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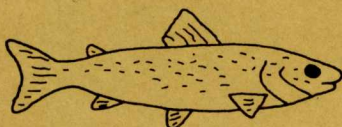
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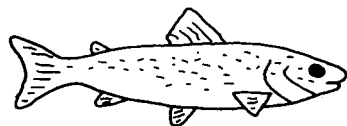
MAY 29 1974



ANNUAL REPORT 1971

RESOURCE DEVELOPMENT BRANCH
NEWFOUNDLAND REGION
ST. JOHN'S

 ENVIRONMENT CANADA
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**ANNUAL REPORT
1971**

RESOURCE DEVELOPMENT BRANCH
NEWFOUNDLAND REGION
ST. JOHN'S

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I N T R O D U C T I O N

INTRODUCTION

V. R. Taylor
Branch Chief

The year just ending will see a substantial change in some Branch responsibilities, in that its involvement with water pollution control will be considerably diminished. Many of our former responsibilities in this area will, as of April 1, 1972, pass to the local unit of the newly created Environmental Protection Service (E.P.S.), together with those of our staff who have been working on what are now E.P.S. problems. Resource Development will retain a responsibility in the general area of environmental quality for fishes but the main water pollution control functions (negotiation, regulation and implementation) will be within the bailiwick of the new E.P.S. Those related activities that remain with Resource Development will be handled by our new Water Resource Group.

While on the subject of organization, it will be noted (see Chart, Appendix I), that the Branch has two new Group titles, namely a Recreational Fishery Group and a Commercial Fishery Group. The former is our old Lake Management Group, with broadened responsibilities; and the latter a new Group designed primarily to carry out investigative work, mainly in the marine area, necessary to provide information for more precise management of Newfoundland Atlantic salmon stocks. In summary, the main changes in Branch work, aside from loss of the E.P.S. component, are expected to be a new emphasis on the broader aspects of recreational fishing and the beginning of certain investigations on local salmon populations in the marine area, the latter in close cooperation with the Anadromous Fish Unit of F.R.B., St. John's.

Amongst a number of Branch projects that might be mentioned in this introduction are the Exploits River Development Program and the proposed "fish culture establishment". The first named, which has been in the investigative and early developmental stages for many years, will take another step in 1972 in the construction of fish collection works at Grand Falls. To reach fruition, the program will require a number of years since each succeeding step is predicated on the success of preceeding ones. In the case of the "fish culture establishment", planning is at a less advanced stage. However, groundwork for such an establishment, in the form of guidelines and preliminary plans, will be laid in the coming year.

The rejuvenation of the old Canadian Fish Culturist, perhaps by another name, or a totally new publication, has recently come up again. The old C.F.C. was the main publication medium for ours and

similar work and its dormancy for the past year or so, with no obvious successor, has left a publication gap. Whatever the end result in this direction of moves now underway, it is again emphasized, especially to all of our professional staff, the necessity to "write up" these things that should be reported; not only because in this way our work reaches a wider audience than ourselves, but also because of the value of "writing for publication" to the individual himself and to his work.

As always, Branch work is dependent in many ways on the cooperation of other Branches, both at regional HQ and in the field, and I express our appreciation to all of them. Similarly, it requires coordination with the local F.R.B. Anadromous Fish Unit, and the rapport which exists between our staff and those of the F.R.B. Station is to our mutual benefit and to be commended.

Finally, on behalf of those of us who remain with Resource Development, a pleasant "bon voyage" to those of our brethren who will soon be setting sail in the new E.P.S. "ship". We wish them well!

EXPLOITS RIVER

EXPLOITS RIVER

J.D. Pratt, Group Leader (Development)

S.G. Pond, Group Leader (Pollution)

The 4,400 square miles of drainage area in the Exploits River watershed constitutes the largest potential for the development of Atlantic salmon on the island of Newfoundland. At present, only the area below Grand Falls is accessible to salmon (Fig. 1).

The objective of the Exploits River Development and Management Program is to maintain existing runs and to establish additional populations of Atlantic salmon within the watershed. If fish passage facilities are provided at Grand Falls and at other areas and if salmon populations are established in now-unused rearing areas, an adult spawning escapement of approximately 30,000 fish and a commercial and recreational fishery of some 55,000 fish could be developed.

