

THE LAKE WASHINGTON SOCKEYE SALMON SPORT FISHERY

Catch, Fishing Effort, and  
Economic Evaluation, 1973

by

Mason D. Bryant and Stephen B. Mathews

SPECIAL REPORT

Project R/F-3

Utilization and Production of Lake  
Washington Sockeye Salmon

Washington Sea Grant Program  
National Oceanic and Atmospheric Administration

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### Abstract

The 1973 sport fishery for Lake Washington sockeye was monitored for catch, effort, and economic information. We estimated a sport catch of 23,000 sockeye in about 55,000 angler trips. Approximately 6,900 individual fishermen participated in the fishery. Anglers spent about \$500,000 on the fishery, including out-of-pocket daily fishing expenditures and durable items such as boats, fish-finders, etc. A hypothetical question on willingness to pay a fee to fish was used to estimate a net economic value of \$100,000 for the Lake Washington sockeye sport fishery in addition to expenses incurred.

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INTRODUCTION

Until recently, management of the Lake Washington sockeye population was directed toward the development of a commercial fishery; however, over the past few years a popular sport fishery on Lake Washington sockeye has developed. Evidence of this development may be seen in the 1972 sport catch which was in excess of 20,000 (Nye and Ward, 1973).

This study had three primary objectives: (1) To determine the 1973 sport catch of sockeye in Lake Washington, (2) to estimate fishing effort, and (3) to develop a basis for economic valuation of the fishery to determine its recreational value.

METHODS

Angler interviews and boat counts were used to collect catch, effort, and economic data. Sampling effort was distributed over four strata-- (1) weekday mornings, (2) weekday afternoons, (3) weekend mornings, and (4) weekend afternoons--and was divided equally between morning and afternoon strata. Four weekday periods and two weekend periods were sampled each week. Two locations were sampled, with two-thirds of the sampling effort allocated to the Atlantic City boat ramp and one-third to the Renton Park boat ramp (Fig. 1).

Sampling began on 18 June and terminated on 25 August. Catch and effort before and after these periods, which appeared to be minimal, are not included in the estimates.

