevant to the specific contingent behavior questions used in the current study related to fishery management issues in Alaska. The contingent behavior from the current study is used to predict behavior and is not used to develop the valuation models.

Contingent behavior data has been used in a variety of ways in the resource economics literature, usually in conjunction with travel cost or contingent valuation models. Some economic studies have used contingent behavior questions to measure changes in visitation rates and to derive demand curve shifts. McConnell (1986) asked respondents how visits to local beaches would change if pollution of New Bedford Harbor, Massachusetts by polychlorinated byphenyls (PCBs) could be eliminated. Thayer (1981) asked recreationists how their choice of sites to visit would be altered by construction of a geothermal plant in the vicinity of the recreation sites. Narayanan (1986) uses a conceptually similar approach to estimate values associated with instream flow in the context of a travel cost demand model. Duffield et al. (1990) also used contingent behavior to model changes in visitation rates in response to changes in instream flow (but with baseline values derived from a contingent valuation model). Other studies have used essentially contingent behavior responses (for example, site choice in the face of varying travel costs and site attributes) in the context of a discrete choice model derived from the contingent valuation literature. For example, Morton et al. (1995) develop a contingent behavior analysis of recreational hunting in northwest Saskatchewan. Another approach is to combine actual and contingent behavior data in recreation or other resource demand models (Cameron et al. 1996; Cooper 1997).

To our knowledge there has not been work done on validation of contingent behavior valuation models. One comparison of predicted and actual recreational visitation has been undertaken by the defendants in a natural resource damages lawsuit. Cicchetti et al. (1991) resurveyed the

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respondents to the government study (McConnell 1986) at New Bedford Harbor after 12 months had passed and concluded that the first study overestimated actual beach usage by 30%. It is not known what rebuttal of this finding was made by the plaintiffs.

While the literature on using contingent behavior models to measure valuation changes is fairly limited, there is a very large and varied literature on the basic problem of using surveys to predict future behavior. Two of the largest areas of application are voting behavior and consumer buying intentions.

With regard to voting, the accuracy the polls used to predict the election outcomes is closely scrutinized. In general, surveys of voters are fairly good predictors of actual voting patterns. For example, Mitofsky (1996) compared predictions and actuals for U.S. presidential elections from 1956-1996 and found that the percentage difference between actual and predicted for the winner was only 1.9%. Of course some years are better than others, and the difference for 1948 (4.9%) was enough to create the infamous wrong prediction for the Truman-Dewey race. However, an interesting result from the voting literature is the overestimation of voter turnout based on surveys compared to actual voter records. This is a well-known result that has been reported in many studies over the years. For example, Traugot and Katosh (1979) noted that the Center for Population Studies 1976 national elections survey estimated 72% voter turnout, the U.S. Census Bureau estimated 59% and the actual based on voter records was 54%. Belli (1997) found survey estimates of voter participation in the 1996 Oregon vote-by-mail special senate election overestimated voter turnout by 12% to 20% (depending on the specific survey questions) compared to actual. These findings are not specifically for a contingent behavior prediction per se but illustrate the problems inherent in collecting and interpreting survey data having to do with behavior.

The literature on the accuracy of polls to predict voter turnout is directly relevant for contingent valuation models that use a referendum question format. Carson et al. (1986) conducted a validation study of this type by conducting a CV-like study of how California voters intended to vote on a referendum proposition (for a sewage treatment plan) with the actual voting behavior in a subsequent election. As summarized in Mitchell and Carson (1989), the study developed a demand function that predicted a passing vote of 70% to 75% at the level of the actual project cost. The actual vote in favor was 73%, well within the 95% confidence interval for the predicted result. This finding of predictable referendum voting is replicated in other studies of referendum voting behavior conducted by political scientists (Magleby 1984).