Immediate implementation of the full development program is hampered by current uses of the waters. These are mining, logging, hydroelectric, pulp and paper, and domestic water-users within the system. Current efforts to upgrade present water quality and to prevent further pollution are expected to permit intensive fisheries development. Provision of adequate quantities of transportation water for migrant fish at Grand Falls may be complicated by the diversion of a major tributary (Victoria River) into the Bay D'Espoir Power Development. Proposed diversion of a second main tributary (Lloyds River) could further decrease the flows in the main river. Cooperation and coordination of federal, provincial, and private agencies with interests in the watershed is a prerequisite to establishment of Atlantic salmon populations above Grand Falls.

DEVELOPMENT

M.K. Farwell
H.J. Rietveld
K.M. Mercer

Grand Falls Obstruction and Fishway

Detailed hydrographic surveys of a portion of the Exploits River below the obstruction and powerhouse at Grand Falls have been completed. These investigations have revealed that there are no physical hindrances to migrating salmon between the natural obstruction at Grand Falls (Fig. 2)

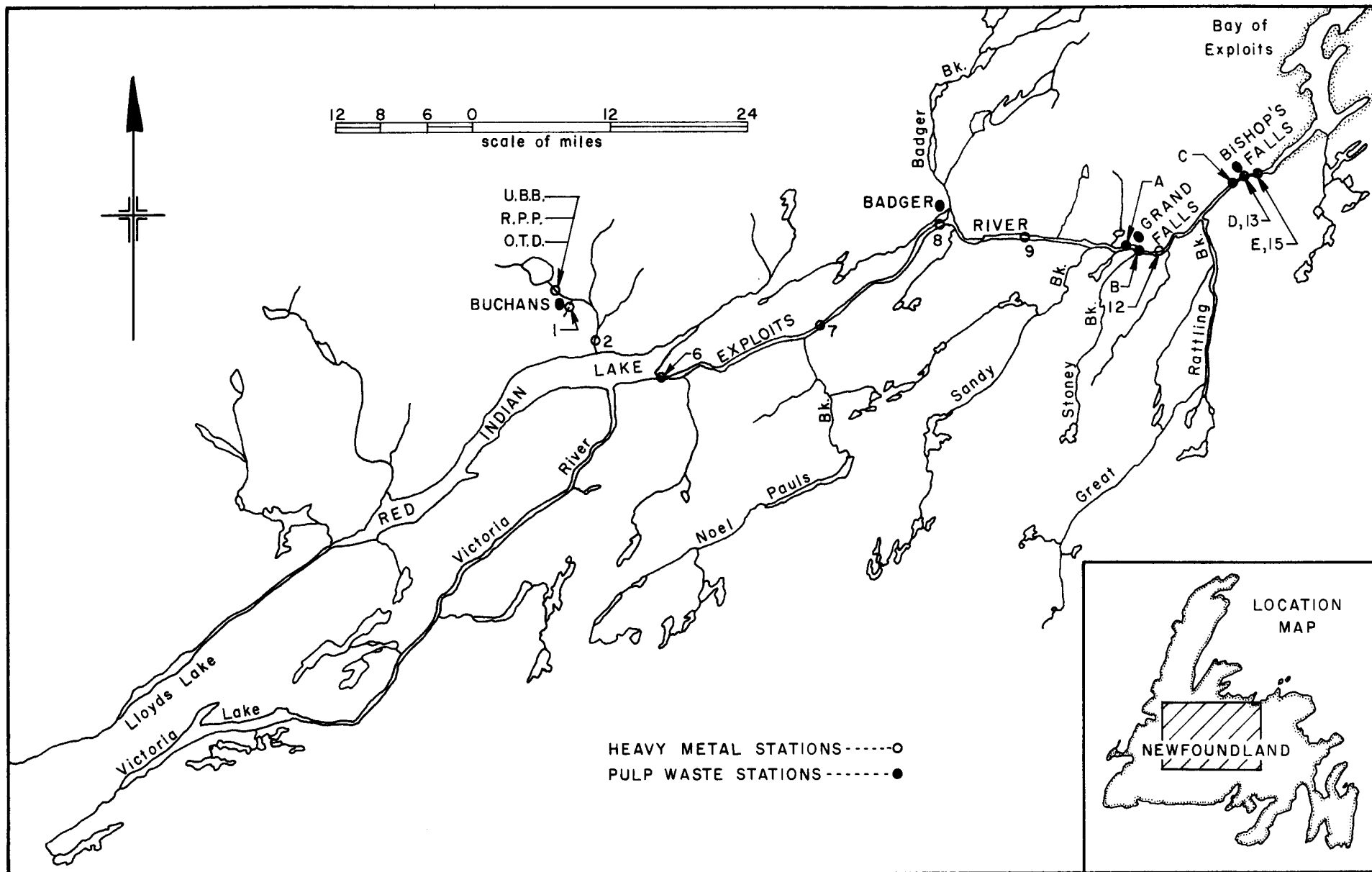


Fig. 1 The Exploits River Basin showing Pollution sampling stations, 1971

and the powerhouse tailrace farther downstream. Water currents in the tailrace will attract salmon there temporarily, but the river flow should be sufficient to attract salmon to the fish pass facilities to be located upstream on the spillway channel.



Figure 2. Grand Falls.

In November, a resumé of the development program and a request for construction funds for the fishway at Grand Falls was submitted to Ottawa, subsequently approved. By the end of this fiscal year, design and construction plans for a vertical slot fishway into a fish collection facility will be ready for the construction to take place in 1972. The fishway will be operable in 1973 to provide the progeny of Noel Pauls Spawning Channel passage over the obstruction enroute to Noel Pauls Brook.

Hydroelectric Facilities

Investigations of forebay delay and subsequent turbine mortality of downstream-migrating smolts and kelts were carried out at both the Grand Falls and the Bishop's Falls power facilities. Twenty-seven hundred smolts and several hundred kelts were tagged at Noel Pauls Brook for use in identifying migration timing, delay, and routes near the hydroelectric forebays. Such tagging also will provide data on contribution to sports and commercial fisheries.

