A RE-ASSESSMENT OF MORICETOWN FALLS AS AN OBSTRUCTION TO SALMON MIGRATION

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Vancouver, B. C.
JUNE 1964

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INTRODUCTION

Moricetown Falls, located on the Bulkley River near Moricetown, British Columbia (Figure 1) was long recognized as a point of difficult passage to upstream migrant salmon and steelhead trout. The river at this point enters a narrow canyon and is characterized by a nearly vertical falls with an area of extreme turbulence immediately below. Biological studies conducted during the three years 1945-47 confirmed the existence of a major obstruction at Moricetown Falls and fishways were recommended as a remedial measure (Milne, 1950). These were constructed prior to the 1951 migration and an assessment of the facilities was conducted during the same year (Hourston and Stokes, 1952). The study indicated, on the basis that the period of delay to migration had been greatly reduced, that the fishways were operating satisfactorily.

Moricetown Falls has been, throughout the period of recorded history, the site of a major native food fishery. Traditionally, salmon were captured in traps and baskets as they accumulated in the canyon below the falls. In 1935 all traps were banned at Moricetown; gaffing was introduced as the legal fishing method and this technique has been followed since that time.

This report which represents a general summary of the known information on the salmon stocks of the Bulkley River

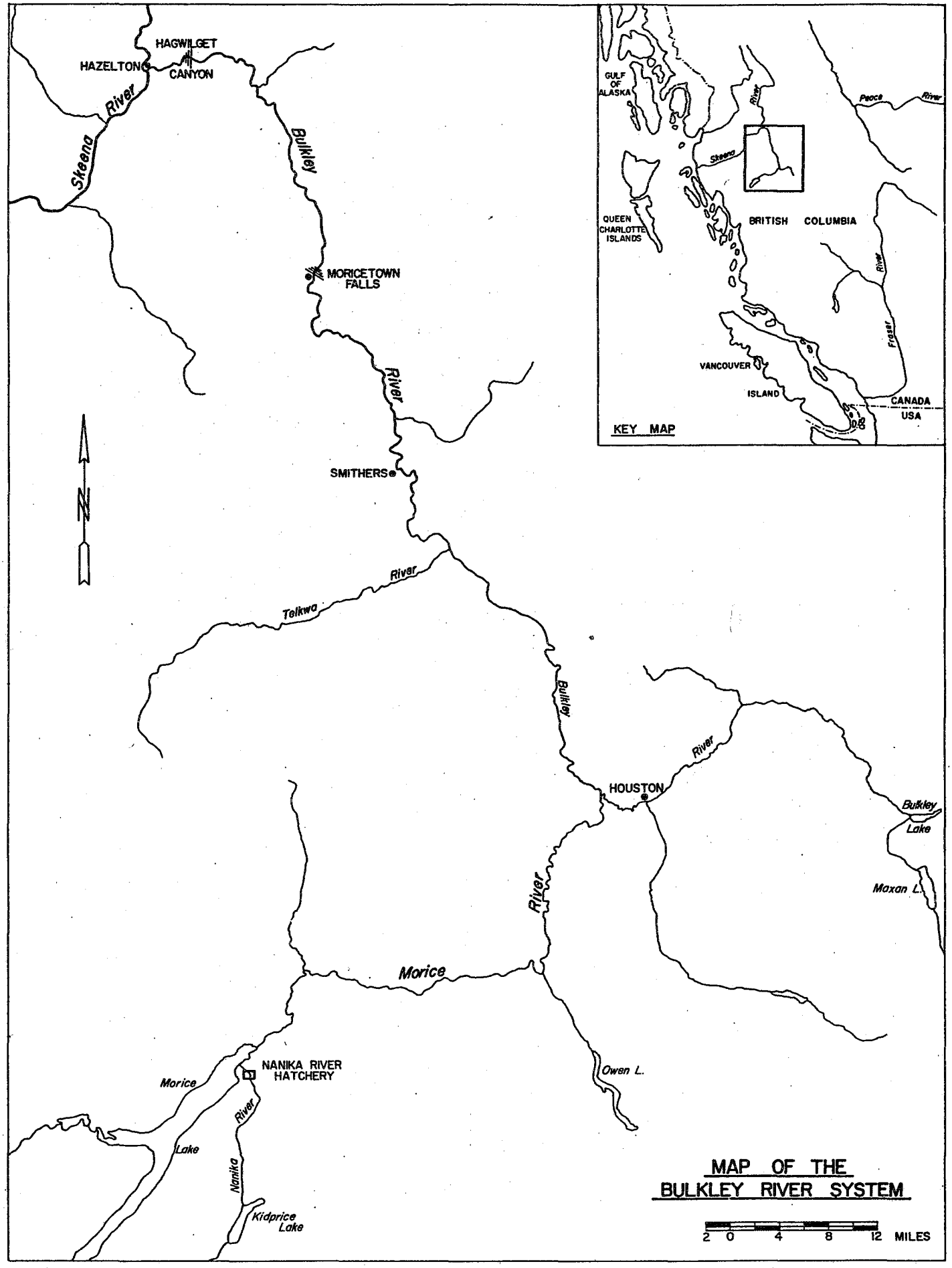

Figure I Location Map of the Bulkley River System

system, has been prepared in order

(a) to describe the effect of the Moricetown Falls native food fishery on the salmon and steelhead trout stocks,

(b) to further evaluate the Moricetown fishways as an aid to migration.

SALMON ESCAPEMENTS TO THE BULKLEY RIVER SYSTEM

Although the annual spawning escapement to the Bulkley River system has not been evaluated each year, largely because of adverse physical conditions, the general abundance of each species has been well established. Enumeration data have been acquired through spawning ground observation, from tag and recovery programs at Moricetown Falls and from live counts on the migration routes upstream of Moricetown.

1. Sockeye Salmon

The escapement data on sockeye is more complete than that for the other indigenous species. Since 1945, periodic studies have been conducted at Moricetown Falls and certain of these have provided, from tagging and recovery assessments, the basis on which the size of the escapements could be calculated. In 1963 the sockeye salmon escapement to the Morice system, the only major producer of this species in the Bulkley watershed, was established by a tower count conducted below the outlet of Morice Lake. The 1963 return

of sockeye to the Bulkley River system has been calculated as follows:

Morice River	2,000 (Tower count)
Upper Bulkley	600 (Spawning ground inspection)
Native Food Fishery (Moricetown)	3,500 (Adjusted for loss of injured fish)

Available data on past sockeye escapements as measured at Moricetown Falls and calculated from tag-recovery data and from total count, are presented in Table I.

TABLE I. Calculated Escapements of Sockeye Salmon to Moricetown Falls for the years 1945-47, 1951 and 1961-63 inclusive.

Year	1945	1946	1947	1951	1961	1962	1963
Spawning escapement	70,000	50,000	24,000	53,600	18,000	11,500	6,100

The escapements calculated for the years 1945-47 are reported by Milne, 1950 while the 1951 estimate is reported by Hourston and Stokes, 1952. The 1961-63 escapements were calculated from data obtained by Department of Fisheries personnel.

