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DEPARTMENT OF FISHERIES
OF CANADA

THE
RATTLING BROOK TRANSFER
1957—1965

BY
C. STURGE

ST. JOHN'S NEWFOUNDLAND
1966

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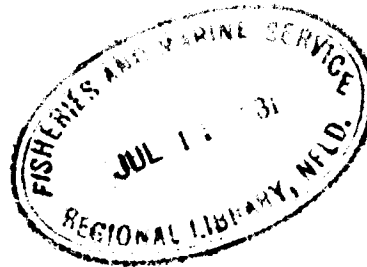
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by

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March, 1966.

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INTRODUCTION

Rattling Brook is a moderate size stream (drainage area: 160 sq. mi.) flowing into Bay of Exploits, Notre Dame Bay (Fig. 1). Before 1957, this stream supported an Atlantic salmon population estimated to number about six to nine hundred. Although no statistics are available to indicate the degree of contribution of the Rattling Brook salmon population to the commercial fishery, it is known that some contribution was made, (observations at the Rattling Brook counting fence, constructed in 1956 to obtain an accurate count of the run to this stream, indicated that from 15 to 20 per cent of the run carried gill-net marks.) However, the value of this run lay mainly in the sports fishery. Rattling Brook is conveniently located near the population centres of Grand Falls, Bishop's Falls, Botwood, Gander and several smaller places, and ranked next to the Exploits and Gander Rivers as a sport fishing stream in these areas. An indication of the angling success at Rattling Brook is given in Table I.

Table I. Salmon angling returns, Rattling Brook,
1952 - 1956.

Year	No. of fish taken	No. of Rod - Days	Fish per rod day
1952	193	458	0.3
1953	292	810	0.4
1954	240	1,261	0.2
1955	156	871	0.2
1956	245	1,206	0.2

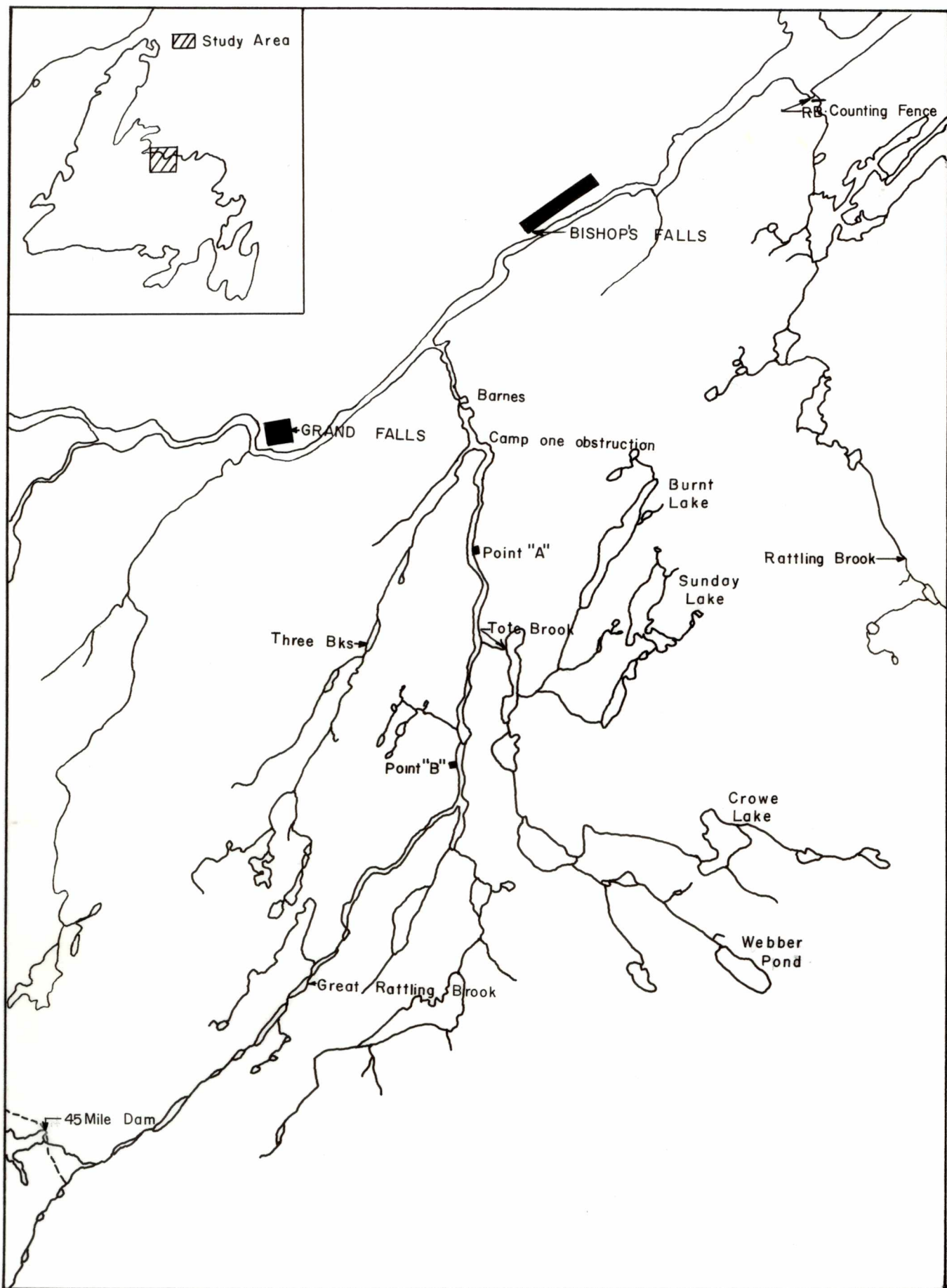


Fig. 1. Map of Rattling Brook and Great Rattling Brook.

In general, then it should be noted that although the Rattling Brook salmon run contributed to the commercial fishery, its greatest value lay in its contribution to the sports fishery.

In 1955, Newfoundland Light and Power Company Limited announced plans that were destined to terminate the value of Rattling Brook as a production area for Atlantic salmon. Plans for a power development on this stream would make it impossible to maintain the salmon run there.

Figure 2, a map of the lower Rattling Brook watershed, shows the location of the major engineering works, which are generally described as follows: The hydro project was designed to produce a total of 16,000 h.p. from two powerhouses. A diversion dam, about thirty feet high, was to be constructed at the outlet of Rattling Lake, which would divert the main stream from its former outlet at Rattling Lake into Amy's Lake, leaving about two miles of the original stream bed without water. A main control dam, also about thirty feet high, was to be erected at the new outlet of Rattling Brook from Amy's Lake. An excavated channel would carry water from Amy's Lake to forebay pond no. 1. A twenty-five foot dam, known as intake dam No. 1, would back up the water of the forebay. The intake for powerhouse no. 1, situated about half a mile downstream, was to be located behind this dam. A wood stave pipeline would convey water from forebay no. 1 to powerhouse no. 1. Water from the tailrace of powerhouse no. 1 would flow through the downstream part of the old river channel.

An eighteen foot dam, known as intake dam no. 2, erected downstream from powerhouse no. 1, would create a second forebay, from