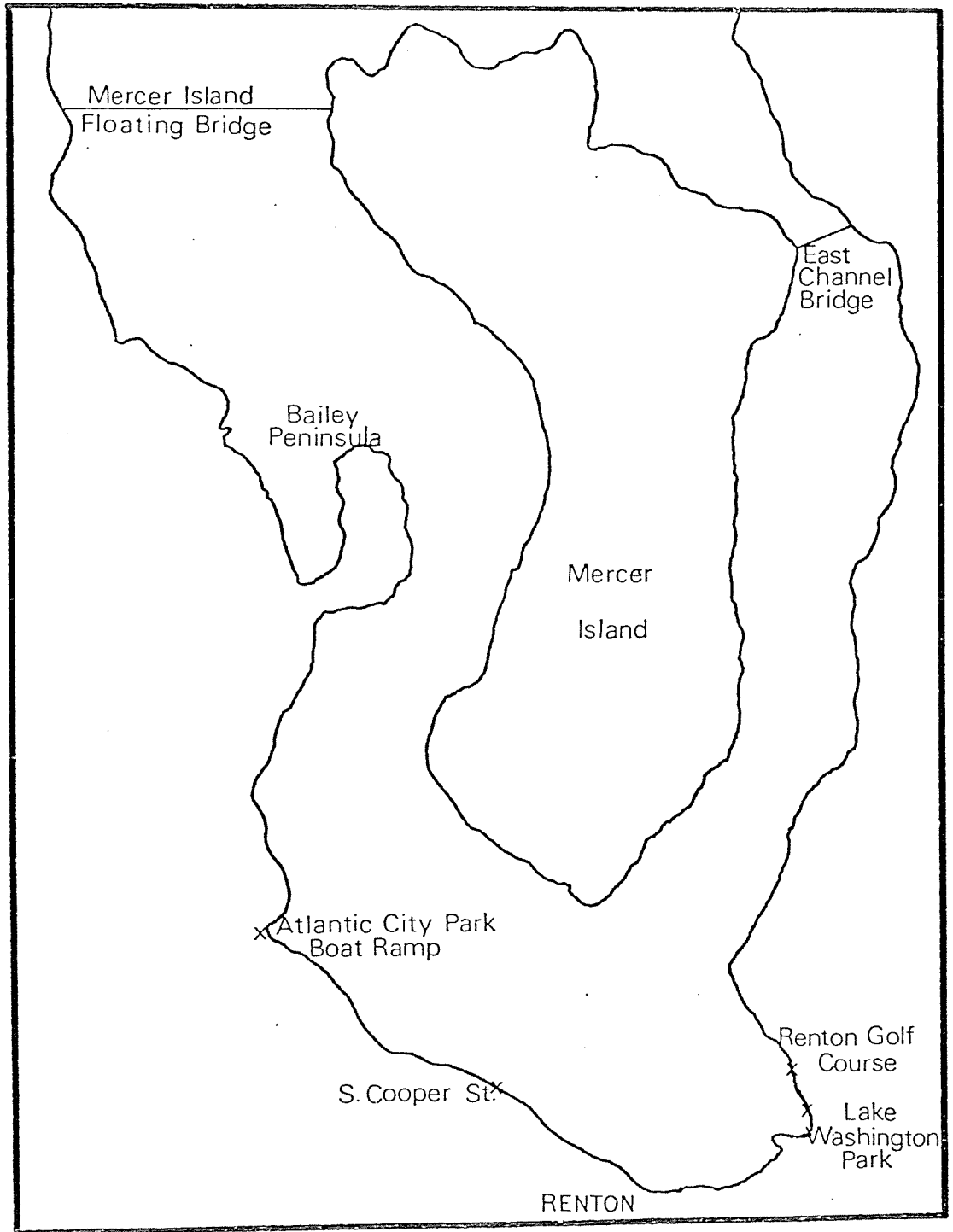


Fig. 1 Map of south end of Lake Washington showing sampling sites for the 1973-1974 angler survey.

Angler interviews and boat counts were conducted by students from the College of Fisheries, University of Washington, as a class project for Fisheries 367. The angler interview form is attached as Appendix I. All anglers returning to the ramps were interviewed, except occasionally when several boats landed simultaneously.

On days of angler interview, boat counts were also taken at two-hour intervals, 0630, 0830, 1030, and 1230 hours for the morning period, and 1430, 1630, 1830, and 2030 hours for the afternoon period. When interviews were taken at the Atlantic City ramp, boat counts were made opposite South Cooper Street along Rainier Avenue (Fig. 1). At the Renton landing area, boat counts were made at the Renton Golf Course. It was apparent that not all boats fishing for sockeye were visible from these areas. Using several aerial surveys conducted simultaneously with boat counts from the two shore areas, we derived correction coefficients of 1.1 and 1.2 for Cooper Street and Renton boat counts, respectively.

An estimate of total boat hours was made from the following equation (Averett, 1966):

$$P = h (1/2 (b_1 + b_4) + b_3 + b_2) Z$$

where  $h$  = length of interval (2 hours)

$b_n$  = number of boats in the  $n$ th interval

$P$  = total boat hours of effort in one sampling period

$Z$  = correction coefficient

Total catch for a sampling period was obtained by multiplying the effort ( $P$ ) by catch per hour calculated from angler interviews for that sampling period. Catch estimates for each stratum were obtained by multiplying the average daily catch in the stratum by the number of days in the stratum. Total estimated catch for the season was the sum of the catch estimates

for each stratum. The number of boats on the lake for a stratum was calculated by dividing fishing effort in boat hours by the average number of hours fished by a boat.