The Nanika River is the most important sockeye spawning stream in the Bulkley River system and the data indicate that the pre-1954 escapements ranged within the general magnitude of between 20 and 70,000 fish annually. In 1954, however, a sharp decline occurred in the population and escapements to the Nanika River during the entire period

1955-63 have ranged from a few hundred to 6,000 fish annually, Table II. The estimates for the years 1955-62 inclusive were based on visual estimation while the 1963 estimate was derived from an actual tower count of fish entering the spawning area.

TABLE II. Annual Sockeye Salmon Escapement to the Nanika River for the period 1955-63.

Year	1955	1956	1957	1958	1959	1960	1961	1962	1963
Escapement	4000	6000	<1000	<1000	1000	3500	5000	3500	1200

2. Chinook Salmon

The Bulkley River system is one of the ten most important chinook salmon producing areas in British Columbia. Annual escapement data for the Bulkley and Morice Rivers, as listed in the local Fishery Officer's annual reports, are presented for the period 1951-63 in Table III. The chinook salmon escapement upstream of Moricetown Falls has averaged 9,900 fish annually since 1951.

3. Coho Salmon

The spawning characteristics of this species, which include a wide range in timing, sparse distribution and extension into minor headwater tributaries precludes accurate spawning ground enumeration. Annual escapement estimates for this species are, therefore, very limited. In 1961, however, an escapement of 26,300 coho salmon was

TABLE III. Annual Escapement of Chinook Salmon to the Spawning Areas of the Bulkley and Morice Rivers, 1951-1963 inclusive.

Year	Morice River	Bulkley River	Total
1951	3,500	750	4,250
1952	7,500	750	8,250
1953	10,000	750	10,750
1954	11,000	1,500	12,500
1955	7,000	750	7,750
1956	15,000	1,500	16,500
1957	15,000	200	15,200
1958	15,000	200	15,200
1959	15,000	400	15,400
1960	3,500	750	4,250
1961	3,500	Nil	3,500
1962	4,000	1,500	5,500
1963	7,500	2,000	9,500
Mean 1951-1963	9,050	850	9,900

calculated from tag and recovery data obtained at Moricetown Falls. Observations on the spawning grounds and at Moricetown Falls suggest that the 1961 coho escapement was not better than average and this estimate is probably indicative of the general magnitude of the coho salmon spawning escapement to the Bulkley River system.

4. Pink Salmon

Historically, the pink salmon escapement above Moricetown Falls was generally recorded at a few hundred fish and the reported escapement never exceeded seven thousand. Since the removal of a rock obstruction at Hagwilget Canyon early in 1959, however, the escapement has increased significantly in each of the odd years (Figure 1). On the basis of tag and recovery data acquired at Moricetown Falls in 1961 the population at Moricetown was calculated at 24,000 fish. In 1963, the local Fishery Officer reported an escapement of approximately 35,000 pink salmon to the Bulkley River system. There is also an even year stock of pink salmon indigenous to the system and although it has not yet shown the same strength in the area above Moricetown, there are preliminary indications that it is increasing.

5. Chum Salmon

Observations indicate that the chum salmon escapement to the Bulkley River system numbers only a few hundred fish.

6. Steelhead Trout

Although no estimates of steelhead trout escapement to the Bulkley River system are available, observations throughout the watershed clearly indicate that the Morice River is one of the major producers of steelhead trout in British Columbia.

THE NATIVE FISHERY AT MORICETOWN FALLS

The native food fishery at Moricetown Falls is basically a gaff fishery. The fishing locations are concentrated immediately at the base of the falls in the general vicinity of the fishway entrances and the actual fishing effort during the salmon migration period ranges between two and ten fishermen at any one time. In addition to this gaff fishery a very limited gill-net fishery also operates in an area situated 300 yards below the falls. The major portion of the native food catch of salmon at Moricetown Falls is taken, however, by the gaff fishery.

An accurate record of the Indian food fish catch at Moricetown Falls has been kept for several years. These data are presented by species for the years 1945-1963 in Table IV.

In order to assess the exploitation at Moricetown Falls it is necessary to consider the very high rate of loss associated with the use of gaff hooks. Very frequently fish which have been impaled on the hook struggle free and escape severely injured. Milne (1950), during the three years 1945-47 determined by observation that of all fish hooked at Moricetown approximately 35 percent were never landed. Considering the severity of the wounds inflicted, it must be assumed that nearly all these fish die unspawned. As evidence of this, observations over several years have indicated that virtually no gaff injured sockeye reach the spawning grounds. In order to determine the

TABLE IV. The Annual Catch of Salmon and Steelhead Trout by the Native Food Fishery at Moricetown Falls, 1945 - 1963.

	Number of Fish (to nearest hundred)						
Year	Sockeye	Chinook	Coho	Pink	Chum	Steelhead	Total
1945	17,300	500	1,300	*	0	0	19,100
1946	8,500	800	3,500	*	0	500	13,300
1947	3,300	1,200	2,500	600	0	400	8,000
1948	9,800	1,100	1,900	*	0	200	13,000
1949	7,600	1,500	2,300	0	0	200	11,600
1950	5,700	1,400	1,700	0	0	200	9,000
1951	2,800	800	400	*	0	200	4,200
1952	1,100	1,200	500	100	0	400	3,300
1953	700	1,200	800	200	0	1,000	3,900
1954	400	1,900	5,900	0	0	200	8,400
1955	600	1,300	1,900	300	0	200	4,300
1956	1,400	3,200	1,600	0	0	300	6,500
1957	200	2,400	500	*	0	100	3,200
1958	200	2,900	200	*	0	100	3,400
1959	600	2,500	1,300	1,000	0	300	5,700
1960	500	700	900	200	*	100	2,400
1961	2,100	2,500	1,200	1,200	0	600	7,600
1962	800	2,500	1,400	500	*	400	5,600
1963	2,300	2,600	1,400	1,600	*	500	8,400

* Less than 100

full rate of exploitation of each species at Moricetown Falls the actual catch of the Indian food fishery as outlined in Table IV has been adjusted to include a 35 percent injury rate. The exploitation at Moricetown Falls is discussed by species in the following sections.

1. Sockeye Salmon

As outlined previously in this report the total sockeye salmon population at Moricetown Falls has been enumerated during seven years of the period 1945 to 1963. These data along with the actual and adjusted Indian fishery catch, the escapement upstream of Moricetown Falls and the percent exploitation of the Indian fishery are presented in Table V.

TABLE V. Catch, Escapement and Exploitation Data on the Bulkley River Sockeye Population as Determined at Moricetown Falls for Seven Years During the Period 1945-1963.