The other very large literature related to contingent behavior are the fields of market research and buying intentions. The latter is of considerable interest for macro-economic forecasts of future business activity and economic growth. A good example from this literature are studies by Theil and Kosobud (1968) and Ferber and Piskie (1965) that both used subsamples from large data sets developed by the U.S. Bureau of the Census in its Current Population Survey of 36,500 households in the late 1950s and into the mid-1960s. Households were asked about their intentions to buy consumer durables (such as cars), household services, education and vacations.

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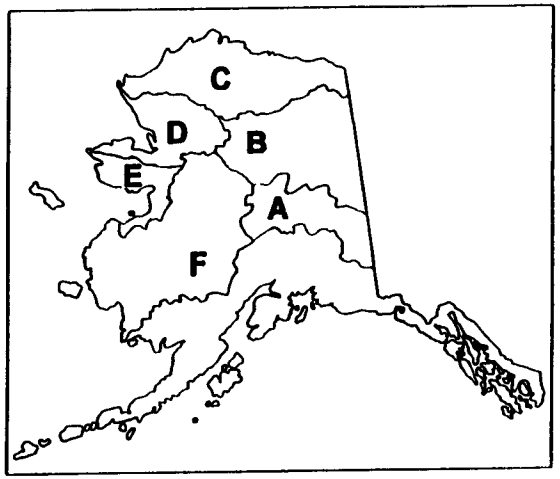
The same households were resampled 12 months later so that predicted and actual behavior could be compared. A basic finding from this literature is that generally buying intentions overstate actual future purchases. This is not surprising since the response categories include not only "yes-probably" and "yes-definitely" but also "maybe-depends on…" and "maybe-other reason." For example, for a subsample of respondents reported in Ferber and Piskie, for those who stated that the probability of a future purchase for a given commodity was from 60% to 100%, the actual percentage who purchased durables (such as cars) was 33% of those with planned purchases. The percentage was much higher for house services, vacation and education purchase decisions (60%, 62% and 67% respectively). The latter categories indicate some level of overestimating purchase, but it is not clear how much since the distribution of probability within the 60% to 100% range is not provided. For example, if almost all respondents were clustered at the 60% level, there is no or little overstatement.

To conclude, the economics literature shows that contingent behavior data is used by resource economists for a variety of purposes, including resource valuation. The broader scientific literature including polling and market research shows that survey questions can fairly accurately predict at least some kinds of future behavior – for example, with regard to voting choices. The results from the buying intentions surveys having to do with decisions to take vacations are most like the kinds of questions asked of recreationists regarding trip and site choice. A general finding from this literature is that respondents tend to overstate the likelihood of an actual purchase. However, the extent of this overstatement varies considerably being quite large for consumer durables and smaller for things like vacation and education purchases. The literature shows that overstatement can be reduced by using question formats that allow the possibility of excluding responses that are less certain or indicate a lower probability of future purchase.

APPENDIX C
SURVEY INSTRUMENT, CONTACT LETTER, REMINDER POSTCARD AND REMINDER LETTER

Arctic - Yukon - Kuskokwim Region

Angler Survey



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Alaska Department of Fish and Game
Division of Sport Fish

Spring 1997

The purpose of this survey is to obtain information about angler use of grayling and other fish in the Arctic-Yukon-Kuskokwim region. The map on the cover of this survey shows the different general areas within this region. The map on the back of the letter enclosed with this survey shows the location of the specific waters we are asking about. In this survey we are particularly interested in your use of wild grayling. We appreciate your participation in this survey.

Section I. General questions about your sport fishing.

1. How many years have you been sport fishing? ____ years

2. About how many days per year do you spend sport fishing? _____days

3. Do you take trips specifically to try to catch grayling?
   ____yes (continue with question 4)
   ____no (skip to question 5)

4. Please rate your preferences (circle the number) from least preferred (1) to most preferred (5) when fishing for grayling.

