AN ABSTRACT OF THE THESIS OF

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Net economic value for steelhead sport anglers of five selected Washington rivers (the Skagit, Skykomish, Green, Cowlitz, and Humptulips Rivers) was estimated to be about $23 per steelhead fishing trip, or $20 per fishing day during the 1975-76 winter season. This amount is the maximum that steelhead anglers would be willing to pay, on the average, rather than forego the opportunity to participate in this recreational activity. The estimate was based on the 1,304 respondents from a mail survey conducted by Dr. Jack Richards of the National Marine Fisheries Service, Seattle.

Construction of dams on Columbia river have seriously damaged salmon-steelhead habitat, although hundreds of millions of dollars had been spend on hatcheries, fish passage facilities, and other protection programs. Income and population increases over the years have contributed to

increasing demand for salmon-steelhead sport fishing, but this increased demand has shifted in an opposite direction from an even more rapidly decreasing supply. The estimated net economic benefits for steelhead sport fishery should be useful for comparisons between the value of the steelhead sport fishery and the benefits resulting from alternative uses of the river.

This estimate of $23 per winter steelhead fishing trip, or $20 per day of steelhead fishing, is thought to be a reasonable estimate of willingness to pay, given the very low 1975-76 winter steelhead catch. However, a limitation pertaining to the estimate should be noted. The travel cost-based estimates of net economic benefits may likely be higher than if all rivers involved in steelhead sport fishery in Washington had been included in the analysis.

Estimated Net Economic Benefits from Steelhead Sport Fishing of Selected Washington Rivers

by

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Estimated Net Economic Benefits from Steelhead Sport Fishing of Selected Washington Rivers

CHAPTER I

INTRODUCTION

The economy of the Pacific Northwest is closely related to the development of the Columbia River Basin. Agriculture, lumber, and fishing constitute a greater percentage of economic activity in the Pacific Northwest than in most other regions in the nation. The Columbia River Basin also has a great hydroelectric potential; much of the water falls from high elevations and traverses the distance to the ocean through excellent sites for the production of electric power. Because of these excellent sites, many dams have been built. Dams also can provide navigation for commerce, irrigation for agriculture, flood and water control for urban development, and recreational facilities for leisure time. Therefore, dams often result in complementary use of water resources. But this beneficial effect of dams is not usually the case for anadromous fish. Dams prevent movement of fish in the river and result in serious deterioration of fish habitat.

Anadromous salmonids are hatched in fresh water, migrate to the ocean for the growing stage of their life cycle, and return to the fresh water of their birth for spawning. Thus, it is necessary that these fish have freedom to migrate in the river. Construction of dams for power and other uses have severely degraded valuable salmon and steelhead habitat, despite expenditures of hundreds of millions of federal, private, and state dollars for hatcheries, fish passage facilities, and other protection programs. As population increases and per capita income gains over the years have contributed to growing demand for salmon-steelhead sport and commercial fisheries, this accelerating demand has been on a collision course with the even more dramatically decreasing supply. Given the competition between the salmon-steelhead fishery and several other uses for the same water resources, the object of this study is to try to place a monetary value on the fishery resource. Such estimates should be useful both when the economic feasibility of fish-protective or enhancement facilities are being considered or when the value of the fishery to be forgone is compared with benefits resulting from alternative uses of the streams.

When fish are caught and processed commercially, an economic evaluation appears to be conceptually straight forward, and it should be possible to estimate benefits empirically. However, economists face a more difficult task when trying to estimate economic value for sport fisheries, since there are no market prices for sport fishing, at least not in the Pacific Northwest.

Evaluating the contribution of a water-related project is generally done by using benefit-cost analysis. Benefits represent the values of the goods and services derived from the proposed project, while costs are the values of goods and services that could be produced if resources were not withdrawn from other uses in order to construct or develop the proposed project. The difference between benefits and costs is termed "net benefit". Strict application of a benefit-cost criterion would require that in choosing among feasible projects the project be chosen that maximizes positive net benefits. Using this benefit-cost criterion should ensure that it would be possible for those who benefit from the project to fully compensate the losers so that no one would be made worse off, and at least some persons would be made better off. If compensation were to be made, the benefit-cost criterion would appear to be a reasonable basis for project selection. But in fact, it is unlikely that full compensation ever occurs, and decision makers must consider the actual incidence of losses and gains. However, the point is that with this justification of the benefit-cost criterion, it is necessary to use willingness-to-pay to measure project benefits and desired compensation to measure most losses.

Although many procedures based on willingness-to-pay have been suggested for measuring the net economic value of recreational resources, most of these earlier suggested alternative procedures have later been found to be invalid.

Perhaps the most commonly employed fallacious method of estimating net value has been the gross expenditure method (discussed in detail by Brown, Singh, and Castle, 1964). However, one method, the so-called "travel cost" method has stood the test of time and is generally recommended for use whenever possible (Dwyer, Kelly, and Bowes, 1977, pp. 138-140). Some other recently suggested alternative approaches, e.g., the household production function or the Oliveira and Gordon (1976) approach might also yield useful estimates of net economic benefits. However, those alternative approaches are beyond the scope of my study and will not be used in this study, even though comparison of net economic benefits estimated by the travel cost method versus benefits computed by some other alternatives might be interesting and useful.

The travel cost methods have been used to develop models for estimating the willingness of users to pay for a site, resources, or area. This method can, if properly applied, develop models that will provide estimates of value that are highly useful for planning purposes. The concept of the travel cost method appears to have been first advanced via an ingenious suggestion by Harold Hotelling (National Park Services, 1949), then developed by the extensive research of Marion Clawson (1959), and is discussed in more detail by Brown, Singh, and Castle, 1964. More recent developments of this method are given by Dwyer, Kelly, and Bowes, 1977.

The simple concept of the travel cost method, according to Hotelling's letter to National Park Service (Land and Recreational Planning Division, 1949), is the following: Let concentric zones be defined around a recreational site so that the cost of travel to ths site from all points in one of these zones is approximately constant. The persons using the recreation site in a year, or a suitably chosen sample of them, are to be listed according to the zone from which they come. The comparison of the cost of coming from a zone with the number of people who do come from it, together with a count of the population of the zone, enable us to plot one point for each zone on a demand curve. By using an appropriate fitting process, it is possible to get a good enough approximation to this demand curve to provide, through integration, a measure of the consumers' surplus resulting from the availability of the recreational site.

The most important approach to the application of the travel cost method was developed by Clawson (1959). In his research, Clawson estimated the demand curve for the recreational experience by plotting the number of visits per 100,000 population in a distance zone as a function of the estimated travel costs per visit in the given distance zone. Clawson assumed that the visit to the recreational site was the main purpose of the trip and, therefore, had to bear all costs of the trip. Clawson's procedure is simple and direct and has greatly influenced research in resource economics. Nethertheless, certain limitations of Clawson's model should be noted. As noted by Clawson (1959) himself, "the correspondence between cost per visit and number of visits per 100,000 based population may include some variables, such as the cost of distance in time, and to this extent may not represent a pure demand curve showing the net relation between price and volume." Because of the effect of the time constraint, the Clawson demand curve is an underestimate of actual demand for given resources, as explained by Knetsch (1963). In addition to the complication of travel time, distance can be expected to shift the demand curve to the left. The greater the distance a zone is from a particular recreational site, the greater are the number of available substitutes for that particular site, because other sites become relatively cheaper in time and money. Thus, there obviously exists a negative relationship between number of visits and distance traveled. It would seem desirable to take account of distance explicitly rather than indirectly, if possible.

The approach used in this study was to use the travel cost method in an attempt to estimate the net economic value of the steelhead sport fishery of selected Washington rivers. The major relevant variable that should be included in the travel cost method is obviously trip costs (travel cost per mile times miles traveled per trip). Instead of recreational days, as in some of the previous studies, fishing trips per capita was taken to specify the quantity variable for recreational participation in this study, following the recommendation of Dwyer, Kelly, and Bowes, p. 132. The concentric zones around each stream were defined in terms of counties. In some cases, a distance zone consisted of several counties. In other cases a county was subdivided into two or more zones, if there were enough observations.

CHAPTER II

SOURCE OF DATA

Before presenting the data processing and numerical results of this study, the procedures used in obtaining the sample will be presented in this section. First, it should be noted that the data analyzed in this thesis were kindly made available by Dr. Jack A. Richards, National Marine Fisheries Service, Seattle, Washington. Dr. Richards was in charge of constructing the questionnaire (shown in Appendix A) and conducting the survey of Washington Steelhead Sport Anglers. More details concerning the survey and the characteristics of the anglers has been given in an unpublished report by Richards and Peterson (1978).

Sampling Design

An important factor influencing the selection of the sample data was the decision to reduce error from memory bias by mailing questionnaires to steelhead anglers at the end of each month during the 1975-76 winter season. A preliminary step before selecting the sample was to decide the approximate number of questionnaires to be mailed during the fishing season. Based upon cost per respondent and an estimated 50% return, this figure was first set at 10,000. However, because names and addresses were obtained by random selection from the 1973-74 and 1975 license files maintained by the Washington State Department of Game, based on previous pilot surveys, it was estimated that about ten percent of the survey would be undeliverable due to inadequate address. Therefore, a somewhat larger sample was selected to compensate for this deficiency in addresses. A total of 10,238 questionnaires were actually mailed during the winter season (see Appendix A for a copy of questionnaire). A very small possibility existed that the same individual might be selected from both the 1974 and 1975 license lists. About 3.4 percent[1/] of the total number of Washington steelhead anglers (for both 1974 and 1975 years) were included in the sample. Many individuals would have held licenses in both 1974 and 1975. It was estimated (by judgement) that a steelheader probably had about a five percent chance of being included in the sample from either the 1974 or 1975 license list.

