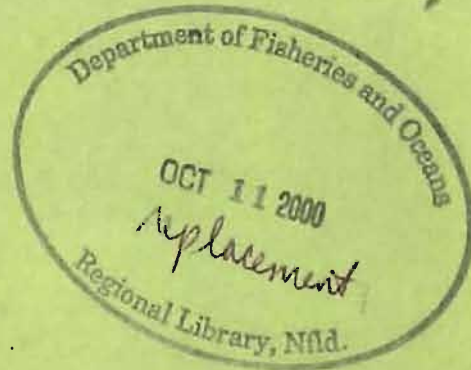




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# Atlantic Salmon Development Techniques Used in Newfoundland



by  
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Technical Report Series No. NEW/T-73-1  
Resource Development Branch  
Newfoundland Region



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ATLANTIC SALMON DEVELOPMENT  
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FISHERIES AND MARINE SERVICE  
DEPARTMENT OF THE ENVIRONMENT  
ST. JOHN'S, NEWFOUNDLAND

AUGUST 1973

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<sup>1</sup>Presented at the Northeast Fish and Wildlife Conference,  
American Fisheries Society, Mount Snow, Vermont, U.S.A., June 5, 1973

ABSTRACT

Fishways, adult transfers and controlled flow spawning channels are being used to extend the distribution of Atlantic salmon within Newfoundland watersheds.

Fishway construction in the Upper Terra Nova River has resulted in a gradual population extension into the headwaters. Construction of a fishway and concurrent adult transfers in Great Rattling Brook have resulted in rapid increases in the adult salmon population. The stocking of unfed fry from a controlled-flow spawning channel on Noel Paul's Brook has resulted in subsequent smolt productions which indicate a rapid establishment of a salmon population.

The comparative efficiencies of these development techniques are discussed.

## Introduction

Since the Resource Development Branch of the Federal Fisheries Service first began stream investigations in Newfoundland it has been aware that suitable freshwater habitat for rearing and spawning of Atlantic salmon exists which is not in production because of natural and a few man-made barriers. These obstructions make large stretches of rivers inaccessible to sea run populations. Detailed stream reconnaissance surveys indicate that Newfoundland and Labrador drainage systems could support an additional 1.5 million smolts provided the systems could be made accessible and runs established. These estimates are derived from the number of rearing units (100 sq. yd.) and a smolt production of 1.7 smolts per unit as established by counting weirs on surveyed streams.

Three techniques or combination of these have been and are used in Newfoundland. These are:

1. fishways
2. adult transfers
3. spawning channels

The production of salmon with each of these techniques and their comparative efficiencies or deficiencies will be discussed.