These investigations indicate that passage of fish through the turbines at the Grand Falls power plant will result in a heavy mortality. However, in the forebay a surface-spilling gate apparently allows fish to leave the forebay and re-enter the main river successfully. During the smolt and kelt migrations this gate spilled water continuously, and no fish accumulated in the forebay. A guaranteed spill arrangement should prevent future excessive mortalities.

The Bishop's Falls power plant has been an annual problem for migrating smolts and kelts. This year large accumulations of smolts and kelts were present in the forebay during the latter part of May. Due to economic conditions, the Price (Nfld.) Pulp and Paper Mill shut down generating operations in late May and those fish were rescued from the forebay. In Mid-June, Noel Pauls Brook smolts began entering the forebay and were present until early July when another power production shutdown occurred, enabling the fish to be successfully removed. These observations lead to increased concern over the fish delays at Bishop's Falls. Comparison of the Grand Falls and Bishop's Falls forebays and assessment of the behaviour of the fish in the forebay at Bishop's resulted in the design of a surface-spill opening in the forebay. This alteration will be completed during this winter for operation in 1972. If the remedy results in free passage of smolts and kelts, then there will be no need for previously-anticipated turbine mortality studies and/or costly diversion screening.

Investigations were also begun involving the Sandy Brook Hydroelectric Plant and the Victoria Lake Control Dam. At present, these two structures are located away from the portion of drainage accessible to anadromous fish but will be involved in the future development program. Preliminary results suggest that fish migration difficulties at these two sites can be solved.

Stream Survey Investigations

Adult and smolt counts and spawning surveys were continued in 1971 to assess size, distribution, and salmon population trends in the Exploits.

A smolt fence was installed on Stoney Brook (Fig. 1) to ascertain the extent of an apparent decline in the Atlantic salmon population. However, an early spring run-off prevented obtaining a complete count, and only 750 smolts were counted.

The annual counts at Great Rattling Brook and Bishop's Falls fishways were both done this year (Fig. 1). At Bishop's Falls 1,341 adults were enumerated by using a temporary wooden trap installed in the flashboards, as in past years, because the new fishway was under construction. The new fishway-counting facility was completed in the early fall and will be used next year. During the peak of the run at Bishop's Falls, blood serum samples were taken from one hundred adults for biochemical analysis.

