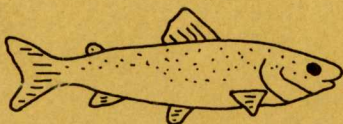


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PROGRESS REPORT NO. 46

PRELIMINARY INVESTIGATIONS OF  
THE HARRY'S RIVER SYSTEM

BY

D.F. DOWNER

RESOURCE DEVELOPMENT BRANCH  
NEWFOUNDLAND REGION  
ST. JOHN'S

1968

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PRELIMINARY INVESTIGATIONS OF  
THE HARRY'S RIVER SYSTEM

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D. F. Downer

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St. John's, Nfld.

May, 1968

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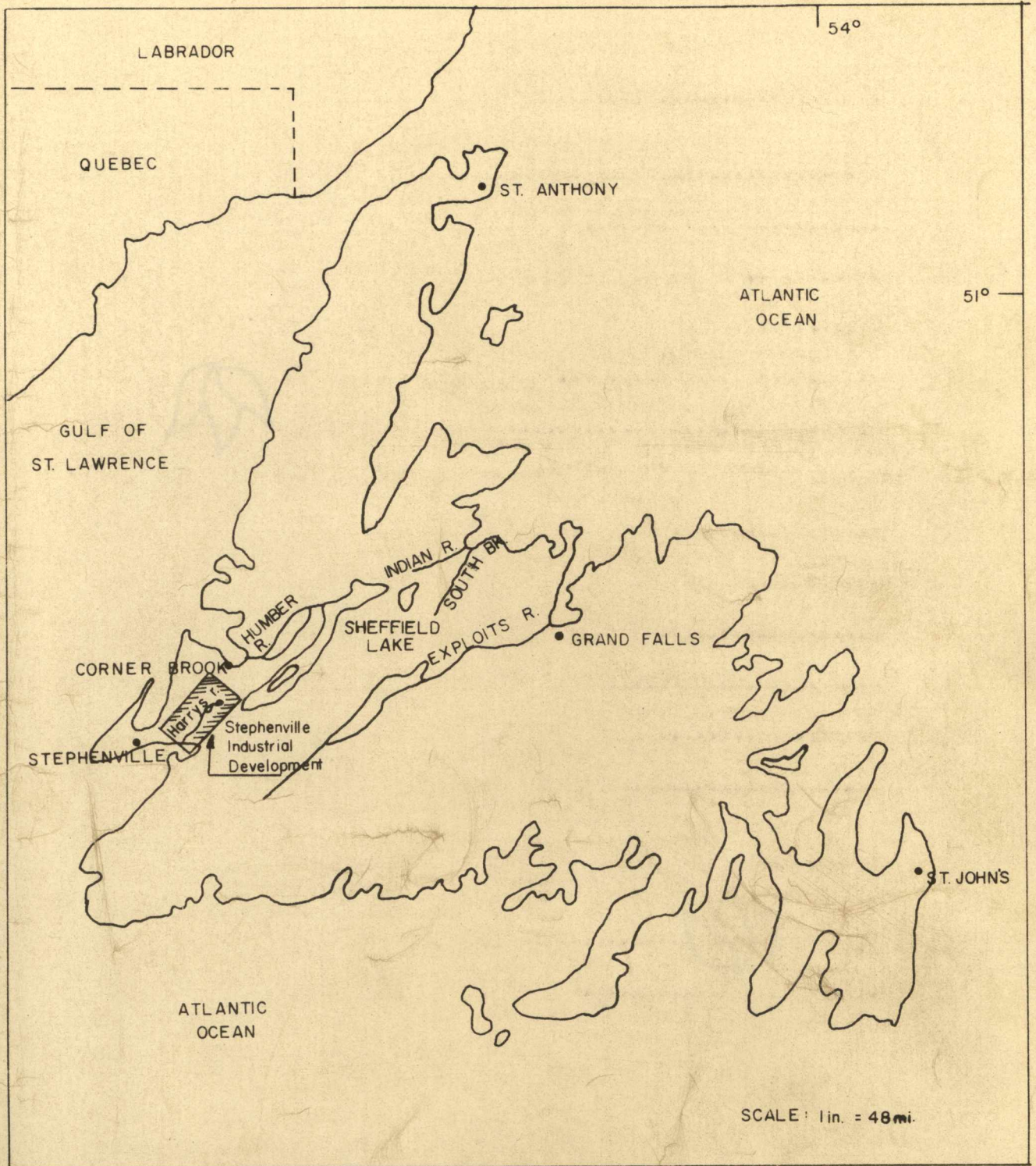


FIG 1 LOCATION MAP  
OF STEHENVILLE INDUSTRIAL DEVELOPMENT

## INTRODUCTION

In 1967 a survey was completed on Harry's River by the Department of Fisheries to assess its status as an Atlantic salmon river. The survey was conducted to determine the effects of a proposed partial diversion for a water supply for the industrial development and a domestic water supply at Stephenville.

The proposed industry is a liner-board mill to be located on the western shore of Stephenville Pond. A preliminary feasibility study completed by Resources Engineering Limited for the Atlantic Development Board determined that Harry's River was the closest and most economical supply of water. An estimated 100,000,000 Imp. gallons of fresh water will be required daily for industrial and domestic purposes at Stephenville.

Prior to 1966, the only information on adult escapement to this river was obtained from angling statistics and Fishery Officers' reports. Department personnel attempted a spawning survey on the river in the autumn of 1966, but poor observation conditions prevented a comprehensive assessment of the number of spawners utilizing the river.

In 1967, a counting fence was operated  $2\frac{3}{4}$  miles above the mouth of the main river for the period June 23 - September 2. The fence was inoperative for two short periods during this time, and operation terminated September 2 with a complete washout.

During the autumn, Resource Development personnel, with the aid of Protection Branch staff, conducted a spawning survey on the system. Helicopter reconnaissance constituted the first part; the second part was a ground examination of as much of the system as time warranted and as deemed necessary.

During the fall observation period, physical characteristics, potential spawning area, and rearing ground area in the main river and tributaries were tabulated. This information, as well as redd numbers for individual stream sections, is given in Appendix I.

PROPOSED INDUSTRIAL DEVELOPMENT AND  
WATER SUPPLY SCHEME

The Atlantic Development Board announced in 1966 the future establishment of a liner-board mill at Stephenville. Precise date of initial construction has not been disclosed.

Such a project will necessitate a large, continuous supply of fresh water. In addition, water for domestic purposes at Stephenville is to be obtained from the same source.

A preliminary feasibility report produced by Resources Engineering Limited for the Atlantic Development Board estimates a requirement of 100,000,000 Imp. gallons of water per day for the project. Harry's River was considered the closest and most economical source, and a plan of partial diversion was formulated (Fig. 2).

Essentially, the plan involves the diversion of water from the river near the town of Black Duck via a series of canals and ponds to the mill site near Stephenville on the western shore of Stephenville Pond. An intake structure will be placed in the river approximately  $\frac{1}{4}$  mile above the town of Black Duck. Alternate routes are also under consideration to move the water from the riverbed to the mill site. The first choice is a gravity system via ponds and canals to the site, and the second choice involves a pump and pipeline system to conduct the water (Fig. 2).

Water storage of 51,000 acre-feet is required to ensure the steady 100,000,000 gallon daily requirement. A dam located 2,800 ft. downstream from Georges Lake will provide 13 ft. of storage on the lake for this purpose. The dam, 20 ft. in height with earthfill abutments, spillway, and fish works, will be located on a 70 ft.-long concrete slab in the normal flow direction.

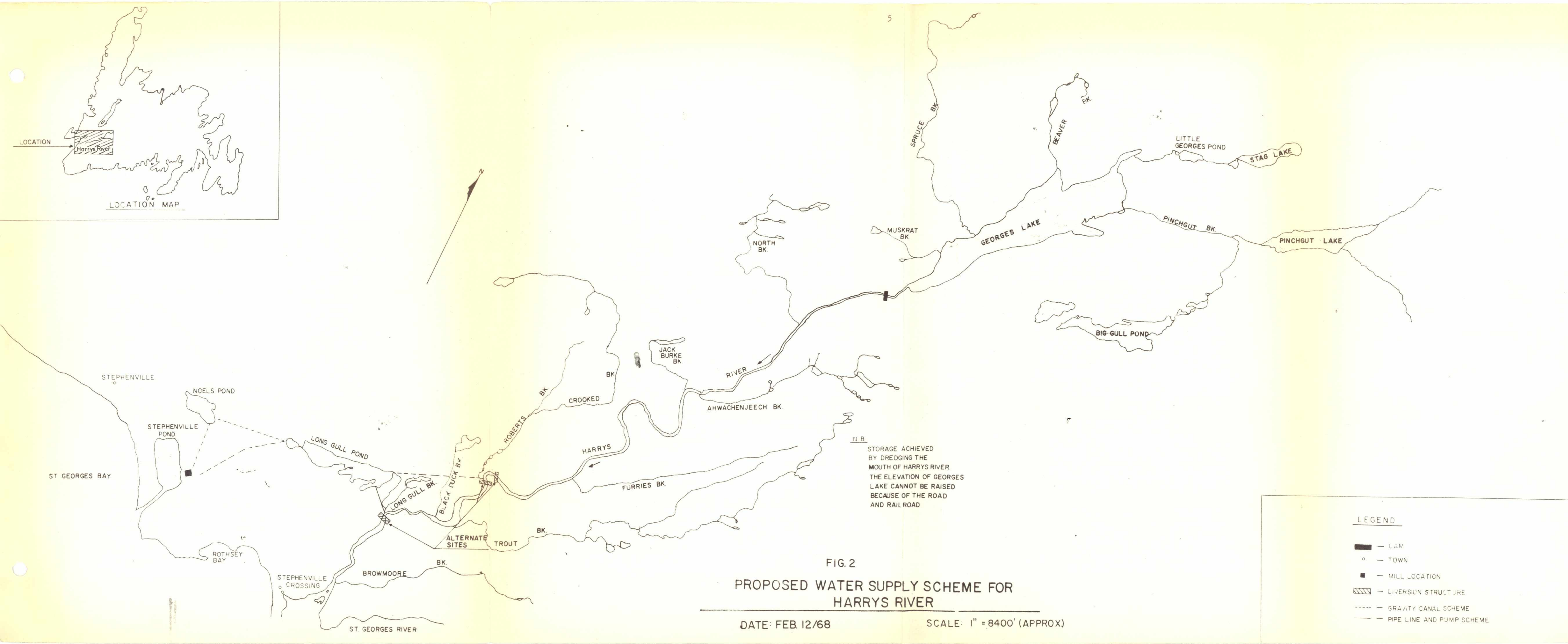
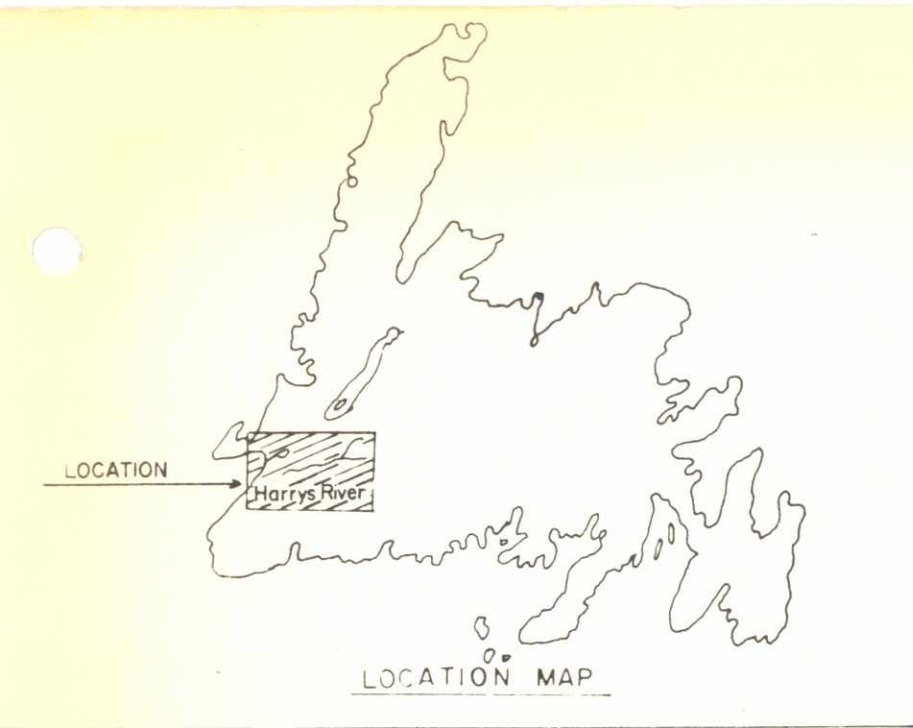


FIG. 2  
 PROPOSED WATER SUPPLY SCHEME FOR  
 HARRYS RIVER

DATE: FEB. 12/68      SCALE: 1" = 8400' (APPROX)

LEGEND

- LAM
- — TOWN
- — MILL LOCATION
- ▨ — DIVERSION STRUCTURE
- — GRAVITY CANAL SCHEME
- — PIPE LINE AND PUMP SCHEME

Adequate screening facilities placed over the intake structure near Black Duck should eliminate most danger to resident or migrant fish species in the main river if the first diversion route is selected. If the second alternative route for water to the site is selected, there could be a partial or complete loss of Long Gull Brook and Black Duck Brook. These tributaries contain good spawning and rearing ground so their relative value would have to be assessed. A more serious threat, however, is that posed by the storage dam located near Georges Lake. Problems which it could create are the following:

1. Without adequate fish works to allow passage of ascending adult salmon through the dam, access to a large body of spawning and rearing ground above the dam would be lost.
2. Some threat to descending smolts exists. Whereas injury to descending smolts would be difficult to assess without study, the actual kill can be assumed to be negligible at a 20 ft. dam with no turbines.
3. A serious decrease in the volume of water flowing in Harry's River could pose a problem to salmon ascent in dry periods as well as a threat to juvenile fish in rearing areas.