Fishing Experience	Preference				
	least				most
fishing easily accessible site near a road	1	2	3	4	5
fishing in a wilderness setting	1	2	3	4	5
harvesting grayling	1	2	3	4	5
catching and releasing grayling	1	2	3	4	5
catching large-sized but fewer grayling	1	2	3	4	5
catching more but smaller grayling	1	2	3	4	5
having good trail access to fishing waters	1	2	3	4	5
having more developed camping facilities	1	2	3	4	5

5. Did you sport fish in 1996? _____yes (continue with question 6)
   _____no (please skip to Section III)

6. Which of the following fishing sites did you fish during open water in 1996? Please check yes or no for each site and indicate how many trips you made from home to each site last year (See map on the back of the enclosed letter). If you fished other Area A or E waters that are not listed below, please write in the name of the water you fished most frequently in those areas in 1996.

Fishing Site	Fished in 1996?		Number of fishing trips in 1996
	yes	no	
Area A. Tanana River drainage			
Chena River	___	___	___
Chatanika River	___	___	___
Salcha River	___	___	___
Delta Clearwater R	___	___	___
Goodpaster River	___	___	___
Tangle Lakes/River	___	___	___
Fielding Lake	___	___	___
Piledriver Slough	___	___	___
Other Area A water (write in)			
_____	___	___	___
Area B. Haul Rd/Koyukuk waters	___	___	___
Area C. North Slope waters	___	___	___
Area D. Northwest/Kotzebue	___	___	___
Area E. Norton Sound / Nome			
Nome River	___	___	___
Snake River	___	___	___
Pilgrim River	___	___	___
Sinuk River	___	___	___
Fish/Niukluk Rivers	___	___	___
Other Area E water (write-in)			
_____	___	___	___
Area F. Yukon/Kuskokwim area	___	___	___

If you did not visit any of the sites listed above in 1996, please skip to Section III

Section II. In this section, we would like to ask you about your most recent fishing trip to one of the sites or areas during open water in 1996.

7. Please look back at the sites listed in Question 6 and circle the name of the site to which you took your **most recent 1996 open water fishing trip.**

Please write the name of the water or area that you circled in question 6 on the following line _____

The rest of the questions in this sections are about this most recent open water fishing trip to the site or area you indicated above.

8. What was the approximate date of your most recent open water fishing trip to this site?

_____ Month _____ Day _____ Year

9. Please indicate which of the following best describes the importance of fishing on this trip (check one).

- ☐ Fishing this site was the main purpose I took this trip.
- ☐ Fishing this site was one of the main purposes I took this trip
- ☐ Fishing this site was just one of several activities for me on this trip.

10. How many days did you fish **at this site** on your most recent trip?

_____ days

11. What was the primary species of fish you intended to catch at this site? (check one)

- ☐ Salmon
- ☐ Burbot
- ☐ Northern Pike
- ☐ Rainbow Trout
- ☐ Other_____
- ☐ Whitefish
- ☐ Arctic Char
- ☐ Lake Trout
- ☐ Grayling
- ☐ No specific species was targeted

12. On this most recent trip, how many grayling did you catch? _____ harvest? _____

-continued-

13. Did you catch any grayling larger than 15 inches?

☐ No ☐ Yes

_____ How many larger than 15 inches?

14. For this site, would you characterize your fishing experience on your most recent trip as: (Check one)

☐ Poor ☐ Above average
☐ Below average ☐ Excellent
☐ Average

15. How many people were in your party on this particular trip?
_____ Number of people

16. How much did you personally spend in dollars on this trip including the following (if you can't recall the exact amount, please give your best estimate):

Auto, air, or other travel expenses	$ _____
Food & beverages	$ _____
Lodging or camping fees	$ _____
Equipment purchased just for this trip	$ _____
Equipment rentals and Other trip expenses	$ _____
Total amount you spent on this trip	$ _____

17. Was this trip worth more to you than what you actually spent?

☐ Yes ☐ No

If YES, would you still have made the trip if your share of the expenses had been $ _____ more?

☐ Yes ☐ No

If NO, what is the main reason you would not take this trip under these circumstances?

_____

-continued-

Section III. In this section, we would like to ask your preferences for possible options for the Alaska Fish & Game grayling regulations.