The Great Rattling Brook adult count conducted at Camp One Falls Fishway totalled 1,163 fish. The adult escapement has gradually increased as a result of the transfer of the adult salmon run from Rattling Brook in the early 1960's. However, counts of the last few years indicate that the run is "levelling off". Further investigations are necessary to determine why the run has stopped increasing. Deterioration of the wooden dam at the falls has made the modification of the dam and fishway necessary.

Selected Exploits tributaries were surveyed by air in 1971 in an attempt to define more accurately the rearing and spawning potential within the watershed. This survey revealed a few migration obstructions of which all but one can be removed by minor remedial action.

These surveys also served to inspect an intensive logging program on the Lloyds River (Fig. 1), a major tributary located above Red Indian Lake. Logging practices presently in use are being examined because of possible deterioration of salmon habitat. This assessment will result in recommendations for environmentally-safe harvesting of pulp wood. The Environmental Protection Group and the Forestry Service are also cooperating on this project.

A survey of the upper Victoria River revealed that rearing and spawning areas lost due to the Bay D'Espoir diversion of Victoria Lake may not justify plans for developing the area for salmon unless sustained water flow from the dam is arranged.

Commercial and Recreational Fisheries

In 1971, investigations into the homewater commercial fishery in the Bay of Exploits (Fig. 3) were started. Home waters have been defined as that area within 25 miles of the Exploits River mouth (i.e. the bottom of the Bay of Exploits). Commercial data since 1960 and