Year	Size of Escapement at Moricetown	Indian Fishery Catch		Escapement above Moricetown	Percent Exploitation Indian Fishery
		Actual	Adjusted		
1945	70,000	17,300	26,615	43,400	38.0
1946	50,000	8,500	13,076	36,900	26.2
1947	24,000	3,300	5,077	18,900	21.2
1951	53,600	2,800	4,308	49,300	8.0
1961	18,000	2,100	3,231	14,800	18.0
1962	11,500	800	1,231	10,300	10.7
1963	6,100	2,300	3,538	2,600	58.0
1964	10,500	2300	3500	7000	33.3
1966	16,000 (prelim.	Tagging est.) (2450 (prelim.)	4000 (prelim.)		25.0
1965	22000		3009		13.5

The success of the Indian fishery at Moricetown is largely dependent upon the accumulation of fish below the falls. Milne (1950), found that the severity of the obstruction at Moricetown Falls increased at lower water levels. It would be expected, therefore, that the rate of exploitation would be higher in years of low water. The range of discharge of the Bulkley River recorded at Quick, located some 30 miles upstream of Moricetown Falls, during the peak period of sockeye salmon migration is presented in Table VI for each year in which the rate of exploitation of sockeye salmon has been calculated. In addition, the daily range of discharge at Quick during the period July 15 to August 15 is presented for each of the seven years in Figure 2. During the two years of highest recorded exploitation, 1945 and 1963, water levels were low during the main period of migration. As indicated in Figure 2, 1963 was a year of relatively late runoff. The migration in that year occurred later however, and over a shorter period of time, and water conditions during the peak of migration were actually similar to the conditions recorded for 1945.

The particularly high exploitation rate of 1963 apparently occurred, therefore, as a direct result of low water conditions during the peak period of migration.

The increased exploitation rate during low water is probably the result of two factors: the increased delay at low water; and the probable increased effectiveness of the

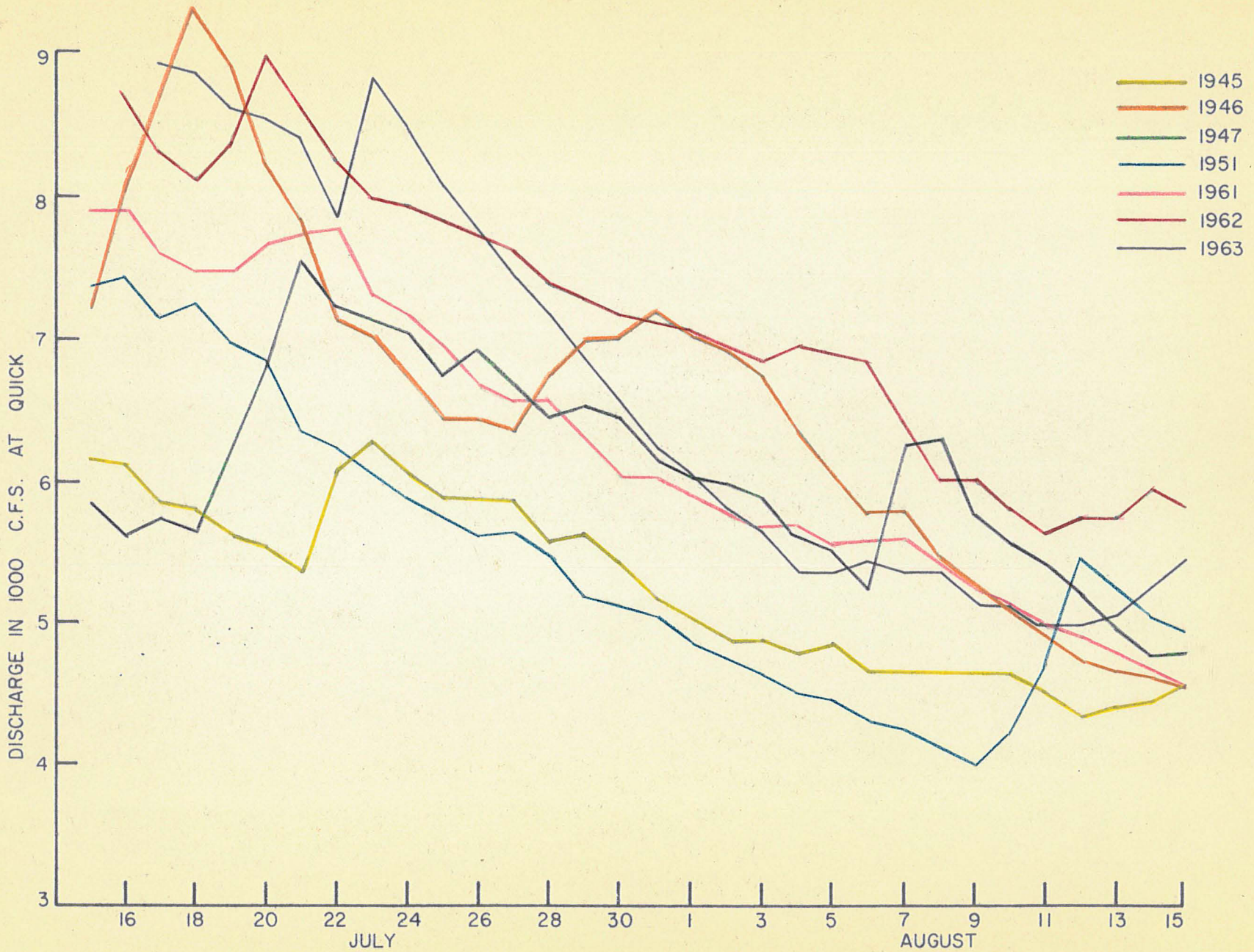

Figure 2. Daily discharge in cfs of the Bulkley River at Quick during the period July 15 to August 15 in 1945-47, 1951 and 1961-63 inclusive.

TABLE VI. Discharge Range During the Peak Period of Abundance and Percent Exploitation of Sockeye Salmon at Moricetown Falls in 1945-47, 1951 and 1961-63.

Year	Peak Period of Abundance	Discharge Range cfs	Percent Exploitation
1945	July 15 - Aug. 10	4630 - 6170	38.0
1946	July 15 - Aug. 10	5080 - 9840	26.2
1947	July 20 - Aug. 10	5210 - 7540	21.2
1951	July 20 - Aug. 5	4450 - 6820	8.0
1961	July 15 - Aug. 5	5520 - 7900	18.0
1962	July 25 - Aug. 5	6840 - 8820	10.7
1963	July 31 - Aug. 15	4980 - 6220	58.0

gaff fishery because more good fishing sites become available at low water. In 1962, a year of low exploitation, water levels were high throughout the migration period. In the years 1946, 1947 and 1961 both the water levels and exploitation rate were intermediate.

There has been only one exception to this pattern of increased susceptibility of sockeye salmon to the native fishery at low water levels. In 1951, the first operational year of the fishways, the river discharge was relatively low during the migration period and yet the seasonal exploitation rate was also low. There is no factor apparent at this time to explain this exception.

2. Chinook Salmon

Estimates of chinook salmon spawning ground escapement as presented in the annual spawning reports for the period 1951-1963 are listed along with the adjusted Indian fishery catches at Moricetown Falls in Table VII. From these data

TABLE VII. The Chinook Salmon Escapement to the Morice River System; the Calculated Escapement Size of the Chinook Salmon Population to Moricetown Falls; and the Calculated Exploitation on the Population by the Moricetown Native Food Fishery for the Period 1951 to 1963.

