

## PINK SALMON TAGGING AT HELL'S GATE - 1953

### INTRODUCTION

Hell's Gate, the narrowest constriction of the Fraser River Canyon, constituted a serious obstacle for salmon migration between the years 1913 and 1945, at which time the International Pacific Salmon Commission completed a fishway on the right bank of the river at this point. The block to migration was caused in 1913 when large amounts of rock were dumped into the river immediately above Hell's Gate, during railroad construction.

In the years prior to 1913, large runs of pink salmon passed above Hell's Gate. The report of the Commissioner of Fisheries for 1905 states, "More than 200,000 sockeye passed into our retaining pond (Seton Lake Hatchery) during the past season, together with many thousands of Hump-backs,---". In the report of 1913 a C.P.R. masonry inspector told the Commissioner of Fisheries that he had seen thousands of both sockeye and pinks at every inspection point along the Thompson, in 1901, 1905 and in 1909. However, in 1913, the year of the blockage, this C.P.R. inspector reported that a few sockeye were present in the Thompson River, but no pink salmon. In his 1913 report, the Fisheries Commissioner states, "No hump-backs succeeded in passing through the canyon," and in 1915 the Commissioner reported that, "No pinks were observed in the canyon this season." The 1917 report includes these general observations. "-----No pink salmon were observed in the Thompson or any of its tributaries this season. Previous to the blockade of 1913, many millions of pink salmon passed up the Thompson every other year and spawned on its gravel beaches or spawned in its tributaries. The bed of the Nicola, the principal tributary of the Thompson,

from its source to its mouth was literally paved with pink salmon every other year." Another very interesting observation included in the 1917 report was that in 1905 and 1909, large numbers of pink salmon passed through the canyon above the mouth of Bridge River.

These reports of the pink salmon populations above the Fraser canyon are very general observations and do not include definite estimations of abundance. During the early years of salmon investigation, interest was almost totally confined to sockeye. Consequently, very little attention was given to pink salmon, which partially explains the lack of definite estimates of numbers for that species. However, the observations made do give an indication of the abundance of pink salmon above Hell's Gate prior to 1913.

After completion of a fishway at Hell's Gate in 1945 by the International Pacific Salmon Commission, some interest was shown in possible migration of pink salmon above Hell's Gate. During the sockeye tagging program carried out at Hell's Gate by the Salmon Commission, the number of pinks caught at Hell's Gate was recorded. Pink salmon were first noticed in 1941 and were caught every other year from 1941 to 1951, by the tagging crews at Hell's Gate.

From 1913 until 1947, no pink salmon were reported on the spawning streams above Hell's Gate. In 1947, the Fisheries Inspector for the Squamish-Lillooet district reported between 1000 and 2000 pinks spawning in the Seton-Cayoosh system. In 1949, the Inspectors reported 500-1000 pinks in Seton-Cayoosh, 100-300 in the Nicola River and reported evidence of spawning in the Thompson River.

During the pink salmon migration of 1953, a tagging program at Hell's Gate was carried out by the Department of Fisheries, the

chief purpose of which was to obtain if possible, an estimate of the population of this species passing above Hell's Gate.

#### METHODS

Pink salmon were obtained for tagging by means of dip-nets operated at locations shown in Fig. 1. Petersen type tags were attached below the dorsal fin by means of a non-corrosive nickel pin. In addition to the tag number and date of capture, the length (fork), sex, and condition of the salmon were recorded. In conjunction with the tagging, dip-netting was carried out upstream from the fishways (See Fig. 1), for the purpose of recovering tagged fish and establishing a tagged to untagged ratio. The hours of actual fishing time above and below Hell's Gate were recorded to calculate the catch per unit effort.

Late in the migration season, a limited stream survey program was carried out. The live pink salmon were enumerated and all dead were counted and examined for tags. This survey was initiated as a further check on the estimate to be made from the Hell's Gate work. The streams covered included the Nicola River, Deadman's Creek, Portage Creek, Stein Creek, Bonaparte Creek, the Seton-Cayoosh system and a few of the accessible bars of the Thompson River (See Fig. 2).