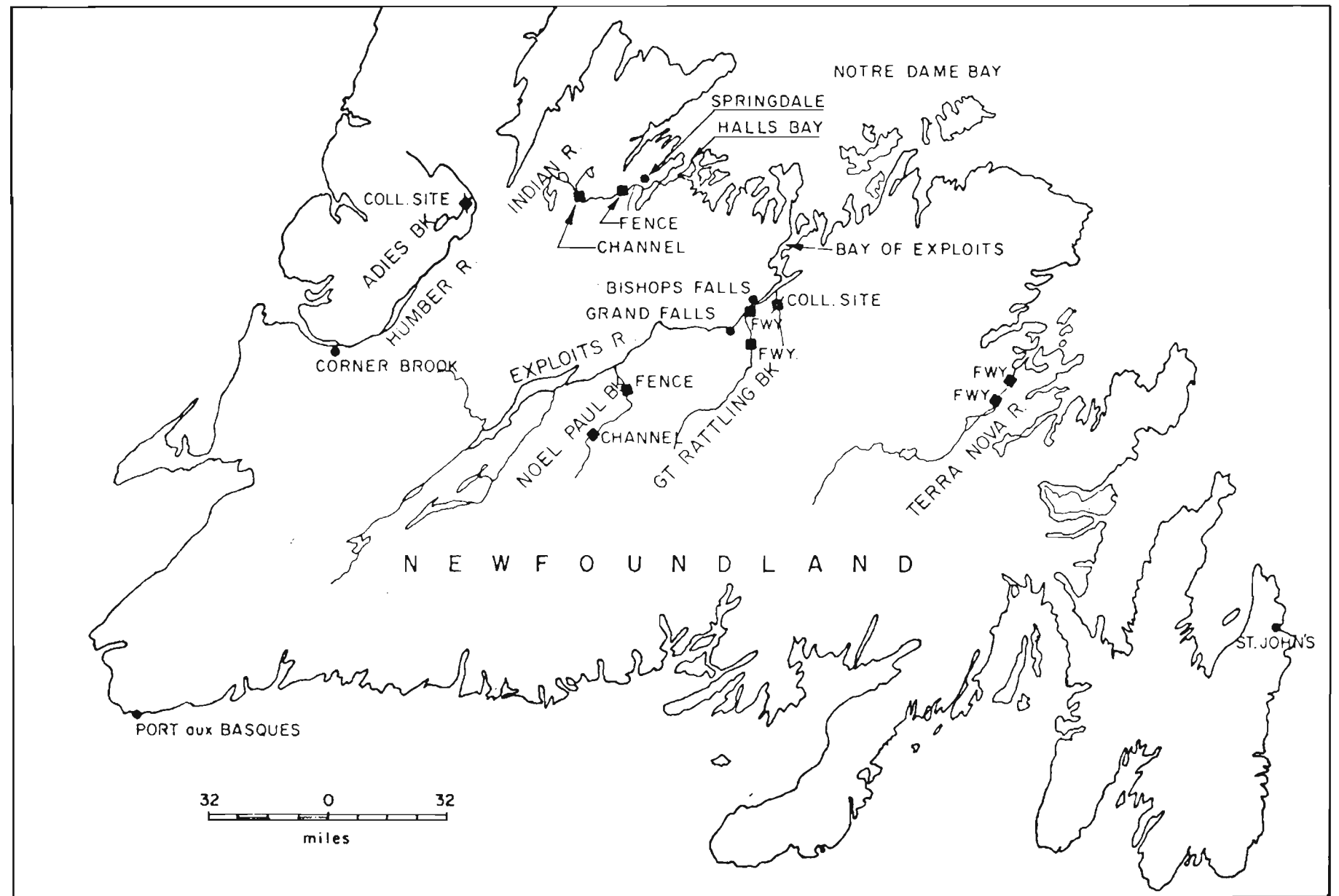


FIG. 1 PROJECT LOCATIONS

As examples of the above techniques, the Upper Terra Nova Fishway Development, the Great Rattling Brook Adult Transfer Stocking Project, and the Noel Paul's Brook Controlled Flow Spawning Channel Project are described (Fig. 1).

#### Upper Terra Nova Fishway Project

In 1954 the Upper Terra Nova Fishway was constructed 14 miles from the river mouth (Fig. 8). The fishway opened 160 square miles of drainage to migrating salmon. A counting trap at the fishway has been operated for the past 18 years and the adult movement recorded. The counts at the fishway are shown in Fig. 2. In the initial years a few fish (21-120) were counted. These are fish which presumably would return to the lower portion of the river. The first noticeable increase at the fishway was in 1962 - seven years after the fishway opening. Since this time, the run has gradually increased to its annual current level of 400 to 700 fish. Similar increases have been noted at an established fishway on the lower portion of the stream as well as in the angling catch below this fishway.

Numbers inside the arrows represent the average yearly escapement to the Terra Nova River before and after the 1960 period coincident with the first major return (from 3 yr. smolts) that could be expected at the upper fishway due to the 1955 escapement. To quantitatively assess the opening of the upper fishway, the average yearly counts at the lower fishway plus the angling catch below amounts to 679 fish per year until 1959. However, the corresponding escapements afterward amount to a yearly average of 1174 fish to the river. The difference between these yearly averages represents an increase of 495 fish per year. Thus it is concluded that the fishway development on the Upper Terra Nova River has nearly doubled the escapement to this river over an 18 year period.