Year	Spawning Ground Escapement	Adjusted Indian Fishery Catch	Calculated Population at Moricetown	Percent Exploitation at Moricetown
1951	4,250	1,231	5,481	22.5
1952	8,250	1,846	10,096	18.3
1953	10,750	1,846	12,596	14.7
1954	12,500	2,923	15,423	19.0
1955	7,750	2,000	9,750	20.5
1956	16,500	4,923	21,423	23.0
1957	15,200	3,692	18,892	19.5
1958	15,200	4,462	19,662	22.7
1959	15,400	3,846	19,246	20.0
1960	4,250	1,077	5,327	20.2
1961	3,500	3,846	7,346	52.4
1962	5,500	3,846	9,346	41.2
1963	9,500	4,000	13,500	29.6
Mean	9,900	3,041	12,924	24.9

the total chinook salmon population at Moricetown Falls and the rate of exploitation at Moricetown Falls are calculated for each year. Exploitation of chinook salmon at Moricetown Falls averaged 24.9 percent during the years 1951-1963.

Although there is no apparent relationship between the calculated rate of exploitation of chinook salmon and water levels at Moricetown Falls, catches in recent years would indicate that the effectiveness of this fishery on chinook salmon is increasing.

3. Other Species

The exploitation of coho, pink and chum salmon and steelhead trout stocks at Moricetown Falls remains largely unassessed. In 1961, however, the coho and pink salmon escapements were enumerated and exploitation rates of 7.0 and 7.7 percent respectively were calculated. In that year the native fishermen harvested 1,846 coho and 1,846 pink salmon from total stocks of 26,300 and 24,000 respectively. These native fishery catches have been adjusted for a 35 per cent loss rate.

MIGRATION AT MORICETOWN FALLS

1. Timing

The timing of migration of each species at Moricetown Falls established both by observation of the Indian fishery and by actual counts of fish ascending the fishways is illustrated in Figure 3. The peak periods of exploitation by

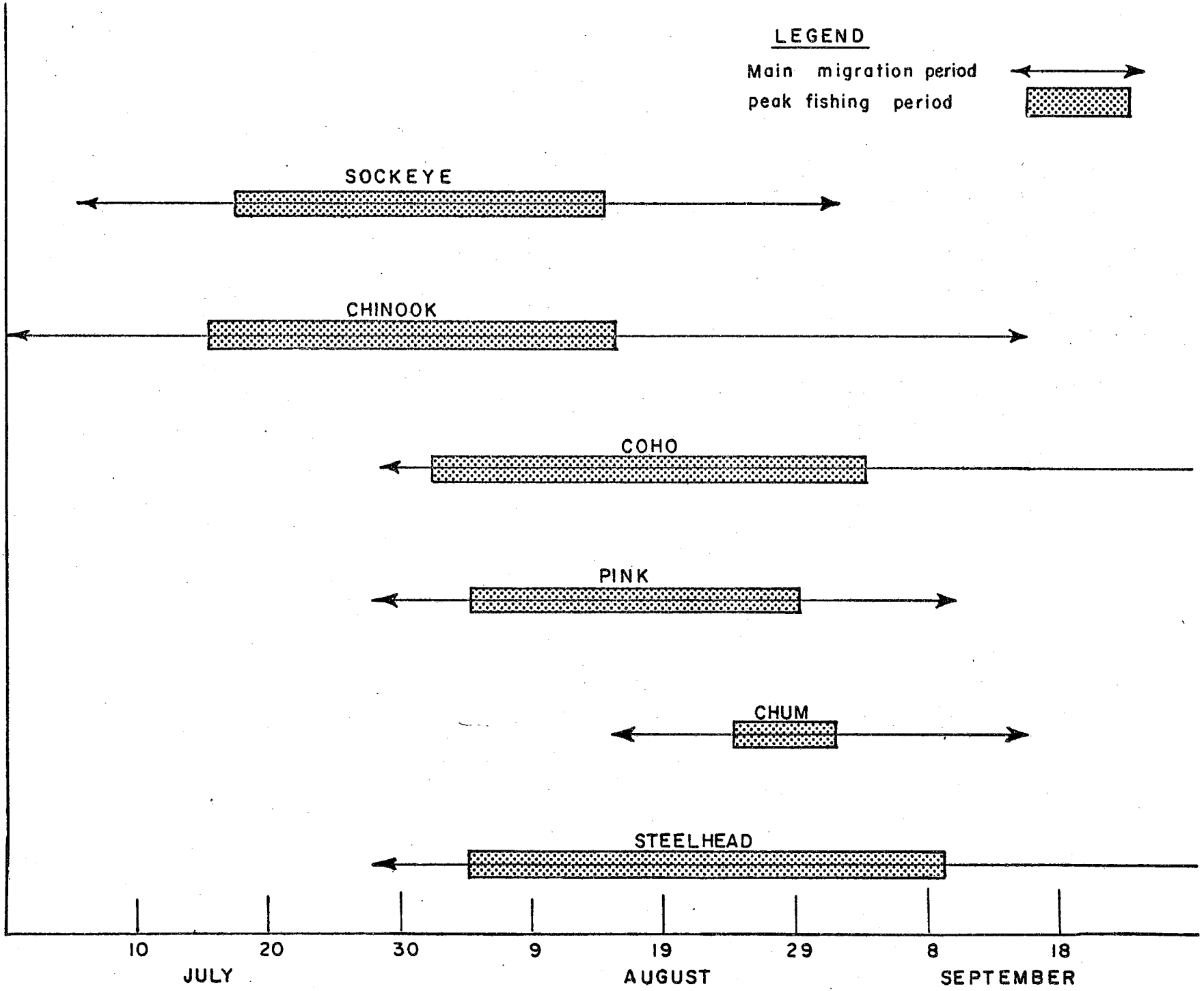

Figure 3. Timing of migration and the peak periods of exploitation of salmon and steelhead trout at Moricetown Falls during the food fishing season in 1961 and 1962.

the native fishery coincide with the peak period of migration of each species. As a further illustration of migration timing at Moricetown Falls the combined daily counts of all species utilizing the fishways during the study period in 1961 and 1962 are outlined in Figure 4 and the daily counts of sockeye, coho and pink salmon which passed through the fishways during the main migration period in 1961 are outlined in Figure 5.

Sockeye salmon generally appear at Moricetown Falls during the first week of July, demonstrate a peak of abundance during late July and early August and are usually past Moricetown by the end of August.

Chinook salmon exhibit a similar timing but they are available at Moricetown over a greater period of time. The first chinooks generally appear at the beginning of June and a few fish are still in evidence as late as the end of September. The main period of abundance however, coincides with that of sockeye salmon.

Coho and pink salmon and steelhead trout arrive at Moricetown Falls in most years during the last week of July and all three species reach a peak of abundance during the second and third weeks of August. While the coho salmon and steelhead trout migration at Moricetown generally continues until at least the end of September, the pink salmon migration is generally completed by September 10.