#### RESULTS

##### Number tagged and Recovered

From September 6 to October 9, a total of 1029 pink salmon were tagged and released below the Hell's Gate fishways. From this number tagged, a total of 60 were recovered. Of these, 14 were recovered at the tagging sites, 2 at the recovery stations above,

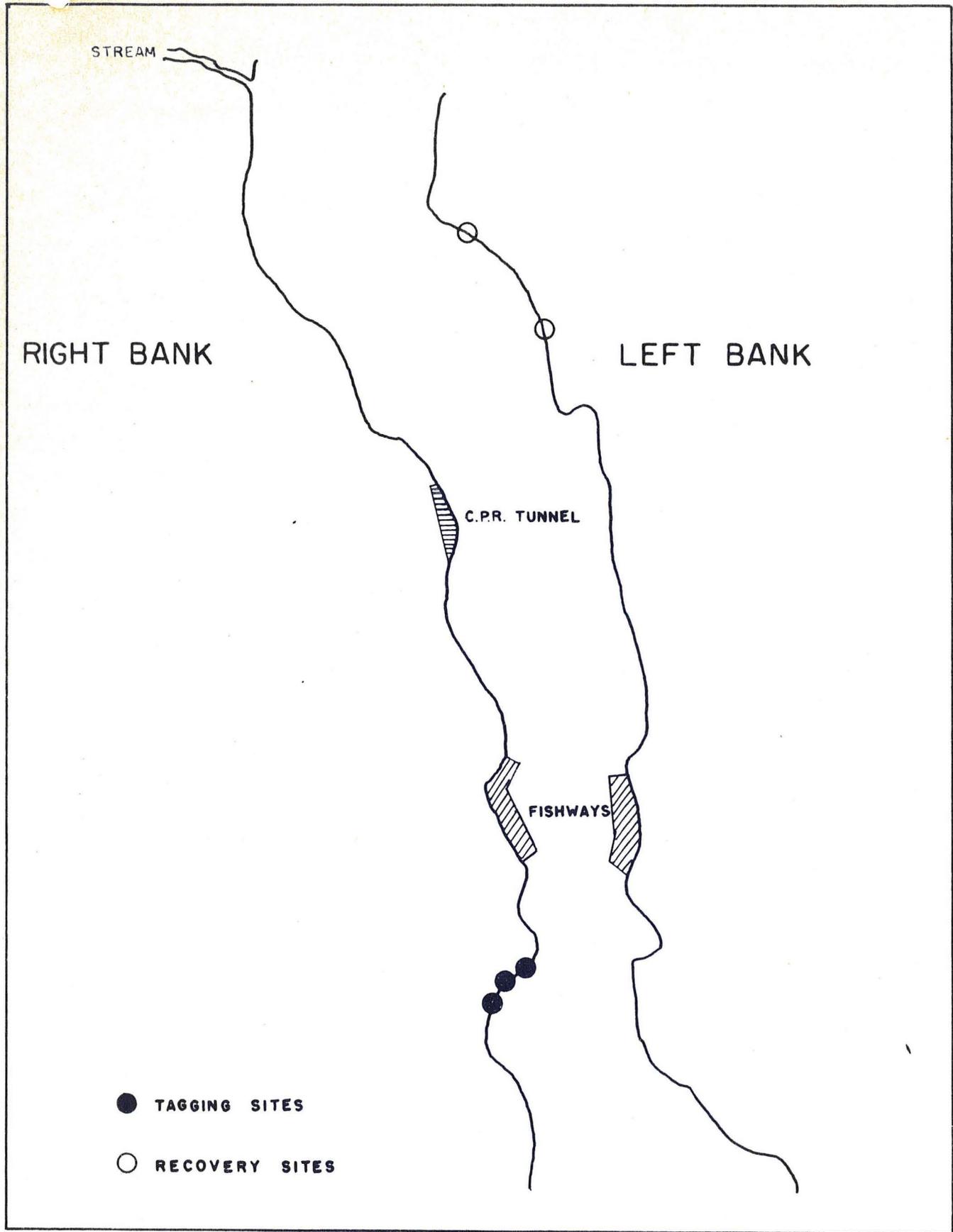


FIG. 1 TAGGING AND RECOVERY SITES — HELL'S GATE

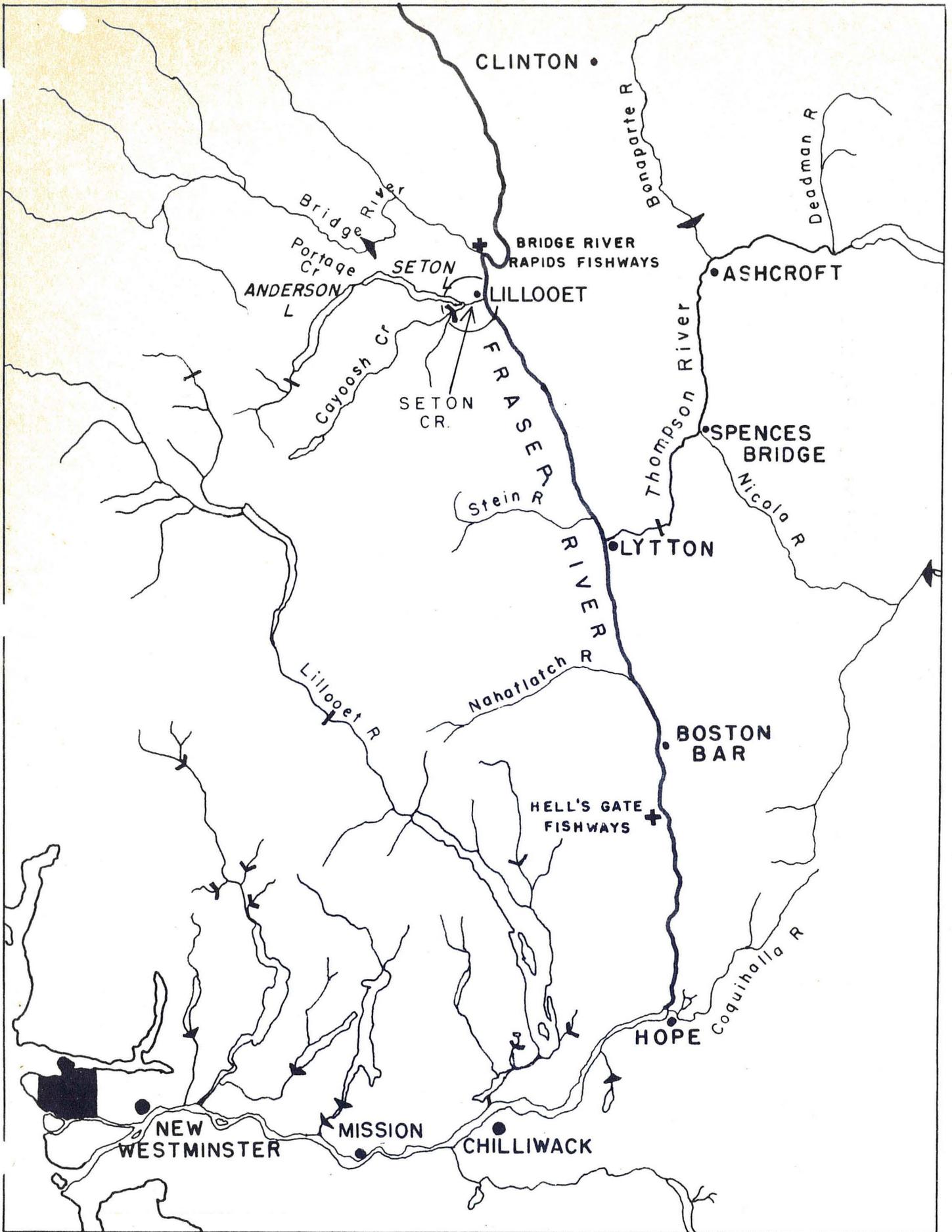


FIG. 2 LOCATION MAP

2 below Hell's Gate and 42 above Hell's Gate. Of the total recoveries above the Gate, 38 were recovered on the stream surveys, and the remaining 4 were turned in by the local Fisheries Officers and residents of the district.

With reference to the tags recovered at Hell's Gate itself, Table I shows the number recovered and the number of days between tagging and recovery. These data are also illustrated graphically in Fig. 3, which includes the gauge readings at Hell's Gate during the tagging period.

The number of recoveries made at Hell's Gate is too small to estimate or measure the time required for pink salmon to pass above the constriction. However, Table I shows that of the 14 tags recovered below the fishways, 6 were recovered the same day they were tagged, 4 were recovered after one day, 2 were recovered after two days, and one fish was recovered after five and another after ten days. The average time of recovery below is thus 1.6 days for 14 tag recoveries.

A comparison between catch per unit effort for tagging below the fishways and recovery above, would seem to show that the pink salmon were not delayed in 1953. Except for a short period between September 26 and October 1, the catch per unit effort curves for tagging and recovery are very similar (See Fig. 4). During this period, the gauge reading at Hell's Gate was between twenty and twenty-two feet and during this same period, 6 of the 14 tags recovered below the fishways, were picked up. It is also interesting to note that 11 of the 14 tags recovered were captured when the gauge reading was between 20 and 22 feet. Since these observations are based on a recovery of only 14 tags, no