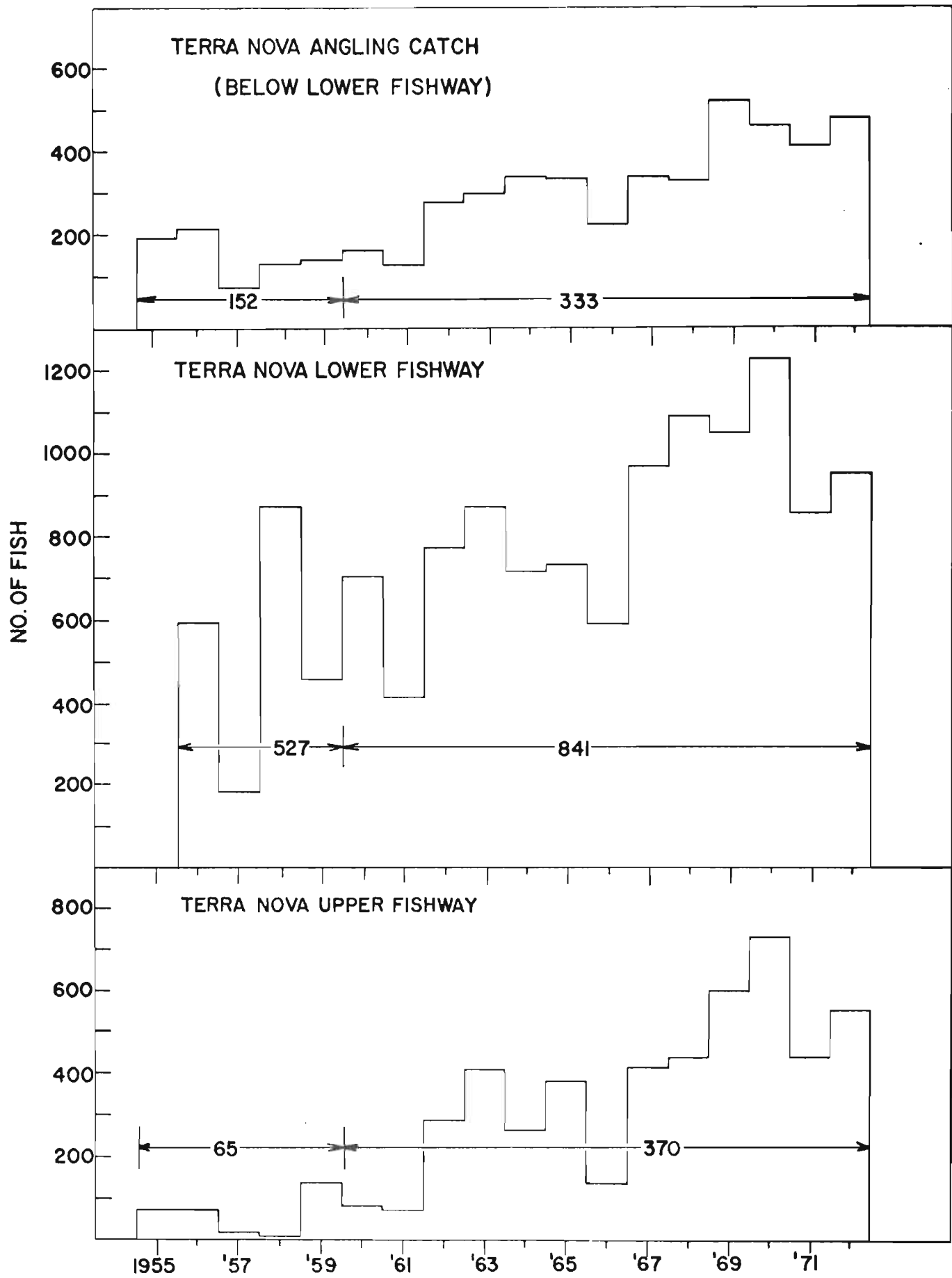


FIG. 2 TERRA NOVA RIVER DEVELOPMENT 1955-1972

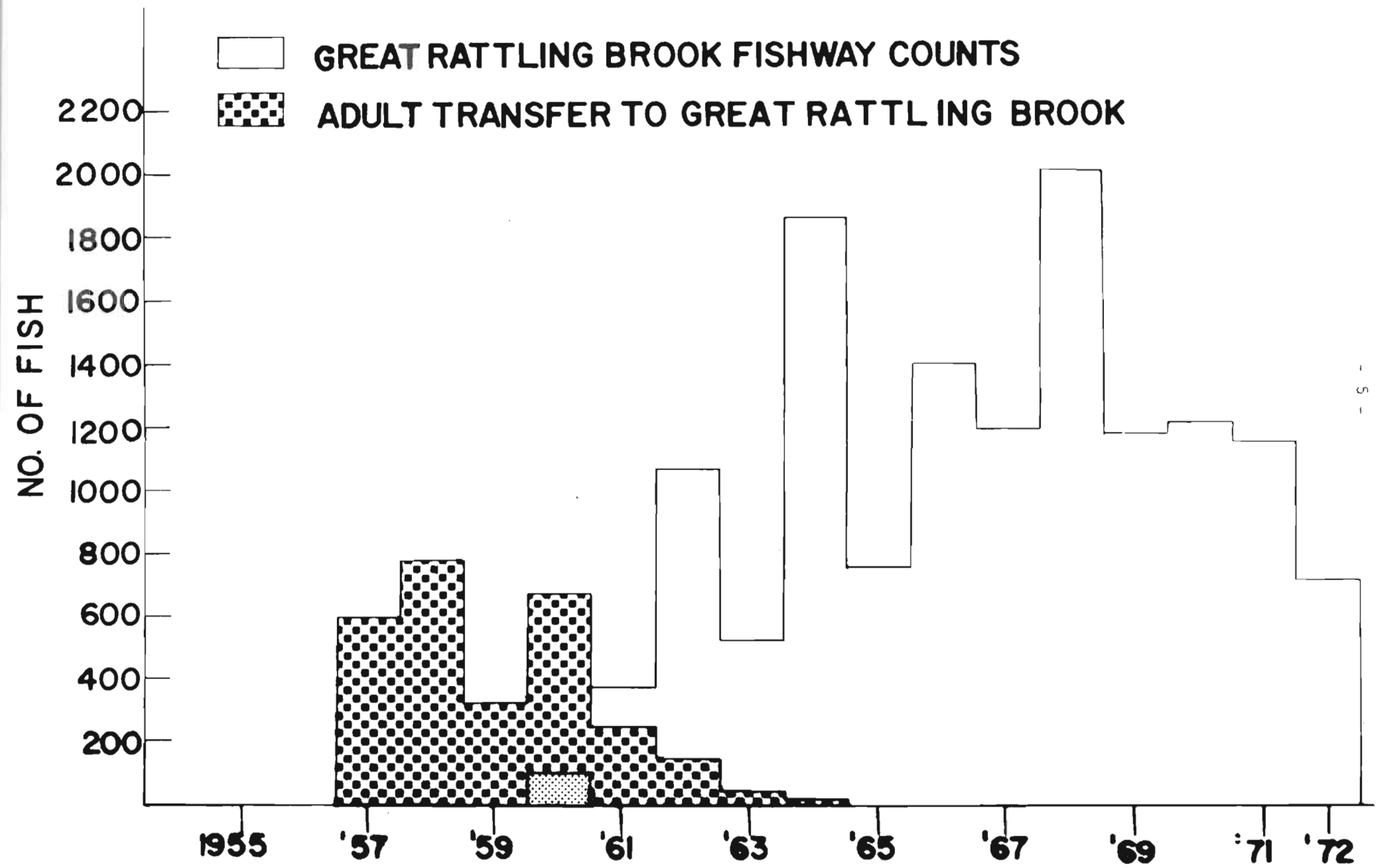


FIG. 3 GREAT RATTLING BROOK PROJECT 1955—1972

Great Rattling Brook Adult Transfer Stocking Project

Beginning in 1957, with the development of a hydroelectric station at Rattling Brook, Bay of Exploits, the entire adult run to this system was collected each year at a collection fence on Rattling Brook and transported 35 miles to Great Rattling Brook. This is a large tributary, consisting of 640 square miles of watershed, draining into the Exploits River below Grand Falls. Each year, adults were released at two points within Great Rattling Brook located two miles and seven miles upstream above an impassable 23 foot vertical obstruction at which a fishway was opened in 1960, to make an added 522 square miles available to salmon (Fig. 9).