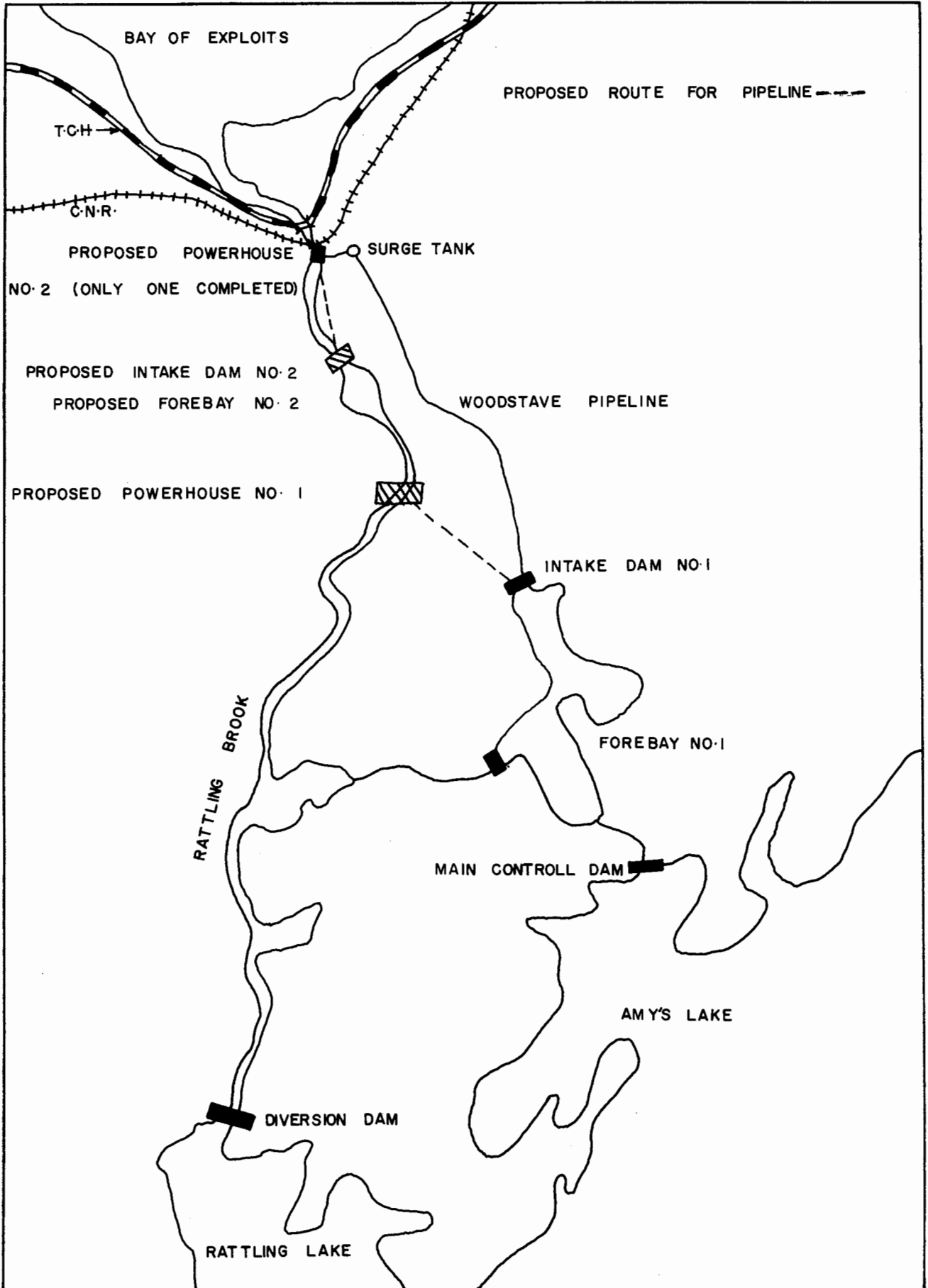


Fig. 2. Map of Rattling Brook watershed showing major Engineering works.

behind which water would be carried by wood stave pipe to powerhouse no. 2 which was to be situated about a quarter mile from the stream mouth.

Subsequent developments dispersed with powerhouse no. 1 and intake dam no. 2. Instead, water was conducted directly from intake dam no. 1 through wood stave pipe to powerhouse no. 2. The net result of this change in plans was to leave an extra half mile of river bed, between powerhouse no. 2 and the proposed powerhouse no. 1, without water. The company contemplated no spill at the diversion dam, so it seemed impossible that the salmon run could be maintained in Rattling Brook.

At this time (1955) little information was available regarding the status of Rattling Brook as a salmon stream, so the Department of Fisheries made plans to obtain the needed information. In 1955, a brief aerial survey was made of the watershed, and plans were drawn up for the construction of a counting fence in 1956. The results obtained from this counting fence, given in Table II, warranted consideration of various means for the preservation of the run.

Table II. Counting fence data, Rattling Brook, 1956.

Fence Count	596
Estimated number not in fence count	150
Number angled downstream from fence	24
Total	770

Several means of preserving the salmon run were considered, these being:

- (1) Construction of fishways,
- (2) Transport by vehicles to beyond dams,
- + (3) Construction of Artificial Spawning Area,
- (4) Establishment of a hatchery,
- (5) Diverting the salmon from Rattling Brook,
- (6) Transfer the run to unused spawning area.

Number (1) was ruled out because the company advised that the amount of water, needed to operate the necessary fishway, could not be made available. Also, it was thought that heavy mortality would result when migratory smolts passed through the turbines on the way downstream. (In subsequent years, the presence of many dead eels collected on the Rattling Brook counting fence seemed to confirm the latter suspicion).

Number (2) was considered inadequate because of the cost factor, including the cost of constructing a permanent trapping device, as well as the continuing costs of operating the project each year, especially labour and maintenance and operation of a transport vehicle. Also, there was the problem of turbine mortality on migrating smolts.

The construction of an artificial spawning area was considered impractical, because the downstream powerhouse would be located too near tidewater to permit the construction of such an area. Also insufficient rearing area, for young fish, existed below the powerhouse. If the artificial spawning area were to be constructed upstream from the powerhouse,

the problems of insufficient water to operate a fishway and the turbine mortality on smolts, would again be encountered.

Establishment of a hatchery was ruled out also because of the cost factor and turbine mortality problem.

It was thought that complete diversion of the run from Rattling Brook should only be done as a last resort, since it was not known for sure if diverted fish would enter other rivers, and even if they did, they might have to compete with established populations for sufficient spawning area. It was felt too, that offspring from diverted fish might have to compete unfavourably for a supply of food.

The only acceptable alternative was to transfer the run from Rattling Brook, to another stream in which there was adequate spawning area and reasonable assurance of sufficient food. Several nearby streams which were not being utilized by Atlantic salmon, were investigated, and of these, Great Rattling Brook (Fig. 1) seemed best suited.

Great Rattling Brook, a tributary of the Exploits River, drains into it approximately five miles below Grand Falls (Fig. 1). The drainage area is approximately 600 square miles, of which 50 square miles were accessible to salmon prior to 1959. The total river length of Great Rattling Brook, including tributaries, is 180 miles, only 25 miles of which were accessible to salmon prior to 1959. When this river was compared to Rattling Brook, which has 160 square miles of drainage area (109 of which were accessible to salmon), and a total length of 30 miles (25 of which are accessible to salmon), it seemed reasonable to expect

that Great Rattling Brook was quite capable of supporting the Rattling Brook salmon run.

Three factors favoured the use of Great Rattling Brook for the salmon transfer: (i) plans already called for the construction of a fishway over a complete obstruction, at camp one Falls, located $3\frac{1}{2}$ miles upstream from the mouth of Great Rattling Brook (Fig. 3).



Fig. 3. Camp one obstruction, Great Rattling Brook.

The relocation of the Rattling Brook run above this obstruction would ensure immediate utilization of a vast area of stream, (ii) a suitable road

linked the two rivers, thus affording economic transportation, and
(iii) adequate spawning area existed above camp one obstruction.

Materials and Methods

In 1957, a beginning was made on the transportation of the Rattling Brook salmon run to Great Rattling Brook. All fish were caught as they moved upstream through a counting fence which had been established near the mouth of Rattling Brook. The fish were placed aboard a truck, equipped with a specially constructed salmon tank, and moved to Great Rattling Brook. Transfer operations, which began during the summer of 1957, continued until the summer of 1964; during the last year only 22 fish were caught. Although a few "strays" are expected to turn up at Rattling Brook in future, the transfer is now considered completed.

RESULTS & DISCUSSION

When considering the Rattling Brook transfer, it is necessary to remember that this involved a population of fish which was taken out of its native stream and placed in another (presumably foreign) stream. The first questions to be asked are, "What became of these fish after they were placed in this foreign stream? Did they stay there, and did they reproduce successfully?". From the available data collected on the transfer, it is difficult to give a firm answer to these questions, but there are several aspects which, when considered together, should enlighten us as to the probable fate of these fish: Firstly, there is the available tagging data; secondly, the information available on spawning ground surveys which were carried out by Department personnel; thirdly, the available information collected on juvenile salmon in Tote Brook; and lastly, the increase in the adult salmon count through Camp One fishway.

Tagging Data

Table III presents a summary of the available information on tagged fish which were transferred from Rattling Brook to Great Rattling Brook.

It was originally planned that all transferred fish would be tagged but, as can be seen from Table III, this was not so. Only a fraction of each run was tagged, which is just as well because the presence of colored tags made these fish more easily accessible to poachers. All fish were tagged with Petersen discs.

Table III. Summary of tagging information on transferred salmon, Rattling Brook to Great Rattling Brook, 1957 - 1961.

Year	No. Transferred	No. Tagged	Recaptures		
			Above release site	Returned to Rattling Brook	Below release, other than Rattling Brook
1957	610	87	4	-	1
1958	786	128	-	-	-
1959	329	21	-	1*	3*
1960	682	-	-	-	-
1961	254	189	45	3 + 6*	-

* These fish were caught the following year.

In 1957, 87 fish were tagged before being released in Great Rattling Brook. All fish were released at Point A (Fig. 1). One fish was recovered downstream at Bishop's Falls Dam. This fish was moving upstream again when it was caught. Four fish were recovered upstream (angling returns) from the release point. In addition, many tagged fish were seen in pools above the release point. Regular surveillance by field staff revealed the presence of many tagged and untagged fish in a pool below Tote Dam on Tote Brook. One angler took two salmon upstream from Tote Brook. It would seem, therefore, that the transferred fish did adapt to their new environment. As an added insurance that these fish had successfully spawned in the new environment, loggers working at Camp 45 Dam, 35 miles upstream from the 1957 release site, reported seeing kelts in the spring of 1958.

In 1958, a total of 128 salmon were tagged prior to their release in Great Rattling Brook. Sixty-five fish were released at Point A and sixty-three at Point B (Fig. 1). None of these fish were recovered in the general area but some were sighted in pools above the release site. Observations by Department personnel indicated that the fish had moved well upstream from the release site, as far as 45 Mile Dam.

In 1959, twenty-one adults were tagged prior to their release in Great Rattling Brook. Nine fish were released at Point A and twelve at Point B (Fig. 1). No immediate recoveries were recorded but, again, spot checks by Department personnel showed that many fish moved upstream to Tote Brook and Rushy Pond tributaries and up to 45 Mile Dam. Three of these fish were taken in the commercial fishery in 1960, and one was angled at Rattling Brook in 1960.