The total of 10,238 questionnaires were mailed from November 1975 to April 1976 with the size of each monthly sample based on the approximate relative proportion of steelhead caught for the same month during the 1974-75 winter steelhead season. A total of 1,172 of the mailed

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1/ Total steelhead permits for 1974 143,697
Total steelhead permits for 1975 158,182
301,879

10,238÷301,879=3.4%

questionnaires were returned due to incorrect address (11.4 percent). Reasons for the large number of undeliverable questionnaires include incomplete address for the randomly selected license-holder (as listed on the dealer stub) and the long time between purchase of license and mailing of the questionnaires. Slightly less than 60 percent were returned. This study was based upon the 5,377 returned questionnaires for the 1975-76 winter steelhead season. A summary of the number of questionnaires mailed each month and the corresponding response rate is presented in the following table.

Table 1: Sampling and response rate for the 1975-76 winter steelhead season

Month	Number of questionnaires mailed	Number returned due to incorrect address & percent undeliverable	Number of questionnaires returned and percent returned2/
November	1016	108 (10.6%)	555 (61.1%)
December	2161	229 (10.6%)	1259 (65.2%)
January	2064	206 (10.0%)	1126 (60.6%)
February	2044	263 (12.9%)	992 (55.7%)
March	2036	245 (12.0%)	977 (54.6%)
April	917	121 (13.2%)	468 (58.8%)
Total	10238	1172 (11.4%)	5377 (59.3%)

Selection of Useful Data

Before proceeding to the analysis of the survey data, it should be noted that based on the response to the

2/ Percent of those delivered to respondents.

mail survey, only about one steelhead angler in ten keeps a written record of steelheading activities (349 out of 3010 respondents, equal to 10.4%). Without this written record, some memory bias was likely since some questions were asked about fishing done several years prior to the survey period. For the sake of minimizing memory bias, data used for developing the travel cost model to estimate net economic benefits were confined to the preceding month, thus utilizing relatively current data from the questionnaire.

Information about the fishing activity during the preceding month was obtained in Questions 14, 15 (see Appendix A). Respondents were asked about the number of steelhead fishing trips that were taken during the month. Information requested included stream name, trip length, fish caught, travel distance, transportation cost per person, travel hours, and expenditures. Steelhead anglers were asked about each of the first four fishing trips taken during the month. Based on the response of 5,377 returned questionnaires, 4,073 respondents did not go steelhead fishing: 204 respondents took one trip, 198 respondents took two trips, 148 respondents took three trips, and 754 respondents took four or more trips, ranging up to 28 trips. The number of available trip observations, therefore, was 4,060[3/].

The distribution of number of trips among individual rivers is shown in Table 2. Although there were 116 rivers and streams involved in steelhead sport fishery according to the response of 4,060 available observations, only those 13 rivers that had a total of 100 or more fishing trips reported during the sample month are listed in Table 2.

Table 2: The distribution of number of trips among individual rivers with 100 or more reported steelhead fishing trips

River name	Total number of trips
Cowlitz	373
Green	222
Skykomish	188
Stillaguamish	181
Snoqualmie	163
Skagit	156
Puyallup	154
Humptulips	149
Toutle	148
Kalama	140
Lewis	118
Snohomish	107
Chehalis	101

3/

Number of trips for which information was available on the questionnaire for each respondent	Number of respondents	Number of available observations
1	204	204
2	198	396
3	148	444
4	754	3016
Total	1304	4060

It is well known that the larger the sample size, the more accurate the estimate that can be obtained, since the sample variance becomes smaller as sample size increases. However, given the limited time for this study, the sample used was confined to those observations corresponding to five selected rivers (Cowlitz River, Green River, Skagit River, Skykomish River, and Humptulips River). This selection was primarily based on the popularity of the river for steelhead fishing, as well as the relative geographical location of each river to the other rivers.

Before using the travel cost method to develop outdoor recreational demand models, some steps must be taken to ensure a "good" sample. First of all, those trips where fishing was not the main purpose of the trip were deleted since, for such trips, there was insufficient information in the questionnaire to compute the amount of travel cost that should be allocated to the steelhead fishing. Secondly, as mentioned earlier, only a small portion of respondents kept a written record of steelhead activities. Therefore, some unreasonable data might have been recorded due to memory bias. Two rules were followed in order to exclude unreasonable data: (1) mileage traveled per hour computed for each observation needed to be in the interval from 20 to 80 miles per hour. (2) travel cost per mile computed for each observation needed to be in the interval from zero to 30 cents per mile.

Thirdly, those observations with incomplete information items were deleted. Consequently, about 41 percent of those observations corresponding to the five selected rivers were dropped because of unreasonableness or for being incomplete. The number of usable versus deleted observations for each of the selected rivers and the corresponding percentage rate are shown in the following table.

Table 3: Number of usable and deleted observations for the five selected rivers to be analyzed

River name	Deleted	(percentage)	Usable	(percentage)	Total
Cowlitz	117	(31.37%)	256	(68.63%)	373
Green	128	(57.66%)	94	(42.34%)	222
Skagit	58	(37.18%)	98	(62.82%)	156
Skykomish	83	(44.15%)	105	(55.85%)	188
Humptulips	62	(41.61%)	87	(58.39%)	149
Total	448	(41.18%)	640	(58.82%)	1088

CHAPTER III

ANALYSIS OF THE DATA

Formation of Distance Zone for The Travel Cost Method

Once the list of usable observations of steelhead fishing on each river was obtained, the list was simplified by group-printing each 'distinct' observation. At this point, it should be noted that the total number of fishing trips was the same as the total number of observations, but the total number of fishing trips was not the same as the total number of 'distinct' observations. For example, the same respondent might have taken four fishing trips on the Cowlitz river during the sample month. In this case, four fishing trips or four observations were obtained, but only one distinct observation can be counted.

After obtaining the list of distinct observations for each river, the distinct observations were divided into zones around each river. The concentric zones were defined in such a way that the travel distance from all points in one of these zones was approximately equal. Then, one zone might be divided into several subzones, depending on the number of distinct observations. One factor that needed to be considered was that each distance subzone should contain approximately the same number of observations, if the travel cost demand function is to be estimated by ordinary least squares (OLS), as has usually been done. The reason that approximately equal numbers per subzone are required if OLS is to be used is because the property of homoskedasticity is destroyed if unequal number of observations per subzone is used, as explained by Johnston (1972, p.229). However, in this study, the number of distinct observations for each subzone could not all be made exactly equal because of a problem that existed. When several counties were combined into one subzone or a populous county was divided into several subzones, the number of distinct observations for each subzone was difficult to set equal because of the limited number of available observations in some counties. How the zones were defined in terms of the counties and how many subzones were constructed from each main distance zone is shown in Table 4.

Specification Of Variables In The Demand Model

As mentioned earlier, the number of fishing trips was selected as the unit of quantity for the dependent variable. After summing the number of fishing trips for each subzone, this number was divided by the population of the subzone to give the per capita number of steelhead fishing trips for each subzone. In most cases the subzone population was the corresponding population of the county (or counties if there were two or more counties in the zone) divided by the number of subzones. For some cases the subzone population was simply the corresponding population of the county (or counties), if the zone consisted of only one subzone.

Table 4: Zones and subzones in terms of the counties included for each river

River name	Main distance zone	Number of subzones per main zone	County or counties included in each main distance zone
Skagit	1	2	Skagit
Skagit	2	3	Island, Snohomish, Whatcom
Skagit	3	1	Douglas, King
Skykomish	4	3	Snohomish
Skykomish	5	3	King
Skykomish	6	1	Chelan, Douglas, Pierce, Spokane
Green	7	4	King
Green	8	1	Kitsap, Snohomish
Humptulips	9	4	Gray Harbor
Humptulips	10	1	Kitsap, Pierce, Thurston
Cowlitz	11	1	Garfield
Cowlitz	12	2	Lewis, Okanogna
Cowlitz	13	1	Yakima
Cowlitz	14	2	Gray Harbor, Mason, Thurston
Cowlitz	15	7	Pierce
Cowlitz	16	2	King
Cowlitz	17	1	Douglas, Franklin, Kitsap, Snohomish, Whatcom

The survey information used in constructing explanatory variables in the demand model was: (1) number of people on the steelhead fishing trip; (2) mileage driven on each round trip; (3) hours traveled per round trip; (4) transportation cost for each person per round trip. Transportation cost per trip was obtained by calculating the number of people on the trip times transportation cost per person. The subzone values of the variables included transportation cost per trip, mileage traveled, and hours traveled. The values for these variables were computed by taking the simple average of all the distinct observations in each subzone. Subzone values for transportation cost, mileage traveled, and the corresponding number of distinct observations in each subzone are shown in Table 5.

A regression equation was estimated to find the relationship between subzone transportation cost per trip (SUTC) and subzone mileage traveled each trip (AVMILE). Eighty-eight percent of the variation in SUTC can be explained by AVMILE, which was included in the following estimated equation.

$$\text{SUTC} = \underset{(-1.258)}{-1.1935} + \underset{(16.600)}{.118301}\ \text{AVMILE}$$

Values of t are given in parentheses below the estimated regression coefficients. Then, average mileage traveled per trip was converted into average travel cost by multiplying it by the costant .118301 dollars per mile. The reason why the converted travel cost was used in the demand model instead of the transportation cost given by the respondents from the survey can be explained by two points: (1) There exists a strong relationship between distance traveled and number of fishing trips taken.