The total expenditures by sport fishermen on the Lake Washington sockeye fishery were estimated as follows:

$$T_V = C_f (Tr/A) + C_D (Tr)$$

where  $T_V$  = total expenditures

$Tr$  = total number of trips by all fishermen during the season

$C_f$  = average fixed costs per angler

$C_D$  = average daily costs per angler trip

$A$  = average number of trips per angler

The daily cost per angler trip and the average fixed cost per angler were obtained from angler interviews (Appendix I). Anglers were asked to estimate their daily out-of-pocket expenses (without itemization) for their trip and to estimate the cost of durable new equipment purchased specifically for sockeye fishing. These were used as estimates for variable and fixed costs, respectively.

Recreational value was estimated on the basis of the expenditures and the willingness to pay, since the recreational benefit (i.e., the value over and above out-of-pocket expenditures) represents a value added to the fishery. A hypothetical question asking the angler how much he would be willing to pay was used to estimate a price (recreational value) for the sockeye fishery.

Distance traveled was also recorded as a method of estimating the recreational value of the sockeye sport fishery. The results obtained from this method were not examined in detail.

## RESULTS

### Catch and Effort Estimates

Catch estimated for each sampling stratum is presented in Table 1. The estimated catch for the season (June 18 - August 31) is 23,023. The greatest catches occurred during the morning throughout the season. It appears that there is a decrease in the catch later in the season but this is accompanied by a decrease in effort (Table 2).

Catch per boat was higher in the mornings (season's average, 0.942) than afternoons (season's average, 0.362) (Table 3). Another comparison indicates that weekday fishermen are slightly more successful than weekend fishermen, but the difference is probably not significant. Differences in catch-per-boat among the three months of the season are not readily identifiable.

Morning fishing effort in boat hours was twice as high as the afternoon fishing effort (Table 2). With the exception of August, weekend morning effort was greater than weekday morning effort. Afternoon effort within the same period was about the same as morning effort, presumably because of evening fishing after work.

The average length of a fishing trip over the season was 4.46 hours ( $\pm 1.25$ ; 95% C.I.) and did not appear to vary seasonally. There was an average of 2.18 fishermen per boat. During the 70-day sampling period (18 June - 29 August), an estimated 25,400 boat trips were taken, giving a total of 55,392 angler trips and 247,327 angler hours. An average of eight trips per fisherman for the season was obtained through interviews during the final weeks of the survey. Using these figures, we estimate that 6,924 individual fishermen utilized the fishery.

Table 1. Lake Washington sockeye sport fishery catch 6/18/73 - 8/26/73. Morning and afternoon catches are given over three time intervals for weekday and weekend. N is number of days in the strata; n is number of days sampled.

Sampling strata	(N)	AM		PM		Total catch
		Catch	(n)	Catch	(n)	
WEEKDAY						
1. 6/18/73-7/5/73	(13)	3064	(5)	367	(1)	3431
2. 7/6/73-7/27/73	(16)	6592	(5)	912	(5)	7504
3. 7/30/73-8/24/73	(20)	4467	(2)	263	(2)	4730
WEEKEND						
1. 6/23/73-7/4/73	(5)	917	(3)	240	(2)	1157
2. 7/7/73-7/24/73	(8)	4337	(5)	322	(3)	4659
3. 8/4/73-8/26/73	(8)	1400	(1)	142	(3)	1542
Total catch for season		20777		2509		23023
Percent of total		89.23		10.79		

Table 2. Total boat hours for season, and by strata

	Fishing effort in boat hours			
	Weekends		Weekdays	
	AM	PM	AM	PM
6/23 - 7/04	7804.5	1399.7	9204.0	4960.8
7/07-- 7/29	21127.7	3341.6	22350.4	6779.2
8/04 - 8/25	6441.6	1624.0	21864.0	5830.0
Season totals	35,369	6,365	53,418	17,570
Total boat hours	112,722			

Table 3. Monthly sockeye sport catch-per-boat-trip, morning and afternoon

Catch per boat trip	AM	PM
WEEKDAY		
June	.606	.360
July	1.260	.361
August	.872	.304
WEEKEND		
June	.522	not sampled
July	.897	.353
August	1.068	.432

### Economic Analysis

Fixed costs were considered to be the new investment in sockeye equipment for the 1973 season only. To ascribe fixed costs to the Lake Washington sockeye fishery accurately, it would be necessary to determine the part of the total investment by fishermen in durable gear used specifically for sockeye fishing. That is, what percentage of the total investment in boat, motor, and associated durable equipment was used for sockeye fishing in comparison to its use for other purposes? We did not have estimates for this; therefore, our estimates of fixed costs may be biased on the high side, because an angler could have used this type of gear in other fisheries.

