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Alaska Angler Survey: Use and Valuation Estimates for 1995, with a Focus on Tanana Valley Major Stocked Waters

by
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May 2001

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 Tanana Valley residents sport fishing in five stocked waters in the Tanana Valley: Chena Lake, Piledriver Slough, Harding Lake, Birch Lake, and Quartz Lake. A mail survey was administered to 3,497 Tanana Valley resident anglers who purchased Alaska sport fishing licenses in 1995. Of this number, 566 surveys were returned as undeliverable. Of the remaining 2,931 surveys that were successfully delivered to anglers, 1,441 completed surveys were returned for a 49.2% response rate.

The dichotomous choice contingent valuation method was used to estimate anglers' net economic value for their most recent fishing trip. The estimated net economic value per fishing trip was $33.81 (SE = 6.45) for Piledriver Slough, $36.04 (SE = $5.44) for Chena Lake, $46.68 (SE = $7.34) for Harding Lake, $58.78 (SE = $6.28) for Birch Lake, and $68.70 (SE = $5.30) for Quartz Lake. Estimated average expenditures per trip for the five waters ranged from $22.88 to $70.07. Overall, 1995 sport fishing at the five major waters is estimated to have a total net economic value of $3,998,458 (SE = $266,949) and an estimated $3,561,765 for fishing of stocked species on the five waters. Benefits from stocking, as measured by total estimated annual net economic value, outweigh hatchery production and evaluation expenditures in the five waters for 1995. The sport fishery at Quartz Lake has the highest mean benefit/cost ratio (20.6), followed by the fishery at Birch Lake (8.0); the ratios for the remaining three fisheries range from 2.3 to 4.2.

In addition to the contingent valuation questions, the survey included several questions on the respondents' preferences for alternative stocking scenarios. Respondents preferred that Arctic char *Salvelinus alpinus* be stocked at Harding Lake, ranked Chena, Birch and Quartz lakes similarly in their preference for stocking rainbow trout *Oncorhynchus mykiss*, and likewise ranked Chena, Birch and Quartz lakes similarly in their preference for stocking landlocked salmon *O. kisutch.* Responses to the contingent behavior questions were not sufficiently clear to perform an optimization of stocking preferences.

Key words: nonmarket economic analysis, net economic value, contingent valuation, contingent behavior, benefit/cost ratio, sport fishing, stocked waters, Tanana Valley.

1.0 INTRODUCTION

This report provides a social and economic analysis of current and alternative conditions for sport fishing in five stocked waters in the Tanana River Valley in 1995: Chena Lake, Piledriver Slough, Harding Lake, Birch Lake, and Quartz Lake (Figure 1). The primary species stocked in these waters are rainbow trout *Oncorhynchus mykiss*, Arctic char *Salvelinus alpinus*, and landlocked salmon *O. kisutch*. 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.

This study had two primary goals. The first was estimation of the net economic value (NEV) that users of the five stocked waters place on these angling experiences. 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. The method employed to estimate the NEV was contingent valuation. Few studies to estimate the nonmarket value of sport fishing trips in Alaska have been conducted. Prior to this research, measures of sport fishing demand were estimated angler days. 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. The problem, then, was to estimate public benefits in dollar terms, and to evaluate the benefit/cost ratio for program planning.