The very few chum salmon that reach Moricetown Falls

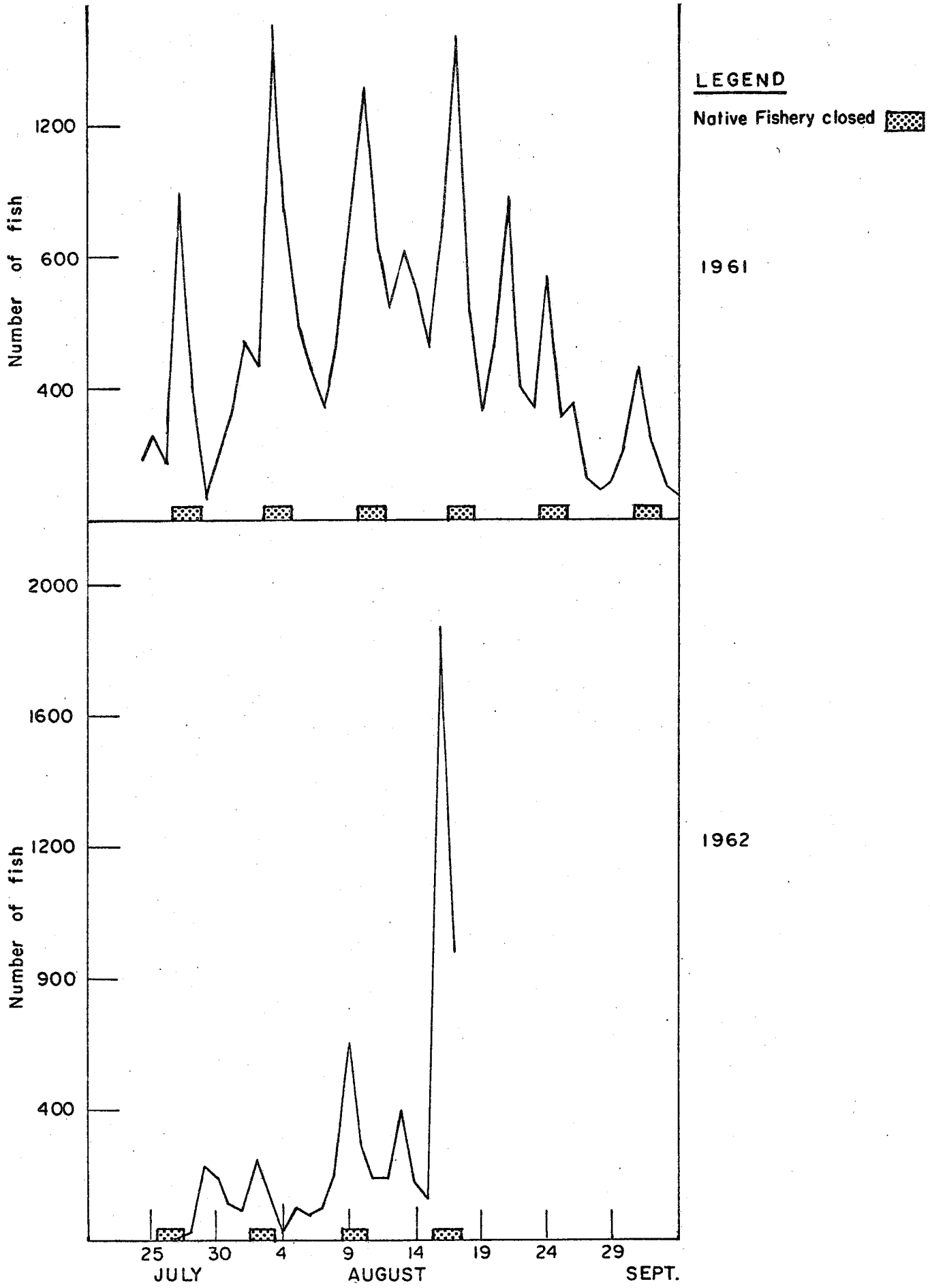

Figure 4. Daily totals of salmon and steelhead trout ascending the Moricetown fishways, July 25 - September 3, 1961 and July 25 - August 17, 1962.