The results of the adult stockings are shown (Fig. 3). The transfer of adults to Great Rattling Brook for the seven year period ranged between 59 and 786 adults per year. The fishway was opened in 1960 before any returns from stocking could be expected. However, a few stray fish (103) ascended. In the subsequent discussion, this is assumed to be the basic yearly escapement to this portion of the river before stocking. Such an assumption is not unreasonable since this level is comparable to initial escapements monitored at the Upper Terra Nova River Fishway and at the Torrent River Fishway both of which had escapements which remained relatively low and stable for the first five or six years after opening. Assuming that 103 fish is the basic escapement each year during 1961 to 1963, it is apparent that immediate results were obtained by the previous adult stockings. Since the majority of smolts are 3 years old, the first adult returns from the stocking were expected in 1962. When the total number of fish transferred in the first five years of stocking is compared with the total number of returns in the succeeding 5 years, there is an average yearly increase of 486 fish. In arriving at this calculation, the total number of strays based on 103 fish per year plus the number stocked were subtracted from the total returns during 1962 to 1966 inclusive. It is impossible to quantitatively compare the relative efficiencies of this Great Rattling Project with the previously mentioned

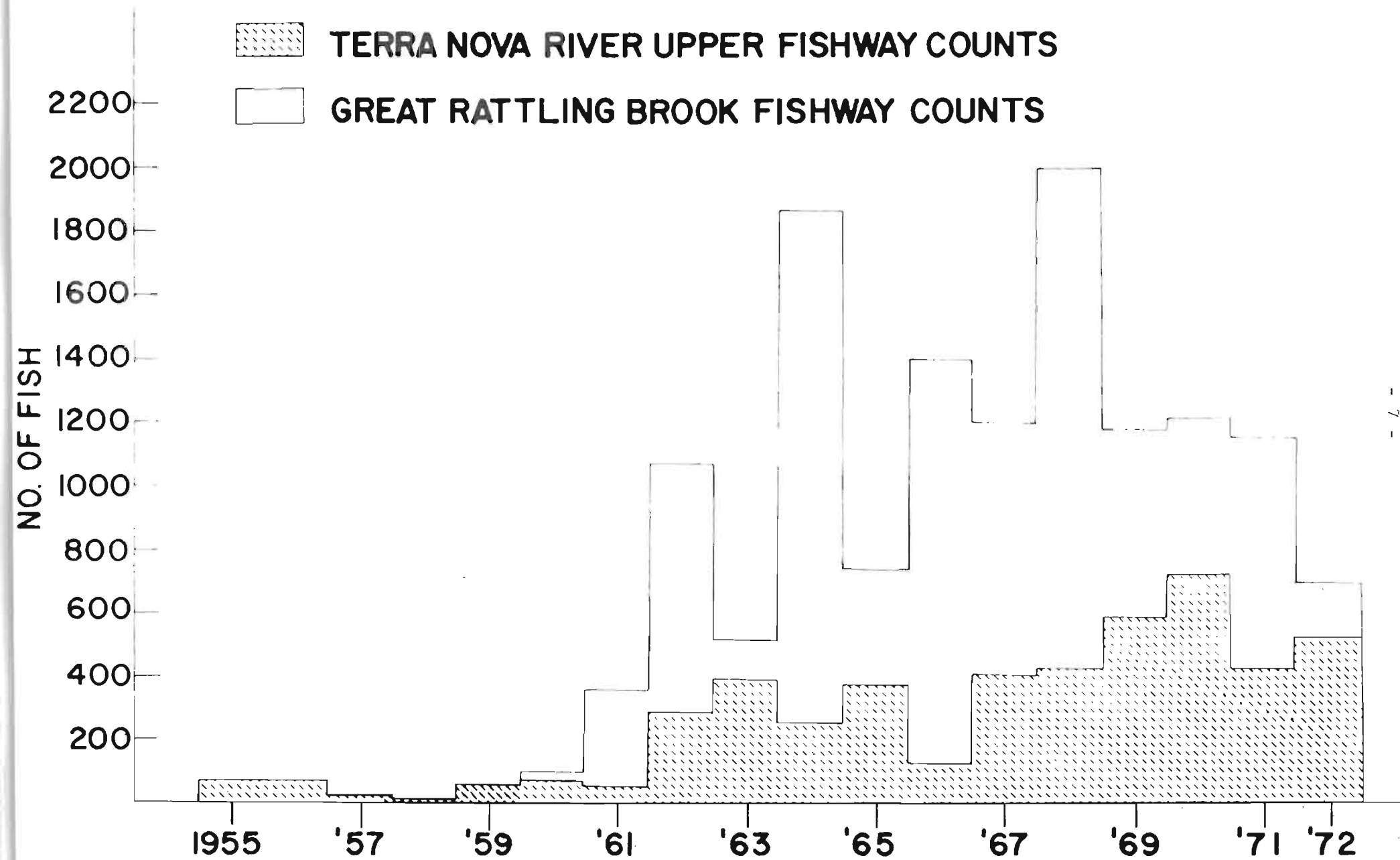


FIG. 4 TERRA NOVA RIVER AND GREAT RATTLING BROOK FISHWAY COUNTS. 1955-1972

Terra Nova Development. However, if brood is available, stocking seems to greatly enhance the rate of establishment of a salmon run in an obstructed stream (Fig. 4).

#### Noel Paul's Brook Controlled Flow Spawning Channel Project

Other means of making efficient use of broodstock are being investigated. With adult transfers, it is not always possible to obtain large brood fish sources. With this in mind, the operation and results utilizing a small controlled flow spawning channel on Noel Paul's Brook, a tributary of the Exploits River will be discussed. The Exploits (Fig. 5) is the largest of Newfoundland rivers and it accounts for almost one quarter of the inaccessible salmon habitat of the Province. A fishway at Grand Falls on the lower portion of this river will make Noel Paul's Brook and adjacent tributaries accessible to salmon.