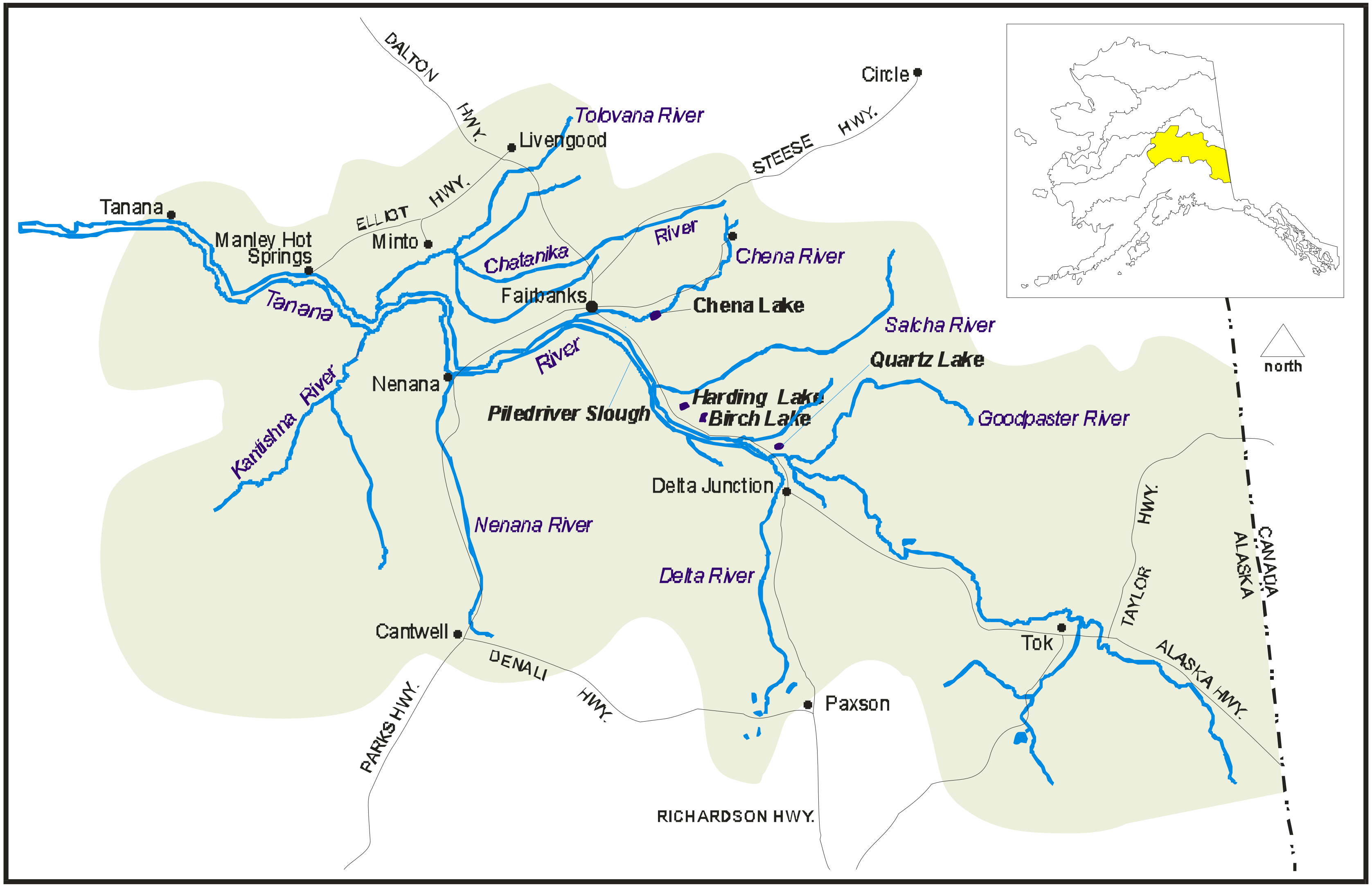

Figure 1.-The Tanana River Valley, showing the five major stocked waters.

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 angler and 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 the Tanana Valley. Well established markets for sportfishing 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 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 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 Tanana Valley stocked waters survey, anglers were asked to place a value on their most recent open water fishing trip to one of the five stocked waters. 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 would change to the five stocked waters if alternative stocking strategies were used for those waters (Appendix B).

3.0 METHODS

In October through November 1995, a mail survey was administered to anglers holding 1995 Alaska sport fishing licenses and residing in the Tanana Valley. At the time of the survey, the 1995 license file was incomplete because it was not year-end, and also because entry of license data lags behind year-end by a month or so. However, both open- and ice-covered fishing opportunity was included in the license file time frame. It was not thought that angler characteristics or stocking preferences would differ appreciably among resident anglers selected in the January - September license file, from those anglers in the January – December license file. The October mailing was selected to reduce recall bias.

One limitation of the sampling strategy employed in this study was that the sample pool for Alaska residents only included those individuals holding 1995 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 trip estimates used in this study were estimated by

ADF&G and do include PID holders.   The design and administration of this survey are discussed in the following sections.

3.1 Population Sampling Design

The primary recipients of benefits from sport fishing at the five stocked waters are local residents. The percentage of participants in these fisheries by residency status was examined from the most recent on-site creel surveys and nonresidents were found to comprise a small percentage of anglers:

	Chena Lake	Birch Lake	Quartz Lake	Piledriver Sl	Harding Lake
Year[a]	1986	1986	1987	1989	1989
% Nonresident	1	29	13	9	18

[a] For 1986, citation is Clark and Ridder (1987); for 1987 citation is Baker (1988); for 1989 citation is Merritt et al. (1990).

While it would be best to identify and survey all categories of users, to receive a sufficient response from nonresidents would have required an extremely large sample, beyond the budgetary means of this project. Thus, a random sample of anglers holding 1995 Alaska sport fishing licenses and residing in the Tanana Valley was surveyed. While the total NEVs reported in this study are conservative, they are an accurate assessment of value for anglers residing in the Tanana Valley.

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 the five stocked waters during 1995. Section II focused the questioning on the one of the five waters 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 stocking the waters as well as how their visitation to the waters would change if their preferred stocking options were employed. Section IV asked respondents a number of socioeconomic questions.

After the survey was developed it was pretested on a sample of 200 anglers. 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 the top bid level for the contingent valuation question. As a result of the pretest responses, the top bid level was set at $200 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 to the sample of license holders on October 10, 1995. After two weeks a reminder postcard was sent to all potential respondents (see Appendix C). After another 24 days, on November 17, a second copy of the survey was sent to those anglers who had not yet responded to the original survey mailing. When it became clear that a response rate on the order of 50% would be achieved after the second reminder contact, a decision was made to not incur the expense of a third reminder. The sample sizes resulting from the 50% response rate yielded welfare estimates and total value estimates with the degree of precision targeted in the survey design.[1]

3.3 Response Rate

A total of 3,497 anglers' names and addresses were included in the survey sample (200 in the pretest and 3,297 in the final survey; pretest results were included in the final analyses because neither the survey nor bid range changed.). Of this number, 566 surveys (16.2%) were returned as undeliverable. This relatively high undeliverable rate is likely due to the large number of armed service personnel in the area surveyed, and the timing of their rotation out of the area. Of the remaining 2,931 surveys that were successfully delivered to anglers, 1,441 completed surveys were returned by the end of the survey process. The resulting response rate to the survey was therefore 49.2%.

4.0 RESULTS

4.1 General Fishing and Socioeconomic Statistics

The survey asked several questions about general fishing habits, frequency of fishing trips to the five waters under study, and socioeconomic characteristics. Respondents on average had engaged in fishing as a recreational activity for 24.2 years, and on average spent 23.0 days per year fishing (Table 1). On average respondents spent 32.8% of their fishing time on lakes, 41.7% on rivers, and 25.5% on saltwater (Table 1).

Table 1.-General fishing characteristics of respondents to the stocked waters survey, Tanana Valley, 1995.

Characteristics of Survey Respondents	
Average years fished in life	24.2 years
Average number of days fished per year	23.0 days
Percent of fishing time spent on lakes	32.8%
Percent of fishing time spent on rivers	41.7%
Percent of fishing time spent on saltwater	25.5%

The highest percentage of respondents (34.9%) had visited Quartz Lake in 1995 (Table 2). The lowest percentage (21.5%) had visited Piledriver Slough. Of those respondents who had visited one or more of the waters the highest average number of trips per respondent were taken to Piledriver Slough and the lowest average number of trips were to Quartz Lake. Piledriver Slough is closer in proximity to Fairbanks (approximately 30 min by car) than is Quartz Lake (approximately 90 min by car), which may be one reason for the higher frequency of trips.