Most estimates of fixed costs for the 1973 season were between \$0 and \$20 (Table 4). In instances of fixed costs above \$100, we assumed that purchases of major items of equipment such as a motor or boat were involved.

The average costs per angler for new durable gear (our proxy for measure of fixed cost) was approximately \$45. Multiplying this by the estimated number of anglers participating in the fishery (6,924), we estimated fixed costs at approximately \$310,000.

Variable costs (the amount spent per angler trip) are summarized in Table 5. The average variable cost was \$3.52 per angler trip. Multiplying this by the estimated number of angler trips (55,392), we obtained an estimated value of \$194,980 for variable costs during the season. Thus, the total expenditure on the Lake Washington sockeye sport fishery was about \$500,000 for the 1973 season, with an average expenditure of \$73 per angler participating in the fishery.

Table 4. Distribution of new sockeye sport fishing gear expenditures for the 1973 season

Interval \$	No. anglers in interval	% of total
0	209	22.5
1-10	376	40.5
11-20	126	13.6
21-30	58	6.2
31-40	33	3.6
41-50	30	3.2
51-100	37	4.0
101+	60	6.5

Table 5. Distribution of estimated daily fishing costs, Lake Washington sockeye sport fishery, 1973

Interval \$	No. of anglers	% of total
0	97	10.4
1-3	519	55.9
4-5	178	19.2
6-10	101	10.9
11-15	20	2.2
16+	14	1.5

Two measures of net economic revenue were computed, based on the hypothetical fishing fee: (1) Consumer surplus, and (2) maximum revenue accruing to a theoretical non-discriminating monopolist (Table 6). The latter would occur at a charge of \$1.50 and realize \$52,749, based on the number of anglers remaining in the fishery after imposition of the hypothetical charge. The former, consumer surplus, was \$100,222. Since there was no fee, this was the total of the gross revenue in each interval if discriminating prices were charged. Despite the various sources of bias and the lack of agreement among economists on the implications of these measures, an approximate net economic value for the fishery was estimated at \$100,000. Analysis of the distance-travelled data showed that fewer than 8% of the anglers interviewed travelled more than 55 miles round-trip between their home and the landing area.

#### DISCUSSION AND CONCLUSIONS

The 1972 sockeye sport catch, estimated from salmon punch card returns, was in excess of 28,000 out of a run size of 220,000. The 1973 escapement to the lake was in excess of 300,000 adults based on acoustic surveys conducted in August. The catch estimated for 1973 was 26,000. If the sockeye were equally available to sport gear in both years, this would suggest that the 1973 catch estimate was low. It is possible that the punch card estimates are high. Since no effort data are available for 1972, the question of equal availability is unresolved.

The method used in this study allows catch estimates to be made at any point in the season within a short time after sampling. In this respect it provides an excellent tool for management if improved with respect to the sampling scheme. Catch estimates are obtained through

Table 6. Economic valuation by angler response to hypothetical fishing fee on the Lake Washington sockeye sport fishery

Trip fee Interval (\$)	No. of anglers in each interval	% in each interval	% remaining after fee	No. of angler trips	Consumer surplus (\$)	Revenue (\$)
0	340	36.4	100	55,329	0	0
1-2	380	40.7	63.6	35,166	33,778	52,749
3-4	65	7.0	22.8	12,631	13,556	44,210
4-5	112	12.0	15.9	8,777	29,878	39,495
6-10	26	2.8	3.9	2,135	12,335	17,079
11-20	7	0.7	1.1	593	6,227	9,488
20+	3	0.3	0.3	178	4,448	4,448
Total	933	--	--	--	100,222	167,469

effort estimates and catch per unit of effort (CPUE) estimates. Refinements in the sampling scheme will improve the reliability of both total effort and total catch estimates. It is possible that further sampling later in the season would indicate a decrease in CPUE but the decrease was not apparent in the 1973 data.