No fish were tagged in 1960, but in 1961, 189 fish were tagged before being released. Forty-nine of these were released at "Barnes" below Camp One fishway (Fig. 1). Twenty-one of these were counted through Camp One fishway (there is no record as to whether or not these tags were removed) and three returned to Rattling Brook. Some tagged fish were reported dead in a pool near "Barnes" but there is no actual figure on just how many. The remaining 140 fish were released above Camp One dam, at Point A, and another point at the mouth of Camp One Steady (Fig. 1). None of these fish were recorded as having returned to Rattling Brook, until the following year (1962) when six were taken there. Many were observed in a pool below Tote Dam and twenty-four were caught by two local anglers above the release site.

Careful examination of available tagging data seems to indicate that the transferred fish adapted quite readily to their new environment and moved on upstream to the spawning grounds in Great Rattling Brook. The data is lacking, however, in that not enough follow-up information is available.

Spawning Ground Surveys

The next clue to the fate of the transferred fish comes from the available data which was collected from spawning ground surveys.

Checks were done each year while the transfer was in operation, but the first extensive survey of the spawning grounds on Great Rattling Brook was made in 1960. In October of that year Departmental staff covered most of the river drainage of Great Rattling Brook. The rivers out of Burnt Lake, Sunday Lake, Crowe Lake, Webber Pond and Tote Brook (Fig. 1), were given special attention since many adults were known to have moved up through Tote Brook Fishway. One hundred redds were counted on a tributary joining Burnt Lake River from Sunday Lake. Ten to fifteen redds were counted on that section of river flowing out of Crowe Lake (high water levels here made the survey difficult), and three redds were counted at the mouth of Tote Brook.

The purpose of this survey was to establish whether or not transferred salmon were spawning successfully in their new environment. This low count of redds does not necessarily indicate that they were not entirely successful, since the survey was carried out between October 17 - October 28, when it is probable that a proportion of the fish had not

begun to spawn. On the other hand, 103 fish moved through Camp One fishway in 1960. Some of the redds observed may have been constructed by these fish.

Other spawning surveys were scheduled on Great Rattling Brook in successive years but because of adverse weather conditions and high water levels they failed to produce any results that would enlighten us as to the fate of transferred fish or fish that had moved through Camp One fishway.

Because of the inconsistency of these spawning surveys, it is difficult to draw firm conclusions but it would seem from the 1960 survey that transferred fish which had moved into Tote Brook and its tributaries did spawn successfully. If this is true, it would seem natural to assume that the same thing happened to those fish that moved into tributaries other than Tote Brook, or those that remained in the main river.

Smolt Data from Tote Brook, 1961 - 1963

Figures 4 and 5 present a summary of age class distribution of the runs to Rattling Brook during 1959 and 1961. Age is denoted by growing season rather than by calendar year. It consists of two figures, the second written as a subscript of the first. The first figure designates the year of life in which the fish was captured. The subscript indicates the number of growing seasons in freshwater. Assuming that offspring from transferred fish would exhibit a similar migratory behavioral pattern, the first major smolt migration on Great Rattling Brook was expected to occur during the spring of 1961. Accordingly, plans were made to carry

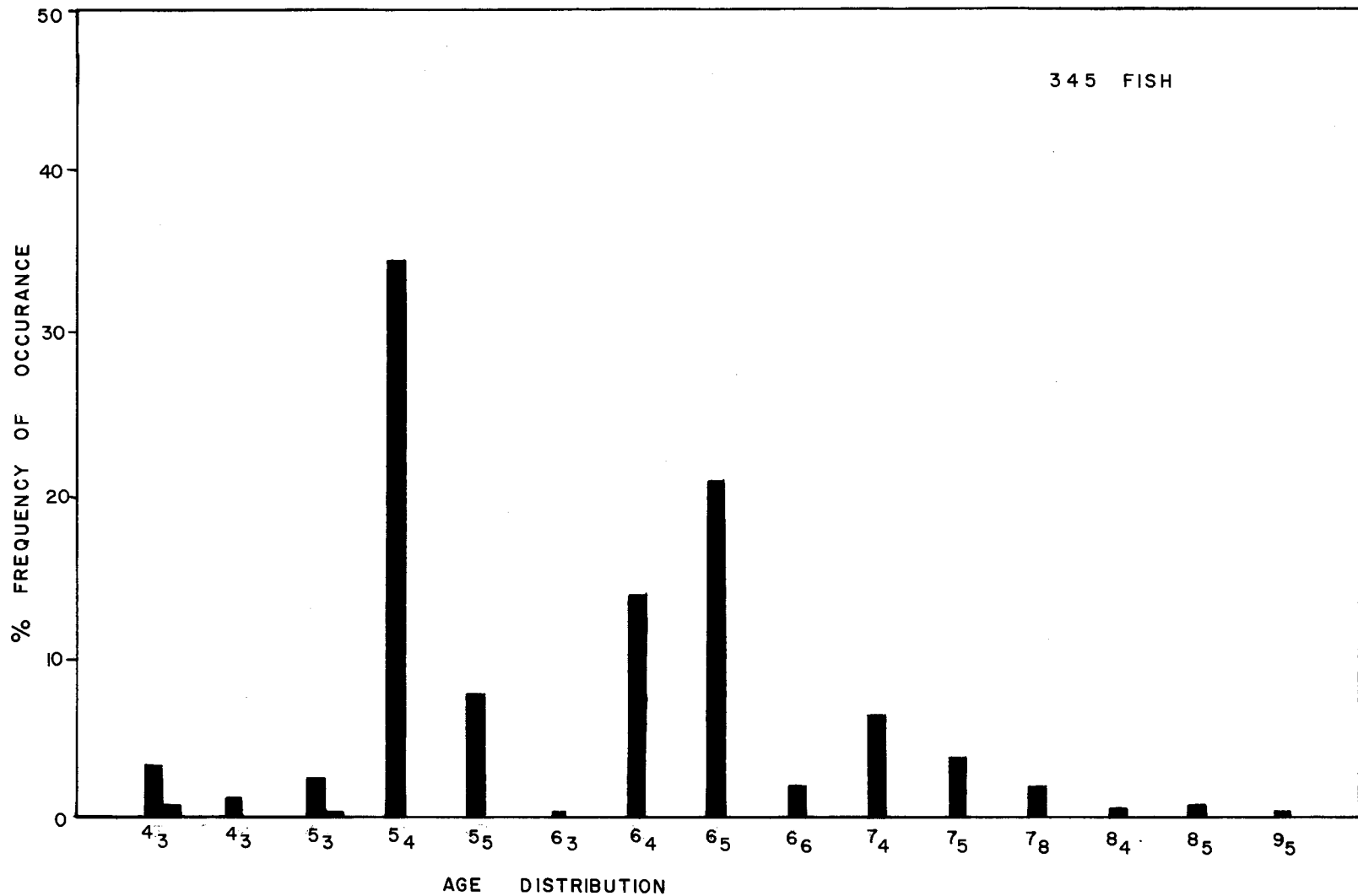


Fig. 4. Age distribution, Rattling Brook Adults, 1959 and 1961.

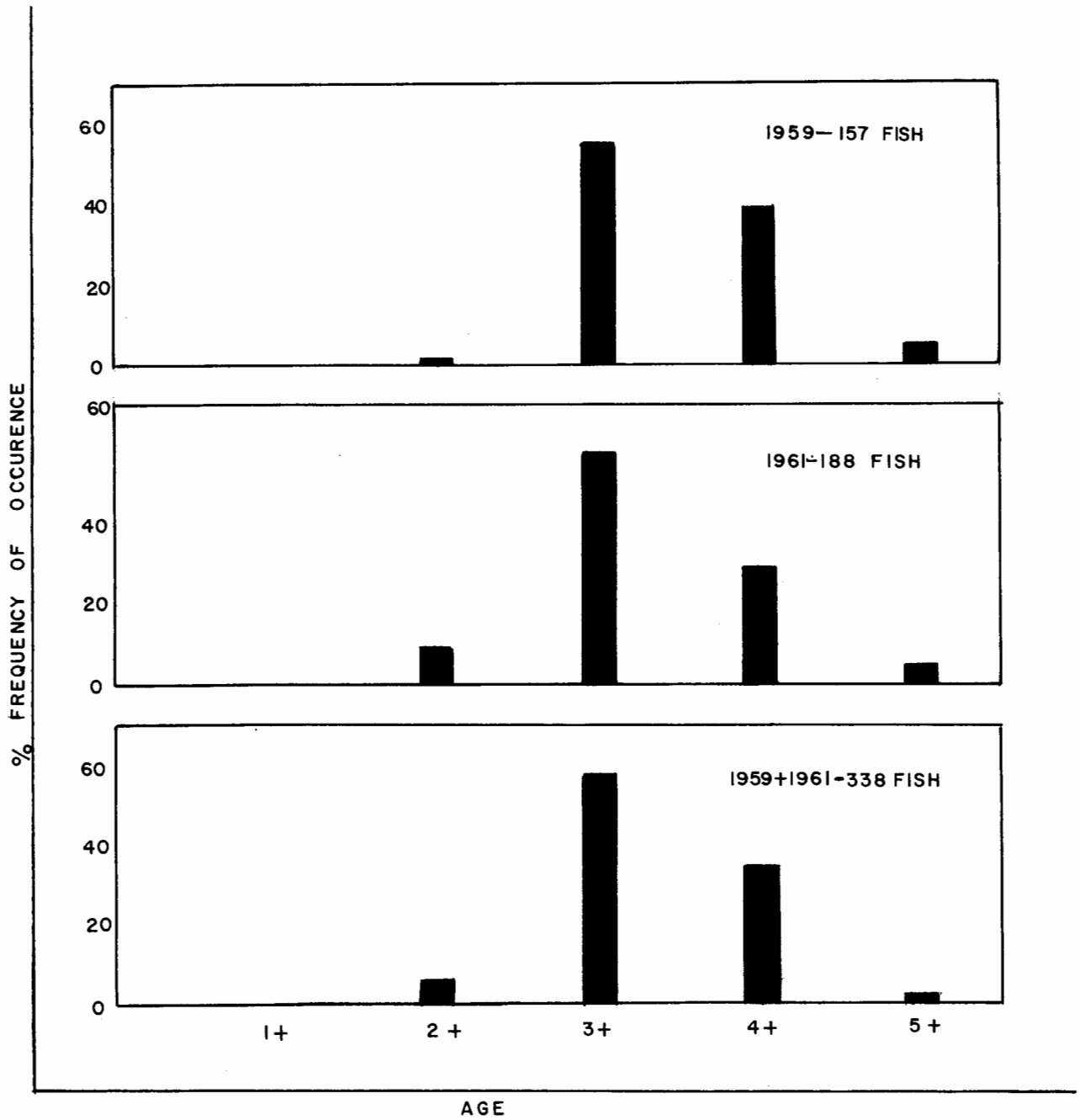


Fig. 5. Adult run to Rattling Brook; 1959 and 1961, showing fresh water age distribution.