[1] Given the use data from ADF&G's statewide harvest survey and estimated precision on net benefits, the estimated total value estimates for the average site should have the precision on the order of ± 30-35% of the mean estimate for a 95% confidence interval. Of course, precision on more heavily used fishing sites will be better, and at lesser used sites will be worse.

Table 2.-Visitation by survey respondents to the five stocked waters in 1995.

Water	% of Respondents Visiting	Average Number of Trips per Respondent
Chena Lake	26.0	3.9
Piledriver Slough	21.5	6.0
Harding Lake	25.5	4.0
Birch Lake	29.9	4.8
Quartz Lake	34.9	3.8

The average age of all respondents was 39 years, 73.2% were male, 15.8% were in the military, and the average household income before taxes was $54, 119 (Table 3).

Table 3.-Socioeconomic characteristics of respondents to the stocked waters survey, Tanana Valley, 1995.

Statistic	All respondents (n=1,441)	Those who had fished on the study waters (n=777)	Those who had not fished on study waters (n=664)
Percent in the armed services	15.8%	21.9%	8.3%
Percent male	73.2%	76.0%	70.0%
Average age	39 years	38 years	40 years
Average household income	$54,119	$52,799	$55,832
Percent employed full-time	76.0%	79.0%	72.4%

The Tanana Valley stocked waters survey was implemented in several waves, or mailings, with those anglers not responding to initial mailings being contacted additional times. Comparisons were made across responses to the three mailings of surveys and reminders to see if responses varied dependent on how promptly anglers returned the survey. Appendices D.1 and D.2 show a comparison of key variables on angler and trip characteristics across mailings. As can be seen from the tables, angler characteristics across mailings are remarkably similar, and percent visitation and average number of trips per angler to the study waters also show strong similarities.

4.2 Site-Specific Statistics and Trip Characteristics

Section II of the survey was answered by those survey respondents who indicated in Section I that they had taken at least one trip to any of the five study waters during 1995. Section II asked respondents to answer a series of questions about the trip they took to the study water that they had fished most recently. While there were many similarities between trips taken to the five waters included in the study, several differences were evident. The average number of years that respondents had been fishing the sites ranged from lows of 4.3 and 4.6 years at Piledriver Slough and Chena Lake, respectively, to a high of 10.0 years at Quartz Lake (Table 4). More people took multi-day trips to Birch and Quartz lakes than to Chena Lake and Piledriver Slough. Finally, use of a boat was much higher at Harding, Birch, and Quartz lakes than at Chena Lake and Piledriver Slough.

Table 4.-Characteristics of respondents' most recent trips to the five stocked waters, 1995.

Statistic	Chena Lake	Piledriver Slough	Harding Lake	Birch Lake	Quartz Lake	All Waters
Average number of years had fished site	4.6	4.3	7.1	7.9	10.0	7.4
Percent taking first trip to site	10.4%	8.5%	15.1%	14.8%	10.9%	11.8%
Percent of trips that were one day trips	81.2%	87.2%	71.4%	54.6%	62.3%	69.1%
Average number of people in anglers group on trip	3.2	2.2	3.0	3.3	3.4	3.1
Percent using a boat	33.1%	15.4%	79.2%	65.6%	77.8%	58.1%

Section II of the angler survey asked respondents a series of questions regarding the types and numbers of fish they targeted and caught on their most recent fishing trips. With the exception of Piledriver Slough and Harding Lake, less than half of the respondents said that they were targeting a particular species of fish on their trip. Of those that were targeting a particular species, the most frequently cited species targeted was rainbow trout in all waters except for Harding Lake where northern pike were most frequently targeted (Table 5). Anglers taking trips to Quartz Lake reported the most success in terms of the percentage of respondents catching large fish (Table 5). The percentage of respondents reporting an above average or excellent fishing experience on their most recent trip to a stocked water ranged from 9.4 to 15.6% (Table 5).

Table 5.-Fishing trip experiences and quality ratings from survey respondents for the five stocked waters, 1995.

Statistic	Chena Lake	Piledriver Slough	Harding Lake	Birch Lake	Quartz Lake	All Waters
Percent targeting specific species	40.9%	66.4%	64.7%	35.6%	49.8%	49.5%
Primary species targeted[a]	RT	RT	NP	RT	RT	RT
Percent catching "large fish"	18.9%	16.9%	25.7%	17.9%	36.7%	25.7%
Average number of large fish caught[b]	2.9	3.9	2.2	4.5	4.0	3.7
Above average fishing experience[c]	14.3%	11.2%	9.4%	13.9%	15.6%	13.4%

[a] RT = Rainbow Trout, NP = Northern Pike

[b] Average for those respondents who reported catching large fish.

[c] 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 Section II of the survey, respondents were asked how much money they spent in a number of expenditure categories on their recent trip to one of the study waters. In general, expenses were highest for trips to Birch and Quartz lakes and lowest to Piledriver Slough (Table 6). The difference between expenditures for trips to Piledriver Slough and trips to Birch and Quartz lakes was about 3-fold.

Table 6.-Average expenditures per trip by category and stocked water.

Statistic	Chena Lake	Piledriver Slough	Harding Lake	Birch Lake	Quartz Lake	All Waters
Gas	$6.19	$6.03	$14.18	$15.77	$18.09	$13.80
Food	$12.32	$7.39	$17.31	$22.11	$22.78	$17.89
Lodging	$7.79	$0.49	$5.16	$9.19	$3.96	$5.34
Equipment rental	$1.15	$0.63	$0.66	$9.01	$3.78	$3.54
Equipment purchase	$6.33	$5.24	$10.47	$7.69	$10.98	$8.98
Other expenses	$4.46	$3.10	$4.79	$6.30	$5.16	$4.99
Total expenditures	$38.24	$22.88	$52.57	$70.07	$64.75	$54.54

4.4 Net Economic Value per Trip

Section II of the Tanana Valley stocked waters 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. Overall, approximately two-thirds of respondents said their most recent trip was worth more than they paid for it. The percentages varied over the five waters from a low of 64.6% at Piledriver Slough to a high of 71.8% at Chena Lake. The second question asked anglers to provide information on their willingness to pay for their most recent angling experience on the five waters. 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 five bid levels (10, 25, 50, 100, and 200 dollars). The responses to this question were analyzed for each of the five waters both individually and for the waters aggregated into two groups 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.