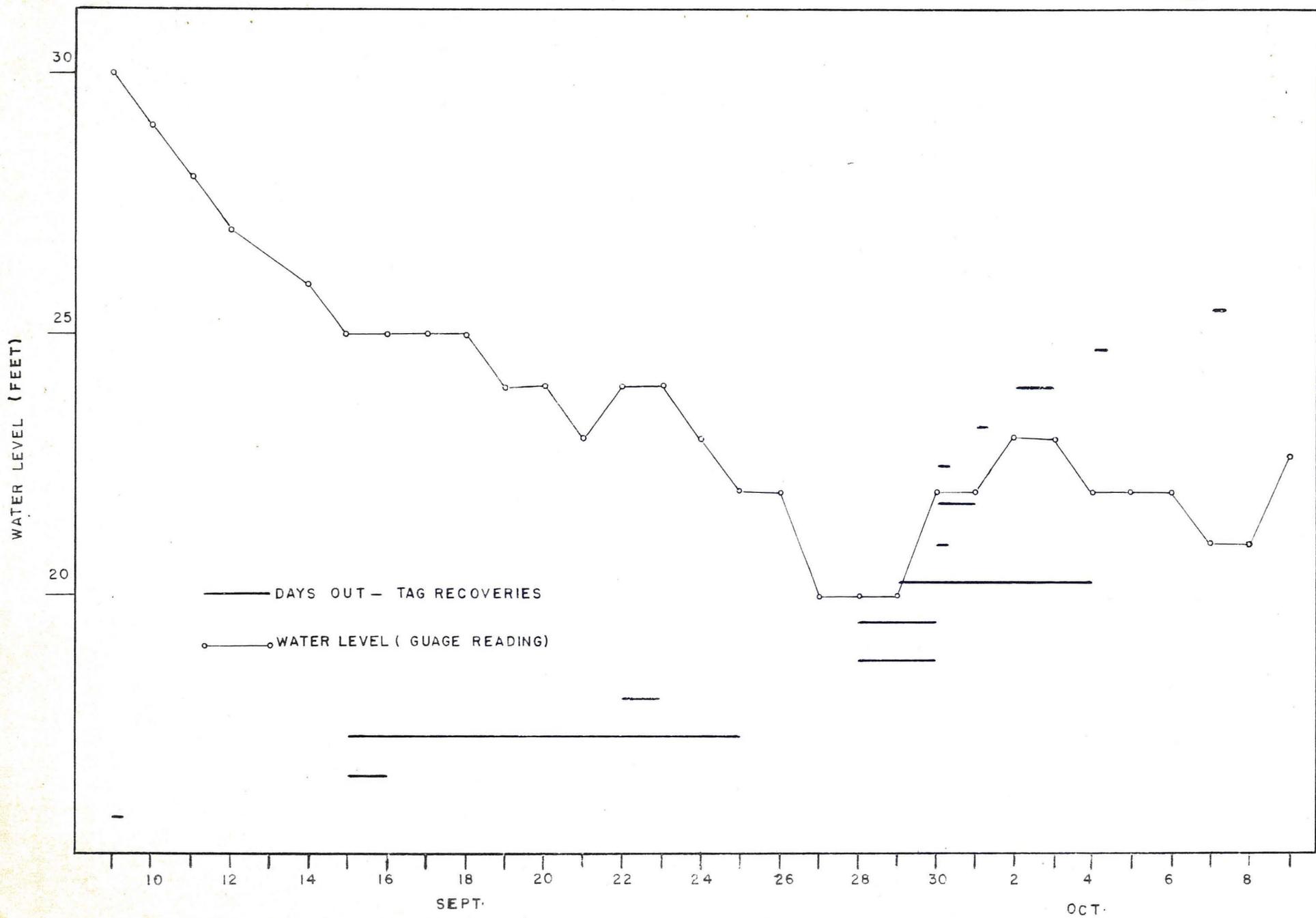


Figure 3---Period between tagging and recovery of Pink Salmon tagged at Hell's Gate.