out a survey of smolt migration on Tote Brook, a major tributary of Great Rattling Brook, into which large numbers of transferred adults were known to have moved. Surveys were started in 1961 and continued during 1962 and 1963. Fish were caught in a modified Fyke net, the construction and operation of which have been adequately described by Ducharme, 1961, and Pratt, 1963.

The 1961 survey was more or less of a trial nature, to test the suitability of equipment. 2,069 juvenile salmon were caught. Analysis of a sample of 153 fish revealed that 7.8% (12) were 1⁺, 58.8% (90) were 2⁺, 29.4% (45) were 3⁺, and 3.9% (6) were 4⁺. These figures are presented graphically in Figure 6. All except the 4⁺ fish could have been offspring from transferred fish. The 4⁺ fish must have been landlocks. It is not known exactly how efficient the gear was, but Ducharme, 1961, estimates that about 80% of the smolt run was caught. The writer feels that this figure is probably high since Ducharme and Pratt, 1962, from a more extensive survey, estimate that only 60% of the run was caught in 1962. The method of capture in 1962 was essentially the same as in 1961. 4,027 juvenile salmon were caught. This was estimated to be about 60% of the total smolt run (Pratt, 1963). No age data was collected in 1962.

In 1963, the smolt census was continued. In that year, 6,492 juvenile salmon were caught. This is believed to represent about 80% of the total smolt run. Examination of age data from a sample of 795 fish (shown graphically in Figure 6) reveals that 0.5% (4) were 1⁺, 21.3% (169) were 2⁺, 51.0% (406) were 3⁺, 25.6% (203) were 4⁺, and 1.6% (13) were 5⁺.

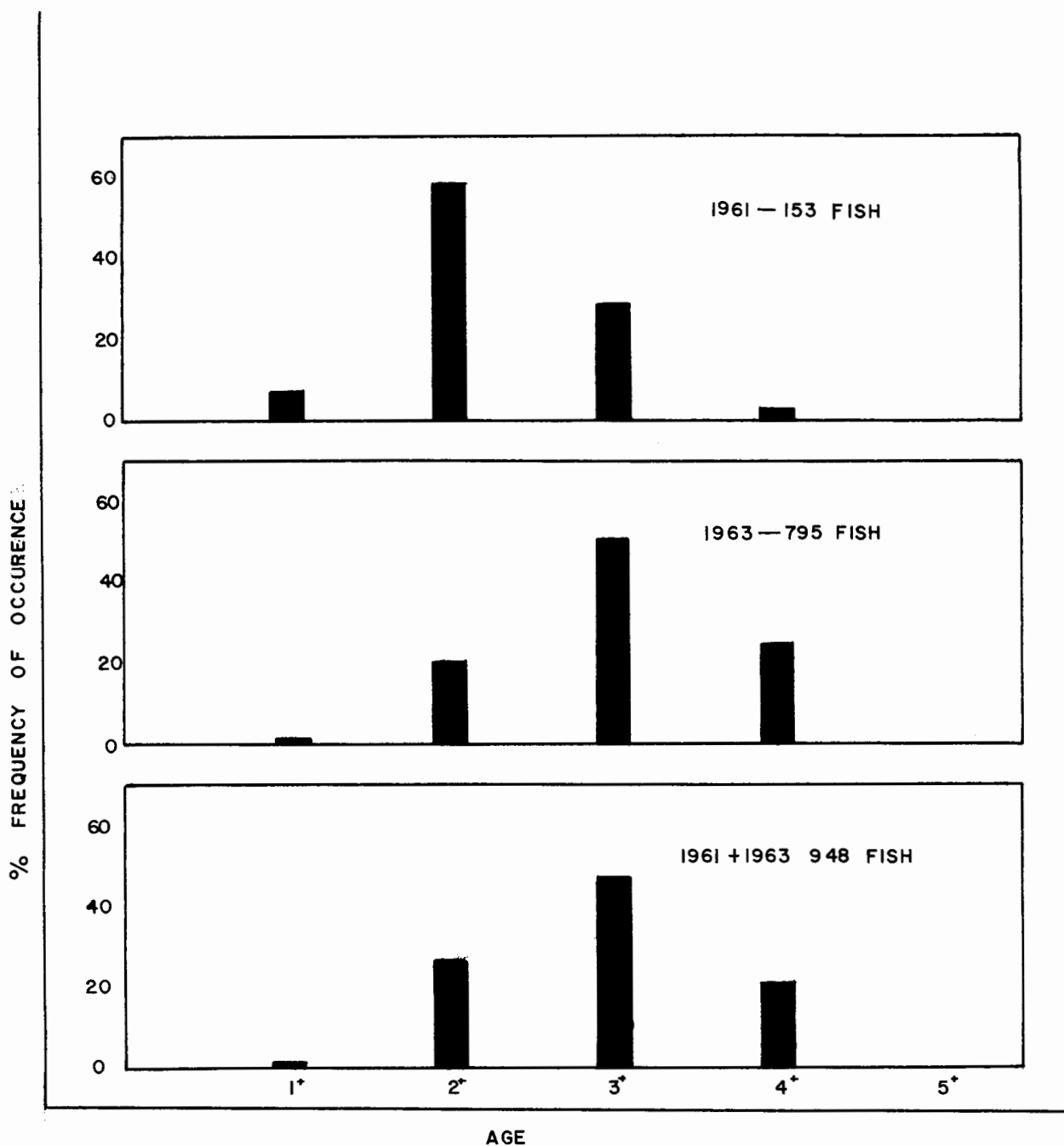


Fig. 6. Age Distribution, Juvenile Atlantic Salmon, Tote Brook, 1961 and 1963.

After much deliberation, the writer concludes that it is difficult to interpret this data with any degree of certainty. Because of the scarcity of data, it is difficult to relate increased smolt movements in Tote Brook to the transferred fish. For example, it would be expected that, since the majority of smolts descending Tote Brook are beginning their fourth year of existence (i.e. 3⁺ fish), the number of descending smolts could be related to the number of adults transferred 4 years earlier. Theoretically, there should be a direct relationship between the two, but this is not so as is shown in Table IV.

The observed increase in 3⁺ smolts, from 985 in 1961 to 1912 in 1962 might be expected because of the increase in transferred adults

Table IV. Showing relationship of transferred adults to 3⁺ smolts, four years later.

Year of transfer	No. of adults transferred	Year of smolt count	Number of 3 ⁺ smolts descending T.B.
1957	627	1961	985
1958	808	1962	1,912
1959	329	1963	3,082

from 627 in 1957 to 808 in 1958, but by the same token, a decrease in 3⁺ smolts would be expected in 1963, since only 329 adults were transferred in 1959. The observed increase cannot, however, be attributed to natural influx from the Exploits, since Camp One fishway was not opened until 1960 and only 103 adults moved through in that year. The writer considers that the apparent discrepancy is due mainly to three reasons: (i) there is

not enough available information on what proportion of the transferred fish utilized Tote Brook, (no count exists before 1960 and those which do exist cannot be considered reliable), (ii) the smolt counts should have been carried out for a greater number of years to provide more detailed information on age class distribution, and (iii) smolt counts should have been conducted before the effect of the transfer could be felt, in order to establish the contribution (if any) which landlocked salmon make to smolt runs. It is known that landlocks existed in the Great Rattling Brook system before the transfer was initiated.

We should not, however, lose sight of the fact that there was a definite increase in the number of smolts migrating from Tote Brook in 1961, 1962 and 1963, and that this apparent increase cannot be attributed to natural influx from the Exploits, since no fish moved through Camp One fishway, until 1960. While it is difficult to state definitely that these smolts were offspring from transferred fish, it is even more difficult to establish that they were not, unless landlocks offer a substantial contribution to smolt migrations, which is unlikely. It can be seen from Fig. 6 that only about 3% of the 1961 smolt run can definitely be attributed to landlocks.

Since there is no evidence to prove otherwise, it must be concluded that the increase in the number of smolts migrating on Tote Brook was a direct result of the transfer.

Camp One Fishway operations

It is known that adult Atlantic salmon utilized that part of

Great Rattling Brook below Camp One obstruction before Camp One fishway was constructed (Department personnel engaged in spawning ground surveys during the Fall of 1959 sighted several redds on Three Brooks), but it is not known just how many fish utilized this area.