The distribution of "yes" responses were used in a logistic regression model; bivariate models of NEV were estimated. Table 7 shows the estimated bivariate models for each of the five waters.

Table 7.-Bivariate current trip models of net economic value for a sport fishing trip to the five stocked waters, for all species, 1995.

Variable/ statistic	Chena Lake	Piledriver Slough	Harding Lake	Birch Lake	Quartz Lake
Intercept	6.3344	4.7218	5.0697	8.1325	5.8491
(t-stat)	3.98	3.15	2.92	4.21	4.70
SE	(1,591)	(1.499)	(1.738)	(1.930)	(1.244)
Ln (BID)	-1.7894	-1.3770	-1.2787	-1.8920	-1.3315
	4.35	3.65	3.11	4.27	4.54
	(0.411)	(0.377)	(0.411)	(0.443)	(0.293)
Chi-square d.f.	3	3	3	3	3
Chi-square	2.73	3.72	7.43	3.46	7.56
P-statistic	0.435	0.294	0.06	0.327	0.056
Sample size	81	60	56	83	145

The estimated coefficients for the Chena Lake, Piledriver Slough and Birch lake models are all significant at the 95% confidence level, and for the Harding Lake and Quartz Lake models are significant at the 90% level (Table 7). 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 as well.

The estimated models shown in Table 7 were used to estimate the truncated mean NEV for each water. These estimated welfare measures are shown in Table 8 for all five study waters.

The NEV per trip estimates shown in Table 8 are estimates of value for those respondents who indicated that their most recent trip WAS worth more than they actually paid in out-of-pocket expenses. In order for these estimates to apply to the entire pool of respondents, these per-trip estimates must be adjusted downward to account for those individuals with zero NEV per trip. The adjusted NEVs per trip are shown in the final column of Table 8. 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 are computed using a standard variance formula.

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 over time.

Table 8.-Estimates of adjusted mean net economic value for a sport fishing trip to the five stocked waters, for all species, 1995.

Water	Mean net economic value [a] (standard error)[b]	Percent of respondents with net economic value greater than expenses	Adjusted mean net economic value per trip
Chena Lake	50.19 (7.58)	71.8%	$36.04 (5.44)
Piledriver Slough	52.33 (9.99)	64.6%	$33.81 (6.45)
Harding Lake	72.02 (11.32)	64.8%	$46.68 (7.34)
Birch Lake	88.79 (9.49)	66.2%	$58.78 (6.28)
Quartz Lake	99.13 (7.65)	69.3%	$68.70 (5.30)

[a] Mean NEV measures are truncated means, truncated at the maximum bid level of $200.

[b] Standard errors were bootstrapped using method suggested by Duffield and Patterson (1991) with 200 bootstrap iterations.

4.5 Total Net Economic Value Estimates

4.5.1 Total Trip Estimates

The ADF&G conducts an annual survey of fishing pressure in the state however, estimates of trips reported in the statewide harvest survey (Howe et al. 1996) are for household-trips. Estimates of angler-trips per household trip for the five waters were approximated following the equations documented in Appendix E. Estimates of total 1995 angler-trips to the five waters are used in this analysis to estimate the total net economic value associated with sport fishing. Table 9 shows the ADF&G estimates of total angler-trips and standard errors for the five waters in this study.

Table 9.-Estimates of 1995 angler-trips to the five stocked waters.

Water	Estimated 1995 Total Angler-Trips (standard error)
Chena Lake	11,034 (961)
Piledriver Slough	13,753 (840)
Harding Lake	8,753 (876)
Birch Lake	16,970 (1,574)
Quartz Lake	25,179 (1,721)

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

Estimates of mean NEVs (Table 8) were multiplied by estimated angler-trips (Table 9) to generate total annual NEV for sport fisheries at the five study waters (Table 10). Skaugstad et al. (1995) estimated that while all fishing occurring at Birch, Quartz and Chena lakes is for stocked fish, only approximately 50% of fishing at Harding Lake and Piledriver Slough is for non-native fish. In order, therefore, to estimate the total annual NEV of fishing associated with stocked fish in the five waters, the total value estimates for Harding and Piledriver should be reduced by 50%. This results in an estimated net economic value associated with fishing for stocked fish in the five waters of $3,561,765. If factors influencing the NEV remain relatively stable over time, the total net economic value of fishing the five stocked waters will vary annually with angler-trips.

Table 10.-Estimated total annual net economic value of sport fishing in the five stocked waters, 1995.

Water	Total annual net economic value	Standard error of total value
Chena Lake	$397,658	69,497
Piledriver Slough[a]	$464,932	93,299
Harding Lake[a]	$408,550	76,425
Birch Lake	$997,524	141,476
Quartz Lake	$1,729,794	178,524
Total of all five waters	$3,998,458	266,949

[a] The total NEV should be reduced by 50% to estimate angling associated with stocked fish at these waters.

4.6 Benefit/Cost Ratio

The Quartz Lake sport fishery is significantly higher in total annual NEV at $1.7 million, followed by the Birch Lake sport fishery at about $1.0 million. The sport fisheries at the remaining three stocked waters have similar total annual NEVs around $400,000. The total annual NEVs (Table 10) were used against hatchery production and evaluation costs (Table 11) to calculate the benefit/cost ratio (Table 11). The sport fishery at Quartz Lake has the highest mean benefit/cost ratio (20.6), followed by the fishery at Birch Lake (8.0). The benefit/cost ratios for the remaining three fisheries range from 2.3 to 4.2. The total benefit/cost ratio for the sport fisheries at the five stocked waters is 7.5 (Table 11).