Pollution will not be a problem if the volume of water in Harry's River is decreased. No industrial wastes will enter the stream from the mill, and the small amount of domestic wastes from towns located near the river will be negligible.

## THE WATERSHED

Drainage Area

Harry's River is located on the West Coast of Newfoundland; the mouth lies 35 miles from Corner Brook and 80 miles from Port aux Basques.

Total area drained by the river is approximately 346.1 square miles (Table I). There is a total of 40.4 linear miles of standing water in the system contained mainly in three large water bodies: Georges Lake, Pinchgut Lake, and Big Gull Pond, all located in the upper watershed (arbitrarily selected to end at the outlet of Harry's River from Georges Lake). There is a total of 117.0 linear miles of tributary streams. Largest single tributary is North Brook draining 35.1 square miles (Table II). The river originates in the large water bodies of the upper watershed and flows 22.0 linear miles in a westerly direction toward the sea.

Table I. General information on physical features of Harry's River system.

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Total drainage area .....	346.1 sq. miles
Linear miles of main river .....	22.0
Linear miles of standing water in system .....	40.4
Linear miles of tributary streams .....	117.0

---

Table II. Location, length, and drainage area of major lakes and stream tributaries in Harry's River system.

Stream or lake	Length (miles)	Drainage area (sq.miles)	Location
Big Gull Pond (with trib.)	3.1	12.7	Flows into Pinchgut Bk. from the south.
Pinchgut Lake (with trib.)	7.4	26.7	Flows into Georges Lake from the east.
Stag Lake (with trib.)	2.2	9.1	Flows into Georges Lake from the north.
Little St. Georges Pond (without trib.)	0.9	2.6	Flows into Georges Lake from the north via tributary.
Beaver Brook	3.2	5.6	Enters Georges Lake from the northwest.
Spruce Brook	9.6	18.6	Enters Georges Lake from the northwest.
Georges Lake	7.6	120.7	Flows into main river 22 miles from the mouth.
North Brook	6.9	35.1	Enters main river $17\frac{1}{2}$ miles from the mouth.
Jack Burkes Pond (with trib.)	0.9	4.1	Flows into main river $14\frac{1}{2}$ miles from the mouth.
Ahwachenjeech Brook	4.6	7.6	Enters main river $14\frac{1}{2}$ miles from mouth.
No Name Brook	6.4	1.1	Enters main river $10\frac{1}{2}$ miles from the mouth.
Furries Brook	6.5	2.2	Enters main river 9 miles from the mouth.
Sanders Brook	3.2	1.8	Enters main river $6\frac{3}{4}$ miles from the mouth.
Roberts Brook	5.7	16.0	Enters main river $6\frac{1}{2}$ miles from the mouth.
Trout Brook	14.4	30.9	Enters main river 5 miles from the mouth.

Table II. (Cont'd).

Stream or lake	Length (miles)	Drainage area (sq.miles)	Location
Crooked Brook	9.2	15.3	Joins Roberts Brook.
Black Duck Pond (with trib.)	0.4	3.1	Flows into main river $4\frac{1}{2}$ miles from the mouth.
Long Gull Pond (with trib.)	2.9	5.1	Joins Rushy Brook via tributary.
Mistaken Pond (without trib.)	0.3	1.2	Flows into Black Duck Pond via tributary.
Rushy Brook	1.6	15.3	Enters main river 3 miles from the mouth.
Browmoore Brook	6.0	9.2	Enters main river 1 mile from the mouth.
Total	103.0	329.3	

Tributaries in the lower drainage originate in small ponds or bog country. This portion of the watershed makes up approximately 40% of the total and consists almost entirely of running water. Especially towards the mouth, streams here flow through flat glacial plain and are slower-moving with smaller bottom material.

Upper drainage (comprising 60% of the total drainage) consists of a much higher percentage of standing water. Streams are generally swifter with rubble and boulder bottoms and have steeper banks. Their basins are more often wooded.

### Geology

The river basin is dominated by Paleozoic rock forms of mostly sedimentary formation. It consists of a varied geologic structure in the upper reaches but swamp plain lower down.

Ahwachenjeech Brook, entering the main river  $6\frac{3}{4}$  miles from Georges Lake, is located at the mid-point of a transition zone. This zone separates Silurian and Ordovician rocks above towards Georges Lake and Mississippian rock below towards the river mouth.

A variety of rock forms above the zone include blue-grey limestone on the western shore of Georges Lake and a strip of dolomite exposed by the railway cut in the same area. The only quantity of igneous rock present is a mass of granite in the upper parts of North Brook.

Two sets of faults trend northwest from Pinchgut Lake to Stag Lake. A fault along Pinchgut Brook has offset the strata on opposite sides. Another dips east after extending north-south midway up Muskrat Brook.

Lower stretches of streams in this region are full of rounded granite and other crystalline rocks, boulders, and rubble. All of these characteristics of the upper drainage seem to indicate that this is a river basin in its early youth.

Below the transition zone the river flows through relatively flat glacial plain which stretches from the transition zone to Stephenville Crossing and from one mile west of the railway over to Bottom Brook. In this region, tributaries run parallel to the strike of bedding or joints. This structurally controlled drainage contrasts with tributaries of the upper reaches where, generally, the opposite is true.

## Flora

Dominant floral species in the Harry's River basin includes four species: black spruce (Picea mariana); birch (Betula papyrifera); balsam fir (Abies balsamea); alder (Alnus sp.). Peat moss (Sphagnum sp.) is widespread especially in the lower drainage area.

In any ecosystem, community development is characterized by a pioneer community being replaced by successfully more mature communities called seral stages. This sequence culminates in a climax community (Odum, 1959).

The Harry's River region has been described as a river basin in early stages of growth, geologically speaking. It is to be expected, therefore, that vegetative features would support this contention.

The lower 17 miles of the main river flows through a swamp basin; bog grass and peat moss are the dominant vegetation throughout long sections. This growth gives way to low shrub and dense alder beds at varied distances back from the river banks.

Above the glacial swamp, spruce and fir occur in mixed communities or as dense individual stands. These species become increasingly dominant ascending the stream towards Georges Lake. White pine (Pinus strobus) and juniper (Larix laricina) are rare.

The final, or edaphic, community is spruce and/or fir depending on drainage conditions. Climactic conditions would indicate that black spruce is the culmination of succession for the region while others in proximity are seral stages. Almost all the tributaries demonstrate similar development.

A few streams, like Furrries Brook and No Name Brook, have spruce or fir growth down to the water's edge. Observed from the air, their basins look like desert oases - large areas of swamp plain cut by a thin ribbon of trees marking the winding descent of a narrow tributary to meet the main river.

Generally, vegetative features support geologic evidence that the glacial swamp is in the process of permanent drainage. The tree line along the marshy plain does show evidence of encroachment. Eventually, if the process continues, all of the marsh vegetation should be replaced by temperate forest.

### Climate

Weather conditions in Newfoundland undergo variations but the island has a temperate Maritime climate which is typically less harsh than most other provinces. Winters are milder and summers are cooler than those of the central provinces - Ontario and Quebec, for example. Precipitation, taken as a whole, is uniformly distributed throughout the year.

Table III shows temperature and precipitation for the Stephenville region from October, 1966, to September, 1967. No figures were available for October - December, 1967. Highest precipitation occurred in February and lowest in April. Highest mean daily temperature occurred in August and lowest in February.

The Stephenville region comes under the influence of the warmer waters of the Gulf of St. Lawrence. Prevailing winds are from the west or southwest so that the influence of relatively warm water offshore is evident the year round. The area is not close to the mixing of cold and warm waters, with the result that fog is less frequent than on other

coastal regions of Newfoundland, such as the south coast, for example. The upper watershed of Harry's River is surrounded by high country. As expected, prevailing onshore winds bring a relatively high rainfall to that region.

Table III. Air temperature °F and precipitation in inches<sup>1</sup> for Stephenville<sup>2</sup>: October - December, 1966; January - September, 1967.

Month	Mean daily temp.	Mean of daily			Precipitation			Snowfall
		Max.	Min.	Range	Total	Normal	Diff. from normal	
Oct.	46.3	51.9	40.7	11.2	5.12	3.88	1.24	0.1
Nov.	40.8	47.6	33.9	13.7	2.78	4.37	-1.59	1.7
Dec.	31.6	37.6	25.5	12.1	3.88	3.79	0.09	19.7
Jan.	23.3	29.3	17.2	12.1	3.05	4.01	-0.96	22.3
Feb.	18.0	25.6	10.4	15.2	6.18	3.70	2.48	51.0
March	20.2	28.5	11.8	16.7	3.60	1.12	1.48	35.7
April	30.3	37.9	22.6	15.3	1.49	2.02	-0.53	6.6
May	42.5	49.9	35.1	14.8	3.32	2.81	0.51	-
June	52.9	61.7	44.1	17.6	3.76	3.03	0.73	-
July	64.4	70.6	58.1	12.5	2.02	3.39	-1.37	-
August	66.2	72.4	60.0	12.4	5.09	3.32	1.77	-
Sept.	55.7	63.4	47.9	15.5	5.96	4.28	1.78	-
Annual	41.0	43.9	33.9		56.25	39.72		137.1
Years of observ.	66-67	66-67	66-67	66-67	66-67	31-60		66-67

<sup>1</sup> Precipitation includes snowfall calculated by adding 10% of snowfall in inches to the rainfall in inches.

<sup>2</sup> Department of Transport, Monthly Meteorological Summary (Ottawa: Dept. of Transport, 1966-67).

The moderating influence of warmer offshore water is felt also in air temperatures. Lowest minimum daily mean for the month of February, 1967, was 10.4°F. A daily mean of 18.0° is recorded for this month. Highest daily mean maximum is 70.6°F reached in July of 1967. The temperature range is not as great as for areas in central Newfoundland, for example, where lows of 0°F and highs of 80°F are not uncommon.

#### Stream flow

Flow measurements were made by the chip method (Lagler, 1956) and by the current meter method. The former provides less accurate results than the latter. Both results are presented in Table IV.

Table IV. Stream flow (cfs.) for Harry's River.

Date	Stn. #1	Stn. #2	Stn. #3	Stn. #4	Stn. #5	Average
July 26	-	-	-	375.1*	-	375.1
August 25	376.5	597.6	482.7	479.0	460.5	479.3
Sept. 26	406.3	337.4	402.7	-	-	382.1
Average	391.4	467.5	442.7	427.1	460.5	

\* Measurement for Stn. #4 for July 26 was made with current meter. All other measurements were made from chip timings.

#### Stream locations and river width:

Station #1 - 18½ miles from mouth.	Width - 68'
Station #2 - 16 miles from mouth.	Width - 156'
Station #3 - 8 miles from mouth.	Width - 165'
Station #4 - 2½ miles from mouth.	Width - 94'
Station #5 - ½ mile from mouth.	Width - 80'

Harry's River is subject to extreme fluctuations in water levels because of the climatic and geologic setting. Daily changes in water levels were recorded by means of a meter stick placed within the trap during operation of the counting fence. Peaks in water levels appeared higher than was actually the case because of a reservoir effect caused by debris buildup on the fence. Records are sufficient, however, to show fluctuations (Fig. 12). It should be noted that all measurements of stream flow were made during periods of near-"normal" summer flow and not during flood.

Different river widths at each station could be the cause of wide ranges of flow for different stations. Station #2 and #3, for example, were located in wide sections of the river. These show stream flows relatively higher than Station #4, which is located only  $2\frac{1}{2}$  miles from the mouth. Inaccuracy of measurement by the chip method could also be a cause of the wide differences. Probably the most accurate flow is that of 375.1 cfs. taken by the current meter at Station #4 on July 26.

Of the three summer months, August has the highest flow, averaging 480 cfs. for the whole river, followed by September, and then July which is lowest.