Noel Paul's Channel was built in 1967 and provides holding and spawning area for Atlantic salmon which are transported from Adies Stream, a tributary of the Humber River (Fig. 10). The adults remain in the holding pools until mid-October and then they move to the adjacent spawning beds. These beds consist of clean round gravel with water velocity-depth profiles similar to those observed on natural salmon spawning beds in Newfoundland.

The fish are mainly grilse averaging 3 pounds in weight and the sex ratio averages approximately 2 females for every male. Two separate sections (containing several spawning beds) are isolated to allow comparisons between different sets of spawning conditions.

Egg deposition in the spawning bed has gradually been increased by increasing the numbers of spawners (Table I). The years 1967 and 1968 were largely trial years operating at low capacities. Since then, the number of females has been gradually increased from a level of one female for 5 square yards of spawning bed and 420 eggs on the average deposited per square yard to one female per 3 square yards of spawning bed and 700 eggs on the average deposited per square yard, with egg to fry survival rate remaining between 50 and 70 percent. Currently, a female spawner

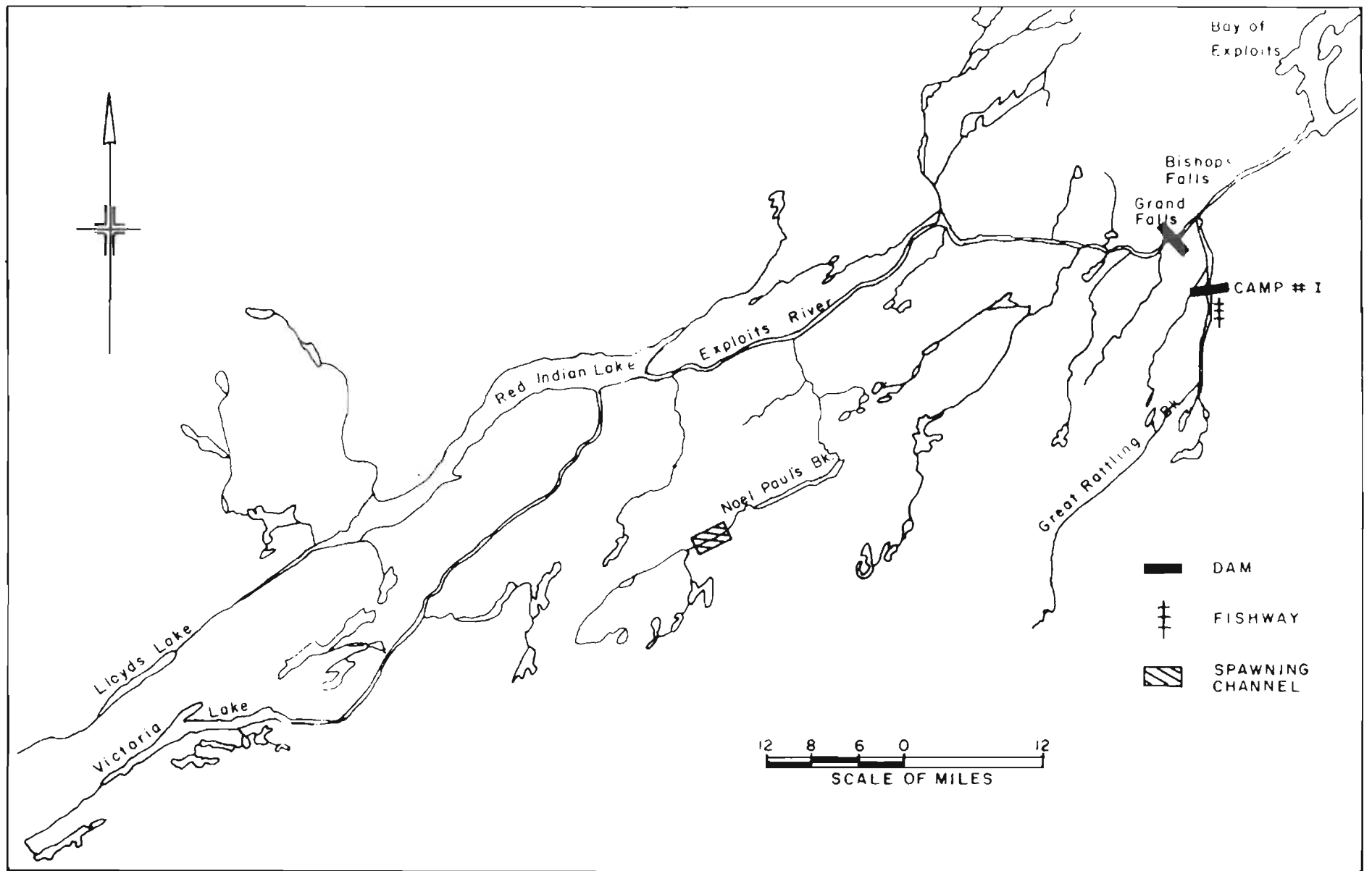


FIG 5 EXPLOITS RIVER DRAINAGE SHOWING MAIN LOCATIONS MENTIONED IN TEXT.