Late in 1959, a fishway was opened over Camp One obstruction, which made that part of the Great Rattling Brook watershed above Camp One accessible to salmon. A fishway count was begun at Camp One in 1960 and has been continued every year since.

Table V presents a summary of the available information on the run to Great Rattling Brook during the years 1960 - 1965.

Table V. Summary of counting trap and angling records on Great Rattling Brook, 1960 - 1965.

Year	1960	1961	1962	1963	1964	1965	66	67
Fishway count	103	372	1,068	528	1,868	777	1412	1204
Angled below fishway	-	-	86	37	171	46	186	44
Total run	103	372	1,154	565	2,039	823	1598	1253

The escapement of 103 fish through Camp One in 1960 must be attributed to natural influx from the Exploits run, since it is unlikely that any effect from the transfer might be felt at this time. Frequency histograms of age composition data for Rattling Brook salmon (Figs. 4 and 5) indicate that none of these fish went to sea after one year of river life. However, Fig. 6 indicates that a small proportion of juvenile salmon caught in Tote Brook in 1961 and 1963 were beginning their second year of

1968 2021+225(224)
 1969 1192
 30
 1272
 1971 1163
 32
 1195

life. Whether or not these fish were actually moving out to sea, is difficult to say. It may be that they were undergoing a secondary migration out of Tote Lake. In any case, it seems extremely unlikely that the transfer had any effect on the run through Camp One fishway in 1960.

In 1961, the run through Camp One fishway was 372 fish. In all probability, most of these fish were also from a natural influx from the Exploits run. However, we cannot rule out the possibility that some of these fish may have been offspring from fish that were transferred in 1957. Fish which hatched in 1958 and went to sea after spending two winters in freshwater might have been returning to their parent stream to spawn in 1961. Fig. 6 indicates that an average of about one quarter of the smolts migrating from Tote Brook were beginning their third year of life.

Fig. 6 also indicates that most smolts migrated from Tote Brook after spending three years in the river (3⁺ smolts). Theoretically, 3⁺ smolts arising from the 1957 transfer would be returning to Great Rattling Brook in 1962, since most Rattling Brook fish were known to return after spending one year in salt water, as is shown in Fig. 4. It was expected, therefore, that the run through Camp One fishway would be greatly increased in 1962. This is confirmed by Table V, which shows that 1,068 adults passed through Camp One fishway in 1962.

Theoretically, the run through Camp One fishway in 1963 would be composed mainly of 5₄ fish from the 1958 transfer and 6₅ fish from the 1957 transfer, since these were the two major age classes found among Rattling Brook adults as is shown in Fig. 4. This is confirmed by Fig. 7. It would be expected then that the run through Camp One fishway

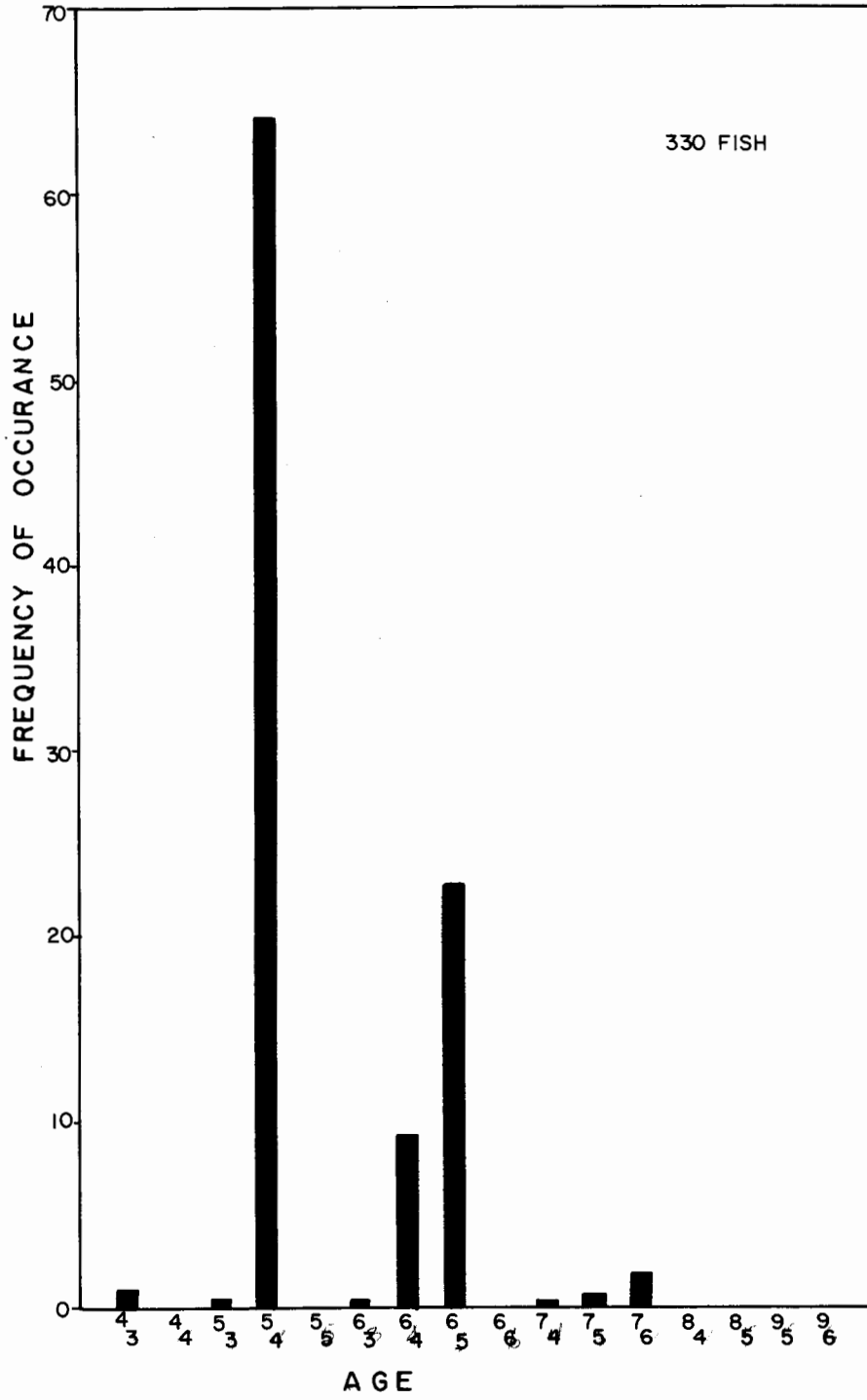


Fig. 7. Age composition of adult run through Camp One, 1963.

would increase in 1963, but this was not so, as is evident from Table V. It should be remembered, however, that although the run to Great Rattling Brook in 1963 was lower than in 1962, it was considerably higher than it was in 1960 and 1961. A possible reason for the apparent decrease from 1,068 fish in 1962 to 528 fish in 1963 is the handling of juvenile fish at Tote Brook in 1961 and 1962. During these years most of the smolt run through Tote Brook underwent considerable manipulation by Department personnel, and it may be that mere handling of smolts caused some mortality. This handling mortality may have contributed to the low run through Camp One in 1963. On the other hand, it would seem unlikely that smolt mortality at Tote Brook would adversely affect the adult run to Great Rattling Brook, since it is probable that the majority of smolts came from areas of Great Rattling Brook other than Tote Brook. Also, it may be noted that although the smolt run during 1963 received an equal, or greater, amount of manipulation, there was a marked increase in the number of adults passing through Camp One in 1964. The run through Camp One in 1964 was 1,868 fish. Theoretically, the adult run in 1964 should have been composed mainly of 3⁺ smolts that had gone to sea during the Spring of 1963. These 3⁺ smolts would be offspring from adults which were transferred in 1959. In view of the fact that only 329 adults were transferred in 1959, it is surprising that such an increase in the run through Camp One fishway should occur in 1964, i.e. if we are to assume that the Rattling Brook transfer was responsible for the increased runs to Great Rattling Brook. On the other hand, it is possible that natural influx from the Exploits may have been largely responsible for the increased runs through Camp One fishway

from 1960 - 1965. Then, again, it is difficult to see why natural influx from the Exploits was not just as great in, say, 1961, as it was in 1964.

The question, "How much did the Rattling Brook Transfer contribute to the establishment of a sizeable salmon run on Great Rattling Brook?" is, then, a difficult, if not impossible, one to answer. There is absolutely no way in which it can be stated, with any degree of certainty that the build-up of the adult run to Great Rattling Brook was not due to a natural influx of salmon from the Exploits, that, in former years, had utilized the area below Camp One obstruction and Three Brooks.

Are Great Rattling Brook fish offspring from Rattling Brook Fish?

Cursory examination of Fig. 8 indicates that there was a considerable increase in the number of adults utilizing Great Rattling Brook during the period 1960 to 1965. Also, it can be seen that the period of this increase was coincidental with depletion of the run to Rattling Brook.

As was pointed out earlier (page 14), the first major contribution of offspring from transferred fish was expected on Great Rattling Brook in 1962. It can be seen from Fig. 8 and Table V, that the run through Camp One fishway showed a sharp increase in 1962, rising by 187 percent over the former year (1961). This would indicate that the transfer was coming into effect. This observation is, however, overshadowed by the fact that the run in 1961 increased by 261 percent over that of 1960, during which time no major effect from the transfer could be expected.