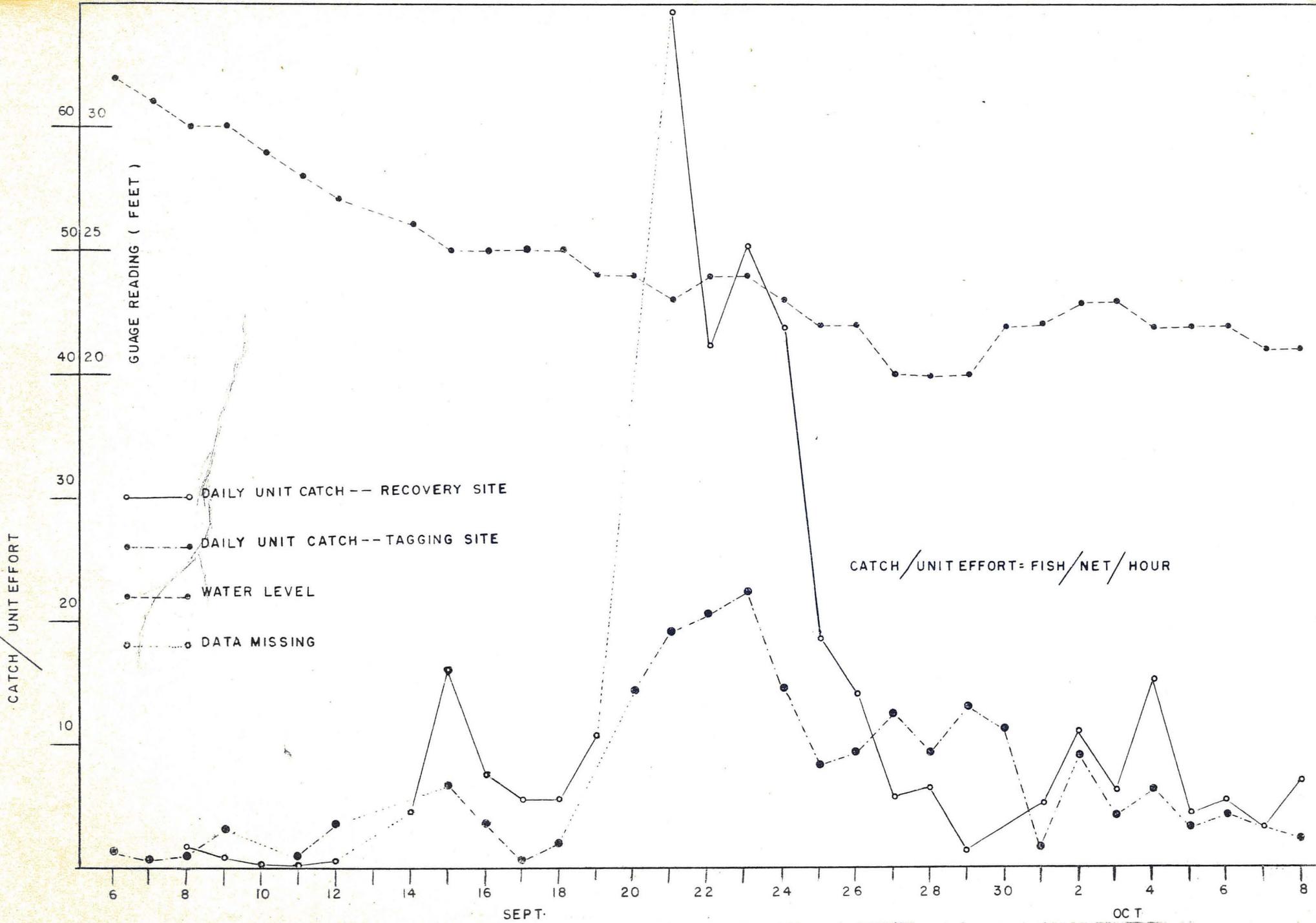


Figure 4---Catch per unit effort above and below Hell's Gate.

Table I. Number of days between tagging and recovery and condition at time of recovery of tagged pink salmon recovered at Hell's Gate.

Number	Date Tagged	Date Recovered	Days Out	Condition	Injuries
1	Sept. 9	Sept. 9	0	Green	Uninjured
2	" 15	" 16	1	Mature	"
3	" 15	" 25	10	Green	"
4	" 22	" 23	1	"	"
5	" 28	" 30	2	Mature	Body Injury
6	" 28	" 30	2	Green	" "
7	" 29	Oct. 4	5	Mature	Uninjured
8	" 30	Sept. 30	0	"	"
9	" 30	Oct. 1	1	Green	"
10	" 30	Sept. 30	0	"	"
11	Oct. 1	Oct. 1	0	"	Body Injury
12	" 2	" 3	1	Mature	Uninjured
13	" 4	" 4	0	Green	"
14	" 7	" 7	0	"	"
			23		

conclusions can be made concerning possible delay at low water levels. It must be mentioned that the greater catch per unit effort below as opposed to that above during the aforementioned period and the increase in number of tag recoveries at gauge readings below 22 feet could be due to a change in tagging sites. The tagging crew may have been able to catch a larger percentage of fish at those levels than they were able to catch when the gauge reading was higher. However the 1953 data could indicate that pink salmon have some difficulty passing through Hell's Gate when the gauge reading is below 22 feet, and if a future pink tagging program is carried out, particular attention should be paid to the ease of passage through Hell's Gate of pink salmon below that gauge level. In 1953, the water level in the latter part of the season at Hell's Gate was unusually high, and the

gauge reading did not drop below 20 feet. However, in some years, the reading does fall below this point, such as in 1945 when it read 9 feet near the peak of the run, and the movement of pink salmon at the lower water levels, should certainly be noted.

From September 8 to October 16, 1414 pink salmon were caught and released immediately above Hell's Gate. However, only two bore tags and the data is insufficient to be of any use. This factor eliminated any chance of making a population estimate from the work done at Hell's Gate alone.

Table II. Number of live and dead pink salmon counted in spawning streams above Hell's Gate and number of tags recovered.