## PHYSICAL CHARACTERISTICS OF THE DRAINAGE

Estuary

The estuary of Harry's River extends approximately  $1\frac{1}{2}$  miles from the upstream side of the first island to the southern end of the town of Stephenville Crossing (Fig. 3). It widens from 600 ft. at its inner end



Fig. 3. Estuary of Harry's River.

to one mile at its outer extremity. Total area of the estuary is 0.76 square miles. It can be described as a long, shallow delta with depths of 2 - 6 ft. throughout most of its area. Travel in the estuary is difficult except by shallow draft watercraft. Bottom texture consists of mud and sand with a few scattered boulders.

Low glacial swamp plain slopes for miles on both sides of the river mouth; 50 ft. elevation m.s.l. is the highest point reached for a distance of two-three miles back from the river on either side.

Dark brown river water, evident well beyond the southern end of Stephenville Crossing during flood, indicates that there is a predominance of fresh water in the estuary at least during these periods. Even under normal river flow conditions, the narrow bottleneck to the sea from St. Georges River prevents extensive mixing of salt and fresh water. It is likely that a predominance of fresh water exists at all times in the estuary.

#### Main River

Sand and mud at the estuary gradually give way to a predominance of gravel and cobbles with a few boulders as one ascends the river. In the lower stretches, the river has a width of 60 - 250 ft. with several deep pools (up to 12 ft. in depth) having mud or sand bottoms. These pools alternate with gravel and cobble stretches.

Above the entrance of Brownmoore Brook,  $\frac{1}{2}$  mile upstream from the mouth, the bottom material becomes more typical of the remainder of the river (Fig. 4). It consists of alternating stretches of large cobbles and boulders in varying proportions.

Between Brownmoore Brook and Georges Lake, width range is 60 - 450 ft. The stream drops from elevation 487 ft. to the estuary in a uniform manner so that a few small rapids but no major falls or rapids are present (Fig. 5). Long, straight stretches with a uniform gradient constitute more than 70% of the river in wider parts; mild riffle areas are found in narrower sections where bottom structure consists of large cobbles and boulders. Few steep banks are found along the river.

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Fig. 4. Typical bottom structure - Main River.

#### Tributary Streams

Physical features of tributary streams show extreme variation. There is a range of types from brooks with boulder bottoms, steep-gradient falls, and rapids to those with mud bottoms, slow flow, and gentle gradient.

North Brook, entering the main river at the  $17\frac{1}{2}$ -mile point, has a predominance of boulder and bedrock. Steep gradient over a relatively short distance creates a number of fast rapids and one high falls. Except near the mouth, North Brook has fast water and sheer cliff banks throughout its entire length. This characteristic causes rapid runoff from the surrounding rocky ground during heavy rainfall.

The opposite gradient slope is present in Browmoore Brook which enters the main river  $\frac{1}{2}$  mile from the mouth. This stream meanders through bog country with a decrease in stream elevation of approximately 200 ft.

in six miles. Low, marshy banks lie on both sides, and bottom texture consists of fine sand and mud with a small amount of gravel.

Spruce Brook is similar to North Brook except that bottom particles are smaller, there is less bedrock, and stream gradient is not as steep. Relatively small bottom material is evident in the lower reaches where the stream flows through flat lowlands but the particle size and proportion of bedrock increases sharply at the 3-mile point. Flow and bottom particle size decrease again near the headwaters in bog country.

Jack Burkes Brook, Ahwachenjeech Brook, Trout Brook, Roberts Brook, and most of the others demonstrate similar physical features. Stretches of slowly-flowing stream with bottom material of sand and gravel alternate with swiftly-flowing stream with bedrock and boulder-type bottoms. Proportions of each stream type vary with the stream.

#### Obstructions

The main river has no apparent physical obstructions to the ascent of most migrant fish species. Except for a few areas of rapid water, the 487 ft. drop in stream gradient is uniformly distributed throughout its 22.0 linear miles (Fig. 5).

Tributaries in the lower drainage flow through bog country and no major drops are to be expected. There are obstructions, however, in the high country tributaries of the upper drainage.

There is a 900 ft. drop in elevation in West North Brook over a distance of  $5\frac{1}{2}$  miles. East North Brook has a 600 ft. decrease in elevation over a comparable distance. Rapid water is widespread in both branches but the only apparent major obstruction to salmon is a 40-ft. falls on West North Brook located five miles from the mouth (Fig. 6).

### LONG STREAM PROFILE HARRYS RIVER

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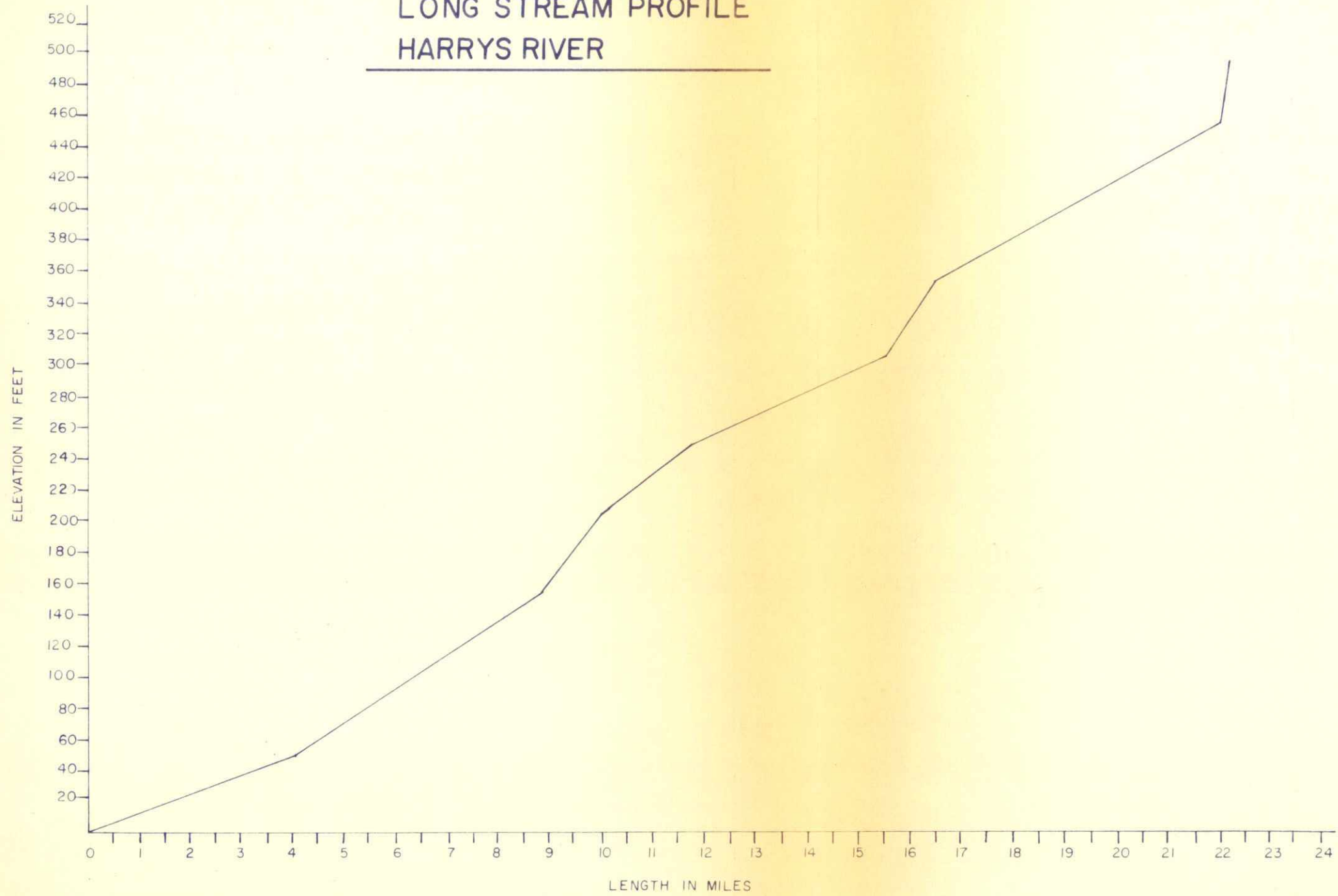


FIG. 5. Long Stream Profile,  
Harry's River.

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Fig. 6. West North Brook Falls.

Above the falls the stream is very rocky and swift. Even if salmon could get to the upper watershed, they would have difficulty finding spawning ground.

Spruce Brook has a series of small falls located three miles from the mouth. The upper and largest is a 12-ft. drop over a horizontal distance of 20 ft. (Fig. 7). A run-around near the left bank would allow easy ascent of salmon in high water but it is dry in low water periods. A series of rounded ledges in the main drop could possibly allow ascent during low water. This falls, and smaller drops further downstream, is not regarded as an obstruction to the ascent of migrating salmon and trout.

The only man-made obstructions observed were old wooden dams erected by Bowater's Pulp and Paper Company at headwater ponds to regulate water supply in log drives (Fig. 8). However, since Harry's River is

no longer utilized for this purpose, most of the dams are in a dilapidated condition and pose no problem to ascending migrants.

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Fig. 7. Spruce Brook Falls.



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Fig. 8. Wooden dams at Headwaters of Roberts Brook.

A more comprehensive description of the physical features of the Harry's River system is given in Appendix I.

## ADULT ATLANTIC SALMON ESCAPEMENT

Counting Fence Results

A counting fence (Fig. 9) was operated on the main river  $2\frac{3}{4}$  miles from the mouth (Fig. 10) for the period June 22 - September 2 (Table V).



Fig. 9. Counting fence at Harry's River.

A total of 1,252 salmon (Salmo salar) and 242 sea-run brook trout (Salvelinus fontinalis) was counted during the operation.

Table V. General chronological data from fence operation.

Date count initiated .....	June 23
First washout .....	June 24 - June 25
Peak of adult run .....	July 10
Second washout .....	Aug. 10 - Aug. 16
Count terminated .....	September 2

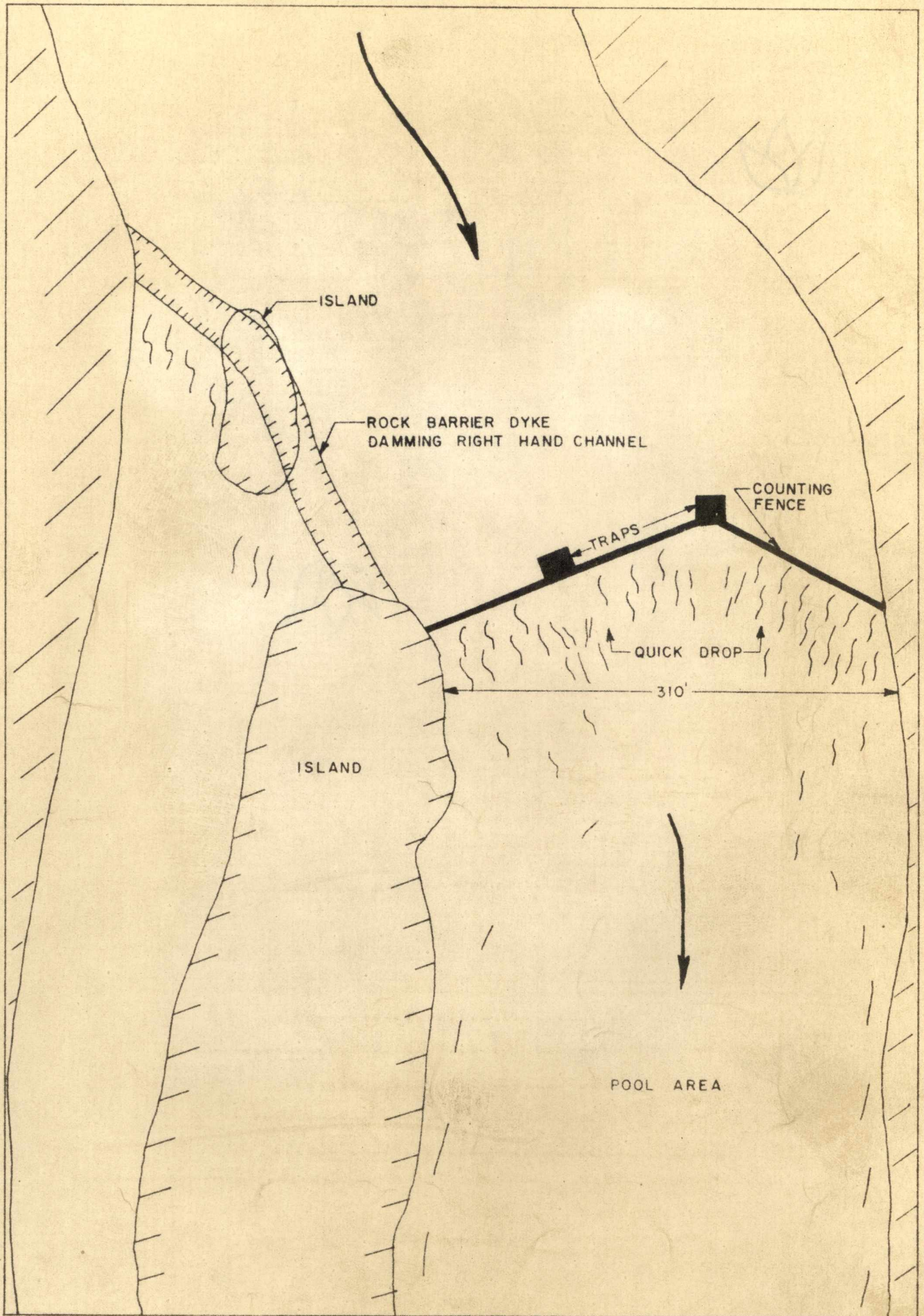


FIG-10. HARRYS RIVER COUNTING FENCE LOCATION

The fence extended a distance of 380 ft. from an island near the centre of the river to the left bank. It was "V"-shaped with one wing approximately 260 ft. and the other 120 ft. in length. One trap was located at the apex of the "V" and another (built later in the season) was placed near the mid-point of the long wing.