Table 11.-Estimates of total hatchery production and evaluation costs, all species, for the five stocked waters, and benefit/cost ratios, 1995.

Water	Total 1995 costs[a]	Benefit/Cost Ratio
Chena Lake	$114,338	3.5
Piledriver Slough	$103,274	2.3
Harding Lake	$48,296	4.2
Birch Lake	$125,090	8.0
Quartz Lake	$84,010	20.6
Total	$475,008	7.5

[a] Costs are for hatchery production-related activities, including transport (Skaugstad and Doxey 1996), summed with estimates from the project biologist on the percentage of evaluation costs spent on each water body (Cal Skaugstad, personal communication, ADF&G Fairbanks). Cost estimates do not include administrative overhead or management.

4.7 Analysis of Contingent Behavior Responses

In addition to estimating NEV per trip and total annual site values for the study waters, the Tanana Valley stocked waters survey asked respondents their opinions about possible changes to the current stocking programs in place on the five waters (see Appendix B). Additionally, respondents were asked to predict how their visitation to the five waters would change if their own preferred stocking program were implemented. On occasion respondents will add a letter or write comments in the margins of the survey relating their opinions on a question in more detail, or offer opinions on additional topics. Appendix F is a summary of comments grouped by a variety of topics.

4.7.1 Angler Preferred Stocking Options

Section III of the questionnaire began by asking anglers how they would prefer to see additional fish stocks distributed among the five study waters. Respondents were presented with the following statement:

> Fish and Game can produce a limited number of fish for stocking at Birch Lake, Quartz Lake, Chena Lake, Harding Lake, and Piledriver Slough. We would like to know your preferences for possible stocking options for Arctic char, rainbow trout, and salmon. Within each group of options, please rank the listed options with 1 = most preferred option.

With regards to stocking Arctic char, there appears to be a clear preference among anglers for stocking fewer (200-400) of 4-10 lb char in Harding Lake rather than greater numbers (3,000-5,000) of 1 lb char in Chena Lake (Table 12). The results for the other two species (rainbow trout and salmon) are not so clear-cut. The highest percentage of survey respondents ranked Chena Lake as their number one preference for stocking rainbow trout (30.4%). However, the estimated percentage of anglers preferring to stock rainbows in Chena Lake is not statistically different from the estimated percentage of anglers preferring to stock rainbows at Birch and Quartz lakes. Finally, for stocking of salmon, the highest percentage of respondents ranked Chena Lake number one (35.8%). Again, however, this percentage is not statistically different from the percentages for Birch and Quartz lakes when applied to all anglers.

Table 12.-Percentage of respondents ranking stocking options number one, by stocked species.

Species	Chena Lake	Piledriver Slough	Harding Lake	Birch Lake	Quartz Lake
Arctic char	40.0%	--	60.0%	--	--
Rainbow trout	30.4%	15.6%	--	26.9%	27.0%
Salmon	35.8%	--	--	33.5%	30.8%

Crosstabs were run on the universe of stocking options presented in the angler questionnaire in order to see if any combinations of preferred stocking options were consistently ranked as number one for all three species. Of the six top-ranked combinations of stocking options the most popular was to stock Arctic char in Harding Lake, and stock rainbow trout and salmon in Quartz Lake (Table 13).

Table 13.-Top ranked combinations of stocking options.

Water ranked number 1 for stocking:			Number of anglers choosing this combination of preferred stocking options	Percent of combinations
Arctic char	Rainbow trout	Salmon		
Harding	Quartz	Quartz	147	16.0%
Chena	Chena	Chena	137	14.9%
Harding	Birch	Birch	134	14.6%
Harding	Chena	Chena	61	6.7%
Chena	Birch	Birch	58	6.3%
Chena	Quartz	Quartz	48	5.2%

4.7.2 Estimated Changes in Angler Trips Under Preferred Stocking Options

Respondents to the stocked waters angler survey were asked to predict how their visitation to the five stocked waters would change if their preferred stocking options were adopted. The questionnaire asked respondents to both estimate their total trips taken to the five waters in 1995 and to predict what their visitation would be in 1996 if their preferred stocking option were to be adopted.

Analysis of these responses was somewhat problematic due to a large amount of missing data specific to these questions. Comparisons were made between the 1995 estimated and 1996 predicted total number of trips with the following assumptions. Those individuals who completed question 19 indicating their preferred stocking options but left either the total 1995 trips or total 1996 trips in questions 20 or 22 blank were assumed to have no net increase from adoption of their preferred stocking options. Additionally, those respondents indicating in question 23 that they would take fewer trips to other fisheries in order to take more trips to the five waters were assumed to have no net increase in visitation resulting from stocking changes. After incorporating the above assumptions it was estimated that visitation increases under the six preferred stocking combinations listed in Table 13 would range between 13 and 34%. Responses to the contingent behavior questions made it clear that anglers were receptive to the proposed stocking changes and would likely fish the waters more often if stocking changes were made.

The estimates of increased visitation under alternative stocking options were not used to calculate estimated increased net economic value under various stocking options due to the imprecision of responses to the contingent behavior questions. The responses to these questions should rather be viewed as indicators of increased interest in visitation under alternative stocking scenarios.

While responses to the contingent behavior questions provided a good indication of which stocking options anglers preferred, responses were not sufficiently complete to allow for optimization of the "best" stocking combination. The imprecision of responses to the contingent behavior question may be due to the complexity of the questions asked and the large amount of information which was to be gathered for each respondent. A more successful technique might have been to ask less from each respondent (perhaps focusing on only one species, or one or two lakes). However, this would require stratifying the sample and perhaps necessarily increasing the sample size. Anglers are a diverse group and it could be that there is no single outstanding stocking combination relating to species, catch rates and size of fish caught that would be preferred by a majority.