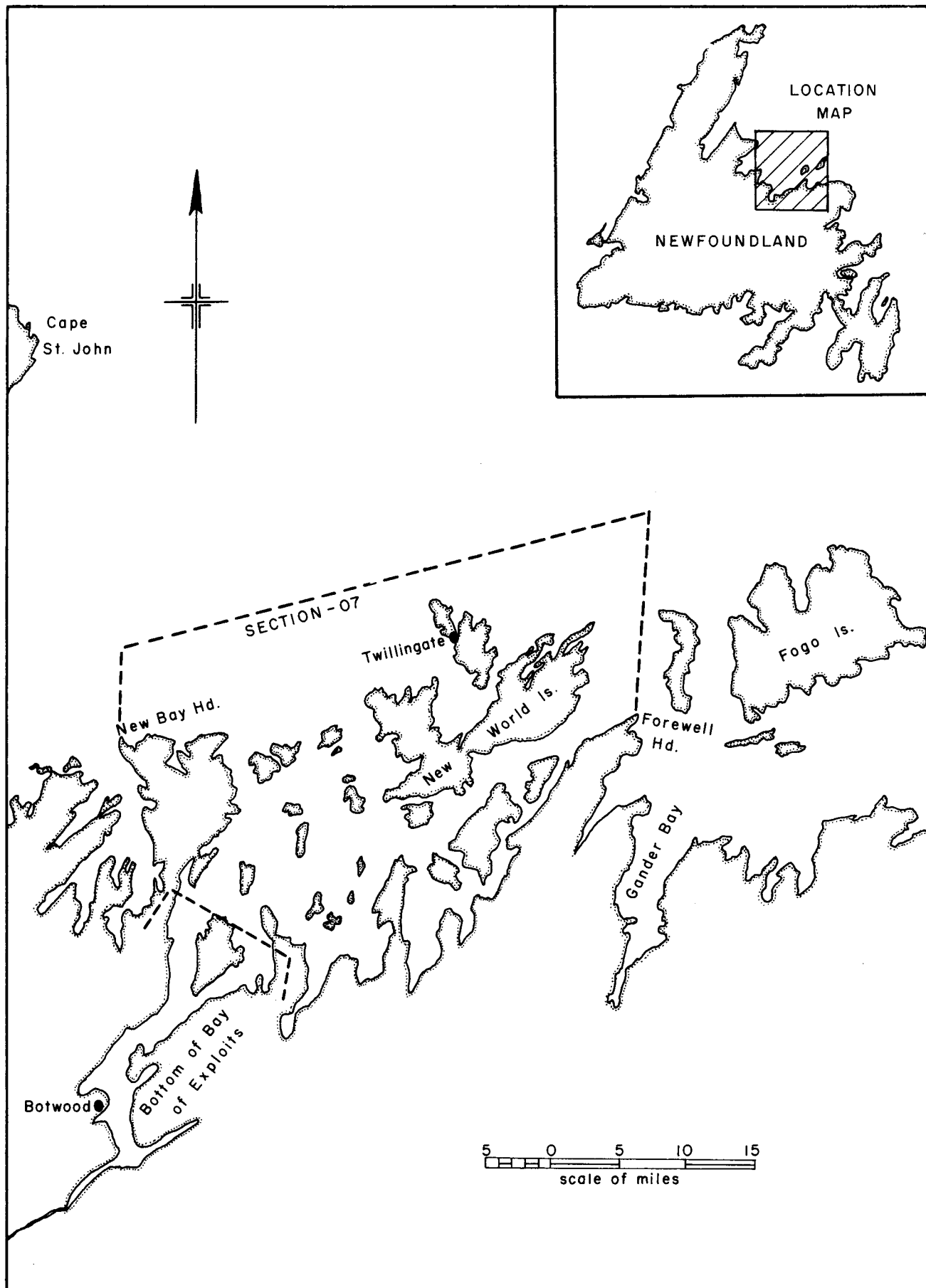


Fig. 3 Location map of commercial fishery area "B", section 07. (Home waters of Exploits River fish are designated as the bottom of the Bay of Exploits)

recoveries of Exploits River tagged kelts since 1964 were analyzed. These data revealed that the Bay of Exploits commercial fishery catch is composed mainly of homewater stock. The commercial catch of recovered kelts is 91 percent of the total return. Thirty percent of these are taken in the home waters. It was concluded that regulations aimed only at Exploits River fish would have to be restricted to the area within approximately fifteen miles of the river mouth.

The commercial fishery survey done in the bottom of the Bay of Exploits in 1971 attempted to define accurately effort and catch during the fishing season. Analysis revealed that the timing of catch and fishing effort followed closely the timing of the run into the Exploits River. The average weight of fish taken in the commercial nets was 4.5 pounds. Further investigation will define the relation of catch and escapement so that the escapement to the Exploits River can be increased.

In 1971 the recreational fishery on the main Exploits was investigated. Areas of angler concentration were located, and past records were analyzed to determine the percentage of the run taken by angling. The recreational fishery in the years 1961 - 1971 took an average of 23 percent of the run. It is evident that the most intense angling effort is expended below Bishop's Falls. Most fishing occurs in the tailrace and pools at the lower end of the rapids below the dam. Further investigation may warrant moving the present boundary to protect fish in this vulnerable area.

Noel Pauls Brook Development

Noel Pauls Brook, a tributary of the Exploits, enters the river between Grand Falls and Red Indian Lake. It has a drainage of 410 square miles, or about one-tenth that of the Exploits River. The Department has initiated a salmon development program which should result in a viable salmon population in Noel Pauls Brook soon enough that planned fish passage facilities at the Grand Falls obstruction will receive immediate use after installation. This approach will reduce the time needed to bring the central Exploits area into salmon production.

Establishment of a salmon population can be achieved by various approaches. A controlled-flow spawning channel was chosen as the method for trial at Noel Pauls Brook.

Annual Channel Escapement. Since 1967, Atlantic salmon spawners have been transferred by truck from Adies Stream on the upper Humber River to the spawning channel on the upper part of Noel Pauls Brook. Annual information on the channel introductions and sex ratios is provided in Table I.

Table I. Annual salmon spawning escapements and egg deposition, Noel Pauls Brook Channel, 1967-1971.

Year	Channel escapement			Sex ratio - F:M		Estimated egg deposition			Egg-to-fry survival			
	Grilse	Salmon	Total	Grilse	Salmon	Natural (Fish deposited)	Planted (Manual burial)	Total	Natural		Planted	
									No. fry	%	No. fry	%
1967	222	3	225	55:45	100:0	289,450	-	289,450	152,838	53	-	-
1968	358	7	365	43:57	57:43	222,158	74,664	296,822	133,043	60	29,366	40
1969	433	3	436	67:33	34:66	468,930	20,092	489,022	327,728	70	5,000	20
1970	392	2	394	66:34	0:100	502,446	-	502,446	302,769	63	-	-
1971	470	9	479	68:32	56:44	627,500	-	627,500			-	-

Since the channel operations started, spawner density has been increased from one female per 12 square yards to one female per 3 square yards. Preliminary results indicate that one female per 4 square yards may be the most practical density, but experiments are continuing to evaluate the density of one female per 3 square yards.