One trap was constructed of a wooden framework, 4 x 4 x 6 ft., with 1 in.<sup>2</sup> mesh wire screen forming the sides and bottom (Fig. 11). Boards were placed vertically along the sides to control undue turbulence in the trap. The other trap was built entirely of wood, both for framing and with closely-spaced pickets for screening the water flow through the trap.



Fig. 11. Counting trap at Harry's River.

Foundation of the fence was made of 8 x 8 ft. wooden cribs, 2 ft. in height, constructed of 6 x 6 in. lumber, set into the river bed to within 6 in. of the top. "A" frames were placed at intervals of 8 ft.

and on them were placed 4 x 8 ft., wooden-frame, wire panels (Fig. 11). Large size of these panels prevented easy removal for debris-cleaning during flood; smaller screen panels would have been more efficient.

A rock dyke constructed by a bulldozer dammed the right hand channel (Fig. 12). It was 400 ft. in length and extended from the right bank to the island.



Fig. 12. Rock dyke at Harry's River.

High flooding damaged the dyke on two occasions (June 23 and August 7) so that salmon were free to ascend the river undetected for a total of six days. That many did so is unlikely, however, because on other occasions in floods, when the counting fence remained operative, an increase in the run was apparent only during the abatement of flood water. The increased fish movement after the peak flow agrees with Hayes' (1953) studies on the effects of freshets on migrant salmon movement. Our fence was back in operation on each occasion shortly

after or during abatement. Further evidence to support the contention that few fish ascended undetected is that the washouts occurred before and after the annual peak of the run.

A final extremely-high flood on September 2 caused heavy damage to the dyke and counting fence (Fig. 13). The damage forced discontinuance of the operation while fish were still ascending the river.



Fig. 13. Fence washout at Harry's River.

Fluctuations in the daily count occurred but there was a buildup to a peak of 84 fish on July 10 (Fig. 14). A total of 1,252 salmon was counted during the fence operation. Another 350 fish is estimated as untallied escapement during washouts and after cessation of the fence count. A total of 954 fish was angled in Harry's River in 1967; 400, or approximately 42% of this number, were taken below the fence. Estimated total river escapement is, therefore, placed at  $2002 \pm 500$  fish.

GRAPH OF DAILY FISH COUNT

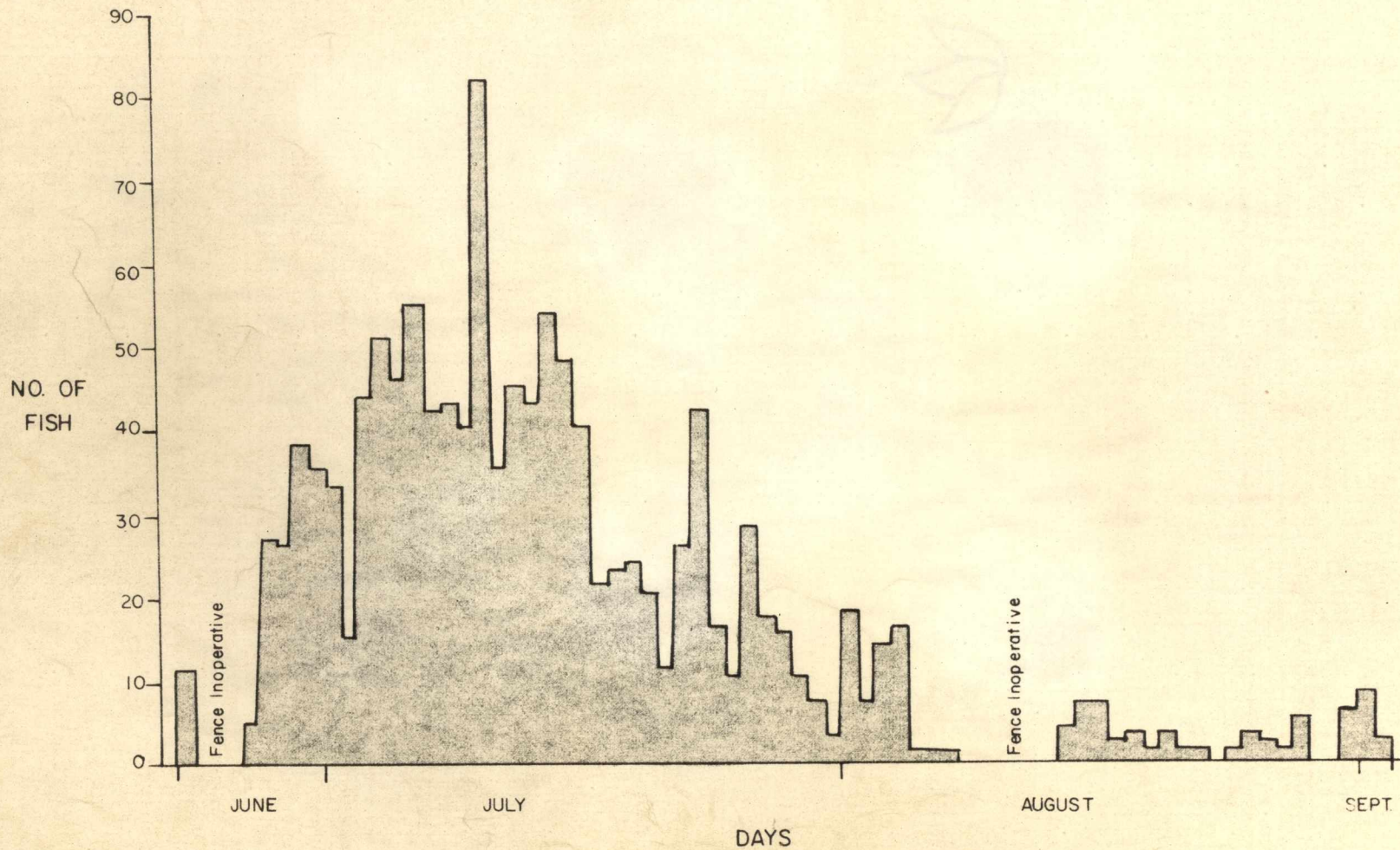


FIG. 14. Graph of daily fish count.

Table VI. Population estimate for Harry's River.

No. of salmon counted at fence .....	1,252
No. of salmon ascending during washouts .....	350
No. of salmon angled below fence .....	<u>400</u>
Total ...	2,002

Water heights were recorded by means of a meter stick placed inside the main trap. This placement resulted in a higher apparent level than that actually attained in flood because of a damming effect created by debris buildup on the panels. Records are sufficient, though, to show fluctuations in water levels.

Fig. 15 shows water heights and temperatures superimposed on daily fish counts. Both water heights and temperatures were recorded at 0900 hours daily, so as to minimize variation caused by recording at different time of day. A slight correlation appears to exist between daily fish count and water heights but no such correlation is evident between daily fish count and water temperatures.

Extremely high water, reaching a height of 3.0 ft. in the trap in late June (during which period flooding damaged part of the fence), was followed in the next two weeks by a gradual buildup to a peak fish count of 84 fish on July 10. Daily fluctuations of temperatures during this period seems to have had little if any noticeable effect on this buildup. Relative uniformity of water heights is maintained from the high in late June to the end of July.

# GRAPH OF DAILY FISH COUNT WITH WATER LEVELS AND TEMPERATURES SUPERIMPOSED

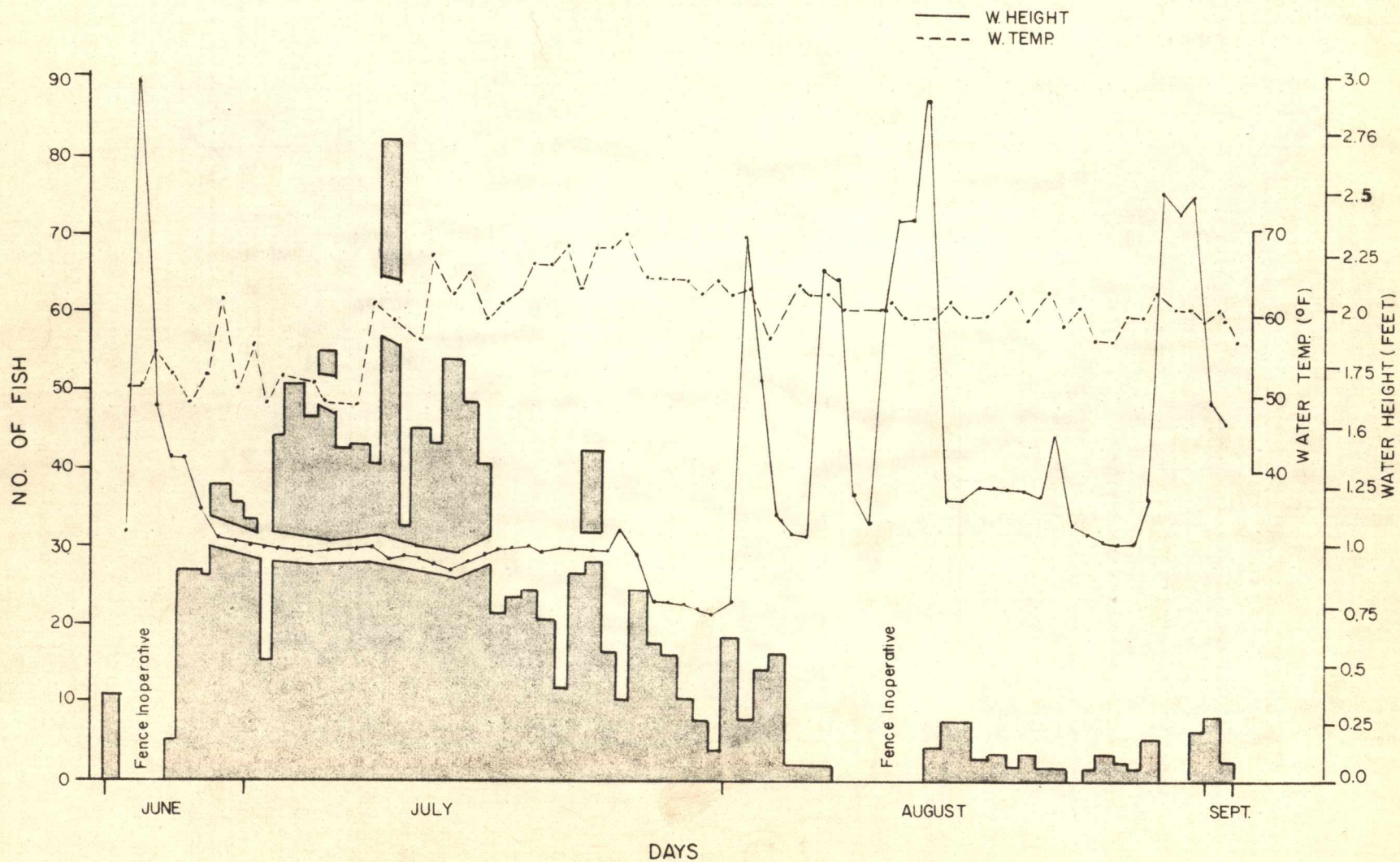


FIG.15. Graph of daily fish count with water levels and temperatures superimposed.

While temperature varied little, water-height peaks on August 1, 7, and 14 were followed by a slight increase in the run. A final heavy freshet in late August and early September saw another slight increase in run until the count terminated September 2 with destruction of the fence.

### Angling

Angling statistics for Harry's River for the period 1961-67 are given in Table VII. Total number of fish angled, number and percent of grilse, number and percent of salmon, and number of rod-days are shown. A progressive increase in catch is noted for the years 1961-64; catch rose from 853 salmon in 1961 to 3001 salmon in 1964. Proportionally more older fish were taken in 1964 when the catch consisted of 14.9 percent salmon and 85.1 percent grilse. The second highest percentage of salmon was in 1963 when there were 11.2 percent salmon and 88.8 percent grilse.