STREAM	LIVE COUNT	DEAD COUNT	TOTAL	TAGS RECOVERED	DATE OF SURVEY
Nicola River	1	456	457	4	Oct. 21
Deadman's Creek	4	5	9	-	Oct. 22
Thompson River	-	37	37	-	Oct. 20 & 23
Portage Creek	1	1155	1156	1	Oct. 24
Anderson Creek	3	7	10	-	Oct. 20
Bonaparte Creek	1	100	101	1	Oct. 22
Seton-Cayoosh	851	3445	4296	14	Oct. 14-16
Seton-Cayoosh	26	3865	3891	17	Oct. 25-26
TOTALS	887	9070	9957	38	

As previously outlined, stream surveys were carried out on several tributary streams above Hell's Gate to determine the ratio of tagged to untagged pink salmon on the spawning beds. Table II lists the streams covered, the live and dead counts and the number of tags recovered on each stream. The Seton-Cayoosh system was visited on two occasions and the remaining streams were covered once.

SEX RATIOS

a. From Tagging Sample

Males	508	48.4%
Females	521	51.6%

b. From Fish Caught Above

Males	616	43.6%
Females	798	56.4%

There is a 4.8% difference between the percentage of males in the tagging sample and in the recovery sample. However the Chi-Square value (0.87) is below the level of significance, and this difference may be attributed to sampling.

c. From Stream Tag Recoveries

Males	17	44.7%
Females	21	55.3%

INJURIES

a. In the Tagged Sample

Male	87/508	17.1%
Female	82/521	15.7%
Combined	169/1029	16.4%

b. In the Sample Caught Above

--- the sampling above was done by one man, and the data on injuries was not recorded.

c. Injured Tagged Fish Recovered on Streams

Male	4/21	23.5%
Female	2/17	5.3%
Combined	6/38	15.8%

The total number of tagged recoveries is too small to compare the percentages of injured with those of the tagged sample, and since the injuries of fish captured immediately above Hell's Gate were not recorded this factor cannot be shown to have any effect on migration of pinks above or through Hell's Gate.