Table 5: Number of distinct observations per subzone and subzone values for transportation cost and mileage traveled

River name	Distance subzone	Number of distinct observations each subzone	Average transportation cost per trip	Average mileage traveled per trip
Skagit	1	8	6.375	65.000
Skagit	2	7	7.286	53.143
Skagit	3	10	8.900	97.600
Skagit	4	9	11.222	86.667
Skagit	5	9	9.889	96.333
Skagit	6	12	25.250	190.083
Skykomish	7	9	3.111	37.556
Skykomish	8	9	4.889	42.444
Skykomish	9	9	8.111	45.889
Skykomish	10	11	7.545	64.182
Skykomish	11	10	8.800	79.500
Skykomish	12	10	7.100	78.200
Skykomish	13	4	21.000	192.500
Green	14	11	5.273	46.818
Green	15	11	4.000	48.182
Green	16	11	2.818	34.091
Green	17	10	4.600	42.000
Green	18	11	4.727	72.182
Humptulips	19	10	7.200	58.500
Humptulips	20	10	7.000	50.000
Humptulips	21	10	8.400	61.400
Humptulips	22	9	5.000	46,556
Humptulips	23	11	18.909	215.000
Cowlitz	24	6	11.667	137.667
Cowlitz	25	7	7.000	52.857
Cowlitz	26	6	4.333	57.500
Cowlitz	27	9	26.333	261.111
Cowlitz	28	11	13.182	109.091
Cowlitz	29	11	12.455	116.182
Cowlitz	30	9	15.333	152.222
Cowlitz	31	9	14.222	144.667
Cowlitz	32	9	15.778	163.333
Cowlitz	33	9	16.333	150.556
Cowlitz	34	9	14.000	153.111
Cowlitz	35	8	16.125	160.375
Cowlitz	36	8	16.500	174.375
Cowlitz	37	11	27.364	228.182
Cowlitz	38	10	13.300	186.000
Cowlitz	39	8	51.250	338.125

Mileage traveled can then be taken into account explicitly by using converted travel cost. Consequently, specification bias from ignoring distance can be avoided. (2) Respondents in the survey tended to be more sure about their mileage traveled than their transportation cost. Using converted travel cost increases the reliability of the data to be used. Consequently, more reliable and consistent estimates of values can be obtained. Subzone values for the basic variables used in the demand analysis are presented in Table 6.

Another set of independent variables to be used in the travel cost demand model consisted of indicator variables, which account for the differences in per capita participation rates among the five rivers. Futhermore, a related set of independent variables needed to be considered since some interaction effects between travel cost and individual river was expected. Even though the indicator variables are qualitative, interaction effects were introduced into the model in the usual manner, by including cross-product terms.

Fitting The Regression Model

Based upon some considerations to be discussed subsequently, equation (1) was fitted by ordinary least squares (OLS). The dependent variable and explanatory variables are the same as defined in the preceding section.

Table 6: Subzone values for the basic variables used in the demand analysis

Distance subzone	Average travel cost per trip	Average hours traveled per trip	Sample steelhead fishing trips	Subzone population	Number of trips per capita * 10000
1	7.960	1.625	21	28374	7.4010
2	6.287	1.571	10	24828	4.0278
3	11.546	2.400	20	138015	1.4491
4	10.253	2.222	11	124214	0.8856
5	11.396	2.222	21	124214	1.6906
6	22.487	4.500	15	1161891	0.1291
7	4.443	1.111	13	88067	1.4761
8	5.021	1.333	16	88067	1.8168
9	5.429	1.667	18	88067	2.0439
10	7.474	1.818	20	405419	0.4933
11	9.405	2.300	11	368563	0.2985
12	9.251	2.100	18	368563	0.4884
13	22.773	4.500	9	781989	0.1151
14	5.539	1.636	20	292279	0.6843
15	5.700	1.545	19	292279	0.6501
16	4.033	1.273	20	292279	0.6843
17	4.969	1.400	18	265708	0.6774
18	8.539	1.818	17	1523456	0.1116
19	6.921	2.000	14	15729	8.9009
20	5.915	1.600	21	15729	13.3514
21	7.264	1.900	14	15729	8.9009
22	5.508	1.444	22	14156	15.5413
23	25.435	4.909	15	624966	0.2880
24	16.286	3.000	9	154590	0.5822
25	6.253	1.571	17	28629	5.9380
26	6.802	1.500	13	24539	5.2977
27	30.890	5.556	12	155516	0.7716
28	12.906	2.727	16	88714	1.8035
29	13.744	2.455	27	88714	3.0435
30	18.008	3.333	15	61339	2.4456
31	17.114	3.333	17	61339	2.7717
32	19.322	3.667	17	61339	2.7717
33	17.811	3.222	25	61339	4.0760
34	18.113	3.444	21	61339	3.4239
35	18.972	3.625	14	54519	2.5679
36	20.629	4.125	16	54519	2.9348
37	26.994	5.182	16	598475	0.2673
38	22.004	4.100	11	544069	0.2022
39	40.000	7.625	10	517750	0.1931

$$(1)\quad NTRIP_i = \underset{(5.340)}{5.70876} - \underset{(-0.502)}{.986494}\ TRAHOUR_i$$

$$+ \underset{(0.050)}{.01774}\ TRACOST_i + \underset{(0.405)}{.734541}\ D_1$$

$$- \underset{(-2.214)}{3.45474}\ D_2 - \underset{(-1.111)}{3.49144}\ D_3 + \underset{(6.150)}{10.7017}\ D_4$$

$$- \underset{(-1.108)}{.143098}\ D_1{*}TRACOST_i + \underset{(0.638)}{.069769}\ D_2{*}TRACOST_i$$

$$- \underset{(-0.090)}{.042410}\ D_3{*}TRACOST_i - \underset{(-4.579)}{.476669}\ D_4{*}TRACOST_i$$

$n = 39$

$R^2 = .8668$

where $NTRIP_i$ = Per capita number of steelhead fishing trips from distance subzone i

$TRACOST_i$ = Average travel cost per trip from subzone i to the river fished

$TRAHOUR_i$ = Average hours traveled from subzone i to the river fished

D_1, D_2, D_3, D_4 4/ = Indicator variables

4/ D_1 = 1, for Skagit River
= 0, otherwise

D_2 = 1, for Skykomish River
= 0, otherwise

D_3 = 1, for Green River
= 0, otherwise

D_4 = 1, for Humptulips River
= 0, otherwise

The numbers in parentheses indicate t-values of the estimated regression coefficients. Both of two important variables, travel cost (TRACOST) and travel hours (TRAHOUR), fell far short of statistical significance. It should be noted that the simple correlation coefficient between travel hours and travel cost is high as 0.9932. For this set of sample data, we are forced to drop TRAHOUR due to the low t-value of both TRACOST and TRAHOUR, but it does not mean that the variable TRAHOUR has no effect on the dependent variable. The problem of multicollinearity resulting from the high positive correlation between travel cost and travel time might be reduced, if a larger set of sample data could be used. However, such research is beyond the time schedule of this study. The other variables with estimated coefficients that are not significantly different from zero are D_1, D_3, (D_1*TRACOST), (D_2*TRACOST), and (D_3*TRACOST). Because high correlations are expected between the variable D_1 and (D_1*TRACOST) and also between the variables D_3 and (D_3*TRACOST), only one variable from each set was deleted.

Deleting TRAHOUR, D_1, (D_2*TRACOST), and (D_3*TRACOST), equation (2) was obtained:

$$(2)\quad NTRIP_i = \underset{(7.452)}{5.47960} - \underset{(-4.362)}{.156501}\ TRACOST_i - \underset{(-4.251)}{3.09157}\ D_2$$

$$- \underset{(-4.666)}{4.01727}\ D_3 + \underset{(7.833)}{10.2801}\ D_4$$

$$- \underset{(-1.886)}{.102064}\ D_1{*}TRACOST_i - \underset{(-5.057)}{.467774}\ D_4{*}TRACOST_i$$

$n = 39$

$R^2 = .8621$

$F_{6,32} = 33.33$

The values in the parentheses indicate t-values for that estimated regression coefficient. The F-value shows that the model is a good predictor. The R^2 shows that 86 percent of the variation in quantity of trips are explained by the variables included in the regression. The fitted response function for each river, together with the actual observations are presented in Figure 1.

One thing that might be interesting to point out is that Figure 1 makes clear for model (2) that the effect of individual river upon quantity of fishing trips taken depends on travel cost levels. For lower levels of travel cost, according to Figure 1, Humptulips River has a larger number of fishing trips, but for higher levels of travel cost, Cowlitz River shows the larger number of fishing trips. Namely, Humptulips River tends to attract more short-distance steelhead anglers from greater distances. If comparisons are made among the five rivers, it can be seen from Figure 1 that the Humptulips and Cowlitz rivers