It should be noted that in 1964, 3001 fish were taken in 3845 rod-days, whereas in 4123 rod-days in 1963, 160 fewer fish were taken. Catch/rod-day rate shows a progressive buildup from 0.51 in 1961 to 1.05 in 1964. After 1964, a progressive decrease in total catch is noted while a steady low catch/rod-day was maintained. In 1965, the catch was less than half the number taken in 1964 and, in 1966, there was a further decrease of approximately 1/3 from 1965. The years 1966 and 1967 remained about the same with catches of 936 and 954 respectively.

The comparatively large angling harvest for 1964 might have been the result of a large smolt run in 1963. The large proportion of older fish in 1964 probably was the result of a large smolt run in some year

previous to 1963 or to more suitable angling conditions when larger fish were available in the river. A look at the commercial catch for this period provides interesting information, page 36.

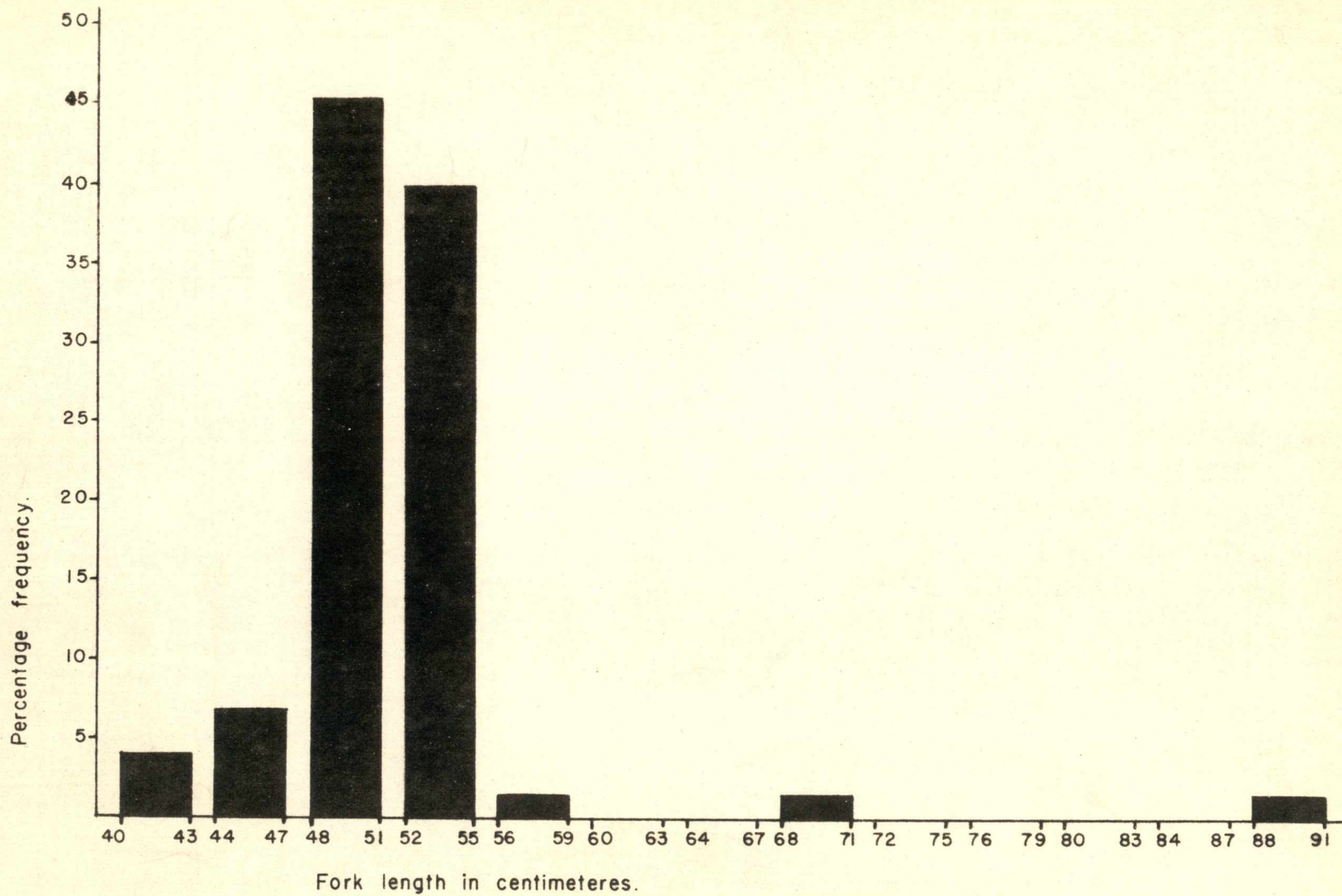
Table VII. Angling statistics for Harry's River - 1961/67.

	1961	1962	1963	1964	1965	1966	1967
Total no. of fish	853	1640	2841	3001	1437	936	954
No. of grilse	781	1555	2523	2554	1370	883	867
% " "	(91.5)	(94.8)	(88.8)	(85.1)	(95.3)	(94.3)	(90.9)
No. of salmon	72	85	318	447	67	53	87
% " "	(8.5)	(5.2)	(11.2)	(14.9)	(4.7)	(5.7)	(9.1)
No. of rod-days	1676	3141	4123	2845	3338	2113	2630
Catch/rod-day	0.51	0.52	0.69	1.05	0.43	0.44	0.38

#### Length Composition

Project plans were to select randomly 10 percent of the Atlantic salmon ascending through the traps during 1967 for sampling of biological statistics. Circumstances forced abandonment of this objective during the latter part of the run with the result that less than 10 percent of the fence count was randomly sampled. A total of 73 fish was scale sampled and measured (fork length in cm.).

Fig. 16 shows the fork length distribution for Harry's River escapement sample (N = 73). Length range was 41 - 90 cm. but the bulk of the sample was in the range of 41 - 58 cm. Only two fish were larger than 58 cm. and these were 70 and 90 cm. respectively. Mean length for the sample was 50.5 cm. with a standard deviation of 2.6 cm. No weights were taken.



**Fig.16 Length-Frequency distribution for 73 Atlantic Salmon  
Harrys River, 1967**

Age Composition

No attempt was made to determine the sex of the samples taken. Scale samples were taken from the fish to provide information on age composition of the population (Table VIII).

Table VIII. Age composition of Atlantic salmon, Harry's River sample, 1967.

	$5_4$	$6_5$	$6_4$	$7_4$
Number of samples	61	7	4	1 <sup>73</sup>
Percent of samples	83.6	9.6	5.5	1.3
Average fork length (cm.)	50.31	50.86	56.5	90

Bulk of the population in 1967 was composed of five year old grilse, 61 of the 73 fish sampled were  $5_4$  age class. Almost all the remainder were six year old fish that had gone to sea in the fourth or fifth year of river life. Only one fish ( $7_4$ ) was over six years old, and this one had spent more than two successive years in salt water.

Average fork length for the  $5_4$  and  $6_5$  age groups were essentially the same at 50.31 and 50.86 cm. respectively. Average for the  $6_4$  age group was 56.5 cm. The one specimen in the  $7_4$  age group had a fork length of 90.0 cm.

## COMMERCIAL CATCH FOR ST. GEORGES BAY REGION

Commercial catch for four communities around St. Georges Bay is given in Table IX. These communities lie in close proximity to Harry's River, South-west Brook, Bottom Brook, and Little Barachois Brook. It is assumed that, since the nearest salmon river of any significance is Flat Bay Brook, 10 miles to the south, the bulk of salmon taken by fishermen in these towns was destined for the four streams listed. It is further assumed that the proportion contributed to the commercial catch by each river remains the same annually.

Table IX. Commercial catch<sup>1</sup> of salmon for four communities in St. Georges Bay, 1962-1967.

Community	1962	1963	1964	1965	1966	1967
St. Georges	5,160	550	4,950	14,300	16,500	18,150
Barachois Brook	4,860	4,160	505	1,760	3,850	5,170
Stephenville Crossing	360	418	165	550	3,520	5,500
Stephenville	558	1,760	2,750	8,250	6,600	6,380
Total	10,938	6,888	8,370	24,860	30,470	35,200

Between the years 1963 and 1967, there was a progressive increase in the commercial catch. There was a decrease of 4,000 pounds between 1962 and 1963 but in the following year it increased approximately 1,500 pounds. The year 1965 saw a trebling in the catch over 1964. Each year

<sup>1</sup> Figures represent pounds of salmon with head on (round weight).

following, there was a further 5,000 pound increase over the preceding year. In the peak year of 1967, a total of 35,200 pounds of salmon was taken.

Table X lists the numbers of gill nets and traps engaged in the salmon fishery in this region (no figures are available previous to 1963). There was a slight decrease in total gear engaged between 1963 and 1964 and there was a corresponding slight increase in total catch between these years. Barachois Brook had an approximate decrease of 3,500 pounds for 1964 over 1963 although gear in operation remained the same. Stephenville Crossing also showed a decrease in fish landed with a corresponding decrease in gear operation for this period. The other two communities of Stephenville and St. Georges show an increase in both gear used and total landings.

Increase in total gear used resulted in increased catch for the years 1965 and 1966. In 1967, gear in operation remained the same as for 1966, but the catch increased by 1/6. Low water conditions in the summer of 1967 in South-west Brook, Bottom Brook, and Barachois Brook could have kept fish near the estuaries longer without ascending the river resulting in proportionally greater commercial harvest.

The increase in fishing effort and commercial catch in St. Georges Bay for the last three-four years is not surprising since many areas of Newfoundland are experiencing the same development. The economic position of this particular location, however, could conceivably lend impetus to the trend.

Ernest Harmon Air Force Base completed phase-out in 1966. Talks with local residents revealed that people were aware of eventual closing

Table X. Commercial salmon gear engaged in St. Georges Bay, 1963-67.

Communities	1963			1964			1965			1966			1967		
	Gill nets	Traps	Total	Gill nets	Traps	Total	Gill nets	Traps	Total	Gill nets	Traps	Total	Gill nets	Traps	Total
St. Georges	10	5	15	4	9	13	3	25	28	2	24	26	2	20	22
Barachois Brook	4	-	4	4	-	4	8	-	8	12	-	12	17	-	17
Stephenville Crossing	6	-	6	4	-	4	4	-	4	5	-	5	7	-	7
Stephenville	12	1	13	13	3	16	12	3	15	15	3	18	12	3	15
Total	32	6	38	25	12	37	27	28	55	34	27	61	38	23	61

for at least two years. Persons employed at the base began to turn to other employment to cushion the impending unemployment. Commercial salmon fishing was one means of other employment. For this reason, principally, there was a substantial increase in gear operation after 1964 and a very substantial catch increase.

Note the correlation of commercial catch for the four communities with the angling catch for Harry's River in the last six-seven years (Fig. 17). A definite negative correlation exists between the two in that as commercial catch increased the angling catch decreased. Between 1961 and 1964 the angling catch in Harry's River showed an increase while the commercial catch remained essentially the same. After 1964, a sharp rise in commercial catch matches almost a mirror-image decrease in the angling catch.

The rapid annual increase in commercial returns seems to have a serious effect on salmon escapement to Harry's River. Although a slight increase was evident in the number angled in 1967 compared to 1966, this trend toward reduced angling catches can be expected to continue as long as the amount of commercial gear in use in St. Georges Bay remains at high levels.