5.0 DISCUSSION

Evaluations of stocking programs often present benefits in terms of harvest, such as return to the creel, or a constrained measure of demand, such as angler days, thus overlooking public welfare measures, such as NEVs. The NEV is the appropriate measure to examine program cost-effectiveness (U.S. Water Resources Council 1983). Using the ratio of total annual NEVs to hatchery production and evaluation expenditures as a measure of program efficiency, public benefits from stocking five major waters in the Tanana Valley outweigh the short-run marginal costs of producing, transporting, and evaluating hatchery fish for 1995.

This research has demonstrated that NEVs can be estimated within objective criteria for precision, and can form the basis for estimation of nonmarket economic benefits of sport fishing. The total annual NEVs reported in this study are conservative due to the limited sampling frame (Tanana Valley residents only) and because the mean NEV was truncated at the highest bid level.

A challenge for policy-makers is to define the cost basis, and to obtain accurate and consistent estimates of costs for purposes of program evaluation. Loomis and Fix (1999) discuss methods to estimate costs of hatchery production. Costs as applied in this study account for the hatchery component including transport, and also evaluation, however not management or supervision. Obtaining accurate estimates of costs associated with projects is difficult without activity-based cost accounting in place. Additionally, the long-run costs of facilities replacement or expansion are not considered in the current cost estimates.

The benefit/cost ratios for three of the five stocked waters were unexpectedly low (2 to 4), prompting the question, "How low is too low?" The extent to which the benefit/cost ratio influences program decisions is still under discussion by policy-makers. The benefit/cost ratio is only one of several considerations in program planning, and its weight in the policy-making process is likely to be variable, depending upon the importance of other influences, such as conservation or political concerns.

For the three stocked species under consideration, respondents preferred that Arctic char be stocked at Harding Lake, ranked Chena, Birch, and Quartz lakes similarly in their preference for stocking rainbow trout, and likewise ranked Chena, Birch, and Quartz lakes similarly in their preference for stocking salmon. Aggregating responses to six preferred stocking options resulted in estimates of trip increases to the five major stocked waters from 13 to 34%. Thus, responses to the contingent behavior questions made it clear that anglers would likely fish more often if their preferred changes were made.

Responses to the ranking and contingent behavior questions were not sufficiently clear to perform an optimization of stocking preferences. The ability of management to influence anglers' decisions to take fishing trips may be overshadowed by more significant variables such as weather, the angler's economic situation, and motives for initiating a trip.

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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:

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

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:

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

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:

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

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).

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 1988, Bowker and Stoll

-continued-

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. THE CONTINGENT BEHAVIOR MODEL

Appendix B.-Contingent Behavior Model.

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

-continued-

respondents to the government study (McConnell et al. 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.

-continued-

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.

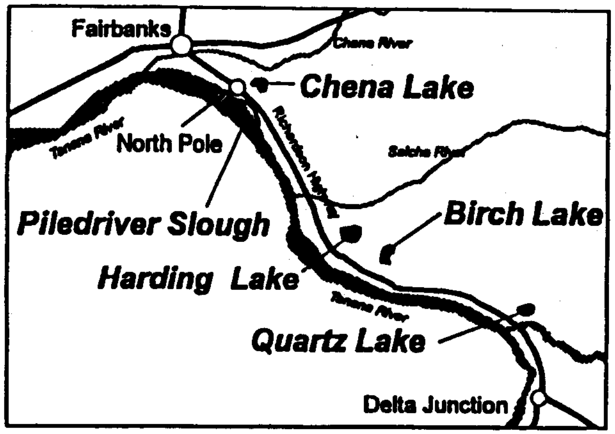
To conclude, the economics literature shows that contingent behavior data is used by resource economists for a variety of purposes, including resource valuation. The broader scientific literature including polling and market research shows that survey questions can fairly accurately predict at least 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

Tanana Valley

Major Stocked Waters

Angler Survey



Alaska Department of Fish and Game
Division of Sport Fish

Summer 1995

The purpose of this survey is to obtain information about angler use of the five major stocked waters in the Tanana Valley. These fishing sites are Birch Lake, Quartz Lake, Chena Lake, Harding Lake and Piledriver Slough. We appreciate your participation in this survey.

Section I. First, we have some general questions about your fishing.

1. How many years have you been fishing? ______ years

2. Approximately how many days per year do you spend fishing?
______ days

3. About what percentage of your fishing time do you spend at each of the following:

Lakes	_____	percent
Rivers	_____	percent
Salt water	_____	percent
Total =	100	percent

4. Which of the following fishing sites have you visited this year (since January 1, 1995)? Please check yes or no for each site and indicate how many trips you have made from home to each site so far this year.

Fishing Site	Visited this year? Yes	No	Number of fishing trips this year
Chena Lake	_____	_____	_____
Piledriver Slough	_____	_____	_____
Harding Lake	_____	_____	_____
Birch Lake	_____	_____	_____
Quartz Lake	_____	_____	_____

If you did not visit any of the sites this year, please skip to Section III.

-continued-

Although you have not fished at any of the 5 sites listed on the previous page this year, would you consider fishing these waters in the future if Alaska Fish and Game fish stocking programs increased the numbers and sizes of fish in these waters?

- ☐ Yes --------> Skip to Section III
- ☐ No --------> Skip to Section IV

Section II. In this section, we would like to ask you about your most recent fishing trip to one of the sites.

5. Which of the following sites did you fish most recently? (Circle one)
   - A. Chena Lake
   - B. Piledriver Slough
   - C. Harding Lake
   - D. Birch Lake
   - E. Quartz Lake

The rest of the questions in this sections are about this most recent fishing trip to the site you circled in Question 5.