Table I. Spawning Activity, Egg Deposition and Fry Survival, Noel Paul's Brook Spawning Channel

Year	Female Spawning Activity			Egg Deposition		No. of Fry	Egg to Fry Survival Rate (%)
	No. of females	Square yd./♀	% of Bed in Redds	No. of eggs	No./sq. yd.		
1967	113	12	19	289,450	175	152,838	53
1968	146	5	31	296,822	420	162,409	60
1969	232	4	31	489,022	525	332,728	69
		5	31		420		70
1970	242	3	30	502,446	700	302,769	52
		4	33		525		69
1971	297	4	34	627,500	525	311,871	36
		3	21		700		54
1972	282	4	32	598,192	525		
		2	44		1050		

density of one female per 2 square yards of spawning bed is being tested. In all years and at all spawning densities, distributions of adults have resulted in low redd superimposition with the exception of one group of fish in 1971. In that group spawner aggregation with redd superimposition occurred due to the presence of patches of unsuitable coarse substrate which have since been replaced.

Although there is no indication that we have reached the upper limit of crowding spawners onto the bed, plans to begin gravel incubation experiments using manual planting methods and incubation containers of various designs are now under study. Even at the highest spawner density only 44% of the bed area is in redds while egg deposition within the redd area itself has been quite high (up to 3400 eggs per square yard in 1971 with an egg to fry survival of 54 percent). It seems probable that the adult egg deposition capacity of the channel can be established at one million eggs at fry survivals above 50% with a potential capacity of 2 to 3 million eggs; that is, if planting of green eggs proves practical on a large scale.

The fry upon emergence from the spawning beds are collected, enumerated and distributed to various sections of the main river and tributaries for rearing.

The stocking procedure consists of distributing predetermined numbers of fry evenly over one-quarter-mile sections of suitable stream rearing area. These areas are selected on the basis of habitat type and level of standing crop as determined from stream electrofishing inventories prior to channel fry stocking. The distribution interval was based on channel fry planting studies conducted under similar stream habitat and standing crop conditions in a portion of Indian River located in Central Newfoundland (Fig. 1). It has been shown that the majority of channel fry introduced to stream areas containing low standing crops moved downstream 0.2 to 0.4 miles when average stocking densities were low (75 and 150 fry/unit).

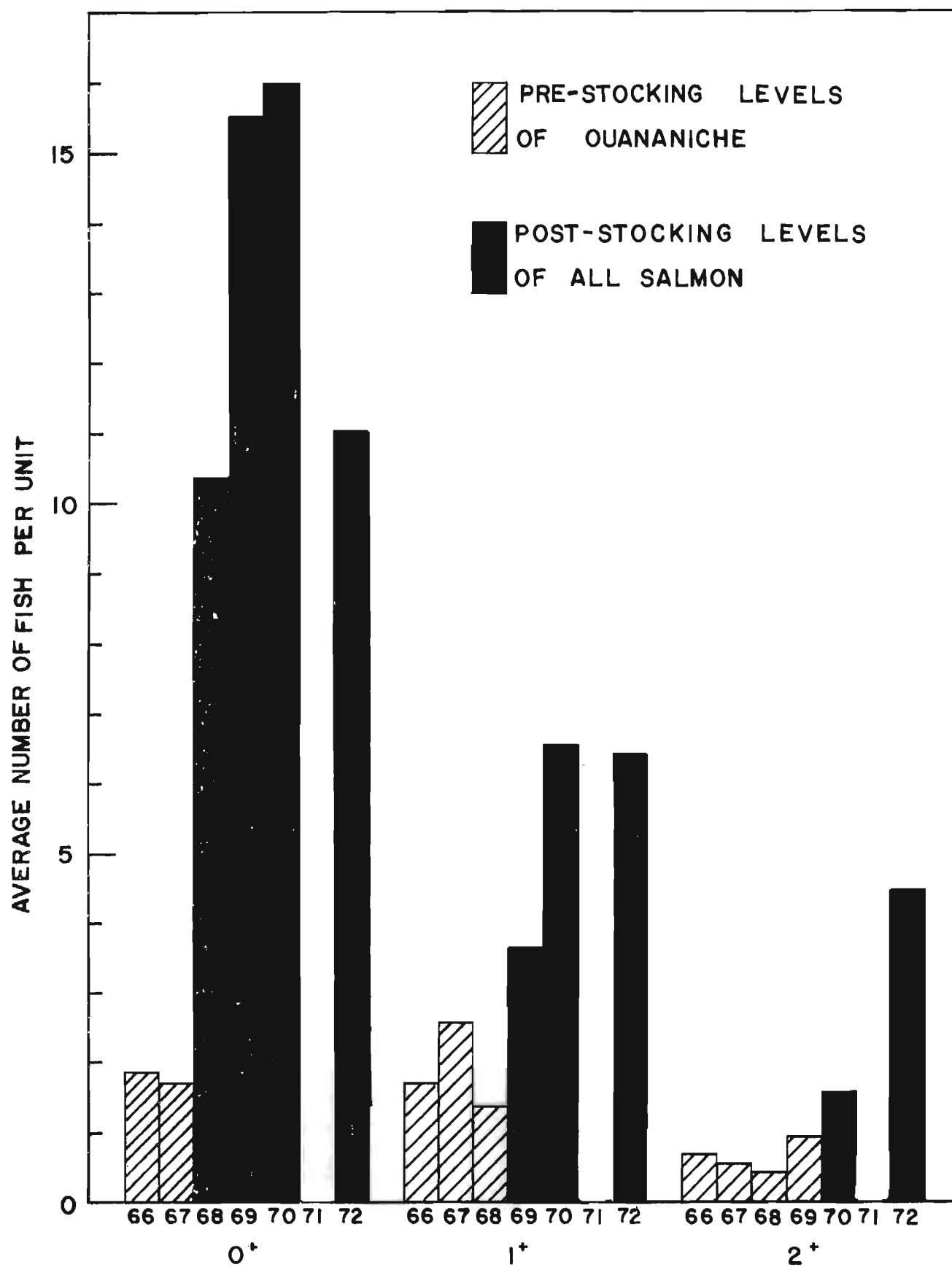


FIG-6. STANDING CROPS IN THE STUDY AREAS OF NOEL PAUL'S BROOK, 1966-1972

Also at Indian River, it has been shown that in areas already stocked, the highest parr densities were associated with rubble-boulder stream bottom type. The Noel Paul's Brook consists of fine bottom type (judged suitable for spawning) distributed throughout the coarser rubble type bottom. Several large tributaries occur in the drainage and these represent approximately one fifth of the total rearing area of the system. Most of these tributaries contain coarse rubble-boulder bottom types which are excellent for rearing but unsuitable for spawning.