18. In the following tables, please circle the numbers indicating your preferences for the listed management options from least preferred (1) to most preferred (5). Please write in the names of any streams which you would recommend for the following options.

OPTIONS	Preference least → most				
Group I. Options for Grayling in Tanana drainage streams (Area A)					
1. No change	1	2	3	4	5
2. Catch and release only (potential for more & bigger fish). Which streams?_____	1	2	3	4	5
3. Manage streams for harvest. Which streams?_____	1	2	3	4	5
Group II. Options for Dalton Highway streams (highway corridor only in Area B)					
1. No change	1	2	3	4	5
2. Harvest 1 fish/day, no size limit.	1	2	3	4	5
3. Catch and release only (potential for more & bigger fish)	1	2	3	4	5
Group III. Options for Seward Peninsula streams (Area E).					
1. No change	1	2	3	4	5
2. Catch and release only (potential for more & bigger fish). Which streams?_____	1	2	3	4	5
3. Manage streams for harvests. Which streams?_____	1	2	3	4	5

19. Alaska Fish and Game may consider proposing to the Board of Fisheries changes to the current catch and release regulations on the Chena River. Please read the 3 options below and indicate how you expect each management option would affect the number of fishing trips you would take to the Chena in 1997. Place an X in column A if you think you would take the same number of trips as you took in 1996, or write in column B or C how many more or fewer trips you would take under that option.

Management option for Chena R.	No change (A)	How many more trips? (B)	How many less trips? (C)
1. Harvest 1 fish per day, no size limit			
2. Harvest 2 fish per day, 1 over 15"			
3. Catch and release with lower river open to harvest.			

☐ I would not fish for grayling on the Chena River regardless of regulation changes.

☐ I support continued catch and release grayling fishing on the Chena River to further boost population numbers.

20. The Nome River is closed to grayling fishing however the population is showing signs of recovery and there are several policies Alaska Fish and Game can pursue. Please write the number of trips you expect you would take in 1997 to the Nome River to sport fish for grayling for each possible regulation.

Management options for grayling fishing in Nome River	How many trips in 1997?
1. Catch and release only (potential for more and bigger fish).	
2. Harvest 1 fish per day, no size limit	
3. Harvest 2 fish per day, 1 over 15"	

☐ I would not fish for grayling on the Nome River regardless of regulation changes.

☐ I support a continued grayling sport fishing closure on the Nome River to further boost population numbers.

21. The Delta Clearwater River will be catch and release for grayling in 1997 due to low fish numbers. Think about how many trips you anticipate taking to the Delta Clearwater this year. Place an X in column A if you think you would take the same number of trips as you took in 1996, or write in column B or C how many more or fewer trips you would take under catch and release management this year.

Management change for Delta Clearwater River	No change (A)	How many more trips? (B)	How many less trips? (C)
1.Catch and Release in 1997			

☐ I would not fish for grayling on the Delta Clearwater River regardless of regulation changes.

22. If you indicated that you would take more trips to either the Chena, Nome, or Delta Clearwater Rivers under any of the regulation changes, is this increase in trips because:

☐ You think you would take more fishing trips during the year.
☐ You would take fewer trips to other fisheries so that you could fish more often at the Chena, Nome or Delta Clearwater River.

IV. These last few questions will help us to compare respondents to the general population.

23. Where do you live? City: _____
State: _____

24. What is your age? _____ years

25. Are you: ☐ male ☐ female

26. How many years of formal schooling have you attended? _____years

27. Please circle your household's income before taxes for 1996:

1. Less than $20,000
2. $20,000 to $39,999
3. $40,000 to $69,999
4. $70,000 to $79,999
5. $80,000 to $124,999
6. Over $125,000

Thanks for your help!

Appendix C2.-Contact Letter and Map Accompanying Initial Survey Mailing.