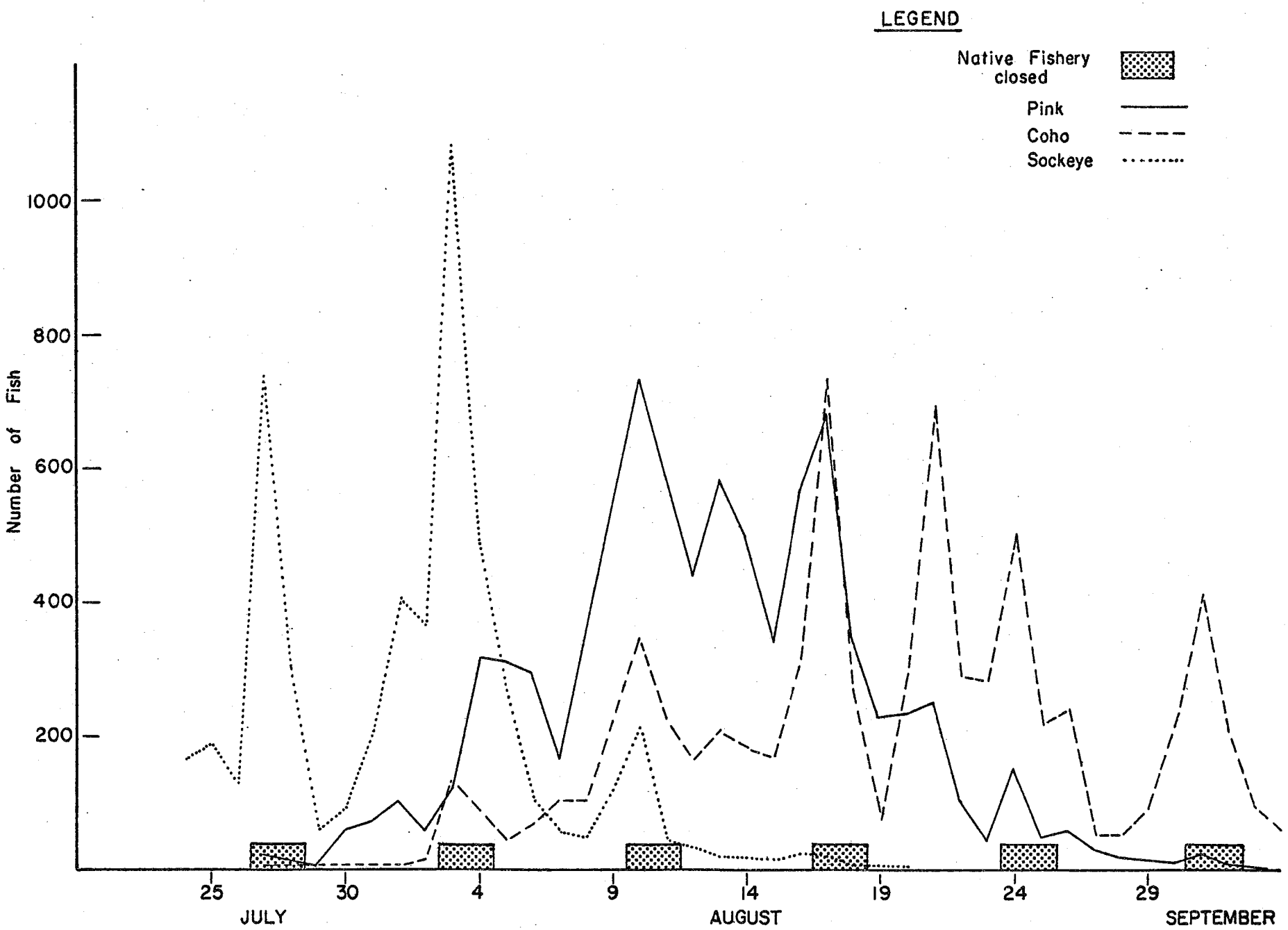

Figure 5. Daily totals of sockeye, coho and pink salmon ascending the Moricetown fishways, July 25 - September 3, 1961.

first show during mid-August and are in evidence until mid-September. This species is generally most abundant during the last week of August.

2. Migration Through the Fishways

Counting weirs were operated in both of the Moricetown fishways during at least part of the salmon migration in 1959, 1961 and 1962. In 1959, installation of the weirs was not completed until August 11 because of high water conditions. As a result almost the entire sockeye and chinook salmon and the early portion of the coho and pink salmon and steelhead trout runs were missed. The peak of migration of the latter three species was covered, however, in 1959. In 1961 the peak migration period of all species was encompassed within the counting period July 17 to September 9. In 1962 the weirs were operated from July 25 to August 17. In that year the enumeration of the fishway migration of sockeye and chinook salmon was nearly complete but the study terminated before the peak migration of coho and pink salmon and steelhead trout. During each of these years, daily counts were taken during the 14-hour period 7:00 A.M. to 9:00 P.M. daily.

a) Enumeration

Daily counts of all species recorded in the Moricetown fishways in 1959, 1961 and 1962 are presented in Tables VIII, IX and X respectively. The combined daily total

TABLE VIII. Daily Counts of Salmon and Steelhead Trout Utilizing the Moricetown Fishways, August 11 to September 8, 1959.

Date	Sockeye	Chinook	Coho	Pink	Steelhead	Total
Aug. 11	15	7	18	-	-	40
12	35	37	65	2	5	144
13	11	9	4	-	1	25
14	26	15	79	212	7	339
15	43	30	195	261	27	556
16	32	13	198	366	47	656
17	12	12	369	337	8	738
18	11	12	678	225	7	933
19	22	41	788	322	57	1,230
20	14	1	230	423	16	684
21	10	11	330	458	10	819
22	14	11	603	212	41	881
23	5	6	467	106	28	612
24	3	1	468	131	60	663
25	9	2	280	88	15	394
26	1	30	436	47	28	542
27	1	8	44	18	1	72
28	1	1	24	26	-	52
29	3	1	21	37	6	68
30	1	1	36	21	3	62
31	2	3	126	22	8	161
Sept. 1	3	4	200	12	23	242
2	6	11	453	11	66	547
3	1	5	124	4	32	166
4	-	1	201	7	28	237
5	1	1	36	2	4	44
6	-	3	164	3	11	181
7	1	1	77	-	49	128
8	-	-	124	1	26	151
Total	283	278	6838	3354	614	11,367

TABLE IX. Daily Counts of Salmon and Steelhead Trout Utilizing the Moricetown Fishways, July 17 to September 9, 1961.

Date	Sockeye	Chinook	Coho	Pink	Steelhead	Total
July 17	4	2	-	-	-	6
18	9	1	-	-	-	10
19	91	3	-	-	-	94
20	37	11	-	-	-	48
21	10	1	-	-	-	11
22	-	-	-	-	-	-
23	13	2	-	-	-	15
24	168	15	-	-	-	183
25	187	75	-	-	-	262
26	125	47	1	4	-	177
27	739	239	4	22	-	1,004
28	301	79	3	12	-	395
29	61	6	1	8	-	76
30	96	33	3	60	-	192
31	204	43	3	72	-	322
Aug. 1	406	27	2	104	4	543
2	363	26	15	61	2	467
3	1081	152	132	119	29	1,513
4	491	41	91	316	8	947
5	267	7	42	311	5	632
6	104	8	67	293	-	472
7	59	5	104	165	13	346
8	47	3	103	368	7	528
9	121	12	230	568	10	941
10	217	13	344	735	14	1,323
11	44	19	223	598	19	903
12	35	5	162	440	11	653
13	20	6	206	587	20	839
14	20	7	182	496	3	708
15	17	5	168	337	7	534
16	23	3	311	566	23	926
17	21	5	733	680	46	1,485
18	4	4	263	348	37	656
19	1	-	79	227	6	313
20	2	1	286	243	21	553
21	7	1	680	254	46	988
22	-	-	288	101	14	403
23	1	-	279	47	18	345
24	2	1	494	152	106	755
25	-	4	217	49	45	315
26	2	1	238	60	55	356
27	-	-	55	32	44	131
28	1	-	51	20	26	98
29	-	-	87	15	20	122
30	-	-	220	11	24	255
31	-	2	408	24	39	473

TABLE IX. (Cont'd)

Date	Sockeye	Chinook	Coho	Pink	Steelhead	Total
Sept. 1	-	1	205	6	23	235
2	-	-	95	2	16	113
3	-	-	60	1	19	80
4	-	-	11	-	1	12
5	-	-	7	-	1	8
6	-	-	7	-	1	8
7	-	-	19	-	3	22
8	-	-	17	-	4	21
9	-	-	30	-	2	32
Total	5401	916	7226	8514	792	22,849

TABLE X. Daily Counts of Salmon and Steelhead Trout Utilizing the Moricetown Fishways, July 25 to August 17, 1962.

Date	Sockeye	Chinook	Coho	Pink	Steelhead	Total
July 25	1	-	-	-	-	1
26	3	1	-	-	-	4
27	10	7	-	-	-	17
28	20	9	-	-	-	29
29	200	35	-	-	-	235
30	142	58	-	-	-	200
31	39	73	-	-	-	112
Aug. 1	27	69	-	-	-	96
2	64	186	3	-	-	253
3	38	103	-	-	-	141
4	9	22	-	-	-	31
5	50	53	3	-	-	106
6	16	55	18	-	-	89
7	18	43	41	-	-	102
8	39	79	120	2	2	242
9	118	110	373	-	10	611
10	31	16	245	-	9	301
11	10	13	160	4	4	191
12	10	11	156	12	8	197
13	29	38	334	1	6	408
14	10	48	110	5	8	181
15	7	43	80	3	2	135
16	55	79	1607	25	105	1,871
17	2	18	787	36	52	895
Total	948	1169	4037	88	206	6,448

counts are illustrated graphically in Figure 4. Additionally, the individual daily counts of sockeye, coho and pink salmon obtained in 1961 are illustrated in Figure 5. As indicated in Tables VIII, IX, and X, the maximum count during a 14-hour day totalled 1,230 fish in 1959; 1,513 fish in 1961 and 1,871 fish in 1962.

b) Daily Timing

Definite daily periods of migration activity were observed at Moricetown Falls. The daily migration through the fishways was generally characterized by two peak periods of activity; one in the morning between 7:00 A.M. and 11:00 A.M. and the other during the late afternoon between 2:00 P.M. and 6:00 P.M. Very few fish moved through the fishways during the twilight and dawn periods. A similar pattern of migration was observed in 1951.

c) Fishway Utilization

From the data obtained at Moricetown Falls it is evident that a major segment of the salmon population ascends the falls without benefit of the fishways. In 1961, when almost the entire migration of each species through the fishways was enumerated and the escapement of sockeye, chinook, coho and pink salmon above Moricetown was determined the percentage utilization by species was calculated. The data as presented in Table XI, shows that only one-third of the total salmon population used the fishways in 1961.