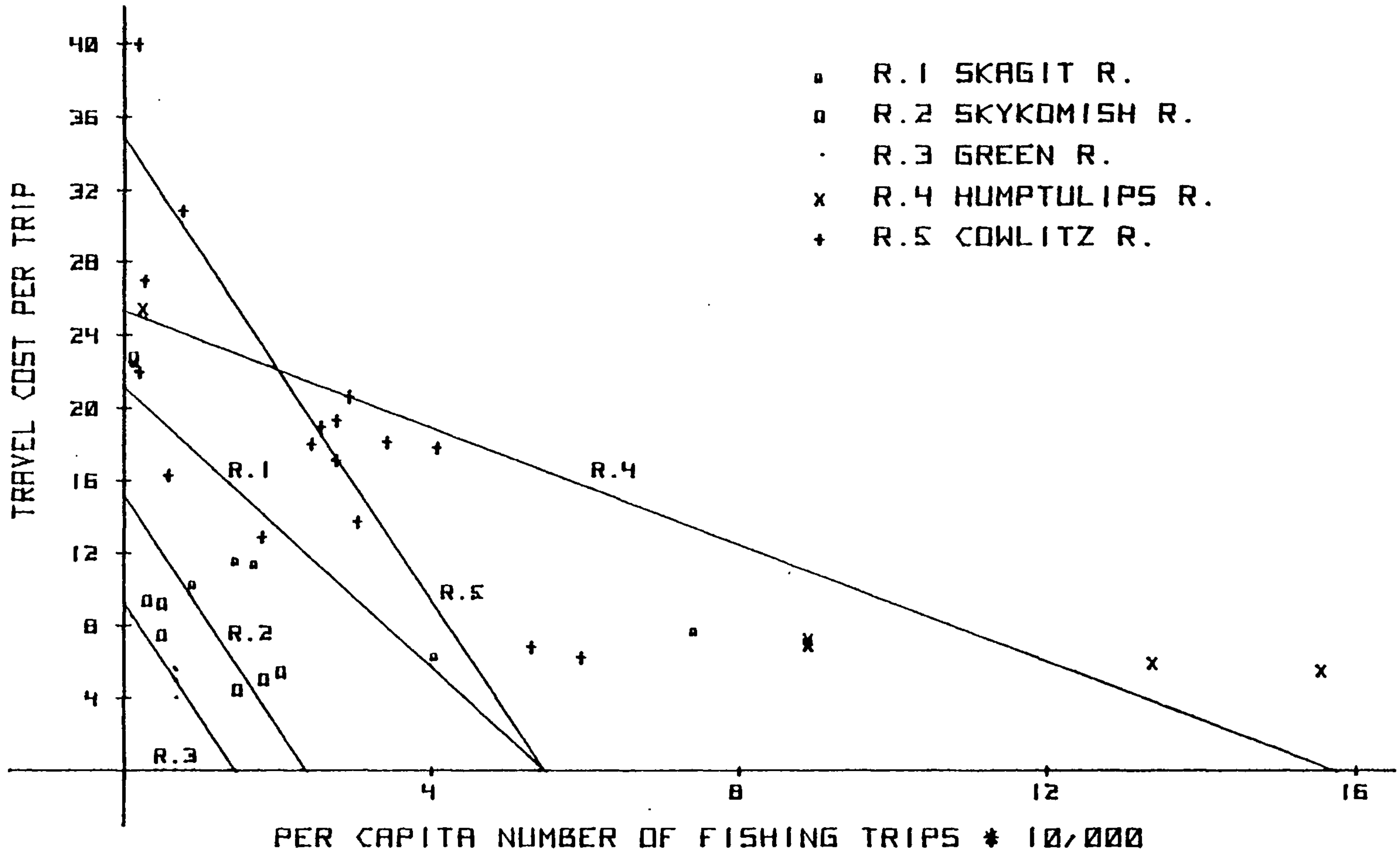

FIGURE 1: FITTED REGRESSION FUNCTION FOR MODEL (2)

tend to attract more steelheaders from all distances than the other three.

Equation (2) was considered to fit the observations fairly precisely. But for certain observations, the estimated per capita number of fishing trips is negative, and needs to be treated as zero when the net economic benefit is estimated. Using an exponential function to fit the observed data can eliminate this problem. Equation (3) was estimated for the sake of comparison. Summary results from the computer output is the following:

$$(3) \quad \ln(NTRIP_i) = \underset{(8.617)}{2.63446} - \underset{(-7.522)}{.113339}\, TRACOST_i$$

$$- \underset{(-6.605)}{2.04338}\, D_2 + \underset{(1.962)}{1.09849}\, D_4$$

$$- \underset{(-3.816)}{.088563}\, D_1{*}TRACOST_i - \underset{(-7.740)}{.466008}\, D_3{*}TRACOST_i$$

$$- \underset{(-2.267)}{.090117}\, D_4{*}TRACOST_i$$

$n = 39$

$R^2 = .8202$

$F_{6,32} = 24.33$

Values of t are given in parentheses below the estimated regression coefficients, and ln indicates the natural logarithm. The F-value shows that the model is a good predictor. The R^2 shows that 82 percent of the variation in quantity of trips can be explained by this fitted model. Again, TRAHOUR wasn't included in the model due to the problem of multicollinearity. The indicator variables included in this model are not quite the same as in the linear model. The fitted response function for each river, together with the actual observations are shown in Figure 2.

The following step was taken to see if the resultant estimators of Equation (2) and Equation (3) were minimum variance. Given the unequal number of observations per subzone, this step was needed to test for heteroscedasticity. The absolute values of the least-squares residuals were plotted against the values of the corresponding travel cost variable (see Appendix D, E), following a method discussed by Johnston, p.220. Since there is no statistically significant relationship between the absolute values of the least-squares residual and the travel cost variable, the assumption of homoscedasticity of the residuals is apparently not violated. That is, the estimated parameters in Equation (2) and Equation (3) should be best linear unbiased estimators, since the property of homoscedasticity is not violated (presuming, of course, that the other necessary assumptions for OLS are also fulfilled, which seems likely).

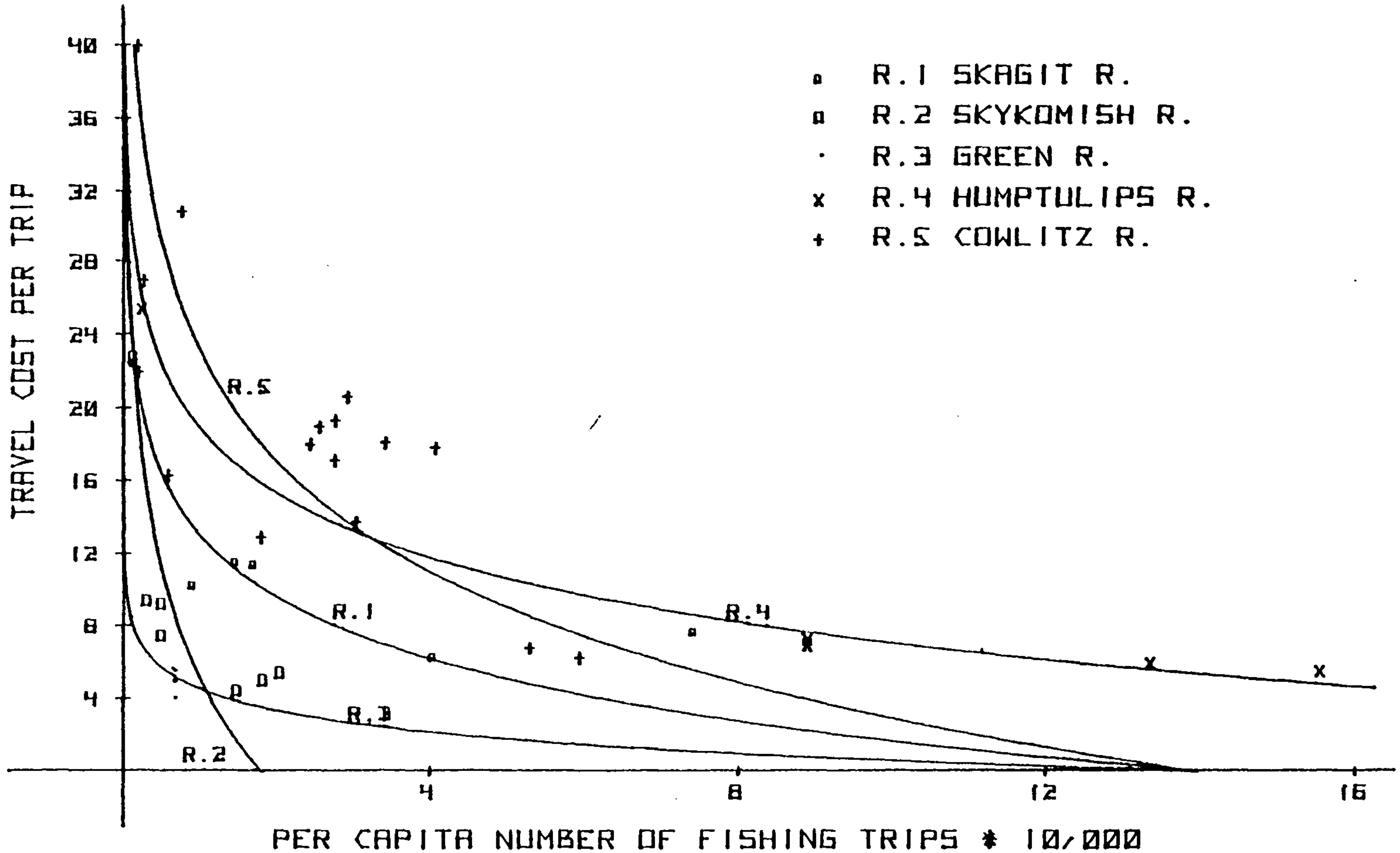

FIGURE 2: FITTED REGRESSION FUNCTION FOR MODEL (3)

CHAPTER IV

ESTIMATION OF NET ECONOMIC BENEFITS

Willingness To Pay As A Measure Of Benefits

The Water Resources Council established the "Principles and Standards for Planning Water and Related Land Resources" (Water Resources Council, 1973) to aid the public planning and decision making process. The "Principles and Standards for Planning" specify that positive benefits arising form increases in the output of goods and services are to be measured in terms of willingness of users to pay for each increment of output provided.

An approximation of willingness of users to pay for particular recreation opportunities can be developed from a demand curve, as discussed in detail by Dwyer, Kelly, and Bowes (1977). A demand curve[5/] or schedule indicates the quantity of use that participants would be willing and able to purchase at each price. A demand schedule is

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5/ There are four important determinants of quantity demanded: the price of the good under consideration, the income of consumers, the price of substitutes and complements for the good, and consumer tastes and preferences. A change in the price of a good results in a movement along its demand curve, while a change in other variables results in a shift of the demand curve. For example, a decrease in income may shift the demand curve to the left.

illustrated by the line AB in Figure 3. In normal circumstances, if the price of a good diminishes, more of it is bought; if its price increases, fewer units are taken. Thus, demand curves generally have a negative slope. The downward slope of a demand curve indicates that consumers are willing to pay greater amounts per unit for initial units of a good than for later additional units. For consumer goods or services, willingness to pay is an amount approximately equal to the full area under the demand curve up to the quantity demanded. Willingness to pay may be described as the sum of two components: the expenditure actually paid plus any excess amount which consumers might be induced to pay. As long as demand is negatively sloped, this excess amount will be positive and can be defined as "net willingness to pay", that is, total willingness-to-pay net of actual expenditure. This excess amount above actual expenditures is the approximate measure of the net benefits gained by those individuals who have participated. It is the maximum amount that these participants would be willing to pay rather than forego the opportunity to participate in the recreational activity. Net willingness to pay may be approximated as the area under the demand curve above the price line (i.e., excluding actual expenditures).