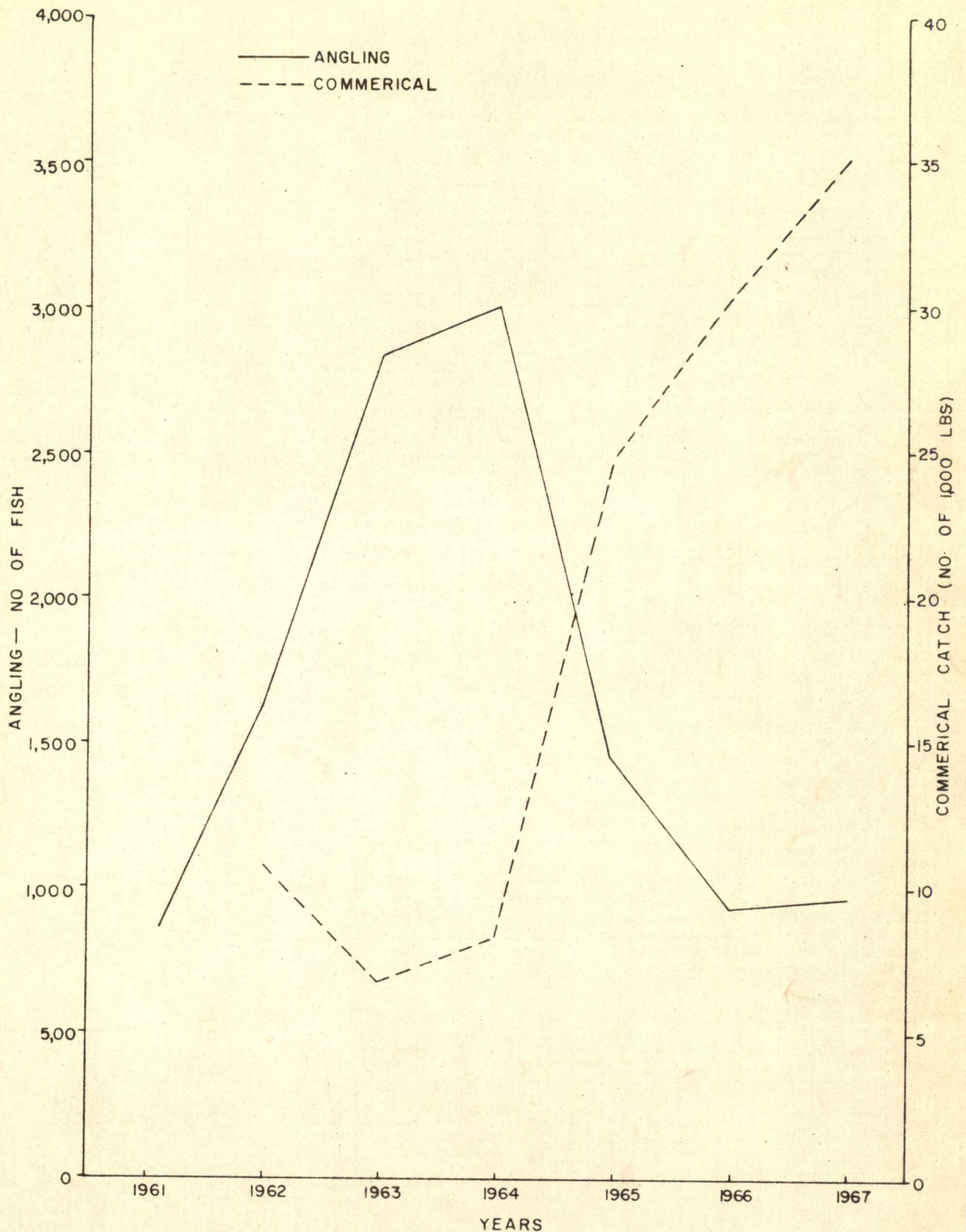


FIG 17. ANGLING / COMMERICAL CATCH

## FISH POPULATIONS

Determination of resident populations of fishes in Harry's River was limited to angling during the summer of 1967, observation at the counting fence site and throughout the system, and netting in Georges Lake in October.

The Eastern brook trout (Salvelinus fontinalis) is the most common resident species. It is found in all lakes, ponds, and tributaries but seems to be most numerous in small tributaries of the lower drainage area where cover and food are abundant.

The gillnet in Georges Lake captured smelt (Osmerus mordax) and Arctic char (Salvelinus alpinus), as well as brook trout. Local residents report a large population of landlocked smelt in Georges Lake. The relatively small size and dark pigmentation would indicate the netted smelt were landlocked, or freshwater. A few others were taken <sup>at</sup> ~~on~~ the counting fence in early operation. It is likely that the Arctic char present in Georges Lake are all resident rather than anadromous. Three netsets carried out by W. D. Seabrook (1961) in Georges Lake yielded four brook trout (Salvelinus fontinalis), three Arctic char (Salvelinus alpinus), and one American eel (Anguilla rostrata).

The American eel is present in abundance throughout Harry's River. A piece of fish or flesh thrown in a quiet area of the stream near the counting fence would soon attract many eels from underneath rocks and the wooden foundation of the fence.

A substantial population of sea-run brook trout frequents Harry's River. A total of 242 was counted up through the traps, and it is likely

that the run is much larger considering that migration was in progress before fence installation.

A few adult alewives (Alosa pseudoharengus) were taken on the counting fence in the first two weeks after installation. It is unlikely that many frequent rivers farther north than Harry's River. This species ascends rivers in early spring to spawn and returns to sea after spawning. It was not possible to determine the number of alewives frequenting this river in 1967.

One unexpected species taken dead on the fence on August 21 was the winter flounder (Pseudopleuronectes americanus). This species is generally found in brackish water around river mouths, but it has been found in water "fresh enough to drink" in the Susquehanna River, a tributary of Chesapeake Bay (Bigelow and Schroeder, 1953).

## FISH POTENTIAL OF HARRY'S RIVER

A major objective of any management procedure at Harry's River would be maintenance of existing stocks. This would be reasonably ensured given adequate fishworks in the diversion structures and sufficient flow when the river is diverted. It is, however, worthwhile to consider the possibility of increasing present stock levels.

Elson (1957) gives figures on Atlantic salmon production for a "typical" Maritime river system as one smolt per 100 square yards of stream without bird control and five to six smolts per 100 square yards with bird control. Various other workers have given comparable figures but Murray (1962) has established 0.9 - 1.7 smolts per 100 square yards as the production rate for the Little Codroy River, an adjoining system. Since Harry's River is easily accessible to hunters, it is my opinion that there is a moderate check on bird populations of the system. Two smolts per 100 square yards is, therefore, arbitrarily selected as the smolt production rate for Harry's River. There is an estimated 40,000 on hundred square yard units accessible to Atlantic salmon in the whole system (including all tributaries). Based on these figures the smolt production for the river is 80,000 fish.

No conclusive figures have yet been established for smolt to adult returns for Newfoundland rivers. Saunders (1966) estimates survival rates for salmon tagged as smolts and recaptured as grilse at two counting fences located on the Northwest Miramichi River, New Brunswick, as 2.5 - 3.8%. Between 1961 and 1967, the Harry's River angling statistics indicate that approximately 85 - 95% of the Atlantic salmon population consisted of grilse. Based on these figures, it is

estimated that 4% of the total smolt production return as adults. Harry's River should, therefore, have an annual Atlantic salmon escapement of 3200. It was estimated that Harry's River in 1967 had a population of 2002  $\pm$  500 Atlantic salmon. It is presently producing at approximately 3/4 of its production potential.

Whereas the introduction of exotic species, such as whitefish (Coregonus clupeaformis) and lake trout (Salmo gairdneri) have met with but limited success in Newfoundland and elsewhere, increase of the stocks of native species could perhaps be extremely successful in a reservoir such as that proposed at Georges Lake.

## SUMMARY

1. The proposed establishment of a liner-board mill near Stephenville has resulted in a proposal to divert part of Harry's River for a water supply.
2. Counting-fence operation, angling, and observation in 1967 permitted an estimate of  $2002 \pm 500$  Atlantic salmon as the escapement to Harry's River. In addition, 242 sea run brook trout were counted up through the fence.
3. Resident populations of brook trout, Arctic char, eel and smelt exist in the Harry's River system.
4. Provision should be made in the water supply structures to protect present stocks.
5. There appears to be an inverse correlation between the commercial catch in St. Georges Bay and the angling catch in Harry's River. The commercial fishery, combined with an angling harvest, may be having a deleterious effect on Atlantic salmon stocks.
6. Population estimates indicate the river is presently producing at below peak potential.
7. Completion of the Georges Lake reservoir will encourage development of present stocks of native species to peak potential and permit consideration of the introduction of exotic species there.
8. Screens placed over the water intake structure near Black Duck and adequate fishworks in the dam near Georges Lake should minimize hazards to resident or migrant fish populations.

## DISCUSSION AND RECOMMENDATIONS

A population of 2002  $\pm$  500 Atlantic salmon in Harry's River is a resource which is too valuable to lose. If the proposed scheme materializes without adequate protection measures, substantial loss of spawning and rearing sections of the river will result. As will be noted in Appendix I, most of the tributaries draining into Georges Lake are particularly productive. Use of this area is threatened if no means for safe ascent and descent over the dam is provided for migrants. Injury and/or mortality will also result at the intake structures if not adequately screened.

Steps which should be taken to protect present fish stocks are the following:

1. A minimum flow is needed in the main river to allow ascent of adult spawners and survival of juvenile stages of Atlantic salmon in rearing areas. As Gordon (1965) notes: "dissipation of energy reserves and ineffective spawning before reaching the grounds could seriously reduce effective reproduction capacity".
2. A fishway is needed at the dam near Georges Lake to permit ascent of adult spawners to spawning ground above.
3. There could be a danger to fish entering the forebay of the impounding dam. Temporary disorientation could cause them to be drawn down over the spillway causing injury. Efficient placement of the fishway would minimize this loss.

4. Provision must be made at the dam for descent of migrating smolts and kelts with no injury or mortality.
5. Screens are needed at the intake structures near the Black Duck diversion dam to protect resident and migrating fish populations.
6. To allow access to Long Gull Brook, a productive tributary, diversion works should be carried via flumes whenever crossing these streams, if this diversion route is selected.

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APPENDIX I

## SPAWNING GROUND SURVEY

FALL - 1967

## Introduction

A field party consisting of one biologist and one technician departed Headquarters on November 7, 1967, to conduct a spawning survey of Harry's River. Duration of the survey was approximately three weeks; the work was continued for one additional week in mid-December.

Helicopter reconnaissance was utilized the first week and a ground survey made up the remainder of the time. The purpose of the aerial observations was to obtain a general picture of the system and to pin-point potential spawning grounds. This information was utilized in the ground survey to estimate the number of redds.

In addition to the main objective, during the spawning ground survey, the following additional objectives were pursued:

1. Determination of approximate location and extent of rearing ground.
2. Tabulation of specific physical features of the whole system.
3. Determination of specific location and degree of obstructions<sup>1</sup>.
4. Tabulation of extent and type of vegetation of the river basin<sup>2</sup>.

Inclement weather conditions grounded the helicopter for the first two days. On November 9 the aircraft proceeded to Indian River and on November 10 arrived at Harry's River.

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<sup>1</sup> Details are included in the main report under "Obstructions".

<sup>2</sup> Details are included in the main report under "Flora".

During the following six days, an aerial survey was conducted on the main river and on all significant tributaries. It is worthy of note that a small Philips, portable tape recorder proved invaluable for record keeping. Taped notes dictated in flight were transcribed during the evening. This system enabled a rapid and accurate account of observations. At the end of the flying period, a detailed set of notes had accumulated which was used to plan activities on the ground in succeeding days.

Bottom types were classified as follows:<sup>1</sup>

Standard Classification of Bottom Material

Bedrock .....	rock strata
Boulder .....	10.0"
Cobble .....	4.0" - 10.0"
Gravel .....	0.1" - 4.0"
Sand .....	0.1"

Silt was distinguished from sand if it did not feel gritty but greasy when rubbed between thumb and forefinger.

Poor, medium, good, or excellent spawning ground was classified using the following criteria:

1. Optimum flow conditions: 1.1 - 1.6 fps.;
2. Depth of 0.5 - 1.0 ft.;
3. Contains bottom material within the size range 0.5 - 4.0 in.

If only one of these conditions was present, it was regarded as poor spawning ground; two present, as medium spawning ground; and

<sup>1</sup> CUMMINS, K.W. An Evaluation of Some Techniques for the Collection and Analysis of Benthic Samples with Special Emphasis on Lotic Waters. The American Midland Naturalist, 67: No. 2, 1962, p. 495.

three present, as good spawning ground. Excellent spawning ground had all three criteria plus one other complimentary quality such as cover in the form of overhanging bushes or good rearing ground in close proximity.

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## MAIN RIVER

The main river consists almost entirely of rearing ground; spawning ground makes up less than 1%. Quality of the spawning ground present is generally poor to medium since one or more of the requirements is absent. Consequently, the main river had low priority on the list of areas for examination on foot during the redd count.

The estuary is very wide, approaching 1 mile in width at one point. Bottom texture consists of mud and sand with water depths varying from 6 in. - 6 ft. Sand bars are exposed during low tide. Near the entrance of Brownmoore Brook, approximately  $\frac{1}{2}$  mile upstream from tidal penetration, there is a small area of poor quality potential spawning ground 15 square yards in area. Except for small patches, no more occurs to the entrance of Roberts Brook,  $6\frac{1}{2}$  miles upstream.

The stream narrows above the estuary to 150 ft. but widens to 250 - 300 ft. at and above the 3-mile point. Cobbles predominate throughout with a few boulders interspersed. Normal summer flow is generally within the range of 350 - 450 cfs. The stream narrows slightly at and above the 6-mile point but bottom type remains the same: 80 - 90% cobbles and boulders with the remainder coarse gravel.

At the confluence with Roberts Brook, a 500 square-yard section of medium quality spawning ground occurs. Cobble riffle continues above. The depth range is 4 in. - 4 ft. Some rapid water occurs where small islands lie in the river. At the eleven mile point a somewhat wider section and relatively smooth bottom creates laminar flow conditions.

Above this point, the proportion of boulder to cobble increases. Depth range here is 2 -  $2\frac{1}{2}$  ft. for most sections. These conditions continue to the  $12\frac{1}{2}$ -mile mark at which point a 500-yard section of good gravel is evident. Another section of 250 square yards of spawning area occurs at the  $14\frac{1}{2}$ -mile point in patches around an island. The next section of significance for spawning occurs near North Brook entrance and extends  $\frac{1}{4}$ -mile to the town of Gallants. Throughout this stretch, stable bottom structure, good flow, and cover create excellent rearing ground. Except for a few patches, no more spawning ground is evident in the stream from Gallants to Georges Lake.