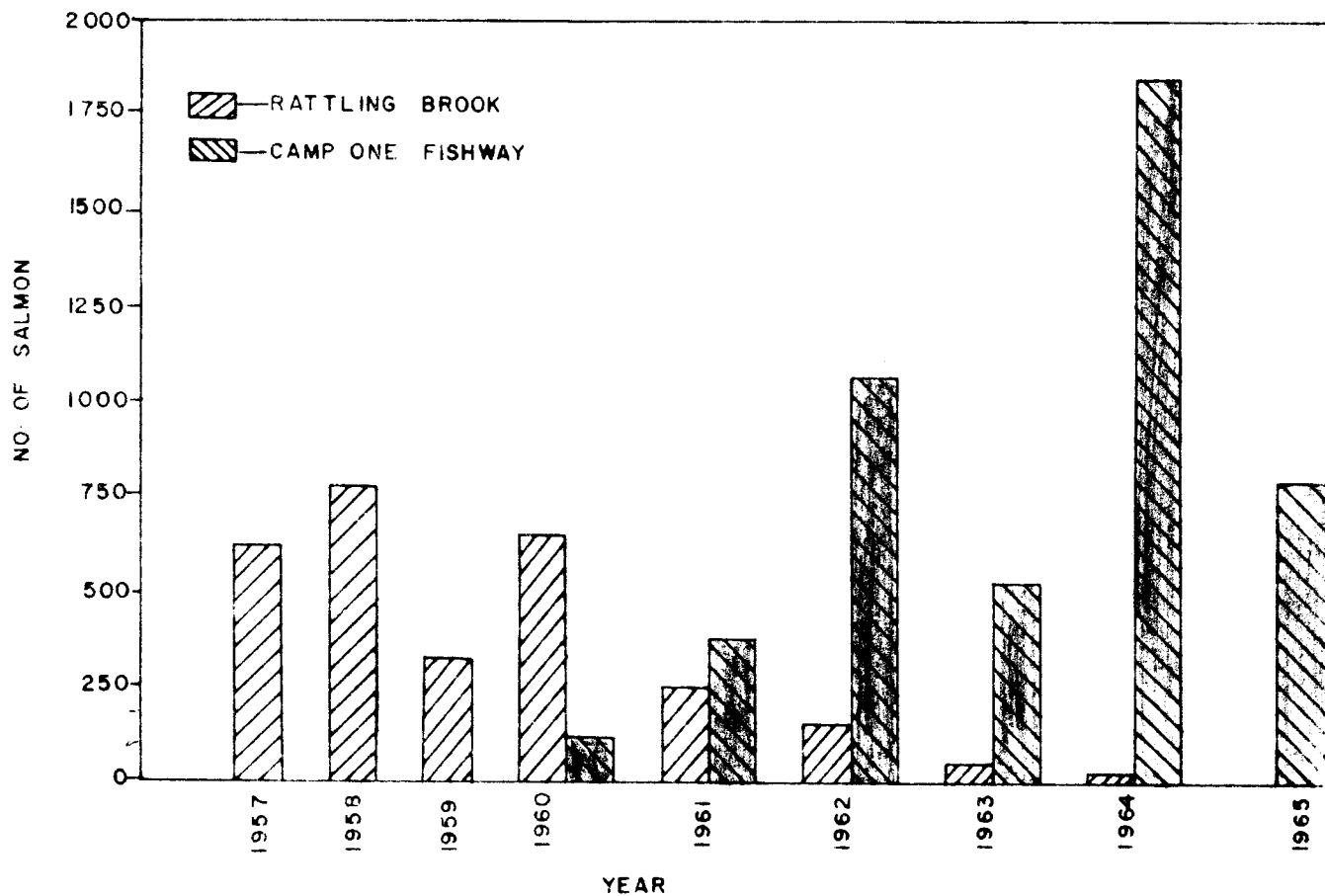


Fig. 8. Showing decrease in run to Rattling Brook, and increase in run to Great Rattling Brook.

Fig. 9 illustrates the relationship between the run to Great Rattling Brook and the total run to the Exploits River. It is apparent that yearly variations in the total run to the Exploits are closely related to yearly variations on Great Rattling Brook. This may suggest that the run to Great Rattling is dependent on the number of fish entering the Exploits, or that the number of fish entering the Exploits depends, to some extent, on the number of adults returning to Great Rattling Brook. The possibility that Great Rattling Brook fish are progeny of transferred fish is not ruled out by these observations. It can be readily seen from Fig. 9, that during the period 1959 - 1965 there has been an upward trend in the number of adults utilizing the Exploits River. It is also clear that this increase is coincidental with an upward trend in the number of adults utilizing Great Rattling Brook. Fig. 9 shows that these two trends are almost identical. Also, it can be seen that there has been an upward trend in the number of adults utilizing Great Rattling Brook, expressed as a percentage of the total run to the Exploits. This would suggest, then, that progeny of transferred fish are returning to Great Rattling Brook to spawn, and that their return is reflected in the increased count for the Exploits.

Additional light may be shed on the relationship between Great Rattling Brook and transferred fish, from a tagging study done on Tote Brook smolts in 1962. In that year a marking program was carried out on migrating smolts. The principle underlying this marking method is that when a solution containing lead is injected into a fish the lead will be

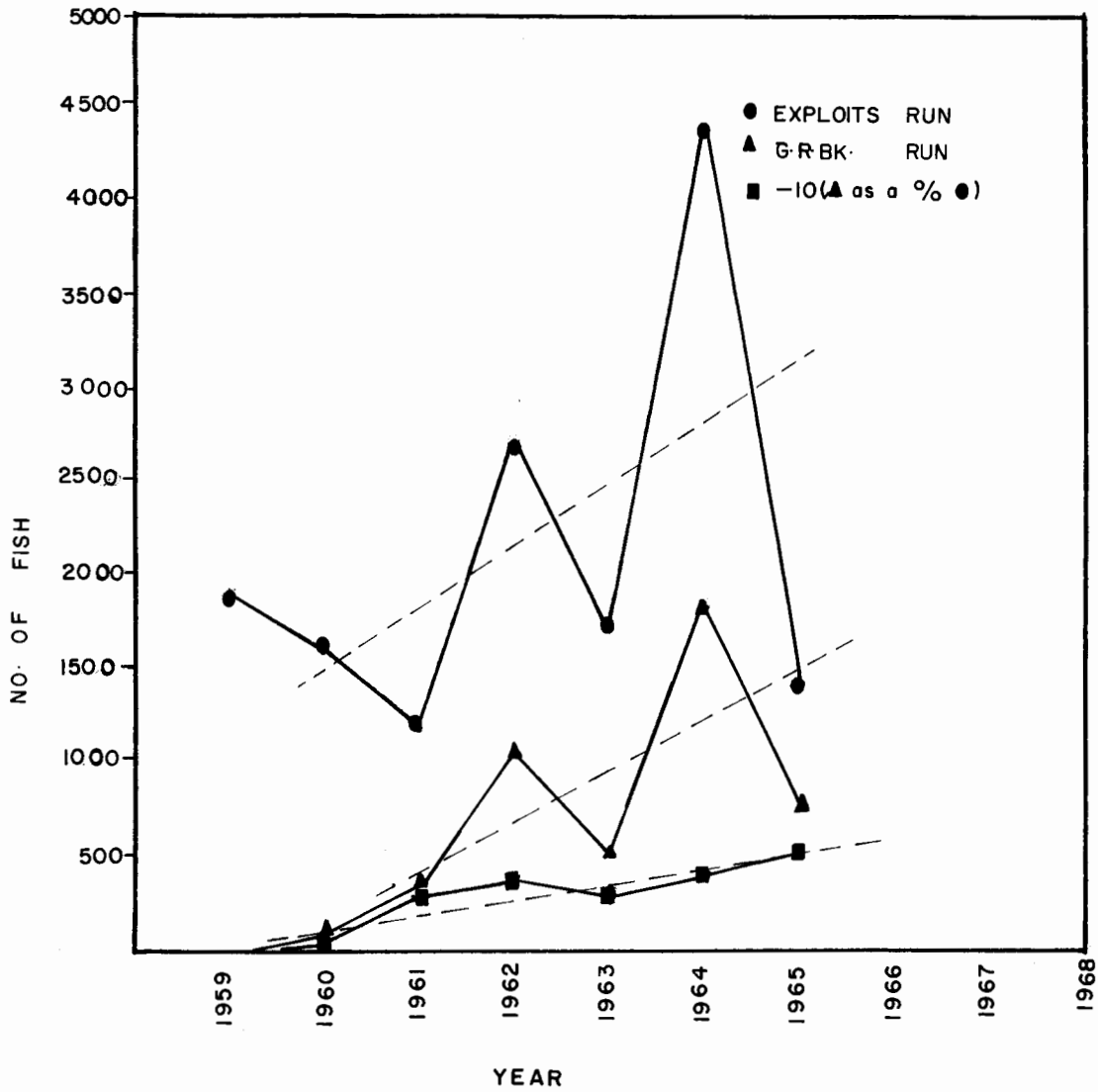


Fig. 9. Showing upward trend in number of fish entering Great Rattling Brook coincidental with upward trend in number of fish entering Exploits River, and increase in contribution of Great Rattling Brook fish to Exploits River run.

deposited in the scales and other hard tissues. Lead deposits will appear as a dark ring on the edge of the scale, when the scale is treated by a special chemical process (this process has been described by Fry, et al, 1960, and need not be discussed further here).