The preceding measure of net willingness to pay is an approximation, since if the initial units were sold at higher prices, the consumer would find himself in a situation similar to having his income reduced by the amount paid in excess of the normal market price. The demand might pivot to the left around the point of intersection with the vertical axis. Such a demand schedule (income-compensated) is represented by the dashed line AD in Figure 3. The shift is referred to as an "income effect". If the income effect results in the curve shifting to the left, then total willingness to pay will be somewhat less than the approximated area under the demand curve. However, this effect is small for most goods or commodities that do not take a large percent of the consumers' income (Willig, 1975), such as outdoor recreation.

Consumers' Surplus As A Measure Of Net Economic Benefits

Benefits are usually approximated by an area under the actual demand curve. In Figure 3, if OQ units were

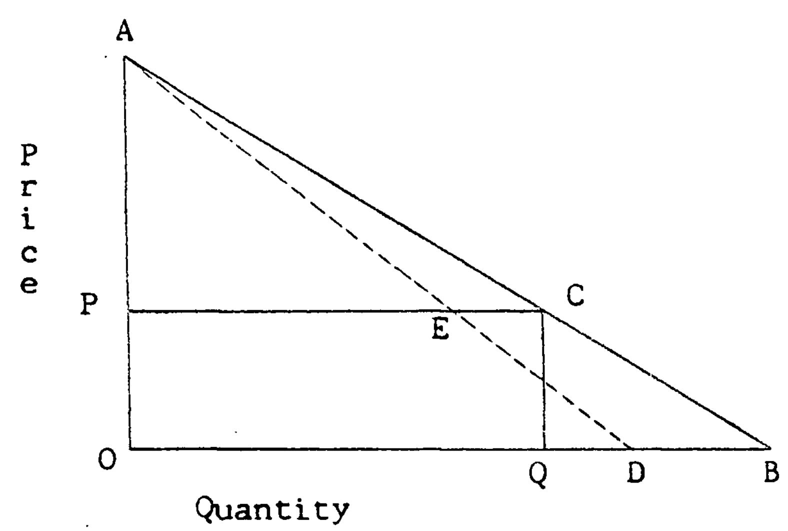

FIGURE 3. THE DEMAND CURVE

consumed at price P, benefits would be measured as the area ACQO. This includes the actual expenditure PCQO, plus an approximation, ACP of net willingness to pay. This area ACP is usually referred to as consumers' surplus since it approximates net benefits to consumers, or the willingness of consumers to pay in excess of their actual payment.

Using the area under the demand curve as an approximation of willingness of users to pay is satisfactory only if the income elasticity of demand for a good is low and the ratio of consumers' surplus to income is low as noted by Willig, 1975. But these conditions are almost always met for the recreation output of resource management alternatives. If these conditions are satisfied, the usual demand curve AB would nearly coincide with the income-compensated demand curve AD, then consumers' surplus plus the actual expenditure, ACQO, will closely approximate the total willingness to pay, AECQO. Therefore, net willingness to pay can usually be approximated by consumers' surplus (ACP) to measure net benefits.

Estimated Net Economic Benefits

Since estimated consumers' surplus is recommended for measuring net economic benefits, given the estimated travel cost-based demand functions, Equations (2) and (3), it is relatively simple to estimate the net economic benefits. For each subzone an estimate of the area beneath the demand curve, but above the presently incurred travel cost, is needed. For Equation (2), the consumers' surplus per capita for the steelhead angler in the survey for subzone i is obtained by computing the following area:

$$(\mathrm{Est}(\mathrm{NTRIP}_{ij}))(\mathrm{TRACOST}^{*}_{j} - \mathrm{TRACOST}_{ij})/2$$

where $\mathrm{Est}(\mathrm{NTRIP}_{ij})$ is the estimated per capita number of trips to be taken to river j in subzone i. $\mathrm{TRACOST}_{ij}$ is the average travel cost per trip from subzone i to river j. $\mathrm{TRACOST}^{*}_{j}$ is the 'critical' travel cost level for river j that would just force anglers to stop fishing. That is, for fitted response equation: $\mathrm{Est}(\mathrm{NTRIP}_{ij})=a_j-b_j*\mathrm{TRACOST}_{ij}$, let $\mathrm{Est}(\mathrm{NTRIP}_{ij})=0$, then $\mathrm{TRACOST}^{*}_{j}=a_j/b_j$.

For Equation (3), the consumers' surplus for subzone i is obtained by evaluating the definite integral:

$$(5) \quad \int_{\mathrm{TRACOST}_{ij}}^{\infty} \exp(\alpha_j-\beta_j X)\, dX$$

where α_j is the estimated constant term of the fitted natural logarithm response equation of river j. β_j is the estimated coefficient of TRACOST of the fitted natural logarithm response equation of river j. α_j and β_j vary from river to river, depending upon the indicator variables or the cross-product terms, respectively.

Computing the consumers' surplus per capita for each subzone, then multiplying by the subzone population, the consumers' surplus for the sample steelheaders in each subzone was obtained (detailed computation are shown in Appendix B and C). Summing the consumers' surplus for each of the subzones that had fishing activities on the same river gave an estimated net economic benefit for the sample steelheaders of each of the five rivers (as shown in Table 7). Dividing the sum of the estimated net economic benefit for the sample steelheaders of each river by the total estimated number of trips to be taken gave an average net economic value of $6.21 per trip for Equation (2), or $6.79 per trip for Equation (3). According to the survey sample used, average fishing days per trip was 1.15. Thus, net economic benefits per fishing day, based upon transportation costs only, is $5.40 for Equation (2), versus, $5.90 for Equation (3).

Table 7: Estimated net economic benefits for the sample steelheaders of each of the five rivers based on transportation costs only and Equations (2) and (3)

River name	Estimated net benefits based on Equation (2)	Estimated net benefits based on Equation (3)
Skagit	650.51	461.83
Skykomish	614.60	1,019.36
Green	175.52	184.20
Humptulips	679.16	417.30
Cowlitz	3,345.88	2,749.60

The estimated net economic benefit based on travel cost of $5.90 per fishing day obtained in this study is relatively low compared to some of the previous studies, e.g., \$21.77 per S-S day in terms of 1974 dollars based on the 1962 survey of Oregon salmon-steelhead sport anglers (Brown, Larson, Johnston, Wahle, 1976). It should be noted that the cost per day used by Brown, Larson, Johnston, and Wahle included all expenditures of the fishing trip, such as food, lodging, charter boat and guide service fees, bait, etc., as well as transportation costs. Transportation costs accounted for only 29.32 percent of the total trip expenses (Brown, Singh, Castle, 1964, p.27). Therefore, a model based only on the transportation cost should predict a value of about only 30 percent that of the Brown-Larson-Johsnton-Wahle model, i.e., $0.2932*(\$21.77) \doteq \$6.39$, not far from the \$5.90 per steelhead fishing day predicted from Equation (3). However, since the steelhead anglers must incur all the trip expenses in order to fish, a more accurate estimate of the net economic benefit per angler day would be $\$5.90 \div 0.2932 \doteq \$20$, based upon the analysis in this thesis.

Relation Of Catch To Value Estimated

The difference in values between the estimate of \$20.0 obtained in this study and the estimate of \$21.77 obtained in the study by Brown, Larson, Johnston, and Wahle is fairly small. However, another factor that should also be considered is fish-catch. During the

1975-76 winter, steelhead sport harvest was the lowest on record with only 47,887 caught. Before 1975-76, the previous low catch (69,730) was recorded for the 1969-70 season (Washington State Department of Game). To give a further indication of how low the catch of 47,887 for 1975-76 was, note that the steelhead catch ranged from over 100,000 to 150,000 fish per winter season during the 1960's, except for the 1969-70 season.

Some idea of the relation of catch and value can be obtained from the figures in Table 8:

Table 8: Sport catch and estimated net economic benefits for each river, based upon all fishing trip expenses

River name	Fish-catch	Estimated net benefits
Skagit	1,512	1,576
Skykomish	3,150	3,475
Green	1,569	628
Humptulips	795	1,422
Cowlitz	9,161	9,379

Data source of fish-catch: Washington State Department of Game.
Data source of net benefits: estimated based upon Equation (3) and divided by 0.2932.

A linear equation was fitted by OLS between sport catch (CATCH) and estimated net benefits (SCS):

$$(6) \qquad SCS_j = \underset{(17.256)}{1.0216}\ CATCH_j$$

$R^2 = 0.9867$

Value of t is given in parentheses below the estimated regression coefficients, j indicates river j. The strong relation between (SCS) and (CATCH) may be an explanation of the slightly lower estimated net economic value of $20 per steelhead fishing day, resulting from the lower fish catch during the 1975-76 winter season.

Estimated Net Economic Benefits For All Washington Rivers

The estimated net economic benefits from steelhead sport fishing for all Washington rivers can be obtained by blowing up the estimated net benefits for the five selected rivers. The estimated net economic benefits for the sample steelheaders of the five selected rivers based on all fishing trip expenses and Equation (3) was $16,480. To find the sample "blow-up" factor, the total number of steelhead permits for 1975 (158,182) was divided by the number of questionnaires returned (5,377 from Table 1), or 158,182÷5,377≐29.41826. Therefore, estimated net economic benefits were (29.41826)*($16,480)≐$484,813 for all steelheaders who had fished on these five rivers. As the number of available observations for all Washington rivers was 4,060, and the number of available observations for the five selected rivers was 1,088, the estimated net economic benefits, $484,813, for the five rivers multiplied by the factor, 4,060÷1,088≐3.7316, equals about $1,809,000, which gives an estimate of net economic benefits from steelhead sport fishing for all Washington rivers. This estimated value divided by the fish catch of the 1975-76 winter season gives a value of $37.78 per fish. This estimate of value could then be used as additional information for computing benefit-cost ratios for steelhead fishing enhancement measures, such as fish hatcheries or stream improvements for spawning (Brown and Larson).

CHAPTER V

SUMMARY AND CONCLUSION

Net economic value for steelhead sport anglers of selected Washington rivers was estimated from data obtained by a mail survey conducted by Dr. Jack Richards of the National Marine Fisheries Service in Seattle. A total of 10,238 questionnaires were mailed in the survey, with questionnaires being sent during each month of the 1975-76 winter steelhead fishing season in an effort to minimize memory bias. Approximately 60% of the mailed questionnaires were returned. The analysis in this study was based on the 1,304 respondents who had gone steelhead fishing during the month preceding the date the questionnaire was mailed.