## THE TRIBUTARY SYSTEM

I. Black Duck Brook

Flowing a distance of 4 miles in a southerly direction, this stream enters Harry's River  $4\frac{1}{2}$  miles from the mouth. It has depth range of 8 in. -  $2\frac{1}{2}$  ft. and a width range of 10 - 30 ft. The tributary demonstrates fairly uniform flow throughout its length.

Two insignificant tributaries, each approximately  $\frac{1}{2}$  mile in length, enter the brook. Neither showed evidence of utilization by salmon spawners.

A total of 75 redds was located in the main stream, and approximately half was found in  $\frac{1}{2}$ -mile of brook in the vicinity of the town of Black Duck. Almost all the remainder was found in the  $\frac{1}{2}$ -mile of stream below Black Duck Pond, the first headwater pond. The latter half of these redds was constructed in good spawning ground while 15 redds were located in poor ground throughout the stream.

Tributary: Mistaken Pond to Black Duck Pond

Poor spawning ground occurs near the mouth where the bottom structure is large gravel and boulders. After the first 300 yards, this boulder riffle gives way to smaller material and optimum flow conditions throughout its  $\frac{1}{2}$  mile length. Width range is 12 - 20 ft., and depth range is 4 in. - 2 ft.

A total of 39 redds was located in the stream distributed in the first, and the last, 200 yards. The remainder of the tributary is rearing ground for salmon parr.

Tributary: Enters stream joining Mistaken Pond and Black Duck Pond

This brook extends 2 miles and consists of bedrock and boulders for the first  $\frac{1}{4}$  mile. Generally, the stream contains material 4 - 10 in. in diameter; smaller material occurs near the edges. Relatively uniform flow occurs throughout except near the mouth where there is rapid water. Width range is 10 - 20 ft., and there is a depth range of 6 in. -  $3\frac{1}{2}$  ft. A total of 22 redds was located here, in poorer material than in the mainstream of Black Duck Brook or Long Gull Brook.

Tributary: Bennetts Pond to Black Duck Pond

This stream enters Black Duck Pond after flowing a distance of 1 mile from Bennetts Pond. There is over 60% gravel in its bottom structure, 25% cobbles, and the remainder is bedrock and sand. The absence of obstructions and the presence of a gentle gradient create uniform flow.

Depth range is 6 in. -  $3\frac{1}{2}$  ft. and width range is 8 - 20 ft.

Heavy boulder makes up most of the bottom structure of the stream near a bridge crossing at the 200-yard point upstream. Similar conditions exist above the bridge but this gives way to good gravel which persists to the end of the stream at Bennetts Pond.

A total of 17 redds found in the stream seems to indicate that the spawning ground was not utilized to capacity here, probably because of the presence of good ground lower down in the system.

II. Browmoore Brook

This tributary, which enters the main river 1 mile from the mouth, was examined from the air. It extends a distance of approximately 6 miles from mouth to headwater.

At the mouth it is 60 - 70 ft. in width, but for most of the upper reaches it is 15 - 35 ft. in width. It narrows to 5 - 6 ft. at the headwaters. Depth range was not measured.

Throughout most of the lower region, long stretches of rocky bottom alternate with short patches of good spawning ground. Rearing ground appears to be good and in large quantity with algae-covered cobbles and boulders and abundant shade.

Above the 3-mile point, good spawning conditions continue for 300 yards in narrow strips along the sides. Further upstream, there is abundant gravel but less than ideal spawning conditions because of deep water. The stream widens considerably at this point while flowing through flat bog country but narrows as the headwater is approached. No redds were located.

### III. Long Gull Brook

This tributary enters Harry's River at the 3-mile point. It is approximately 1 mile in length and flows from Long Gull Pond, the headwater.

Width range is 10 - 28 ft. with a depth range of 6 in. -  $4\frac{1}{2}$  ft. throughout. Boulders and cobbles comprise 60% of the bottom structure at the mouth; sand is found in patches between the mouth and CNR crossing.

Excellent spawning conditions begin 300 yards above the mouth and continue to the origin of the brook as evidenced by the presence of 152 redds. The first two redds occurred immediately above the trestle but the main concentration was immediately below exit of the stream from Long Gull Pond. Here, optimum flow over relatively small material  $1/2$  - 1 in. in diameter obviously creates ideal conditions. Dark bottom caused by

prolific algae growth makes redd building activity resulting in lighter-coloured, overturned stones readily apparent.

There was such an abundance of redds in the stream that distinction of individual nests was made difficult by superimposition. Since only those positively identified were counted, the count may be 10% too low.

#### IV. Rushy Pond Brook

The stream is  $1\frac{1}{4}$  mile long and enters the main river  $3\frac{1}{2}$  miles from the mouth. It has a width range of 3 - 4 ft. and a depth range 1 - 2 ft. Flowing through bog country, it has a mud bottom throughout most of its length. Reported to be intermittent during most of the summer, it is useless for salmon production.

#### V. Ahwachenjeech Brook

The tributary flows a distance of  $3\frac{1}{2}$  miles and enters Harry's River  $14\frac{1}{2}$  miles from the estuary. It was examined by air in its entirety and on foot to within  $\frac{2}{3}$  of the distance to the headwater pond, at which point a large beaver dam completely blocks passage to ascending migrants.

Width range is 15 - 30 ft. and there is a depth range of 1 - 2 ft. lower down, but 6 in. -  $3\frac{1}{2}$  ft. in the upper part where there are a number of dark-bottom pools.

While dark cobbles comprise the first  $\frac{1}{4}$  mile of this stream, above this point good gravel in the 0.6 - 4 in. range begins and extends to the  $\frac{1}{2}$ -mile point. The stretch is characterized by dark, algae-covered rocks, oxbow turns, a few deep pools, and uniform flow.

Beyond this point, boulders and cobbles occur in patches and alternate with good gravel. The latter comprises 70% of the bottom structure.

Above a bridge at the  $1\frac{1}{2}$ -mile point, the proportion of large rock increases and (although it was not examined on foot) this 1 mile section above to Gallants Road crossing appears to be of little use for spawning.

As we ascend the stream beyond the road crossing, large rock and swift water make poor spawning conditions for a distance of  $\frac{1}{2}$  mile. The  $1\frac{1}{2}$  miles below this point, however, appear to be good rearing ground with large cobbles and boulders, apparently large numbers of invertebrates, and overhanging alders providing adequate cover.

At the end of the section, a beaver dam blocks the stream and it was not examined further. Although spawning ground and rearing ground were abundant in this tributary, no redds were found.

#### VI. Jack Burkes Brook

This brook is two miles in length and meets the main river  $14\frac{1}{2}$  miles from the mouth on the opposite bank from the entrance of Ahwachenjeech Brook.

A width range of 7 - 30 ft. and a depth range of 6 in. -  $1\frac{1}{2}$  ft. occurs throughout.

No good spawning ground is evident below the first pond. Rearing ground is also poor since there is deep water and gravel bottom with very little shade in this section.

For a distance of one mile above the pond, however, relatively good spawning ground exists mainly on the right hand side where there is good gravel, optimum flow, and good depth conditions. Near the end of the section, cobbles and boulders increase in number where the stream

descends over a series of drops formed by bedrock outcrops. There is very little spawning ground beyond this point to the headwater pond, but apparently good rearing ground.

No redds were found in this brook although it was examined on the ground in potential areas.

#### VII. Finchgut Brook

With the exception of Black Duck Brook and Long Gull Brook, more redds were found here than in any other tributary. A total of 157 was counted, plus 7 more in Gull Pond Brook, a tributary.

The stream is four miles in length and flows from Finchgut Lake into Georges Lake from the east. The  $1\frac{1}{2}$ -mile section from Georges Lake to the TCH bridge has approximately 90% boulder and cobbles in its bottom structure. The 34 redds found were constructed in a very narrow strip of medium quality gravel close to the right bank underneath overhanging alders. Optimum flow and depth conditions prevailed at the time of examination. Width range for the section is 50 - 100 ft. with a depth range of 6 in. -  $3\frac{1}{2}$  ft.

Between the TCH and Finchgut Lake, a distance of  $2\frac{1}{2}$  miles, 130 redds were located. Width range in this section is 30 - 150 ft., with an average of approximately 60 ft. Water depth range is  $1\frac{1}{2}$  in. - 4 ft.

Immediately above the bridge there is swift water, large boulders, bedrock, and very little gravel. This section is probably of limited use for either spawning or rearing ground for a distance of  $\frac{1}{4}$  mile.

Above this point, optimum flow, suitable depth, and bottom structure of 1 - 2 $\frac{1}{2}$  in. stones create good spawning conditions in a  $\frac{1}{4}$ -mile stretch. A total of 19 redds was located.

Although a few sections of deep water and boulders are present between this point and  $\frac{1}{2}$  mile below Pinchgut Lake, it is mainly excellent spawning ground as evidenced by the relatively large number of redds found in it. This spawning area alternates with good rearing ground with ample cover.

Redds were found to be concentrated along the sides in surprisingly large material (up to 6 in., averaging 2 $\frac{1}{2}$  in. in diameter) and in water sometimes less than 1 $\frac{1}{2}$  in. over the mound. One 150-yard stretch contained a total of 54 redds built under optimum conditions.

The remaining distance to Pinchgut Lake contained no redds, probably because the proportion of cobbles and boulders increases as does water depth and rate of flow. The tributary in this region is narrower and there is a steeper stream gradient.

#### VIII. Hickey's Brook

The only information available about this tributary was gained from helicopter reconnaissance. The stream begins in bog country and is very rocky throughout except for a small section of poor quality gravel immediately below a road crossing. It has an approximate width range of 8 - 15 ft. and flows 1 mile before emptying into Harry's River 1 $\frac{1}{2}$  miles below Georges Lake.

IX. Beaver Brook

Helicopter observation provided the only information on this tributary. It has a length of  $1\frac{1}{4}$  miles with two branches each a mile in length and enters Georges Lake from the northwest. Main stream width range is 10 - 12 ft.; the tributaries have a range of 4 - 7 ft. Most of the brook is rocky and only a very small percentage of it consists of fair spawning ground.

X. Roberts Brook

The stream is  $2\frac{1}{2}$  miles in length to the junction of its two branches; the right branch is 2 miles long and the left branch (Crooked Brook) is 8 miles long. The latter branch was not examined by air or on the ground, although it is believed to contain some good spawning ground.

Mouth of the brook is  $6\frac{1}{2}$  miles from the estuary of the main river. Near the mouth of Roberts Brook in the main river, there is a large stretch of good gravel and this extends up into the brook itself. Above this point, the stream becomes rocky with very swiftly-flowing water, very little gravel, and boulders and large cobbles comprising over 90% of the bottom structure. Similar conditions exist to the two-mile point where bedrock makes up 100% of the bottom structure for a distance of  $\frac{1}{4}$  mile. The width range is 60 - 80 ft. and depth range is 4 in. - 2 ft. for the section examined on foot, i.e. the first  $2\frac{1}{4}$  miles above the mouth.

No gravel except for a few patches is evident beyond the junction in the right branch. Relatively good rearing ground occurs along the

right branch and in the main stream of Roberts Brook. No redds were located in this tributary.

#### XI. North Brook

This tributary extends a distance of 12 miles, including both branches, and enters the main river  $17\frac{1}{2}$  miles from the mouth. None of it was observed on the ground but it was estimated to have a width range of 60 - 100 ft.

The only gravel is a small section near the mouth which is of poor quality. Remainder of the stream and its branches are very swift-flowing with bottom structure consisting almost entirely of bedrock and boulders.

Because of the steep stream gradient, rapids occur throughout, but the only complete obstruction observed is a 40-ft. falls located 1 mile up West North Brook. It is doubtful even if spawners could utilize any of this stream that substantial rearing ground could be found because of very rapid flow and lack of adequate cover.

#### XIII. Furries Brook

The tributary is  $6\frac{1}{2}$  miles in length and meets the main river 9 miles from the mouth. It has a width variation of 8 - 16 ft. and a depth range of 4 in. -  $2\frac{1}{2}$  ft. Observed from the air in its entirety, it was ground-checked for approximately 3 miles but no redds were found.

In the lower  $\frac{1}{2}$  mile it has a predominance of boulder and cobbles with only a few small patches of gravel. Good cover and flow make this excellent rearing ground.

There is a decrease in the boulder percentage above this point, but cobbles comprise 70 - 80% of the bottom structure. With this exception, conditions are very similar throughout the stream.

XIII. No Name Brook

This stream is identical to Furries Brook except that it is somewhat narrower. It was observed from the air and a small section was examined on the ground but no redds were found.