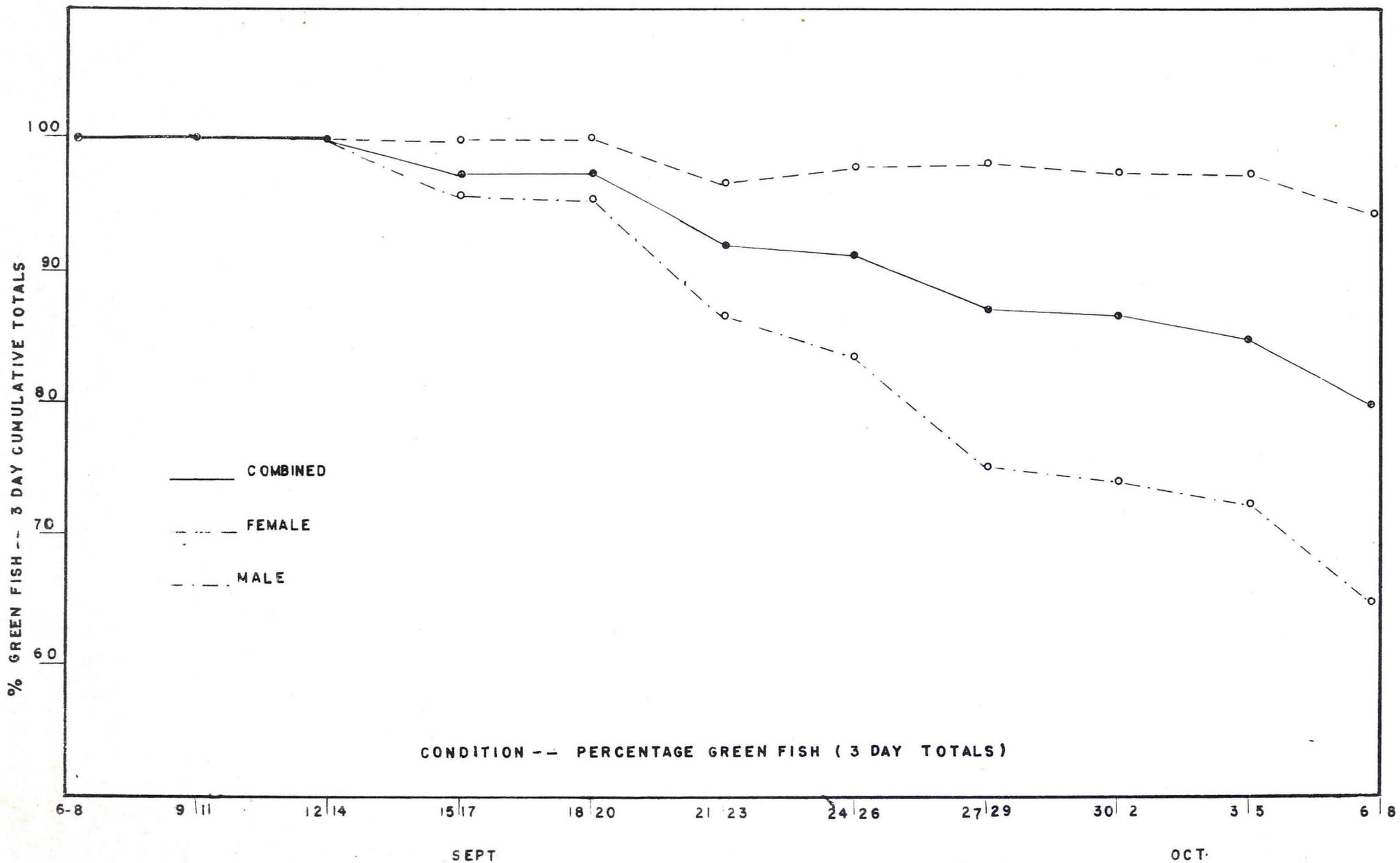
CONDITION ----- Tagged Sample Only

	Mature	Green
Male	36.4%	63.6%
Female	5.9%	94.1%
Combined	21.0%	79.0%

It will be noted that a larger percentage of females than males were recorded as being "green". However, this may not be a real difference. The salmon were classified as being mature if reproductive products were discharged during the tagging process. It is probable that male salmon discharge their products more easily than do females, under such conditions. Too few recoveries were made to indicate whether condition had any effect on migration from below Hell's Gate to the spawning grounds. Fig. 5 also illustrates the fact that the percentage of mature fish increased as the run progressed.

POPULATION ESTIMATE

As outlined previously, this program was primarily designed to make an estimate of the pink salmon escapement above Hell's



SEPT OCT.  
 Figure 5---Cumulative percentages of "green" fish tagged at Hell's Gate.

Gate. The original plan was to tag below the fishways at Hell's Gate and to capture fish above the fishways. From the ratio of tagged to untagged salmon captured above, an estimate was to be made. However, since only two of the 1029 salmon tagged below were recaptured above such an estimate could not be made. Data from the spawning ground recoveries has therefore been used to calculate the population size.

Table II shows that 38 tags were recovered on the streams from a total of 1029 fish tagged, in a sample of 9070 dead salmon. The estimate, calculated from the total tag returns in the stream surveys will be:

$$\left[ \frac{9070 \times 1029}{38} \right] \times 1029 = 247,000$$

At the 95% confidence level, (poisson distribution) the fiducial limits on the tag recovery total will be 26.8 and 32.2 (Ricker, 1937). Therefore, the upper and lower limits of the population estimate will be:

and,  $\left[ \frac{9070 \times 1029}{26.8} \right] \times 1029 = 349,000$

$\left[ \frac{9070 \times 1029}{32.2} \right] \times 1029 = 180,000$

From these calculations therefore at the 95% confidence level, the population of pink salmon above Hell's Gate should fall between 180,000 and 349,000.

This estimate is dependent upon a simple ratio of tagged to untagged fish. All the streams surveyed, excepting the Seton-Cayoosh system, were covered once, late in the spawning season, and the tags recovered were from fish tagged during the middle of the run. The Seton-Cayoosh system was visited near

the peak and at the end of the spawning season. Fig. 6 indicates that the tag recoveries made on Seton-Cayoosh were tagged throughout the season, and in a fairly constant proportion to the total number of fish tagged at Hell's Gate. It would be more correct therefore to base the population estimate on the recoveries made on this system alone. In the course of the two surveys on this system 31 tags were recovered from a dead sample of 7310 pink salmon. The estimate would be:

$$\left[ \frac{7310 \times 1029}{31} \right] \times 1029 = 244,000$$

At the 95% confidence level, the fiducial limits on the number of tag recoveries will be 21 and 44. Therefore the fiducial limits on the population estimate would be 172,000 and 359,000.

A larger number of tags would have been recovered and the population estimate limits accordingly reduced if stream surveys had been carried out during the entire spawning period. Personnel limitations however precluded such an operation. According to actual observations on the spawning grounds and information from the commercial fishery, however, the estimates made are not considered unreasonable.

#### SUMMARY AND CONCLUSIONS

A tagging program on pink salmon was carried out by the Department of Fisheries at Hell's Gate during the period of salmon migration in 1953. The purpose of this program was to attempt an estimate of the pink salmon population passing above Hell's Gate in the Fraser River Canyon.