In 1962, 1,595 injected smolts were released in Tote Brook. In 1963, at Bishop's Falls Dam, the entire adult run to the Exploits River was scale sampled and the scales were chemically treated. Six injects were recovered, four (4) of which moved into Great Rattling Brook. One died and the other is presumed to have utilized some part of the Exploits system, other than Great Rattling Brook. This return of 0.38 percent is undoubtedly very low, but the validity of this method for marking Atlantic salmon is in doubt. However, it does show that some Tote Brook smolts (which are, very likely, progeny of transferred fish), did return to Great Rattling Brook.

One other possibility which suggests that Great Rattling Brook fish are progeny of Rattling Brook fish has been examined. Angling records indicated that fish of larger size could be taken more frequently from Rattling Brook than from the Exploits. In my opinion this is verified from Table VI and Figure 10. Certainly, it can be seen from Table VI, that there is a higher percentage of salmon in Rattling Brook than in the Exploits. Also, it is apparent from Figure 10 that the mean length of fish which entered Rattling Brook is greater than the mean length of fish which entered the Exploits. The most striking point to note here, however, is that the mean length of fish entering

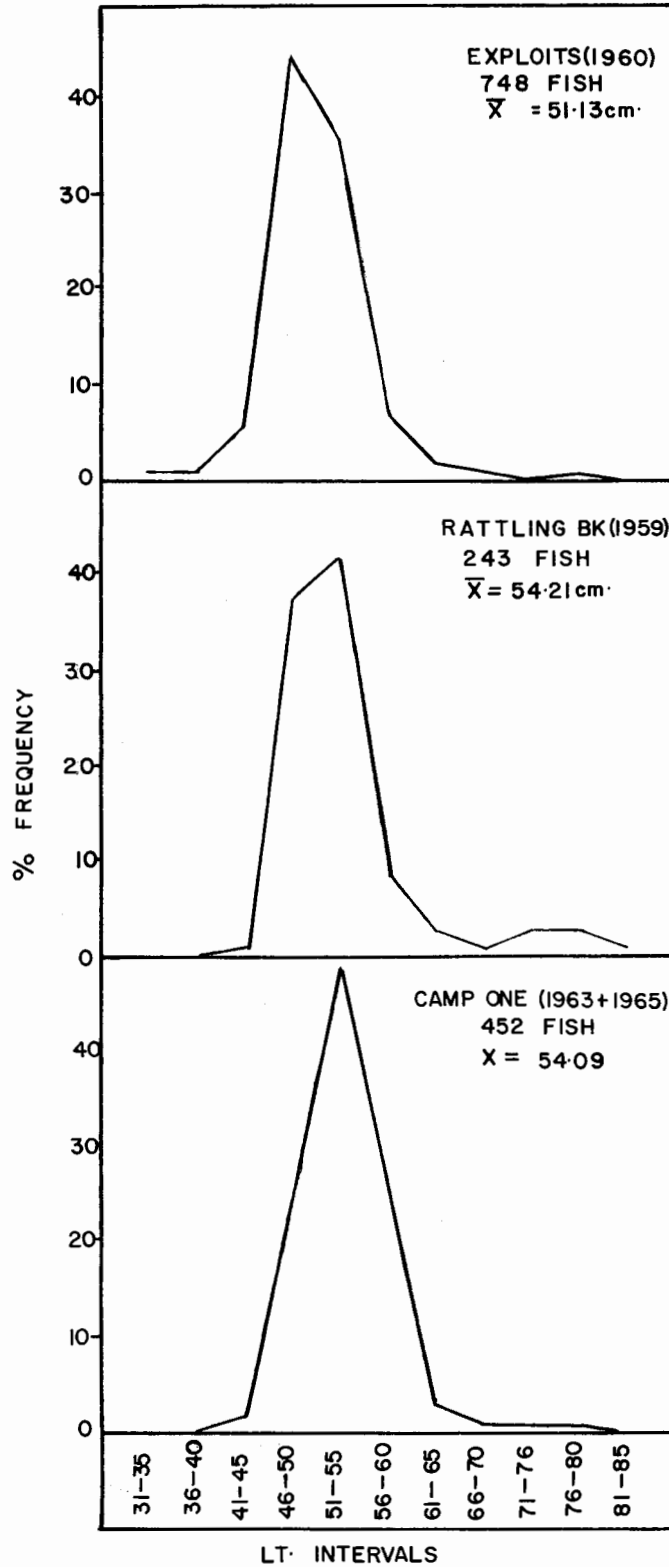


Fig. 10. Length composition of Adult run to Exploits River, 1960, Rattling Brook, 1959, and Great Rattling Brook, 1963 and 1965.

(1)
Table VI. Grilse/Salmon ratio in spawning escapement to Rattling Brook and Exploits River (Ducharme 1961).

	Visual				Scale Reading			
	No. of Fish	% of Run	% Grilse	% Salmon	No. of Fish	% of Run	% Grilse	% Salmon
Rattling Brook - 1956	596	77.4	64.4	37.6				
Rattling Brook - 1957	627	96.1	70.0	30.0				
Rattling Brook - 1958	820	96.4	84.1	15.9				
Rattling Brook - 1959	375	97.6	82.1	17.9	158	41.1	86.5	13.5
Exploits River - 1959	994	51.4	88.0	12.0				
Exploits River - 1960	1211	100.0	86.4	13.6	577	47.6	90.2	9.5

- (1) Grilse = Fish below six pounds
Salmon = Fish above six pounds

Great Rattling Brook is quite similar to that of fish which entered Rattling Brook, but higher than that of fish which entered the Exploits (before any effect of the transfer could possibly be felt). In view of these observations, it was decided to subject this data to statistical tests to determine whether or not the apparent differences (and similarities) are statistically significant. The test used was the well-known test-t. Calculations are shown in the appendix. Results showed that the difference between means (arithmetic mean length) of Rattling Brook fish and those fish now moving through Camp One is not significant at the 0.05 or 0.01 levels of significance. The difference between means of Exploits River fish and Rattling Brook fish is highly significant at the 0.05 and 0.01 levels of significance. The difference between means of Exploits River Fish and Camp One fish is also highly significant at the 0.05 and 0.01 levels of significance.

On the basis of these statistics, then, it would seem more correct to infer that the salmon run, now established on Great Rattling Brook is a direct result of the Rattling Brook transfer. The other view, that this run is the result of influx from the Exploits, seems to be discredited. We must not, however, place too much emphasis on these statistics, since statistics suggest, rather than prove, a point.

It is true, that throughout this report, the evidence is almost always more suggestive than concrete. Here is an example where suggestive evidence approaches the concrete.

Summary and Conclusion

The success of the Rattling Brook transfer, 1957 - 1964 has been evaluated from the following points of view: (1) tagging data indicates that transferred fish stayed in their new environment, (2) spawning ground surveys indicate that transferred fish spawned successfully in their new environment, (3) smolt counts on Tote Brook show an increase in the number of downstream migrants as the transfer became effective, (4) adult counts at Camp One fishway show that the run to Great Rattling Brook increased substantially as the transfer became effective, (5) an increase in the total run to the Exploits River was noted when offspring from transferred fish were due to return from the sea. This increase is coincidental with the increase in the total run to Great Rattling Brook, (6) statistical comparison of the size of Rattling Brook, Great Rattling Brook and Exploits River fish shows that the run established on Great Rattling Brook is more closely related to Rattling Brook fish than to Exploits River fish.

On the basis of these observations, it is concluded that the Rattling Brook transfer was a successful operation.

As an aid to other workers who may be contemplating a program similar to the Rattling Brook transfer, the following is a list of things which the writer considers should have been done, to make the evaluation of the Rattling Brook transfer easier and more meaningful:

- (1) Smolt counts should have been carried out on Tote Brook, at least two years before the transfer could possibly be effective. This would have revealed any contribution being made by landlocks to the smolt run, and any increase in smolts, after this, could be definitely attributed to the transfer.
- (2) Smolt counts should have been carried out on Tote Brook, for a greater number of years, and more detailed information on age and size composition of the run should have been collected.
- (3) More accurate information should have been collected, on what portion of transferred fish utilized Tote Brook, or smolt counts should have been done on Great Rattling Brook somewhere downstream from Tote Brook. This would provide more accurate information when relating smolt

runs to the number of adults transferred four years earlier.

- (4) Accurate information on the number of adults utilizing Great Rattling Brook should have been determined for at least three years before the effect of the transfer could be felt. Any increase in the run to Great Rattling Brook, after the transfer was due to be felt, could, then, be attributed to the transfer.
- (5) Scale sampling and size determinations should have been done on all transferred fish, as well as all fish going through Bishop's Falls trap and Camp One fishway. This would make statistical comparison of fish from these three rivers more meaningful.

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Table I. Length frequency distribution for Exploits River salmon, Rattling Brook salmon, and Great Rattling Brook salmon.

Length Interval (cm)	Exploits River (1960)	Rattling Brook (1959)	Great Rattling Brook (1963 & 1965)	Exploits & Great Rattling Brook, 1963	Exploits alone (1963)
31.0 - 35.9	6	-	-	1	1
36.0 - 40.9	9	1	2	1	1
41.0 - 45.9	44	2	7	18	14
46.0 - 50.9	339	92	97	279	193
51.0 - 55.9	267	102	220	555	353
56.0 - 60.9	54	21	103	174	85
61.0 - 65.9	18	8	12	21	14
66.0 - 70.9	7	3	3	9	6
71.0 - 75.9	-	8	3	3	0
76.0 - 80.9	4	8	4	8	4
81.0 - 85.9	-	3	1	2	1
TOTAL	748	243	452	1,071	672

Table II. Calculation of arithmetic mean length (\bar{x}) and standard deviation (s), for Exploits River fish, 1960.