The economic evaluation must be used with care because of the inherent weakness in obtaining data. Gordon, Chapman, and Bjornn (1973) found an average annual expenditure of \$70.39 per fisherman in the evaluation of an Idaho sport fishery and reviewed other studies which estimated expenditures from \$93.00 to \$437.72 per angler.

The average expenditure per angler in variable costs and new durable gear for the sockeye sport fishery was estimated at \$73. There are some specialized terminal gear requirements not commonly found in other fisheries. The use of echosounding "fish finders" priced from about \$100 to \$250 was common in the sockeye fishery. As Crutchfield (1962) points out, the estimates of gross expenditures should not be construed as a net gain to the economy since this amount would be redirected elsewhere in the economy if not spent on a sport fishery. The data on the willingness-to-pay question give a better idea of net value; however, the expenditure figures are a valid additional indicator of the desire of fishermen to participate in this particular fishery.

An important factor in considering the consumer demand in the Lake Washington sockeye fishery is the proximity of the lake to a major urban center. For this reason distance travelled will be less of a limiting factor. Apparently, it is largely a local fishery, readily available to a large number of fishermen. This feature is, however, a part of its unique value.

The biases inherent in the hypothetical fishing fee are apparent and are discussed in some detail by Gordon, et al. (1973), and Mathews and Brown (1970). Briefly, the threat of imposition of a license fee inferred from the question would tend to bias the estimate downward, although considerable care was taken to avoid this effect in asking the question.

If we assume similar biases existed in other fisheries toward use of this type of question, we can use the hypothetical fee as a comparative index across fisheries. For example, the \$3 fee the anglers are willing to pay on the average for Lake Washington may be compared to the \$2 fee obtained for the Washougal fishery (Haw and Mathews, 1969). This implies a "relative worth" of a fishery. Great care should be exercised with this type of comparison, since other variables should be considered such as the income of the anglers utilizing the fishery and alternative sport fishing opportunities.

The Lake Washington sport fishery is an important recreational resource readily accessible to large numbers of fishermen. The 1973 estimated sport harvest of 23,000 fish was less than 7% of the estimated escapement of approximately 300,000. The sport fishery provides an excellent economic return with a minimum effect on the escapement.

#### ACKNOWLEDGMENTS

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Appendix 1

Sockeye Sport Fishery Interview Form  
Coding Instructions (1973)

Cols

- 1-2 Interview Numer 01-24 for each sheet right justify i.e. 01  
(use these for reference in reamrks section)
- 3-8 Date Month Day Year enter zeros (i.e. for March 5, 1973  
enter as 030573 beginning in col 3)
- 9 Time interval  
morning sample period = 0  
afternoon sample period = 1
- 10-13 Departure time-enter time fisherman started fishing (use 24  
hour clock designation, i.e., 6:30 AM enter as 0630,  
6:30 PM enter as 1830)
- 14-17 Time of Interview - enter time you interviewed this angler  
(use 24 hour clock)
- 18-22 Hours Fished - enter total amount of time spent fishing.  
Round to nearest quarter hour (i.e., for 1 hour and 15  
minutes enter as 1.25)
- 23 Location Fished - consult map with angler and enter the  
appropriate number corresponding to the area fished for the  
greatest amount of time
- 24 Completed Trip - if this is the end of the fishing day for  
this group of anglers then it is a completed trip, otherwise  
it is an incomplete trip  
Complete Trip = 0 (do not plan to continue fishing  
today)  
Incomplete Trip = 1 (plan to continue fishing today)
- 25-26 Total Sockeye Catch in boat for all members of the fishing  
party - enter 00 if no fish, 01 for one fish etc.
- 27-28 Jacks in Catch - enter number of precocious males (i.e., sockeye  
less that 18-20 inches in length)
- 29-30 Number of sockeye released include only sockeye actually landed  
and returned, NOT those hooked and lost
- 31 Method of Fishing  
Trolling = 0  
Still fishing = 1  
Casting = 2