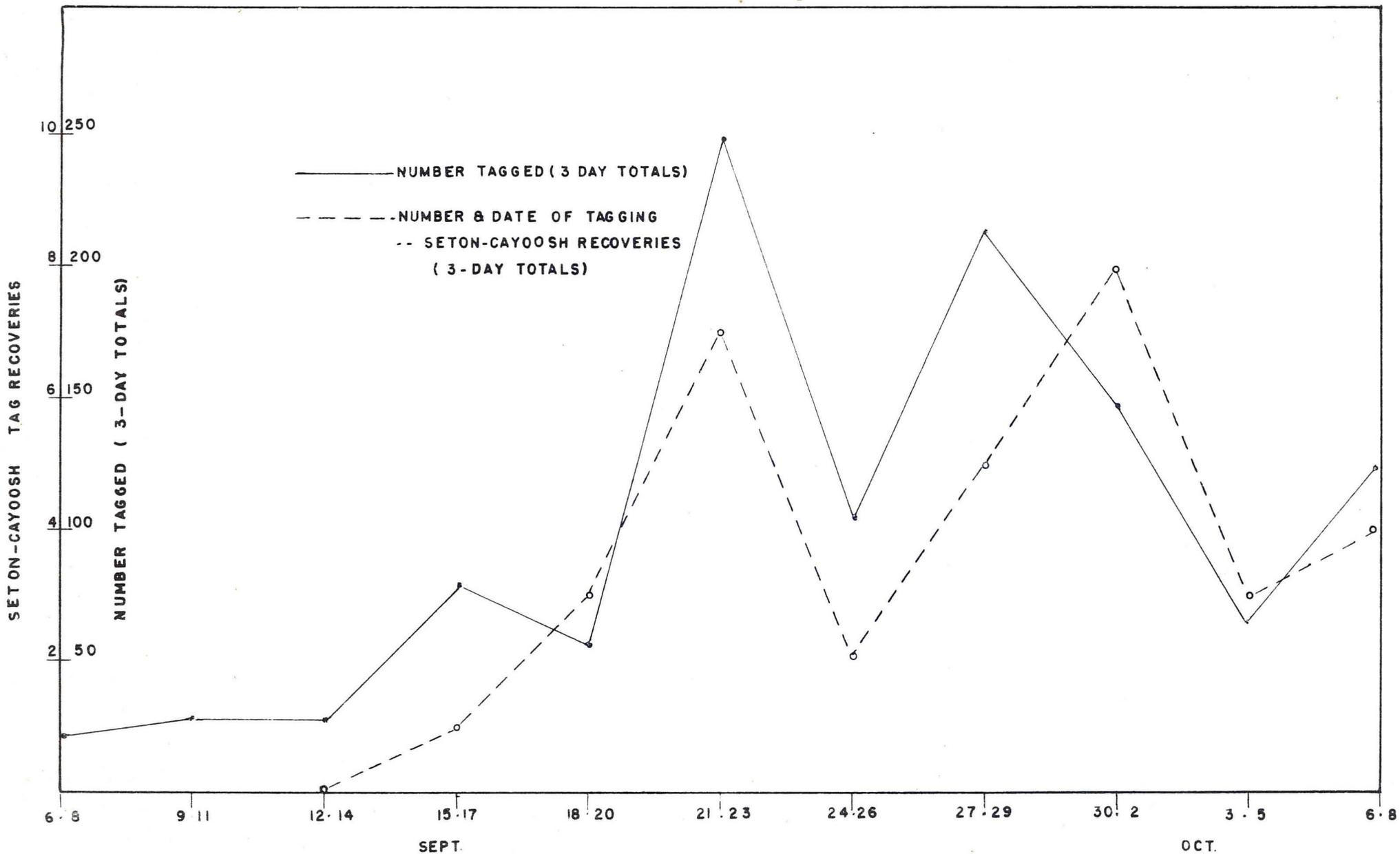


Figure 6---Number of Pink Salmon tagged at Hell's Gate compared with the number and date of tagging of those fish recovered on the Seton-Cayoosh system.

A total of 1029 pink salmon were tagged and released below the river constriction at Hell's Gate and 1416, including two marked fish, were captured and released above.

Surveys were carried out above Hell's Gate on several tributary streams. On these surveys, a total of 38 tags were recovered from a count of 9070 dead unmarked pink salmon.

The average time between tagging and recovery below the fishways, calculated from 14 returns, was found to be 1.6 days.

Because of the small number of tag recoveries, injuries, sex and condition cannot be shown to have any effect on migration above Hell's Gate.

Based on the recovery of tagged pink salmon in the Seton-Cayoosh system the population of pink salmon which passed above Hell's Gate in 1953 was estimated to be 244,000.

LITERATURE CITED

Ricker, William E. 1937. The concept of confidence or fiducial limits applied to the Poisson frequency distribution. J. Amer. Statistical Assn. 32: 349-356.