Dear Angler,

The Alaska Department of Fish and Game is conducting research on sport fishing in the Arctic-Yukon-Kuskokwim Region of Alaska. Our goal is to improve the quality of fishing in this region. In this study we are interested in gathering information on all open water fishing and particularly on grayling fishing in the region. To achieve our goal, we need to know how anglers use these fisheries.

Your name has been randomly selected from a list of Alaska sport fish license holders who either live in the Arctic-Yukon-Kuskokwim Region or bought a 1996 fishing license in the region. In order for the survey to be comprehensive and accurate, it is important that we hear from everyone. We would appreciate it very much if you would complete the attached questionnaire and return it in the enclosed postage-paid envelope. We have purposely kept the survey brief so that it will take only a few minutes of your time.

If you are unfamiliar with the area or waters mentioned in this survey, please refer to the regional map on the cover of the survey booklet and the detailed area map on the back of this letter.

All survey responses are completely confidential. The surveys are numbered only to allow us to keep track of who has responded. If you have any questions about the survey, please feel free to call me at 907-459-7296.

Thank you very much for your help.

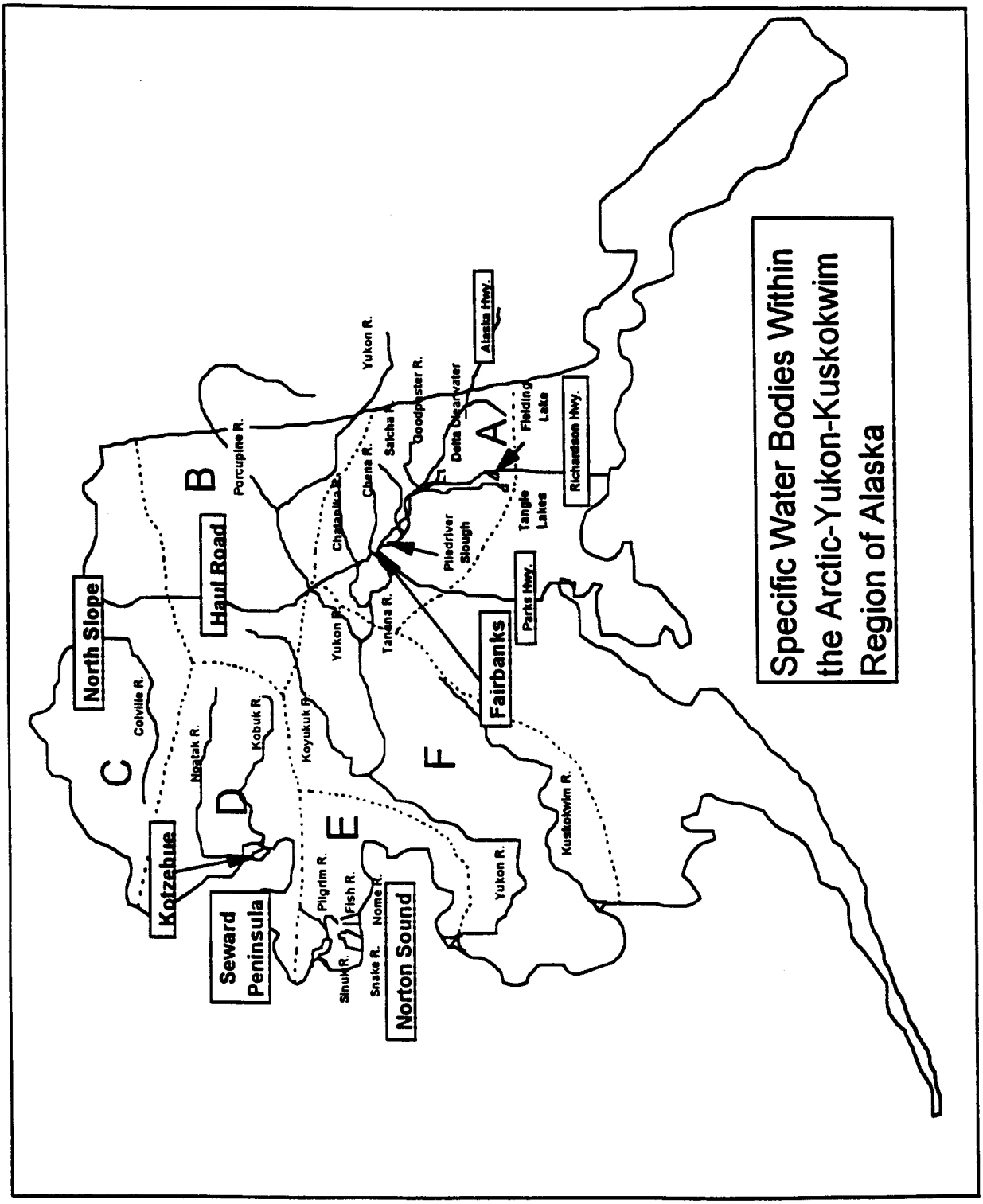
Sincerely,

Dr. M. Merritt

Regional Research Supervisor

-continued-

Appendix C2.-Page 2 of 2.



Appendix C3.-Text of Reminder Postcard.

Dear Alaska Angler,

One week ago, we sent you a survey concerning salmon fishing in Region III of Alaska. If you have not returned the survey, we ask that you do so as soon as possible. If you have already returned the survey, thanks very much for your help!

M. Merritt, Ph.D.

ADF&G/Sport Fish Division

1300 College Road, Fairbanks, AK 99701

Appendix C4.-Text of Reminder Letter.

Dear Angler,

In early June we sent you a survey concerning research on sport fishing in the Arctic-Yukon-Kuskokwim Region of Alaska. Our goal is to improve the quality of fishing in this region. In this study we are interested in gathering information on all open water fishing and particularly on grayling fishing in the region. To achieve our goal, we need to know how anglers use these fisheries. Won't you please take a few minutes to complete the survey and return it to us in the enclosed postage-paid envelope?