XIV. Little Georges Brook

Extending a distance of 1 mile, this tributary enters a long finger of Georges Lake from the north. Examined only from the air, it has a width range of 8 - 20 ft. throughout.

Near the mouth it is relatively wide and descends in a series of little rapids created by rock ledges. Higher up towards the headwater, Little Georges Pond, the brook is swift-flowing, dark-bottomed, with a predominance of bedrock outcrops and boulders.

Of doubtful value for rearing, the tributary is useless for spawning purposes. No redds were found.

XV. Stag Hill Brook

This stream is  $6\frac{1}{2}$  miles long including all its branches. It enters Pinchgut Lake from the east.

The width range is 10 - 25 ft. It was examined only from the air.

In the lower reaches, it is dark-bottomed and contains a fair amount of good potential spawning ground. Above the first mile, however,

there are long stretches of cobble and boulder. A series of short bedrock ledges create rapid-water riffles.

#### XVI. Trout Brook

One of the longest tributaries of Harry's River, this stream flows 17 miles and enters Harry's River 5 miles from the mouth. The width range is 15 - 80 ft., and depth range is 4 in. - 3 ft. It was observed in entirety from the air. Seven miles were examined on foot,  $4\frac{1}{2}$  miles in November and  $2\frac{1}{2}$  miles in mid-December.

This stream, although appearing to have more and better spawning ground than most other streams, had surprisingly few redds. Only five redds were located during both periods, but ice cover obscured large sections of stream in mid-December.

In the lower reaches, particularly, the stream bottom consists of almost 80% medium to excellent quality gravel. Flow conditions and water depths are optimum here where the stream contains a series of oxbows. In many areas, there is almost complete absence of boulders or cobbles. The lower parts were not examined by walking.

Three redds located in November were found in the two-mile section upstream from the TCH bridge. Medium to fair spawning ground lies in strips on either side in this section. Areas unsuitable for spawning make excellent rearing grounds. An average water depth of 1 ft. and a width of 25 ft. is maintained throughout. Sand and gravel comprise 55% and cobbles make up 45% of the region.

Above this point, the bottom structure increases markedly in size, the water is swifter, and the stream is narrower. Indications are that this trend continues to the headwater.

Except for a widening in places, stream conditions are almost the same below the bridge for the  $2\frac{1}{2}$  miles walked. Two redds were located in material somewhat finer in texture to that further upstream. Over 40% of the area covered could be considered good spawning ground.

#### XVII. Spruce Brook

This brook is  $15\frac{1}{2}$  miles long (including both branches); it enters Georges Lake near the settlement of Spruce Brook. It has a depth range of 4 in. - 4 ft. and a width range of 20 - 150 ft.

Although it was examined on foot for  $5\frac{1}{2}$  miles, no evidence of salmon spawning was observed. This stream at the mouth, where it enters Georges Lake near the settlement of Spruce Brook, is 100 - 150 ft. in width, 3 - 4 ft. in depth, and meanders in a series of oxbows through alder-covered lowland. Deep water would prevent spawners utilizing much of the gravel present.

The  $2\frac{1}{2}$  miles between a point  $\frac{1}{2}$ -mile from the mouth and the falls is considerably narrower containing mainly coarse gravel in its bottom structure. Above the falls (a series of drops which are not considered complete obstructions), the stream for a distance of  $2\frac{1}{2}$  miles is characterized by cobble predominance, boulder and bedrock at intervals, very little gravel of any kind, and rapid flow. Cover is available so that the area is potential rearing ground.

Upstream from this point (examined only from the air), long stretches of apparently good gravel exist both in the main stream and its two narrower branches. It is felt that redds would have been located if it had been examined on the ground. These stretches alternate with rearing ground. The upper reaches of both branches head in bog country.

Table 1. Main River.

Section examined	Mouth to counting fence site	Counting fence to entrance Roberts Brook	Roberts Brook to eleven mile point	Eleven mile point to 12 $\frac{1}{4}$ mile point	
Length of section	2 $\frac{3}{4}$	3 $\frac{1}{2}$	4 $\frac{1}{2}$	1 $\frac{1}{4}$	
Sq. yd. of spawning ground	15	500	500	500	
Quality of spawning ground	Poor	Medium	Poor	Good	
No. of redds found	-	-	-	-	
Bottom Structure %	Bedrock	-	5	1	1
	Boulder	5	15	5	60
	Rubble	90	70	90	15
	Gravel	2	5	4	20
	Sand	2	3	-	3
	Silt	1	2	-	1
Remarks	Some rearing ground but unstable bottom structure consisting mainly of large, rounded rocks.	Better quality rearing ground; more stable with larger rocks than lower reaches.	Fewer but larger boulders; much swifter water. Good rearing ground sections.	Heavy boulder section. Coarse gravel present in quantity but flow very swift. Rearing ground present.	

Table 2. Main River.

Section examined		12 $\frac{1}{4}$ mile point to 15 $\frac{3}{4}$ mile point	15 $\frac{3}{4}$ mile point to 17 mile point	17 mile point to 18 $\frac{1}{2}$ mile point	18 $\frac{1}{2}$ mile point to Georges Lake
Length of section		3 $\frac{1}{2}$ mi.	1 $\frac{1}{4}$ mi.	1 $\frac{1}{2}$ mi.	3 mi.
Sq. yd. of spawning ground		1,000	-	8,000	10,000
Quality of spawning ground		Good	-	Fair	Poor-Medium
No. of redds found		-	-	-	-
Bottom Structure %	Bedrock	2	3	2	-
	Boulder	75	70	70	15
	Rubble	15	25	15	70
	Gravel	5	2	10	10
	Sand	2	-	2	4
	Silt	1	-	1	1
Remarks		Rearing ground present, but rounded rocks cause unstable bottom conditions.	Unstable bottom conditions.	More stable conditions and overhanging vegetation gives good shade.	Rearing ground alternates with spawning ground. Redds probably present but examined only from the air.

Table 3. Black Duck Brook: main stream and tributaries.

Section examined	Black Duck Brook: - main stream	Tributary: Mistaken Pond to Black Duck Pond	Tributary: Enters B.D. Pond	Tributary: Bennetts Pond to D.B. Pond	
Length of section	4 mi.	$\frac{1}{2}$ mi.	2 mi.	1 mi.	
Sq. yd. of spawning ground	7,500	2,500	1,500	1,000	
Quality of spawning ground	Good-Excellent	Fair-Good	Fair-Good	Fair-Good	
No. of redds found	75	39	22	17	
Bottom Structure %	Bedrock	3	-	10	5
	Boulder	30	10	7	5
	Rubble	30	25	10	25
	Gravel	30	50	60	65
	Sand	5	10	10	-
	Silt	2	5	3	-
	Remarks	Rearing ground comprises $\frac{1}{3}$ of area examined; region examined on foot throughout.	Spawning ground, which was utilized, alternates with rearing ground.	Mainly bedrock in lower $\frac{1}{4}$ mile. Spawning ground alternates with rearing ground.	Boulder and bedrock in lower reaches gives way to spawning ground above.

Table 4. Browmoore Brook, Long Gull Pond Brook and Rushy Pond Brook.

Section examined	Browmoore Brook: mouth to 2 $\frac{1}{2}$ mile point	Browmoore Brook: 2 $\frac{1}{2}$ mile point to headwater	Long Gull Pond Brook	Rushy Pond Brook
Length of section	2 $\frac{1}{2}$ miles	3 miles	1 mile	1 $\frac{1}{4}$ miles
Sq. yd. of spawning ground	500	500	4,000	-
Quality of spawning ground	Good	Good	Good	-
No. of redds found	-	-	-	-
Bottom Structure %	Bedrock	5	-	-
	Boulder	25	15	1
	Rubble	50	50	25
	Gravel	10	10	70
	Sand	5	10	2
	Silt	5	15	2
	Remarks	Examined from the air only. Good gravel patches alternate with rearing ground & mud bottom.	Examined by air. More gravel than lower down but most in relatively deep water.	Examined on foot and by air. Rearing ground near mouth, spawning ground in upper parts.

Table 5. Ahwachenjeech Brook and Jack Burkes Brook.

Section examined		Ahwachenjeech Brook: mouth to Gallants Road	Ahwachenjeech Brook: Gallants Road to headwater pd.	Jack Burkes Brook: mouth to tributary entrance	Jack Burkes Brook: tributary entrance to headwater pond
Length of section		2½ mi.	1 mi.	½ mi.	1½ mi.
Sq. yd. of spawning ground		20,000	500	100	7,000
Quality of spawning ground		Good-Excellent	Medium	Good	Good
No. of redds found		-	-	-	-
Bottom Structure %	Bedrock	-	-	-	-
	Boulder	5	20	40	10
	Rubble	5	60	50	30
	Gravel	75	10	5	50
	Sand	10	5	3	5
	Silt	5	5	2	5
Remarks		Much of lower reaches good spawning ground but not utilized. Small amount of rearing ground.	Stream blocked by large beaver dam (½ mi. above road). More rearing ground than below.	Good gravel occurs mainly in deep water. Good rearing ground present.	Good gravel (not utilized) alternates with good rearing ground.

Table 6. Pinchgut Brook, Hickey's Brook and Beaver Brook.

Section examined		Pinchgut Brook; mouth to bridge (TCH)	Pinchgut Brook; bridge to lake	Hickey's Brook	Beaver Brook
Length of section		2 mi.	2 mi.	1 mi.	3 $\frac{1}{4}$ mi.
Sq. yd. of spawning ground		300	35,000	100	50
Quality of spawning ground		Good	Good-excellent	Medium	Fair
No. of redds found		34	130	-	-
Bottom Structure %	Bedrock	2	5	15	25
	Boulder	30	15	40	35
	Rubble	60	20	40	35
	Gravel	5	50	2	2
	Sand	2	5	2	2
	Silt	1	5	1	1
Remarks		Gravel found in narrow strip along sides (right generally). Remainder rearing ground.	Long stretches of good-excellent spawning ground alternate with rearing ground.	Examined by helicopter. Rearing ground throughout.	Examined by helicopter. Rearing ground throughout.

Table 7. Roberts Brook and North Brook.

Section examined		Roberts Brook: mouth to junction two branches	Roberts Brook: right * tributary	North Brook: main stream	North Brook: East and West North Brook
Length of section		2½ mi.	2 mi.	3 mi.	9 mi.
Sq. yd. of spawning ground		2,500	-	500	-
Quality of spawning ground		Good	-	Poor	-
No. of redds found		-	-	-	-
Bottom Structure %	Bedrock	30	5	5	5
	Boulder	30	50	50	50
	Rubble	35	40	44	45
	Gravel	4	3	1	-
	Sand	1	1	-	-
	Silt	-	1	-	-
Remarks		Good rearing ground throughout with ample coverage provided by overhanging alders.	Examined only from the air. Stream appears to have rearing ground.	Extremely rocky throughout; many rapids. Only gravel present found at the mouth.	Rocky throughout; much rapid water. No gravel observed. Examined by air only.

\* Left tributary (or Crooked Brook) was not examined thoroughly by air or on foot. It appears to have substantial spawning ground.

Table 8. Furries Brook, No Name Brook, Little Georges Brook and Stag Hill Brook.

Section examined		Furries Brook	No Name Brook	Little Georges Brook	Stag Hill Brook
Length of section		6½ mi.	6 2/5 mi.	1 mi.	6½ mi.
Sq. yd. of spawning ground		100	50	20	20,000
Quality of spawning ground		Poor-Fair	Poor	Fair	Fair-Good
No. of redds found		-	-	-	-
Bottom Structure %	Bedrock	15	15	5	4
	Boulder	42	42	45	20
	Rubble	40	40	45	20
	Gravel	1	1	2	50
	Sand	1	1	2	5
	Silt	1	1	1	1
	Remarks		Examined by air and on foot. Gravel not utilized. Rearing ground predominant.	Similar to Furries Brook in physical features. The small amount of gravel present not utilized.	Examined only from the air. Contains rearing ground and gravel only near the mouth.

Table 9. Trout Brook and Spruce Brook.

Section examined		Trout Brook: mouth to TCH.	Trout Brook: remainder of main stream and tributaries.	Spruce Brook: mouth to junction.	Spruce Brook: both tributaries.
Length of section		7½ mi.	7 mi.	9½ mi.	6 mi.
Sq. yd. of spawning ground		80,000	50,000	6,000	15,000
Quality of spawning ground		Fair-Excellent	Fair-Good	Good	Good
No. of redds found		3	2	-	-
Bottom Structure %	Bedrock	-	3	9	5
	Boulder	5	15	50	5
	Rubble	13	30	35	15
	Gravel	60	40	3	60
	Sand	20	10	2	10
	Silt	2	2	1	5
Remarks		Examined for 1½ miles on foot; remainder by air. Much good gravel but relatively few redds.	Examined for 4½ miles on foot; remainder by air. Also, few redds for apparently good conditions.	Examined on foot for 5½ miles; remainder by air. No redds found; good rearing ground.	Examined by air only. If salmon could ascend falls, redds probably present.