It was estimated that the average trip of recreational steelheading had a net economic benefit of about $23. This amount is the maximum that steelheaders would be willing to pay rather than forego the opportunity to participate in this recreational activity. The net economic benefits from steelhead fishing for all Washington rivers was estimated to be about 1.8 million dollars for 1975-76 winter season. The estimates should be useful in research or policy analysis associated with fishery enhancement programs. For example, the estimate could be used to help measure the benefits from steelhead fish hatchery construction or improvement (e.g., Brown and Larson). Namely, the benefits of the steelhead fishery to be gained can be divided by the associated costs to compute the benefit-cost ratio of various fishery enhancement measures.

Since the five rivers that the estimates were based on are ranked within the top 16 winter-run steelhead streams for steelhead fishermen during the 1975-76 winter season (Cowlitz River, number one; Skykomish River, number two; Green River, number seven; Skagit River, number eitht; Humptulips River, number 16), the travel cost-based estimates of net economic benefits are very likely higher than if all rivers involved in steelhead sport fishery in Washington had been included in the analysis. On the other hand, however, the very low sport catch recorded for the 1975-76 winter season would be a factor causing the estimated benefits to be too low, (A significant statistical relationship was found between estimated net economic benefits and fish catch.) More precise information, such as fish catch per hour, would be required to further clarify the relationship between fishing success and estimated value.

Certain other limitations pertaining to the estimated net economic benefits should also be noted. Firstly, in this study, the travel time variable was deleted due to the problem of multicollinearity resulting from the high correlation between travel cost and travel time. The failure to capture the effects of travel time leads to an underestimation of benefits. Although the overestimation results from ignoring the substitutes, this effect may be reduced by considering distance traveled explicitly, If possible, future studies should measure the substitute effect carefully to improve the estimates. Nevertheless, despite these limitations, the estimate of $23 per winter steelhead fishing trip, or $20 per day of steelhead fishing, is thought to be a reasonable estimate of willingness to pay, given the 1975-76 winter steelhead fishing conditions.

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APPENDICES

Appendix A

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

In cooperation with
State Game Department
Olympia, Washington

O.M.B. 41-R-2878
Expiration Date:
December, 1976

1975-76 WASHINGTON STEELHEAD ANGLING SURVEY

Dear Steelheader:

We need your help to evaluate the quality of steelhead fishing. Changes in spawning areas, differences in water quality, location of fish hatchery sites, and management regulations may affect steelhead angling. The results of this survey will help to indicate what sportsmen think about changes in the quality of steelhead fishing.

You have been selected as a part of a random sample of sportsmen who obtained steelhead punch cards. Your responses will provide important information to help us maintain and improve steelhead fishing. Please complete the questionnaire as fully as possible and return it to us. Your responses will remain confidential, and be used for no other purpose than to provide information to help in planning ways to improve steelhead angling. You may omit any questions you prefer not to answer.

After you have answered the questions, just fold the questionnaire so the address on the back can be seen, and drop it into the mail. No stamp is needed. Thank you for your assistance in this survey.

Sincerely,

Jack A. Richards

Jack A. Richards
Regional Economist

1. What should be done to improve steelhead fishing in Washington? ______________________

____

2. Have you fished for steelhead at anytime since 1972?

YES ( ) If you answer "yes" to this question, please turn to page two.

NO ( ) If you have not fished for steelhead since 1972, which of the following was the <u>single</u> most important reason you did not?

( ) Expected poor fishing
( ) Fishing area too crowded
( ) Preferred other types of recreation
( ) Travel cost too great
( ) Lacked time to spend fishing
( ) Other reasons (please enter):
____

If you have not fished for steelhead since 1972, you need not answer the remaining questions. Thank you for responding, please mail the questionnaire back to us.

3. How many days did you go steelhead fishing in the following seasons? Please fill in the number of days you fished in each season.

Number of Days	Number of Days	Number of Days	Number of Days
___Summer 1972	___Summer 1973	___Summer 1974	___Summer 1975
___Winter 1972-73	___Winter 1973-74	___Winter 1974-75	___Winter 1975-76

4. How many days do you usually spend on an average steelhead fishing trip? _____

5. How would you rate the quality of fishing during the following seasons?

	Excellent	Good	Fair	Poor	Very Poor	Did Not Fish
Summer 1972	( )	( )	( )	( )	( )	( )
Winter 1972-73	( )	( )	( )	( )	( )	( )
Summer 1973	( )	( )	( )	( )	( )	( )
Winter 1973-74	( )	( )	( )	( )	( )	( )
Summer 1974	( )	( )	( )	( )	( )	( )
Winter 1974-75	( )	( )	( )	( )	( )	( )
Summer 1975	( )	( )	( )	( )	( )	( )
Winter 1975-76	( )	( )	( )	( )	( )	( )

6. Listed below are some of the things which many people consider part of the enjoyment of a steelhead trip. Please rank them by putting a 1 for the item that contributes the most to your enjoyment, a 2 for the item that contributes next most to your enjoyment, down to a 10 for that which contributes the least. If some item does not contribute anything to your enjoyment then leave it blank. Please rank the quality for each of the 3 streams.

How do you rank these items?	The Streams You Fished: 1st Most Often	2nd Most Often	3rd Most Often
Enjoying the scenery	___	___	___
The satisfaction of catching steelhead	___	___	___
Solitude, getting away from people	___	___	___
Being with friends or family	___	___	___
Traveling to the fishing site	___	___	___
Eating the fish you catch	___	___	___
Easy access to fishing areas	___	___	___
Being outdoors	___	___	___
The sport of steelhead fishing	___	___	___
Relaxation	___	___	___

7. How many days a year would you go steelhead fishing in the stream you fished most often if you expected to catch: (If you would not fish, please put a 0).

	Days
If you expected to catch one fish for 1 day fishing, how many times would you go?	___
If you expected to catch one fish for 2 days fishing, how many times would you go?	___
If you expected to catch one fish for 3 days fishing, how many times would you go?	___
If you expected to catch one fish for 5 days fishing, how many times would you go?	___
If you expected to catch one fish for 8 days fishing, how many times would you go?	___
If you expected to catch one fish for 14 days fishing, how many times would you go?	___

8. There are a number of reasons which might make it difficult to go steelhead fishing. Some are listed below. Please rank them by putting a 1 for the item which would limit your fishing the most, a 2 for the thing which is next most likely to limit your fishing, etc., down to a 10 for the thing which is least likely to limit the number of times you fish for steelhead. If some items are not important you may omit them. Please rank the difficulties for each of the 3 streams.

How do you rank these items?	The Streams You Fished: 1st Most Often	2nd Most Often	3rd Most Often
Poor access to fishing areas	___	___	___
Not enough time to go fishing	___	___	___
Other recreational interests including other types of fishing	___	___	___
Conflict with family or work	___	___	___
Cost was too high	___	___	___
Fish run was too low	___	___	___
Too many fishermen	___	___	___
Travel required to go fishing is unpleasant	___	___	___
Weather conditions	___	___	___
Other (Please enter): ______________ ______________	___	___	___

9. What type of steelhead fishing do you do? ( ) Plunking ( ) Drift ( ) Boat ( ) Other: ________

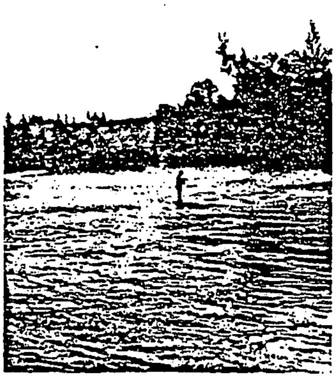
10. Please answer the following questions about the fishing equipment you and members of your household now own.

	Rods, Reels and Tackle	Special Clothing	Boat, Motor and Equipment	Camping Equipment	Other, Please Specify: ____
Do you now own this?	Yes ( ) No ( )	Yes ( ) No ( )	Yes ( ) No ( )	Yes ( ) No ( )	Yes ( ) No ( )
What was the approximate purchase price?	$____	$____	$____	$____	$____
What is the current value for each of the items?	$____	$____	$____	$____	$____
What percentage of these items are for steelhead fishing only?	____%	____%	____%	____%	____%

11. Please fill in the answers to the questions below for each of the streams you fished from June, 1974 to May, 1975. Most of the questions refer to your usual or average trips.

JUNE, 1974 to MAY, 1975

	The Streams You Fished		
	1st Most Often	2nd Most Often	3rd Most Often
Please name the 3 streams in which you did the most steelhead fishing.	____	____	____
How many trips did you take to each stream?	____	____	____
How many steelhead did you catch in each stream? (Total catch for the year).	____	____	____
How many people usually were in your party when you fished each stream? (Include yourself)	____	____	____
How many days did the average trip last?	____	____	____
About how many hours did you, yourself, spend fishing?	____	____	____
Was steelhead fishing the main purpose of this trip? (Please write YES or NO).	____	____	____
About how many miles did you usually travel (round-trip) only for the purpose of fishing? (If fishing was part of a trip made mainly for another purpose, please enter only the extra distance traveled for fishing.)	____	____	____
Approximately how many hours did you usually travel (round-trip) for the purpose of steelhead fishing only?	____	____	____
About how many dollars for each person did the transportation on each fishing trip usually cost your household? Include the round-trip costs only for miles traveled mainly for the purpose of fishing.	____	____	____
Approximately how much was usually spent by your household for the following on an average steelhead fishing trip. If no money was spent, please put 0			
a. Lodging or camping-parking fees	____	____	____
b. Food	____	____	____
c. Tackle, bait, etc.	____	____	____
d. Guide services	____	____	____
e. Boat expenses	____	____	____
f. Other: ____	____	____	____



12. Suppose that you owned the right to fish for steelhead and could sell this right for any area to others. If you sold your right to fish during June, 1974 to May, 1975, you could not have fished for steelhead in that area but you could have fished for steelhead in other areas or for other kinds of fish in any area. What is the least amount of money you could have been paid before you would have sold your right to fish for steelhead in each area from June, 1974 to May, 1975? (Please check one for each stream.)