Standing crops before and after stocking the selected areas with channel fry have changed (Fig. 6). The abundance of underyearlings, one year and two year parr, as estimated by electrofishing census has increased quite substantially over levels of landlocked salmon or ouananiche in years prior to stocking. Stream biomass expressed in pounds per acre has increased from an average level of 4.16 in 1966-67 to 9.24 in 1972 after stocking. Data is missing for the year 1971 due to combined difficulties with the electrofishing gear and high water levels. Stocking densities of fry during 1968, 1969 and 1970 were 35, 45 and 70 per unit respectively. The intermediate density resulted in the highest survival to the fingerling stage, and its use since 1970 has resulted in a 25% survival within all habitats stocked. Survival in the tributaries has been much higher ranging to 70% (average 45%).

In addition, since 1970, downstream smolt assessments have been conducted on the lower section of Noel Paul's Brook (Fig. 11). In 1970 nearly 1000 fish were counted (Fig. 7). Aging analysis indicated that approximately 90 percent of these were landlocks. In 1971, the first year of an expected major searun smolt production, the run was 6200 fish. In 1972 the run was 6500 fish. To estimate the total number of searun smolts in each of these years, the 1970 percent frequency curve for age composition of landlocks was applied. This resulted in estimates of 4014 and 5739 searun smolts in 1971 and 1972 respectively. Without adult returns, it is preliminary to assess the effectiveness of this channel.