Length Interval (cm)	No.	d'	fd'	f(d') ²
31.0 - 35.9	6	-3	-18	54
36.0 - 40.9	9	-2	-19	36
41.0 - 45.9	44	-1	-44	44
46.0 - 50.9	339	0	0	0
51.0 - 55.9	267	+1	+267	267
56.0 - 60.9	54	+2	+108	216
61.0 - 65.9	18	+3	+54	162
66.0 - 70.9	7	+4	+28	112
71.0 - 75.9	-	+5	+0	0
76.0 - 80.9	4	+6	+24	144
81.0 - 85.9	-	+7	+0	0
TOTAL	748		+400	1,035

$$\bar{x} = \bar{x}_d + \frac{\sum fd'}{N} i$$

$$\bar{x} = 48.45 + \frac{400}{748} \times 5 = 51.13$$

$$s = i \sqrt{\frac{\sum f(d')^2}{N} - \left(\frac{\sum fd'}{N}\right)^2}$$

$$s = 5 \left(\sqrt{1.385 - 0.285} \right)$$

$$s = 5.25$$

Table III. Calculation of arithmetic mean length (\bar{x}) and standard deviation (s) for Rattling Brook fish, 1959.

Length Interval (cm)	No.	d'	fd'	f(d') ²
31.0 - 35.9	0	-4	0	0
36.0 - 40.9	1	-3	-3	9
41.0 - 45.9	2	-2	-4	8
46.0 - 50.9	92	-1	-92	92
51.0 - 55.9	102	0	0	0
56.0 - 60.9	21	+1	+21	21
61.0 - 65.9	8	+2	+16	32
66.0 - 70.9	3	+3	+9	27
71.0 - 75.9	8	+4	+32	128
76.0 - 80.9	8	+5	+40	200
81.0 - 85.9	3	+6	+18	108
TOTAL	243		+37	625

$$\bar{x} = \bar{x}_d + \frac{\sum fd'}{N} \cdot i$$

$$\bar{x} = 53.45 + \frac{37}{243} \times 5 = 54.21$$

$$s = i \sqrt{\frac{\sum f(d')^2}{N} - \left(\frac{\sum fd'}{N}\right)^2}$$

$$s = 5\sqrt{2.547} = 7.98$$

Table IV. Calculation of arithmetic mean length (\bar{x}) and standard deviation (s) for Great Rattling Brook, 1963.

Length Interval (cm)	No.	d'	fd'	f(d') ²
31.0 - 35.9	0	-4	0	0
36.0 - 40.9	0	-3	0	0
41.0 - 45.9	4	-2	-8	16
46.0 - 50.9	86	-1	-86	86
51.0 - 55.9	202	0	0	0
56.0 - 60.9	89	+1	+89	89
61.0 - 65.9	7	+2	+14	28
66.0 - 70.9	3	+3	+9	27
71.0 - 75.9	3	+4	+12	48
76.0 - 80.9	4	+5	+20	100
81.0 - 85.9	1	+6	+6	36
TOTAL	399	+11	+56	430

$$\bar{x} = \bar{x}_d + \frac{\sum fd'}{N} i$$

$$\bar{x} = 53.45 + \frac{56}{399} \times 5$$

$$\bar{x} = 53.45 + 0.70 = 54.15$$

$$s = i \sqrt{\frac{\sum f(d')^2}{N} - \left(\frac{\sum fd'}{N}\right)^2}$$

$$s = 5 \sqrt{\frac{430}{399} - \left(\frac{56}{399}\right)^2} = \sqrt{1.089} = 5.20$$

Table V. Calculation of arithmetic mean length (\bar{x}) and standard deviation (s) for Great Rattling Brook, 1965.

Length Interval (cm)	No.	d'	fd'	f(d') ²
31.0 - 35.9	0	-3	0	0
36.0 - 40.9	2	-2	-4	8
41.0 - 45.9	3	-1	-3	3
46.0 - 50.9	11	0	0	0
51.0 - 55.9	18	+1	18	18
56.0 - 60.9	14	+2	28	56
61.0 - 65.9	5	+3	15	45
66.0 - 70.9	0	0	0	0
71.0 - 75.9	0	0	0	0
76.0 - 80.9	0	0	0	0
81.0 - 85.9	0	0	0	0
TOTAL	53	0	54	130

$$\bar{x} = \bar{x}_d + \frac{\sum fd'}{N} i$$

$$\bar{x} = 48.45 + \frac{54}{53} \times 5 = 53.55$$

$$s = i \sqrt{\frac{\sum f(d')^2}{N} - \frac{(\sum fd')^2}{N}}$$

$$s = 5 \sqrt{1.413} = 5.95$$

Table VI. t-test of significance between arithmetic mean lengths of Great Rattling Brook samples, 1963 and 1965.

Sample	N	\bar{X}	S	S^2
1963	399	54.15	5.20	27.04
1965	53	53.55	5.95	35.40

$$S.E.(\bar{x}_1 - \bar{x}_2) = \frac{27.04}{399} + \frac{35.40}{53}$$

$$= 0.743 = 0.862$$

$$|\bar{x}_1 - \bar{x}_2| = 54.15 - 53.54 = 0.61$$

$$t = \frac{0.61}{0.86} = 0.71$$

$$n = (399 - 1) + (53 - 1) = 450$$

From a table of t, for n degrees of freedom, and t = 0.71;

$$0.4 < P < 0.5$$

Therefore, the difference between \bar{x}_1 and \bar{x}_2 is not significant.
(These samples have, therefore, been combined).

Table VII. Calculation of arithmetic mean length (\bar{x}) and standard deviation (s) for Great Rattling Brook, 1963 and 1965.

Length Interval (cm)	No.	d'	fd'	f(d') ²
31.0 - 35.9	0	-4	0	0
36.0 - 40.9	2	-3	-6	18
41.0 - 45.9	7	-2	-14	28
46.0 - 50.9	97	-1	-97	97
51.0 - 55.9	220	0	0	0
56.0 - 60.9	103	+1	+103	103
61.0 - 65.9	12	+2	+24	48
66.0 - 70.9	3	+3	+9	27
71.0 - 75.9	3	+4	+12	48
76.0 - 80.9	4	+5	+20	100
81.0 - 85.9	1	+6	+7	36
TOTAL	452		+58	505

$$\bar{x} = \bar{x}_d + \frac{\sum fd'}{N} i$$

$$\bar{x} = 53.45 + \frac{58}{452} \times 5 = 54.09$$

$$s = i \sqrt{\frac{\sum f(d')^2}{N} - \left(\frac{\sum fd'}{N}\right)^2}$$

$$s = 5 \sqrt{(0.991)} = 4.98$$

Table VIII. t-test of significance between arithmetic mean lengths of Rattling Brook fish, 1959, and Exploits River fish, 1960.

Sample	N	\bar{X}	S	S^2
Exploits River	748	51.13	5.25	27.56
Rattling Brook	243	54.21	63.69	7.98

$$\text{S.E. } \bar{x}_1 - \bar{x}_2 = \frac{27.56}{748} + \frac{63.69}{243} = 0.299 = 0.547$$

$$\left| \bar{x}_1 - \bar{x}_2 \right| = 3.08$$

$$t = \frac{3.08}{0.547} = 5.63$$

$$n = (748 - 1) + (243 - 1) = 989$$

From a table of t, for n degrees of freedom and t = 5.63;

P is much less than 0.01

Therefore, the difference between \bar{x}_1 , and \bar{x}_2 is very significant.

Table IX. t-test of significance between arithmetic mean lengths of Exploits River fish, 1960, and Great Rattling Brook fish, 1963 and 1965.

Sample	N	\bar{x}	S	S ²
Exploits River	748	51.13	5.25	27.56
Great Rattling Brook	452	54.09	4.98	24.80

$$S.E.(\bar{x}_1 - \bar{x}_2) = \frac{27.56}{748} + \frac{24.80}{452}$$

$$" = 0.037 + 0.055 = 0.092$$

$$" = 0.304$$

$$|\bar{x}_1 - \bar{x}_2| = 2.96$$

$$t = \frac{2.96}{0.304} = 9.74$$

$$n = (748 - 1) + (452 - 1) = 1$$

of freedom

From a table of t, for n degrees and $t = 9.41$, P is much less than 0.01.

Therefore, the difference between \bar{x}_1 and \bar{x}_2 is very significant.

Table X. t-test of significance between arithmetic mean lengths of Rattling Brook fish, 1959, and Great Rattling Brook fish, 1963 and 1965.

Sample	N	\bar{X}	S	S ²
Rattling Brook	243	54.21	7.98	63.69
Great Rattling Brook	452	54.09	4.98	24.80

$$\text{S.E. } (\bar{x}_1 - \bar{x}_2) = \frac{63.69}{243} + \frac{24.80}{452}$$

$$= 0.262 + 0.055 = 0.317 = 0.563$$

$$|\bar{x}_1 - \bar{x}_2| = 0.12$$

$$t = \frac{0.12}{0.567} = 0.212$$

$$n = (243 - 1) + (452 - 1) = 693$$

From a table of t for n degrees of freedom, and t = 0.212;

$$0.8 < P < 0.9$$

Therefore, the difference between \bar{x}_1 and \bar{x}_2 is not significant.