Your name has been randomly selected from a list of Alaska sport fish license holders who either live in the Arctic-Yukon-Kuskokwim Region or bought a 1996 fishing license in the region. In order for the survey to be comprehensive and accurate, it is important that we hear from everyone. We would appreciate it very much if you would complete the attached questionnaire.

If you are unfamiliar with the area or waters mentioned in this survey, please refer to the regional map on the cover of the survey booklet and the detailed area map on the back of this letter. All survey responses are completely confidential. The surveys are numbered only to allow us to keep track of who has responded. If you have any questions about the survey, please fell free to call me at (907) 459-7296.

If you have already returned the survey, thank you very much for your help.

Sincerely,

M. Merritt, Ph.D.

Regional Research Supervisor

APPENDIX D
ESTIMATED ANGLER-TRIPS

Appendix D1.-Estimated angler-trips per household-trip from the statewide harvest survey.

This documents the equations used for estimates of angler-trips per household-trip along with estimates for angler-trips for various fishery groupings and poststrata from information from the statewide harvest survey (SWHS) for 1996.

The estimated number of angler-trips expended in a fishery by a poststrata was approximated by (where subscripts denoting fishery or poststrata are dropped for simplicity):

$$\hat{A} \approx \hat{T}\overline{apht}\,; \tag{1}$$

where:

$\hat{A}$ = the estimated number of angler-trips;

$\hat{T}$ = the estimated number of household-trips as provided by the SWHS;

$\overline{apht}$ = the estimated average number of angler-trips per household-trips, which was approximated as outlined in the procedures below.

The variance for the estimated number of angler-trips was obtained utilizing Goodman's (1960) approach:

$$\hat{V}\left[\hat{A}\right] \approx \hat{T}^2\hat{V}\left[\overline{apht}\right] + \overline{apht}^2\hat{V}\left[\hat{T}\right] - \hat{V}\left[\overline{apht}\right]\hat{V}\left[\hat{T}\right]; \tag{2}$$

where:

$\hat{V}\left[\hat{T}\right]$ = the variance of the estimated number of household-trips as provided by the SWHS, by squaring the standard errors as obtained from the bootstrap estimation procedure;

$\hat{V}\left[\overline{apht}\right]$ = the variance of the estimated average number of angler-trips per household-trips, which was calculated as outlined in the procedures outlined below.