Fry Production and Distribution. Egg depositions, fry productions, and egg-to-fry survival rates are summarized in Table I. Channel fry have been distributed manually at one-quarter mile intervals into Noel Pauls Brook and feeder tributaries at an average density of 45 fry per 100 sq. yards of rearing area.

Standing Crop Population Studies. In 1966 and 1967, electrofishing assessments were conducted in stream sections which were to receive first channel fry in 1968. Before stocking, these sections usually contained small populations of ouananiche and brook trout. Figure 4 summarizes the salmon population levels occurring before and after fry stocking within Noel Pauls Brook. The program has now proceeded long enough to show that channel fry stocking has substantially increased standing crops of all year-classes. At the same time, the resident trout population has decreased. Electrofishing results also indicate that the tributaries are more productive rearing areas than is the main river. Preliminary analysis of 1971 electrofishing data shows that all year-classes of parr are abundant in the tributaries but that underyearling and 2⁺ numbers are lower than expected in Noel Pauls Brook. Table II compares the past and recent status of stream biomass production at Noel Pauls Brook by species with that of Indian River during 1966 and 1967, a stream which is considered moderately-productive compared to other European and North American salmonid streams. Production at Noel Pauls Brook after channel fry introductions has increased almost threefold, but total biomass is still only one-third that of Indian River. Figure 4 indicates stocking densities used from 1968-1970 and the corresponding young-of-the-year survival rates. Highest survival was achieved with a channel fry stocking density of 40 to 45 fry per one hundred sq. yds. of stream area. Channel fry dispersal studies also indicate that efficient seeding is not achieved when fry are distributed at greater than 1/2 to 3/4 mile intervals. Hence, our channel fry stocking will continue at densities of 45 fry per unit and release-intervals of less than one-half mile.

Smolt Assessment. The Noel Pauls Brook smolt run was counted at Lower Noel Pauls counting fence and it contained the first complement of 3⁺ smolts which are the progeny of the first (1968) channel fry stocking. An early spring run-off resulted in the enumeration of only the later portion of the smolt run. It was estimated that the total run was composed of 6,200 migrants, 4,000 of which were of channel origin. Age sampling of this segment indicated that 220 were age 2⁺ and 3,800 were age 3⁺ smolts.