TABLE XI. The Degree of Fishway Utilization by Species at Moricetown Falls During 1961.

Species	Escapement Above Moricetown	Fishway Counts	Percent Using Fishways
Sockeye	14,800	5,401	36.5
Chinook	3,500	916	26.2
Coho	24,450	7,226	29.6
Pink	22,150	8,514	38.4
Total	64,900	22,057	34.0

In 1962, as a further indication of fishway utilization, only 948 or 9.2 percent of an estimated escapement of 10,300 sockeye salmon used the fishways.

From the data accumulated in 1959, 1961 and 1962 it is apparent that each species exhibits a definite preference for one of the two fishways. The distribution of each species expressed as percent of the total count is summarized for each year in Table XII. As evidencedin this table, in each of the three study years approximately 80 percent of all fish observed in the fishways were counted on the left bank. The majority of sockeye and coho salmon and almost all the pink salmon used this fishway whereas chinook salmon and steelhead trout, both very strong swimmers, utilized mainly the right bank. It is probable that high water velocity and extreme turbulence at the entrance to the right

TABLE XII. Distribution of Salmon and Steelhead Trout Between the Two Moricetown Fishways Expressed as Percent of Total for the Years 1959, 1961 and 1962.

	1959		1961		1962	
Species	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
Sockeye	-	-	84.0	16.0	86.6	13.4
Chinook	-	-	24.1	75.9	37.1	62.9
Coho	78.5	21.5	76.1	23.9	95.3	4.7
Pink	98.6	1.4	97.7	2.3	-	-
Steelhead	12.9	87.1	28.2	71.8	-	-
Total All Species	78.5	21.5	82.3	17.7	83.2	16.8

bank fishway is restricting the access of the weaker swimming species.

d) Effect of the Indian Fishery on Migration

During the 1961 and 1962 seasons the native fishery was operated on a five-day week and the weekly closed period extended from 6:00 P.M. Wednesday to 6:00 P.M. Friday. Figures 4 and 5 which depict the fishway counts and weekly closed periods in those years clearly illustrate that substantial increases in abundance occurred each Thursday and Friday and these were followed by sharply decreased counts after the Friday night openings.

As a further illustration of the effect of the native fishery on migration, the mean rate of migration on

Thursdays and Fridays of 1961 is compared to the mean rate of migration of the other five days of the week (Table XIII). Although the rate of migration of all species was substantially lower during the fishing period of the week, the migrations of sockeye and chinook salmon were the ones most drastically affected. These latter species were also the most heavily exploited by the Indian fishery.

TABLE XIII. A Relative Comparison Between the Number of Salmon Ascending the Moricetown Fishways During Open Versus Closed Fishing Periods in 1961.

	Mean Number Per Day		
Species	Indian Fishery Closed	Indian Fishery Open	Percent Reduction in Rate Open Days
Sockeye	362	107	70.4
Chinook	46	7	84.8
Coho	225	127	43.6
Pink	273	131	52.0
Steelhead	31	15	51.6

The effect of this fishery on salmon at Moricetown therefore, is a complex one. As shown for sockeye in Figure 5 and in Table XIII significant periods of migration, as measured by fishway counts, occurred only during the weekly closed periods in 1961; and this in spite of the fact that the seasonal exploitation rate for that year totalled only 18.0 percent. The fishery apparently induces a severe scare

reaction, particularly to sockeye and chinook and in so doing effectively contributes to the delay imposed by the falls. This thereby increases the susceptibility of the fish to the fishery and in that the fishery is more effective during periods of low discharge, this accumulative effect would be even greater under that condition.

This apparent scare reaction could be induced in several ways, perhaps, but the well-known olfactory response of salmon to human skin secretions, as reported by Brett and MacKinnon (1954), would seem to be the most obvious possibility. During the operation of this fishery, the constant handling of the gaff poles and the moosehide binder that connects the gaff with the pole socket of these particular tools, would almost certainly transmit skin odour to the water.

3. Delay at Moricetown Falls

Delay to migration at Moricetown Falls was measured for a number of years on the basis of tag and recovery data. Two such methods of measuring delay which have been applied at Moricetown Falls are discussed below.

For several years both before and after fishway installation the time from tagging to recovery in the native food fishery was used as an indicator of delay. These data obtained for sockeye and coho salmon are summarized in Table XIV. In addition to the data presented in Table XIV, pink salmon and steelhead trout in 1961 averaged 4.4 days and

TABLE XIV. The Mean Number of Days Out from Tagging to Recovery in the Indian Fishery for Sockeye and Coho Salmon Tagged at Moricetown Falls in 1945, 1946, 1947, 1951, 1961 and 1962.

		Mean Days Out		
	Year	Sockeye	Coho	Source
Before Fishway Installation	1945	6.7	27.4	Milne, 1950
	1946	5.1	13.0	Milne, 1950
	1947	5.5	10.0	Milne, 1950
After Fishway Installation	1951	4.1	3.7	Hourston and Stokes, 1952
	1961	5.2	7.8	Fish Culture Development Branch Data
	1962	6.2	-	Fish Culture Development Branch Data

TABLE XV. The Mean Number of Days Out from Tagging to Recovery in the Moricetown Fishways for Sockeye, Coho and Pink Salmon and Steelhead Trout Tagged at Moricetown Falls in 1959, 1961 and 1962.

	Mean Days Out		
Species	1959	1961	1962
Sockeye	-	4.8	4.3
Coho	6.7	7.3	-
Pink	1.7	2.9	-
Steelhead	-	8.3	-

11.3 days respectively from tagging to recovery in the native food fishery. In 1959, 1961 and 1962 the time from tagging to recovery in the fishways was used as an additional measure of delay at Moricetown. These data are presented in Table XV. While neither method described above represents an absolute measure of the delay at Moricetown Falls both tend to serve as a useful comparative annual index.

Upon examination of Table XIV it is evident that, while the delay to coho salmon was greatly reduced after fishway installation, the delay to sockeye salmon was not appreciably alleviated. Since the block at Moricetown was more severe at lower water levels and since the critical level was generally reached during the coho migration but after the sockeye migration, the coho salmon were more seriously obstructed below the falls and, therefore, received the most benefit when the fishways were installed.