The estimated ratio of angler-trips to household-trips ($\overline{apht}$) along with its variance (and standard errors) was calculated as a weighted average of the ratio estimated from two categories of households responding to the SWHS. Households with only one angler reporting fishing at a fishery or reported only one household-trip to the fishery were called "Case 1" households. The number of angler-trips for Case 1 households could be logically derived from the data reported by each household, as follows (with subscripts denoting fishery and poststrata dropped for simplicity):

$$a_{1i} = \max\left(m_{1i}, t_{1i}\right); \tag{3}$$

-continued-

where:

a_{1i} = the derived number of angler-trips expended in the fishery by the i^{th} household for Case 1 households;

m_{1i} = the number of anglers in the i^{th} household for Case 1 households; and

t_{1i} = the number of household-trips expended in the fishery by the i^{th} household for Case 1 households.

These derived values of angler-trips were then used to calculate the ratio of angler-trips per household-trips for Case 1 households:

$$\overline{apht}_1 = \frac{\sum_{i=1}^{n_1} a_{1i}}{\sum_{i=1}^{n_1} t_{1i}}; \quad (4)$$

where:

n_1 = the number of Case 1 households participating in the fishery.

A ratio estimation approach was used for approximating the ratio for non-Case 1 households (termed Case 2 households), by using information from both Case 1 and Case 2 households. The approximation involved using the ratio between the derived angler-trips to number of angler-days fished for Case 1 households to "expand" the ratio between angler-days fished to household-trips for Case 2 households. This calculation is assumed to be approximate since we're using the characteristics of Case 1 households to "model" Case 2 households, which may not be entirely accurate. The calculation is as follows:

$$\overline{apht}_2 \approx \hat{w}_1 \hat{r}_2; \quad (5)$$

where:

$$\hat{w}_1 = \frac{\sum_{i=1}^{n_1} a_{1i}}{\sum_{i=1}^{n_1} d_{1i}}; \quad (6)$$

-continued-

$$\hat{r}_2 = \frac{\sum_{i=1}^{n_2} d_{2i}}{\sum_{i=1}^{n_2} t_{2i}}; \tag{7}$$

with:

d_{1i} = the number of angler-days expended in the fishery by the i^{th} household for Case 1 households;

d_{2i} = the number of angler-days expended in the fishery by the i^{th} household for Case 2 households; and

n_2 = the number of Case 2 households participating in the fishery.

The combined estimate of $\overline{apht}$ was calculated as a weighted average:

$$\overline{apht} \approx \left(\frac{n_1}{n}\right)\overline{apht}_1 + \left(\frac{n_2}{n}\right)\overline{apht}_2; \tag{8}$$

where:

$$n = n_1 + n_2. \tag{9}$$

The variance of $\overline{apht}$ was calculated by expansion (using the component weights) as:

$$\hat{V}\left[\overline{apht}\right] \approx \left(\frac{n_1}{n}\right)^2 \hat{V}\left[\overline{apht}_1\right] + \left(\frac{n_2}{n}\right)^2 \hat{V}\left[\overline{apht}_2\right]; \tag{10}$$

where the variance of $\overline{apht}_1$ was calculated using the procedure outlined by Thompson (1992, pages 61 and 62):

$$\hat{V}\left[\overline{apht}_1\right] = \frac{\sum_{i=1}^{n_1}\left(a_{1i} - t_{1i}\overline{apht}_1\right)^2}{\bar{t}_1^2 n_1 (n_1 - 1)}; \tag{11}$$