The Stream You Fished 1st Most Often	The Stream You Fished 2nd Most Often	The Stream You Fished 3rd Most Often
( ) Up to $5.00	( ) Up to $5.00	( ) Up to $5.00
( ) $5.01 to 10.00	( ) $5.01 to 10.00	( ) $5.01 to 10.00
( ) $10.01 to 25.00	( ) $10.01 to 25.00	( ) $10.01 to 25.00
( ) $25.01 to 50.00	( ) $25.01 to 50.00	( ) $25.01 to 50.00
( ) $50.01 to 100.00	( ) $50.01 to 100.00	( ) $50.01 to 100.00
( ) $100.01 to 250.00	( ) $100.01 to 250.00	( ) $100.01 to 250.00
( ) $250.01 to 500.00	( ) $250.01 to 500.00	( ) $250.01 to 500.00
( ) Over $500.00	( ) Over $500.00	( ) Over $500.00
( ) Would not sell at any price	( ) Would not sell at any price	( ) Would not sell at any price

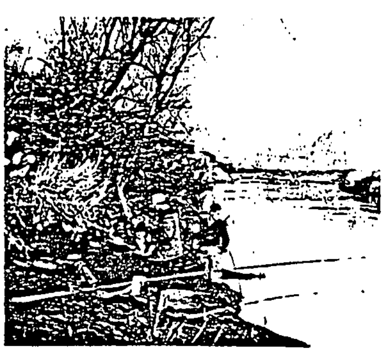
13. The questions below refer to your steelhead fishing experience during the past several years. We recognize that it is hard to remember exact answers; but please answer as accurately as you can. (If necessary, please give us your best estimate.)

Dates	Streams You Fished	Names of Streams	How often did you fish in each stream	What was your total yearly catch	What was your average round trip mileage to each stream
June 1972 through May 1973	1st Most Fished	________	____	____	____
	2nd Most Fished	________	____	____	____
	3rd Most Fished	________	____	____	____
June 1973 through May 1974	1st Most Fished	________	____	____	____
	2nd Most Fished	________	____	____	____
	3rd Most Fished	________	____	____	____
June 1974 through May 1975	1st Most Fished	________	____	____	____
	2nd Most Fished	________	____	____	____
	3rd Most Fished	________	____	____	____
June 1975 through Present	1st Most Fished	________	____	____	____
	2nd Most Fished	________	____	____	____
	3rd Most Fished	________	____	____	____

13A. If you fished during both winter. (October '74 through May '75) and summer. (June '74 through October '75) steelhead seasons please answer the following question. If not. please continue to next page.

I value one (1) day of winter season steelhead fishing as equal to·

CHECK ONE ONLY
( ) less than ½ day of summer season steelheading
( ) ½ to 1 day of summer season steelheading
( ) 1 to 2 days of summer season steelheading
( ) 2 to 3 days of summer season steelheading
( ) 3 to 4 days of summer season steelheading
( ) 4 to 5 days of summer season steelheading
( ) 5 to 10 days of summer season steelheading
( ) more than 10 days of summer season steelheading



If you did not fish for steelhead during February, 1976, please skip to question 16.

The following questions refer to your fishing activities during the month of February, 1976 only. Some of the questions are similar to those you answered relating to the 1974-75 season but we would also like to know how they compare with your fishing during February, 1976.

14. For each of the first four steelhead fishing trips you took during February, 1976, please indicate what stream you fished. If you took more than four trips, please state the total number of trips taken________. If you took no trips during February, 1976, please skip to question 16.

	Name of Stream	Date		Name of Stream	Date
Trip 1	________	________	Trip 3	________	________
Trip 2	________	________	Trip 4	________	________

15. Please fill in the answers to the questions below about your first four fishing trips for steelhead during February, 1976.

	Trip 1	Trip 2	Trip 3	Trip 4
How many days did the trip last?				
On how many days did you, yourself, fish?				
About how many steelhead did you, yourself, catch?				
How many people went with you on this trip?				
How many of these people fished?				
About how many hours did you, yourself, spend fishing?				
Was steelhead fishing the main purpose of this travel? (Please enter YES or NO.)				
About how many miles did you travel (round-trip) only for the purpose of fishing? (If the fishing was part of a trip made mainly for another purpose, please enter only the extra distance traveled for fishing.)				
Approximately how many hours did you travel (round-trip) only for the purpose of steelhead fishing?				
About how many dollars for each person did the transportation to the place that you went fishing cost? Include the (round-trip) cost only for the purpose of steelhead fishing.				
Approximately how much was usually spent by your household for the following on each steelhead fishing trip:				
a. Lodging or camping-parking fees				
b. Food				
c. Tackle, Bait, etc.				
d. Guide Service				
e. Boat Expenses				
f. Other: ________				

16. For how many years have you fished? for steelhead ________ years

for other fish ________ years

17. What is your age? ________ Sex? ________

18. Do you keep a log (i.e., written record) of your steelhead fishing activities:

Yes ( ) No ( )

19. What is your occupation? In addition, if you are retired, please state your <u>former</u> occupation: ______________________________

20. Where do you live? ______________________ ______________ ____________
City State Zip Code

21. Which of the following categories comes closest to the <u>total</u> income of your household last year, from all sources.

( ) Under $2,500	( ) $8,000 - 9,999	( ) $20,000 - 24,999
( ) $2,500 - 4,999	( ) $10,000 - 14,999	( ) $25,000 - 29,999
( ) $5,000 - 7,999	( ) $15,000 - 19,999	( ) $30,000 - or over

22. If you would like to receive a copy of the results of this survey, please give us your name and street address.

____

Thank you very much for your participation in this survey. Please add any comments you would like to make about steelhead fishing in Washington. ______________________________

____

____

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic & Atmospheric Admin.
National Marine Fisheries Service
1700 Westlake Avenue North
Seattle, Washington 98109

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1975-76 Washington steelhead angling survey

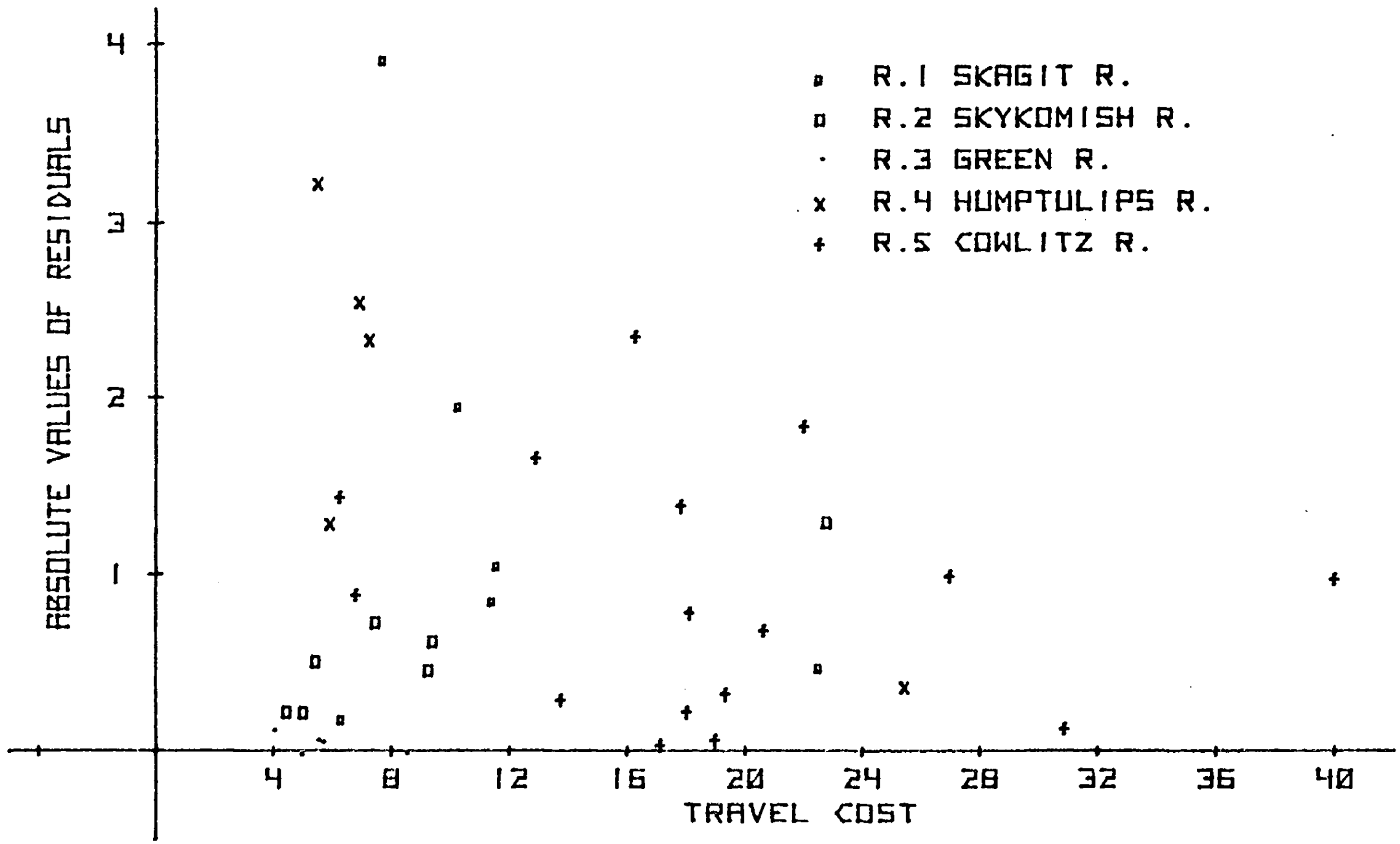
19187

APPENDIX B: COMPUTATION OF CONSUMERS' SURPLUS BASED ON EQUATION (2)