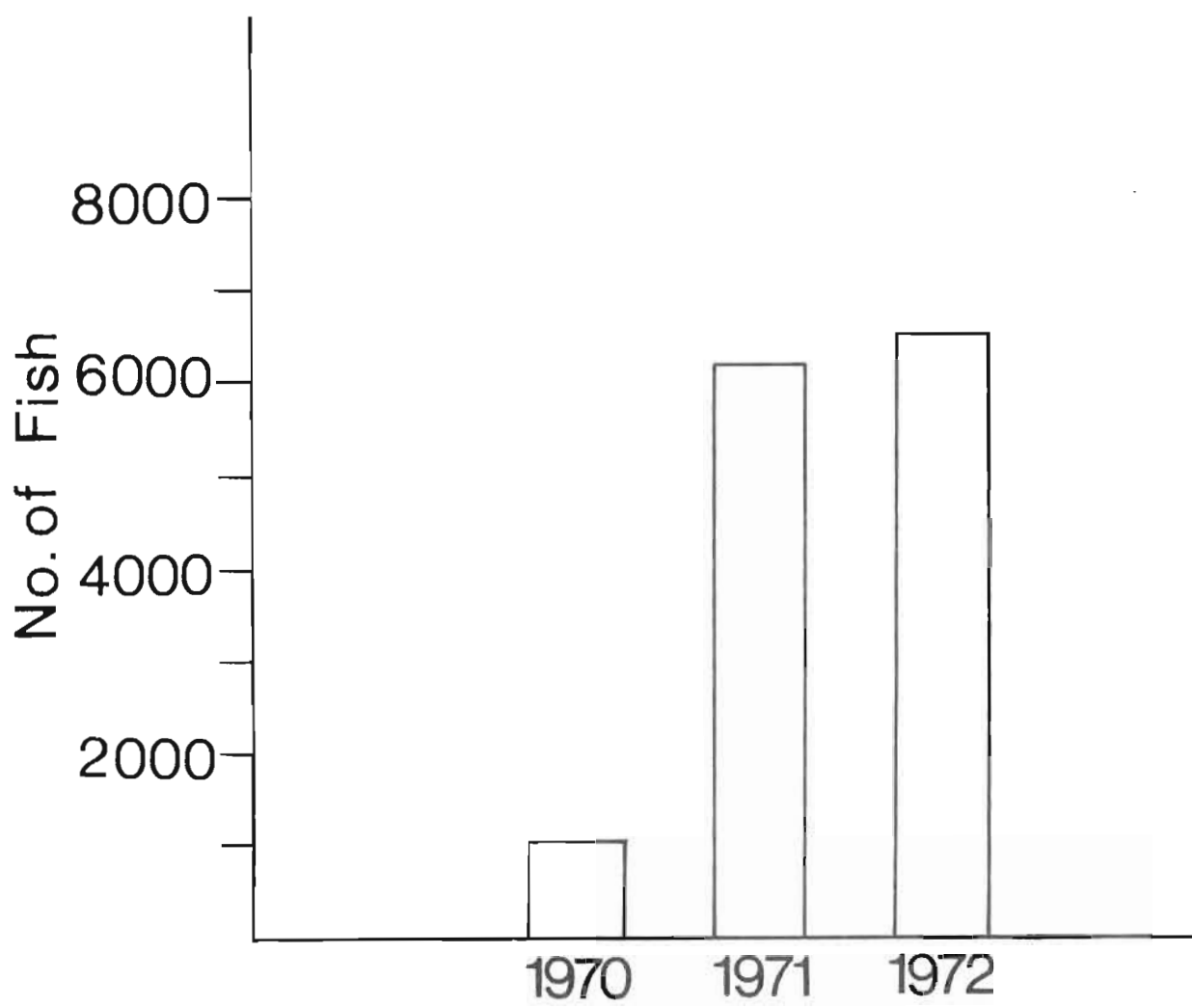


Fig.7 Smolt run, Noel Paul's Brook

However, based on the 1972 smolt run, an estimate of the smolt production of 1.37 per unit stocked is obtained in relation to the first mentioned 1968 channel fry productions and stocking. This figure is quite close to the 1.7 smolts per unit (range 1.4 - 2.0) found in other Newfoundland streams. Also, the high standing crop estimates of 2 year parr suggest a substantial increase in smolt production in 1973. Thus the use of the Noel Paul's Channel appears to be rapidly establishing a searun salmon population. With the completion of the Exploits River Fishway, this can be verified with adult returns. Four tagged adults have been recaptured within the local commercial fishery from 3100 smolts tagged in 1970 and 1971.

To summarize, the opening of fishways on obstructed streams results in a gradual establishment of a salmon population whereas adult stocking coupled with a fishway opening results in an immediate establishment of a fish population. A comparative assessment of the spawning channel efficiency will depend upon adult returns to the Grand Falls Fishway.

#### Acknowledgements

The authors wish to acknowledge Messrs. V.R. Taylor and R.E. Cutting for their support and guidance in carrying out the projects.

We wish to thank Messrs. M.K. Farwell, L.G. Riche, B.R. Bauld, K. Powell, K.M. Mercer, A.P. Cowan, G.R. Traverse, E. Tulk, R. Fitzpatrick and L.G. Goulding for their important efforts in implementing or managing the projects.

Field support was provided by Officers, Wardens and Guardians of the Conservation and Protection Branch.

We again thank Messrs. R.E. Cutting and also G. Hare for criticism of the manuscript, Mr. P. Caines for preparing the figures and Miss C. Colford for typing the manuscript.



FIG. 8 UPPER TERRA NOVA RIVER FISHWAY



FIG. 9    CAMP ONE FALLS FISHWAY, GREAT RATTLING BROOK



FIG. 10 NOEL PAUL'S BROOK CONTROLLED FLOW CHANNEL

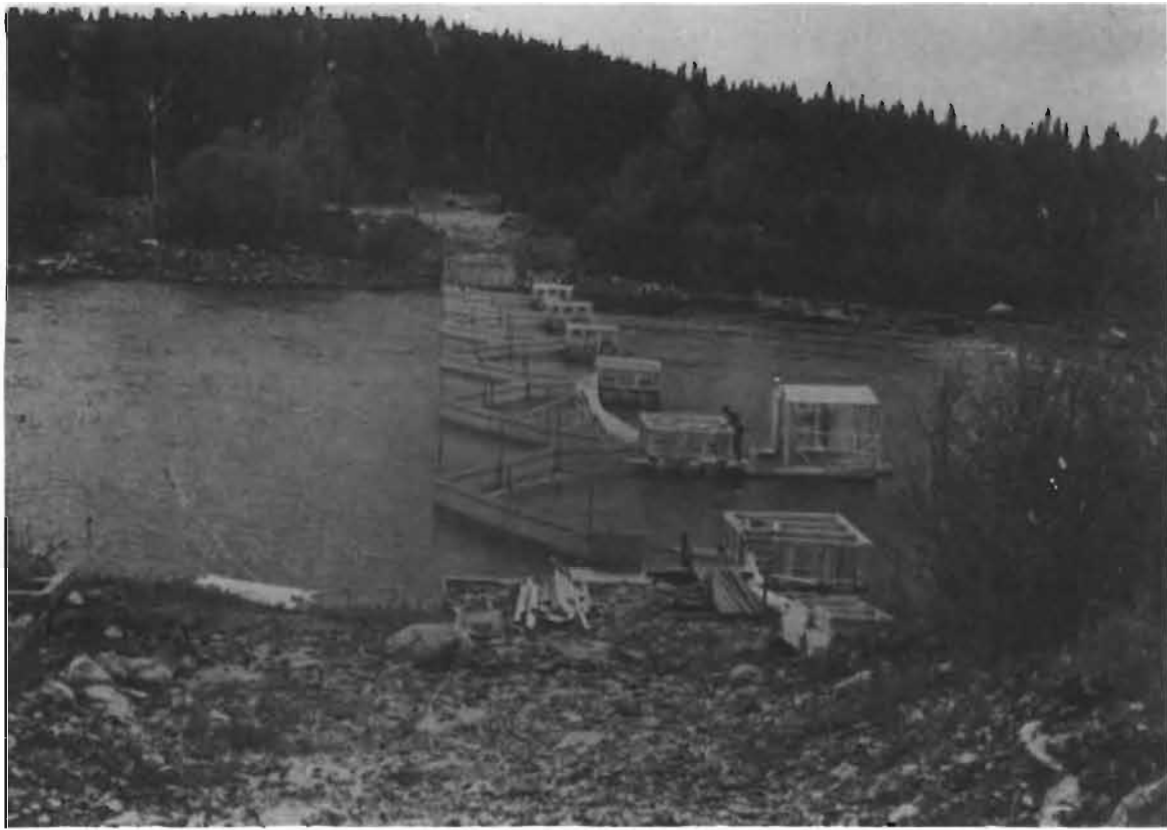


FIG. 11 NOEL PAUL'S BROOK COUNTING FENCE

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