-continued-

with:

$$\bar{t}_1 = \frac{\sum_{i=1}^{n_1} t_{1i}}{n_1}; \tag{12}$$

the variance of $\overline{apht}_2$ was calculated using the procedure of Goodman (1960):

$$\hat{V}\left[\overline{apht}_2\right] \approx \hat{r}_2^2 \hat{V}[\hat{w}_1] + \hat{w}_1^2 \hat{V}[\hat{r}_2] - \hat{V}[\hat{w}_1]\hat{V}[\hat{r}_2]; \tag{13}$$

where both variances for $\hat{w}_1$ and $\hat{r}_2$ were calculated by the procedure outlined by Thompson (1992, pages 61 and 62):

$$\hat{V}[\hat{w}_1] = \frac{\sum_{i=1}^{n_1} (a_{1i} - d_{1i}\hat{w}_1)^2}{\bar{d}_1^2 n_1 (n_1 - 1)}; \tag{14}$$

$$\hat{V}[\hat{r}_2] = \frac{\sum_{i=1}^{n_2} (d_{2i} - t_{2i}\hat{r}_2)^2}{\bar{t}_2^2 n_2 (n_2 - 1)}; \tag{15}$$

in which:

$$\bar{d}_1 = \frac{\sum_{i=1}^{n_1} d_{1i}}{n_1}; \text{ and} \tag{16}$$

$$\bar{t}_2 = \frac{\sum_{i=1}^{n_2} t_{2i}}{n_2}. \tag{17}$$

Standard errors were simply the square root of the variance estimates.

Appendix D2.-Estimated angler-trips per household-trip and estimated angler-trips for five populations of sport fish license holders from statewide harvest survey data for Region III, 1996.

Population	Estimated Household Trips	SE of Household Trips	Estimated Angler-Trips/ hh-Trips	SE Angler-trips/ hh-Trips	Estimated Angler Trips	SE of Angler Trips
Seward Peninsula	7,583	1,046	1.13649	0.03595	8,618	627
Northwest Alaska	672	208	1.25113	0.14053	841	183
Remainder of Region III	109,678	3,756	1.15164	0.01461	126,310	2,678
Nonresidents	13,460	880	1.22818	0.02318	16,531	701
Regions I and II Residents	8,857	731	1.25062	0.03702	11,077	639

Appendix D3.-Number of households with one angler or one household trip (Case 1) and number of households with multiple anglers or trips (Case 2) from the statewide harvest survey, used in estimating angler-trips.

Population	Sample Size		
	Case 1	Case 2	Total
Seward Peninsula	73	55	128
Northwest Alaska	15	4	19
Remainder of Region III	1,833	773	2,606
Nonresidents	657	68	725
Regions I and II Residents	319	44	363

APPENDIX E
SUMMARY OF OPINIONS IN LETTERS

Appendix E.-Summary of opinions in letters or comments by respondents to the survey for 1996 use and valuation estimates, with a focus on grayling.

Topic	Population/Residence	Comments
Catch & Release	Remainder of Region III Fairbanks	Concerned that catch and release results in dead fish and therefore is not supportive of catch and release.
	Fairbanks	Fishes to put food on the table and therefore does not practice catch and release.
	Fairbanks	Believes it is "wrong to play with issues of death"; also has a perception that catch & release leads to death of fish after release.
Habitat	Nonresident Nor. Dakota	Unalakleet River banks have been "messed up" by local residents.
	Remainder of Region III Fairbanks	The Chena River is polluted and "I would never eat a fish from it".
Subsistence	Remainder of Region III Nome	Open Eldorado/Flambeau rivers to subsistence June 20-July at limited times because this is best time for drying, river-caught fish are less oily, and bad weather makes fishing in the ocean difficult.
Regulations	Remainder of Region III North Pole	Boat/motor size on Delta Clearwater should be reduced because river is too small for some of the larger craft.
	Fairbanks	Allow harvest of one fish per day or per trip in the Delta Clearwater River.
	Nonresident Michigan	Allow one trophy fish to be harvested in catch and release areas.
Stocking	Remainder of Region III Fairbanks	In addition to supporting catch and release in the Chena River to boost population numbers also wishes rivers to be stocked.