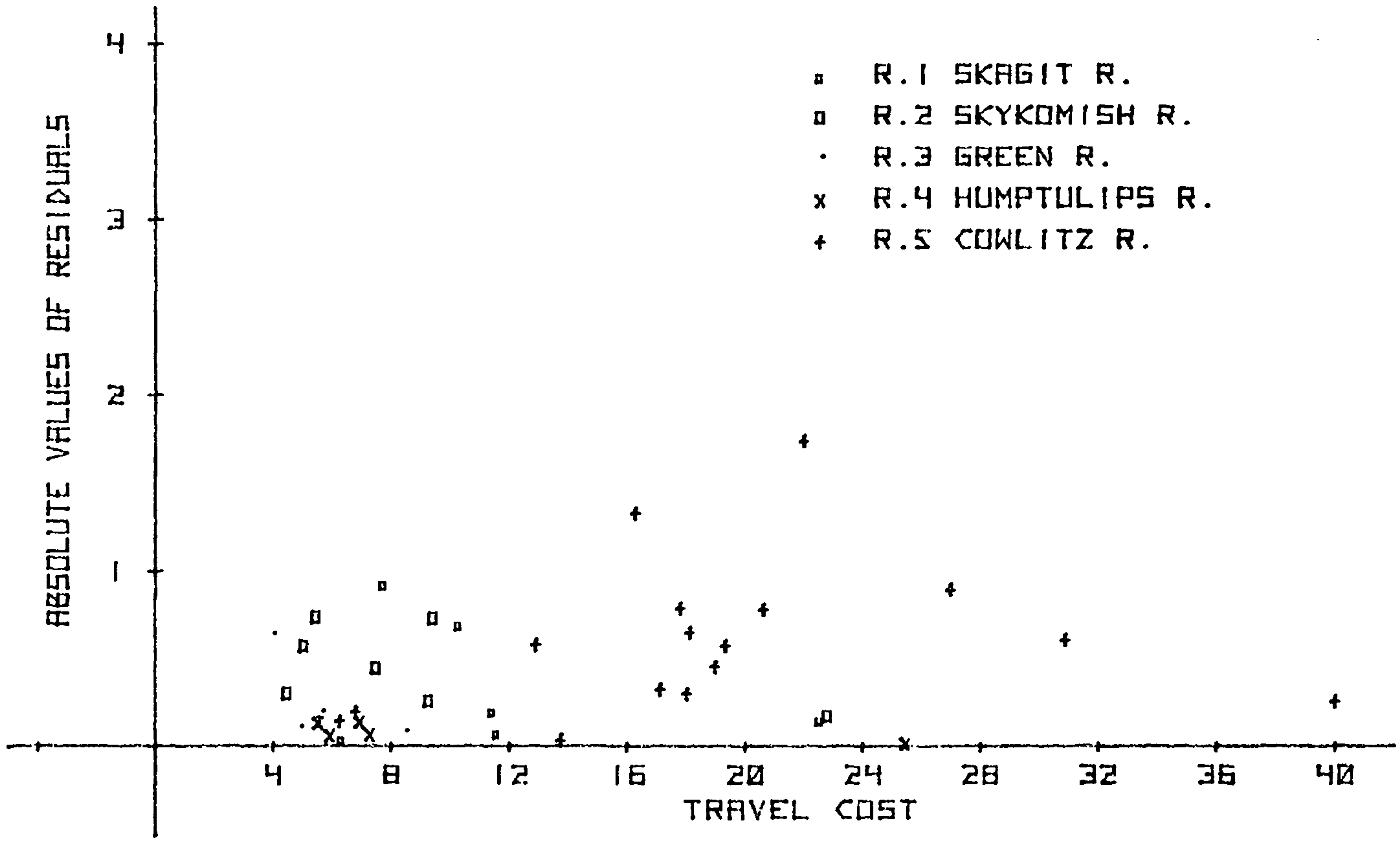
STREAM AND SUBZONE		AVERAGE MILEAGE TRAVELED PER TRIP	ESTIMATED PER CAPITA NUMBER OF TRIPS * 10000	ESTIMATED PER CAPITA SUBZONE CONSUMERS' SURPLUS * 10000	SUBZONE POPULATION / 10000	ESTIMATED SUBZONE CONSUMERS' SURPLUS
1	1	65.00	3.49135	23.571	2.8374	66.883
1	2	53.14	3.85405	28.723	2.4828	71.313
1	3	97.60	2.49417	12.030	13.8015	166.027
1	4	86.67	2.82860	15.472	12.4213	192.182
1	5	96.33	2.53292	12.406	12.4213	154.103
1	6	190.08	-.33475	.217	116.1891	25.177
2	7	37.56	1.69272	9.154	8.8067	80.619
2	8	42.44	1.60221	8.201	8.8067	72.228
2	9	45.89	1.53844	7.562	8.8067	66.593
2	10	63.18	1.21827	4.742	40.5419	192.240
2	11	79.50	.91615	2.682	36.8563	98.832
2	12	78.20	.94022	2.824	36.8563	104.093
2	13	192.50	-1.17595	4.418	78.1989	345.487
3	14	46.82	.59553	1.133	29.2279	33.117
3	15	48.18	.57028	1.039	29.2279	30.369
3	16	34.09	.83116	2.207	29.2279	64.509
3	17	42.00	.68473	1.498	26.5708	39.801
3	18	72.18	.12594	.051	152.3456	7.720
4	19	58.50	11.43934	104.808	1.5729	164.850
4	20	50.00	12.06708	116.627	1.5729	183.439
4	21	61.40	11.22517	100.921	1.5729	158.735
4	22	46.56	12.32146	121.596	1.4156	172.129
4	23	215.00	-.11856	.011	62.4966	.704
5	24	137.67	2.93081	27.443	15.4590	424.238
5	25	52.86	4.50099	64.725	2.8629	185.299
5	26	57.50	4.41504	62.276	2.4539	152.820
5	27	261.11	.64533	1.331	15.5516	20.691
5	28	109.09	3.45987	38.245	8.8714	339.285
5	29	116.18	3.32859	35.398	8.8714	314.026
5	30	152.22	2.66133	22.628	6.1334	138.788
5	31	144.67	2.80121	25.069	6.1334	153.760
5	32	163.33	2.45561	19.265	6.1334	118.160
5	33	150.56	2.69218	23.156	6.1334	142.024
5	34	153.11	2.64487	22.349	6.1334	137.076
5	35	160.38	2.51038	20.134	5.4519	109.769
5	36	174.38	2.25118	16.191	5.4519	88.272
5	37	228.18	1.25499	5.032	59.8475	301.148
5	38	186.00	2.03596	13.243	54.4069	720.518
5	39	338.13	-.78052	1.946	51.7750	100.772

APPENDIX C: COMPUTATION OF CONSUMERS' SURPLUS BASED ON EQUATION (3)

STREAM AND SUBZONE		AVERAGE MILEAGE TRAVELED PER TRIP	ESTIMATED PER CAPITA NUMBER OF TRIPS * 10000 (IN LN FORM)	ESTIMATED PER CAPITA SUBZONE CONSUMERS' SURPLUS * 10000	SUBZONE POPULATION / 10000	ESTIMATED SUBZONE CONSUMERS' SURPLUS
1	1	65.00	1.08192	14.613	2.8374	41.463
1	2	53.14	1.36513	19.397	2.4828	48.157
1	3	97.60	.30327	6.708	13.8015	92.575
1	4	86.67	.56441	8.709	12.4213	108.180
1	5	96.33	.33352	6.914	12.4213	85.876
1	6	190.08	-1.90571	.737	116.1891	85.583
2	7	37.56	.08753	9.630	8.8067	84.810
2	8	42.44	.02198	9.019	8.8067	79.429
2	9	45.89	-.02421	8.612	8.8067	75.844
2	10	63.18	-.25607	6.830	40.5419	276.895
2	11	79.50	-.47487	5.488	36.8563	202.255
2	12	78.20	-.45744	5.584	36.8563	205.811
2	13	192.50	-1.98998	1.206	78.1989	94.316
3	14	46.82	-.57433	.972	29.2279	28.407
3	15	48.18	-.66779	.885	29.2279	25.873
3	16	34.09	.29796	2.325	29.2279	67.961
3	17	42.00	-.24411	1.352	26.5708	35.929
3	18	72.18	-2.31268	.171	152.3456	26.032
4	19	58.50	2.32495	50.264	1.5729	79.059
4	20	50.00	2.52953	61.674	1.5729	97.006
4	21	61.40	2.25516	46.876	1.5729	73.729
4	22	46.56	2.61244	67.006	1.4156	94.852
4	23	215.00	-1.44173	1.163	62.4966	72.655
5	24	137.67	.78861	19.414	15.4590	300.117
5	25	52.86	1.92575	60.529	2.8629	173.288
5	26	57.50	1.86349	56.875	2.4539	139.567
5	27	261.11	-.86654	3.709	15.5516	57.685
5	28	109.09	1.17176	28.478	8.8714	252.640
5	29	116.18	1.07668	25.895	8.8714	229.725
5	30	152.22	.59345	15.972	6.1334	97.961
5	31	144.67	.69476	17.675	6.1334	108.405
5	32	163.33	.44447	13.761	6.1334	84.402
5	33	150.56	.61580	16.333	6.1334	100.175
5	34	153.11	.58153	15.783	6.1334	96.800
5	35	160.38	.48414	14.318	5.4519	78.060
5	36	174.38	.29642	11.867	5.4519	64.700
5	37	228.18	-.42502	5.768	59.8475	345.210
5	38	186.00	.14056	10.155	54.4069	552.483
5	39	338.13	-1.89915	1.321	51.7750	68.383



APPENDIX D: PLOT OF THE ABSOLUTE VALUES OF THE RESIDUALS FOR EQUATION (2) AGAINST TRAVEL COST



APPENDIX E: PLOT OF THE ABSOLUTE VALUES OF THE RESIDUALS FOR EQUATION (3) AGAINST TRAVEL COST