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

   ______ Month ______ Day ______ Year

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

8. Was this trip your first fishing trip ever to this site?
   - ☐ Yes --------> Skip to Question 10
   - ☐ No --------> Continue with Question 9

9. If NO, about how many years have you been fishing this site?

   ______ years

The primary species of fish present at the five fishing sites are:

Fishing Site	Stocked Fish	Native Sport Fish
Birch Lake	rainbow, grayling, char, salmon	none
Quartz Lake	rainbow, salmon, char	none
Chena Lake	rainbow, grayling, char, salmon	none
Harding Lake	char	burbot, whitefish, lake trout, pike
Piledriver Slough	rainbow	grayling, burbot, whitefish, pike

10. On your trip to this site, did you target a specific species of fish?
    - ☐ Yes --------> Continue with Question 11
    - ☐ No --------> Skip to Question 13

11. What was the primary species of fish you intended to catch at this site? (Check one)
    - ☐ Coho/Chinook Salmon
    - ☐ Burbot
    - ☐ Northern pike
    - ☐ Rainbow trout
    - ☐ Other ______________
    - ☐ Whitefish
    - ☐ Arctic char
    - ☐ Lake trout
    - ☐ Arctic grayling

12. For the species you targeted on this trip, did you catch any fish you consider to be large fish?
    - ☐ No
    - ☐ Yes

    If YES, how many large fish for your targeted species did you catch?

    ________ Number of large fish

13. On this most recent trip, how many fish did you catch for each of the following species:
    - ______ Rainbow trout
    - ______ Coho/Chinook Salmon
    - ______ Burbot
    - ______ Lake trout
    - ______ Arctic grayling
    - ______ Whitefish
    - ______ Arctic char
    - ______ Northern pike
    - ______ Other (name of other species) ______________

-continued-

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

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

15. Did you use a boat (canoe, motor boat, float tube, etc.) for fishing on this particular trip?

☐ Yes ☐ No

16. How many people were in your party on this trip? _____ People

17. 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):

Gasoline	$ ______
Food & beverages	$ ______
Lodging or camping fees	$ ______
Equipment rentals	$ ______
Equipment purchased just for this trip	$ ______
Other trip expenses	$ ______

Total amount I spent on this trip $ ____________

18. 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?

____

____

____

Section III. In this next section, we would like to ask your opinions about options for the Alaska Fish & Game stocking program.

19. Fish and Game can produce a limited number of fish for stocking at Birch Lake, Quartz Lake, Chena Lake, Harding Lake, and Piledriver Slough. We would like to know your preferences for possible stocking options for Arctic char, rainbow trout, and salmon. Within each group of options, please rank the listed options with 1 = most preferred option.

Group 1. Options for stocking Arctic char
(Please rank these 2 options from 1 to 2)

Option	Ranking
Option 1. Increase expected catch from 200 to 400 4-10 lb. char at Harding Lk.	(a)_____
Option 2. Increase expected catch from 3,000 to 5,000 1 lb. char at Chena Lk.	(b)_____

Group 2. Options for stocking Rainbow trout
(Please rank these 4 options from 1 to 4)

Option	Ranking
Option 1. Increase expected catch rate of 10 in. trout from 2.4 to 4.5 per day at Chena Lk.	(c)_____
Option 2. Increase expected catch rate of 10 in. trout from 1.0 to 1.2 per day at Piledriver Slough	(d)_____
Option 3. Increase expected catch rate of 10 in. trout from 3.0 to 5.0 per day at Birch Lake	(e)_____
Option 4. Increase expected catch rate of 10 in. trout from 2.5 to 3.5 per day at Quartz Lake	(f)_____

Group 3. Options for stocking Salmon
(Please rank these 3 options from 1 to 3)

Option	Ranking
Option 1. Increase expected catch rate of 10 in. salmon from 1.4 to 2.4 per day at Birch Lk.	(g)_____
Option 2. Increase expected catch rate of 10 in. salmon from 1.1 to 1.6 per day at Quartz Lk.	(h)_____
Option 3. Increase expected catch rate of 10 in. salmon from 1.0 to 2.0 per day at Chena Lk.	(i)_____

-continued-

20. Based on the current fishing conditions at the five sites, how many total trips do you expect to make to each of the sites this year, including trips you have already taken since January 1st?

Site	Trips this Year
Birch Lk.	______
Quartz Lk.	______
Harding Lk.	______
Chena Lk.	______
Piledriver Sl.	______
Total number of trips	______

21. Now we would like to ask you a few questions about how your visitation to the five fishing sites would change if your most preferred options listed in Question 19 were implemented. To remind yourself of your most preferred stocking options, please circle the three letters of the options you ranked as number 1 in Question 19.

(a) (b) (c) (d) (e) (f) (g) (h) (i)

22. If your three preferred stocking options were implemented, what do you think would be the total number of trips you would take to each of the five sites next year?

Site	Total number of Trips You Expect to Make Next Year Under Your Preferred Stocking Options
Birch Lk.	______
Quartz Lk.	______
Harding Lk.	______
Chena Lk.	______
Piledriver Sl.	______
Total number of trips	______

23. If the total number of trips in Question 22 is greater than the total in Question 20, is the increase because: (Circle one)

a. You want to take more fishing trips during the year.

b. You will take fewer trips to other fisheries so that you can fish more often at the above sites.

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

24. Where do you live?

City: ______________ State: ________

25. What is your age? __________ years

26. Are you: ☐ male ☐ female

27. What is the highest level of formal education you have completed? (Circle one)

A. Some grade school
B. Finished grade school
C. Some high school
D. Finished high school
E. Some college
F. Finished college
G. Some postgraduate work
H. Finished postgraduate

28. During the fishing season this year, you were: (Circle one)

A. Employed full time
B. Employed part time
C. Unemployed
D. Retired
E. Homemaker
F. Student
G. Other: ____________

29. Are you a member of the U.S. Armed Services? (Check one)

☐ Yes ☐ No

30. Please circle your household's income before taxes for 1994:

A. Less than $10,000
B. $10,000 to $14,999
C. $15,000 to $19,999
D. $20,000 to $29,999
E. $30,000 to $39,999
F. $40,000 to $49,999
G. $50,000 to $59,999
H. $60,000 to $69,999
J. $70,000 to $79,999
K. $80,000 to $89,999
L. $90,000 to $99,999
M. $100,000 to $124,999
N. $125,000 to $149,999
O. $150,000 to $174,999
P. $175,000 to $199,999
Q. More than $200,000

Thanks for your help!