- 32 Type of Gear  
Plug (i.e., flatfish) 4 Dodger = 0  
Spoon 4 Dodger = 1  
Plug Only = 2  
Spoon Only = 3  
Spinner Only = 4  
Artificial Fly = 5  
Flasher & Fly (or hoochy) = 6  
Bait (live or cut) = 7  
Eggs = 8  
Other = 9 (enter in remarks)
- 33-39 City - enter first 7 letters if number of letters exceeds 7  
(or a legible abbreviation)
- 40-41 State
- 42-45 Approximate round trip mileage - enter angler's estimate of  
mileage to and from home to the fishing area
- 46 Method of travel  
Private automobile = 0  
Bus = 1  
Airplane = 2  
Boat = 3  
Other = 4 (enter in remarks)
- 47 Years fished for Lake Washington sockeye using sport gear
- 48 Boat owner  
Individual interviewed = 0  
Other member in party = 1  
Charter = 2  
Rented = 3  
Other = 4 (enter in remarks)
- 49-51 Length of Boat - enter length in feet by angler's statement
- 52-53 Age of boat by angler's statement
- 54 Material of boat hull  
Wood = 0  
Aluminum = 1  
Fiberglass = 2  
Other = 3 (enter in remarks)
- 55 Type of motor used on boat (if a smaller motor was used in  
actual fishing in addition to the primary source of power  
for the boat, enter the smaller motor in the remarks section  
and the larger motor as coded below)  
Outboard = 0  
In Inboard = 1  
Inboard/outboard = 2  
None (oars or paddles) = 3  
Other = 4 (enter in remarks)

- 56-57 Horse power of motor used for fishing by angler's statement. If greater than 100 enter as 99 and note in remarks
- 58-59 Age of motor by angler's statement in years
- 60-63 Cost of New Sockeye Fishing Equipment - enter nearest \$ by angler's estimate. Include cost of boat and motor if used primarily for sockeye fishing, and any other equipment used specifically for sockeye fishing purchased for this season
- 64-66 Cost of Day's Fishing - enter angler's estimate of his total cost for today's fishing trip. Include transportation, boat fuel, expendable gear, gear lost, bait, lunch, or anything else the angler feels represents a cost to him for his trip. NOTE this may take some time for the angler to estimate. Allow sufficient time for a good answer. This is an important question.
- 67-69 Hypothetical fishing fee - enter the \$ amount in whole dollars. Understand that this is a hypothetical question, to determine the full economic value of the sockeye sport fishery and will not be used to institute a user's or license fee.

READ THIS STATEMENT AND QUESTION VERBATIM TO THE ANGLER:

This question is intended to measure the economic value of the sockeye sport fishery over and above the actual expenditure on gear and travel to go fishing. Suppose that Lake Washington was privately owned and you had to pay the owner to go fishing on a daily basis. What is the most you would pay to go fishing for Lake Washington sockeye per day? as shown in this table?

\$1.00	\$7.00	\$25.00
2.00	8.00	more than \$50.00
3.00	10.00	
5.00	15.00	

- 70-74 Age of Fishermen - enter the number of fishermen in the party in each of the appropriate age groups. All fishermen in the party should be counted in these blocks (i.e., a party of four consisting of a 41 year old man, his 38 year old wife and two children, a boy and girl age 12 and 14 would be entered as follows beginning in col 70 02110)
- 75-76 Sex - enter numbers of each in appropriate blocks of those persons fishing (i.e., using above example beginning in col 75-22)
- 77-78 Age of Respondent. enter as follows

77	Less than 20 = 0
	21 - 30 = 1
	31 - 40 = 2
	41 - 50 = 3
	51 - 60 = 4
	60 + = 5

78

Male = 0  
Female = 1

79-80

Total number of people who were fishing

Total number of individuals with fishing poles in the party