As described earlier, much of the present delay at Moricetown Falls must be attributed directly to the effects of the native food fishery. The fact that the migration pattern of sockeye exhibits such a marked increase during the first day of the weekly closure to the native fishery suggests perhaps that the present fishways, in the absence of the native fishery, would be quite effective in by-passing sockeye salmon. The fact remains, however, that the factors of physical obstruction at the falls and the scare reaction by the native fishery, combine to form a very real obstruction to

migration; one which becomes particularly severe under the condition of low discharge.

REHABILITATION OF BULKLEY RIVER SALMON

As stated previously the sockeye salmon escapements to the Bulkley River system have been very poor since 1954. Annual escapements to the Nanika River, the major spawning area, were within the range of 20-70,000 during the years 1945-1953, but since then have ranged from a few hundred to 6,000 fish annually. This abrupt decline occurred in spite of the installation of the Moricetown fishways in 1951. In order to rectify this situation the Department implemented two major measures designed to rehabilitate this stock to its former level of abundance. The first involved the removal of a rock obstruction at Hagwilget Canyon on the Bulkley River in 1959; and the second involved the construction of a 12.5 million egg capacity hatchery on the Nanika River in 1960.

The obstruction removal at Hagwilget Canyon is of direct benefit to all anadromous species within the Bulkley-Morice River system while the hatchery installation was directed specifically to the rehabilitation of the Nanika River sockeye population.

The improvement work which has been conducted on the Bulkley River with a view primarily to the rehabilitation of the Nanika River sockeye stock will provide equal benefit to the sockeye populations utilizing the spawning areas of Morice Lake and areas available in both the Atna and Upper Bulkley River systems.

Pink salmon should benefit more from this river improvement work than any other species. The pink salmon escapement above Moricetown has demonstrated a significant increase in each of the last three cycles and in 1963 totalled 35,000. The full spawning potential, however, must be projected to the hundreds of thousands.

As described above, the measures being employed to rehabilitate, develop and sustain the various salmon populations of the Bulkley River system are quite extensive. The program would appear to be in serious jeopardy, however, unless the demonstrated basic efficiency of the present native fishery is either more effectively controlled or reduced. There are at least two approaches that could be taken:

1. <u>To control the exploitation</u>

First of all, if this is to be achieved, the proportion and/or maximum catch allowable at this point in the river must be determined, perhaps arbitrarily. A pre-season goal, for example, of 15 percent of the total sockeye stock arriving at Moricetown up to a maximum season catch of 2500 pieces might be set and in that there are distinct sockeye and chinook fishing sites, an independent goal could be developed for chinook salmon. Then if the situation at Moricetown Falls were interpreted weekly on the basis of catch; migration past Moricetown as evidenced by fishway enumeration; migration past the Morice River counting tower site; and on the basis of the relationship between degree of

block and river discharge; this native food fishery could be effectively "managed". This plan would require close liaison between field personnel of both the Protection and Fish Culture Development Branches, and weekly contact with senior District and Headquarters staff.

2. To reduce the basic efficiency of the native fishery

The success of the fishery at Moricetown is dependent upon the degree of delay posed by the combined result of the physical obstruction at the falls and the scare reaction of fish to the native fishery. The possibility that this obstruction could be more effectively alleviated by either additional fish passage facilities or improvements in the present facilities should not be overlooked. With further reference to additional facilities, the probability that the pink salmon stock indigenous to the region above Moricetown might expand in the near future beyond the capacity of the present facilities to bypass them, must be pointed out.

SUMMARY

1. Status of Stocks

a) Sockeye Salmon - Spawning escapements to the Bulkley River system declined abruptly after 1953. Annual escapements to the Nanika River, the major spawning area, were within the range of 20-70,000 during the years 1945-1953, but since then have ranged from a few hundred to six thousand annually.

b) Chinook Salmon - The escapement of this species above Moricetown Falls has averaged 9,900 fish annually for the period 1951-1963 and has demonstrated no trend.

c) Pink Salmon - Since the construction of the Moricetown Fishways in 1951 and the removal of an obstruction at Hagwilget Canyon in 1959, the pink salmon escapement to this system has demonstrated a marked increase. The recorded escapements in 1961 and 1963 for example, totalled 24,000 and and 35,000 respectively. The pre-1959 escapements were never recorded at higher than 7,000.

d) Coho Salmon - The coho escapement to the Bulkley River system as indicated by tagging studies is in the general magnitude of 25,000 annually. There has been no apparent change in abundance of this species in recent years.

e) Chum Salmon - The escapement of this species to the Bulkley River system has never been enumerated but observations indicate that the population numbers only a few hundred fish.

f) Steelhead Trout - Although no complete estimates of steelhead trout escapement to the Bulkley River system are available, observations throughout the watershed clearly indicate that the Morice River remains one of the major producers of steelhead trout in British Columbia.

2. Moricetown Native Food Fishery

Although all species of salmon are very susceptible to capture by the native fishery, sockeye and chinook salmon are the ones most affected.

The rate of exploitation of sockeye salmon at Moricetown Falls, calculated for seven years since 1945, has ranged from 8.0 to 58.0 percent. The data indicate that the degree of obstruction to migration and therefore susceptibility of this species to the fishery increases at low river discharge. The situation was particularly severe in 1963 as a result of a combination of two factors: the peak of migration was apparently late and it coincided with a period of low flow.

Although chinook salmon are heavily exploited by the fishery there is no apparent correlation between effectiveness of the fishery and river discharge.

In addition to the effect of river discharge on migration of sockeye past Moricetown Falls, the data indicate that the actual operation of the fishery affects migration of all species. An apparent scare reaction is set up by this fishery; one sufficiently severe that significant migration, as measured by fishway counts, occurs only during weekly closed periods of the fishery.

3. Utilization of the Fishways

The data indicate in certain years, at least, that as little as one-third of the total escapement above Moricetown Falls utilizes the fishways and that of this as much as 80 percent

ascend the left bank facility.

The data available on delay at Moricetown Falls suggests that coho salmon have benefited to a greater degree than have sockeye. This situation apparently occurs as a result of the fact that Moricetown Falls constitutes primarily a low water block. River discharge is usually at a relatively higher level during the migration period of sockeye and chinook salmon than it is during the migration of coho and pink salmon. As described above, much of the migration delay at Moricetown Falls is caused by the effect of an apparent scare reaction which is set up by the operation of the native food fishery.

4. The Rehabilitation Program

The extensive rehabilitation program developed on the Bulkley River system, particularly as it relates to sockeye salmon, would appear to be in serious jeopardy unless the demonstrated efficiency of the present native fishery is either more effectively controlled or reduced. In this regard the suggestions have been made that the exploitation of this fishery could be controlled by regulation of fishing time to meet a predetermined catch quota and that the possibility of alleviating delay by either improving the present fish facilities or providing additional facilities should be investigated.

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ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, 1964 (72)