Appendix C2.-Text of contact letter accompanying initial survey mailing.

October 10, 1995

Dear Alaska Angler,

The Alaska Department of Fish and Game is conducting research on sport fishing in the Tanana Valley. Our goal is to improve the quality of fishing in stocked waters including Quartz Lake, Birch Lake, Harding Lake, Chena Lake and Piledriver Slough. To achieve this goal, we need to know how resident anglers use these popular fisheries.

Your name has been randomly selected from a list of Tanana Valley sport fish license holders. 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 it will take only a few minutes of your time.

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 or Cal Skaugstad at 459-7207.

Thank you very much for your help.

Sincerely,

Dr. M. Merritt
Research Supervisor
Sport Fish Division

Appendix C3.-Text of reminder postcard.

Dear Alaska Angler,

One week ago, we sent you a survey concerning research on sport fishing in the Tanana Valley. 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 C3.-Text of reminder letter

November 17, 1995

Dear Alaska Angler,

In October we sent you a survey concerning research on sport fishing in the Tanana Valley. Our goal is to improve the quality of fishing in stocked waters including Quartz Lake, Birch Lake, Harding Lake, Chena Lake and Piledriver Slough. To achieve this goal, we need to know how resident anglers use these popular fisheries. Won't you please take a few minutes to complete the survey and return it to us in the enclosed postage-paid envelope?

In order for the survey to be comprehensive and accurate, it is important that we hear from everyone. We have purposely kept the survey brief so it will take only a few minutes of your time.

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 459-7207.

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

Sincerely,

M. Merritt

Dr. M. Merritt
Research Supervisor
Sport Fish Division

APPENDIX D. COMPARISON OF SURVEY RESPONSES ACROSS MAILINGS

Table D1. Comparison of angler characteristics across mailings.

Characteristic/Statistic	Initial Mailing	Reminder Postcard	Second Mailing
Number of years fishing	25.6	24.1	23.1
Days fished per year	22.3	25.4	21.4
% of time lake fishing	36.7%	40.2%	40.2%
Age	39.9	38.9	38.1
Income	$58,039	$50,753	$52,159
% Male	73.6%	73.3%	74.0%
% in armed services	14.6%	18.8%	13.9%

Note: sample sizes for individual statistics vary from stated sample sizes for individual mailings due to missing responses.

Table D2. Comparison of trip visitation to study waters across mailings.

Statistic	Initial Mailing	Reminder Postcard	Second Mailing
% of respondents visiting Chena Lake	24.0	27.2	28.5
% of respondents visiting Piledriver Slough	18.9	27.4	19.1
% of respondents visiting Harding Lake	25.7	29.3	26.8
% of respondents visiting Quartz Lake	31.8	37.1	37.4
% of respondents visiting Birch Lake	29.4	33.2	28.9
Average number of trips taken to Chena Lake	3.94	4.32	3.73
Average number of trips taken to Piledriver Slough	5.72	5.04	6.82
Average number of trips taken to Harding Lake	4.03	4.79	3.10
Average number of trips taken to Quartz Lake	3.87	4.19	3.45
Average number of trips taken to Birch Lake	4.93	5.62	3.52

Note: average number of trips statistics are the average reported number of trips taken so far in 1995 by respondents who reported visiting those lakes.

APPENDIX E. ESTIMATED ANGLER TRIPS

Appendix E1.-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):

$$\hat{A} \approx \hat{T}\overline{apht}\,; \qquad (1)$$

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:

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

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):

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

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

-continued-

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:

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

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:

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

where:

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

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

with:

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

-continued-

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:

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

where:

$$n = n_1 + n_2 . \qquad (9)$$

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

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

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

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

with:

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

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

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

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

-continued-

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

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

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 E2.-Estimated angler-trips per household-trip and estimated angler-trips to five waters for sport fish license holders from statewide harvest survey data for the Tanana Valley, 1995.

Water	Estimated Household Trips	SE of Household Trips	Estimated Angler-Trips/ hh-Trips	SE Angler-trips/ hh-Trips	Estimated Angler Trips	SE of Angler Trips
Chena Lake	9,317	1,317	1.18425	0.050900	11,034	961
Piledriver Slough	12,613	1,556	1.09036	0.039494	13,753	840
Harding Lake	6,743	910	1.29805	0.066285	8,753	876
Birch Lake	11,702	1,275	1.45017	0.070766	16,970	1,574
Quartz Lake	17,569	1,412	1.43314	0.052801	25,179	1,721

Appendix E3.-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.

	Sample Size		
Water	Case 1	Case 2	Total
Chena Lake	80	52	132
Piledriver Slough	100	49	149
Harding lake	84	42	126
Birch Lake	117	79	196
Quartz lake	224	104	328

APPENDIX F. SUMMARY OF OPINIONS IN LETTERS

Appendix F.-Summary of opinions in letters or comments by respondents to the survey for 1995 use and valuation estimates, with a focus on stocked waters.

Topic	Comments
Catch Rate	No winter stock of fish. Poor fishing.
Boat Launch Fee	We were very mad because we had to pay $6 to launch the boat, up $3 from last year.
Fish Size	I was disappointed because fish were too small to keep. Didn't catch anything worth keeping. No trophy size fish.
Motivation	Piledriver Slough is a convenient place to fish after work or when water is high elsewhere. Considering the commercialization, fishing pressure and the stocking of small rainbows, it is not the most desirable place for a serious fishing trip. Fishing was just for fun before work. It was more of a family outing to a beach site. The fishing at Harding Lake is not worth $276 to me. Harding is a good lake to take the family to for a vacation so they can catch fish. We fish for fun around the Fairbanks area and for meat (halibut) when we go to Valdez. I seldom fish buy a fishing license in case a good fisherman offers to take me with him/her. Just having a license makes me feel more Alaskan.
Disruption	Too much disruption by water skiers and jet skis. We were harassed by them. Reported to Park Ranger who did nothing.