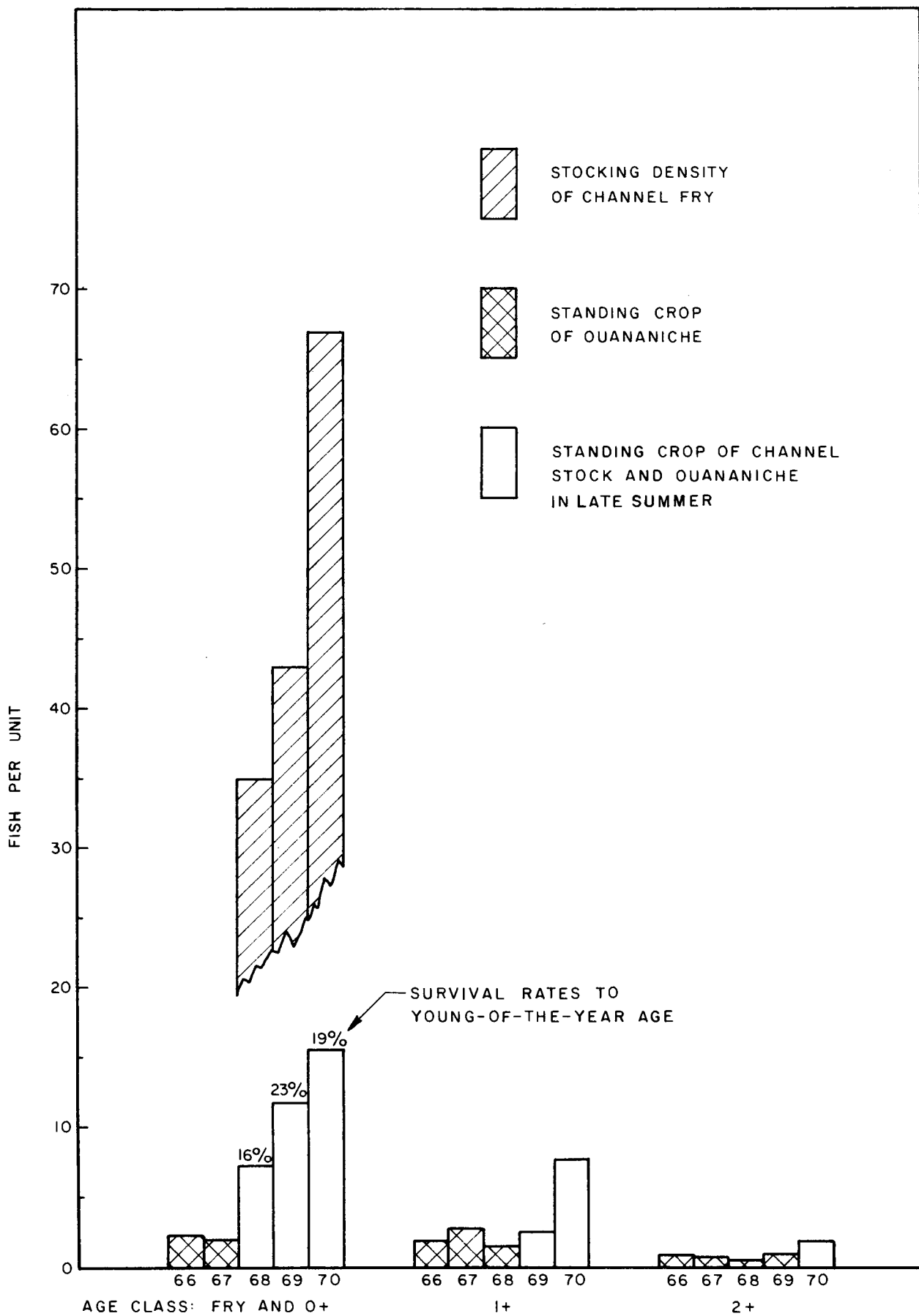


Fig. 4 Standing crops, 12 mile study area, Noel Paul's Bk.

Table II. Stream biomass production by species, Noel Pauls Brook, 1966-67, 1970, and Indian River, 1966-67.

Stream	Year	Pounds per acre					Total
		Salmon fry	Salmon parr	Trout	Eels	Sticklebacks	
Noel Pauls Brook*	1966, 1967	0.26	3.06	1.43	-	***	4.65
Noel Pauls Brook	1970	2.2	10.3	0.3	-	***	12.8
Indian River	1966, 1967	1.4	10.6	15.0	7.9	0.2	34.9

* Average of annual means

** Trace

The 3⁺ smolts represent an egg-to-smolt survival rate of about 1.4 percent. The 1972 contribution of 4⁺ smolts from the 1968 channel fry stocking is expected to increase the total survival rate above 1.8 percent.

Proposed Activities - 1972. Proposed activities in 1972 include further stocking of Noel Pauls Brook and its tributaries with channel fry and continuation of parr and smolt assessments. The first tagged adult returns from the 1971 smolt run are expected at Bishop's Falls in 1972. These fish will be collected, transferred, and released above Grand Falls for possible recovery at the Noel Pauls counting fence, thereby establishing homing and timing to the natal stream.

POLLUTION

R. Wilson

L. Cole

A. Jamieson

Exploits River

Investigation into pollution of the Exploits River system continued in 1971 with a regular sampling program at the sites shown in Figure 1, and with further studies on the effects of pollution on the biota. Previous work has established that three categories of pollutants enter the river; mine effluents from the American Smelting and Refining Company (ASARCO) at Buchans, pulping wastes from the Price (Nfld.) Company at Grand Falls, and untreated domestic sewage from the towns of Windsor, Grand Falls, and Bishop's Falls.

The polluttional load in the Exploits River in 1971 was abnormally affected by industrial conditions. The ASARCO operation was suspended by a labor strike throughout the summer and fall, but the large volume of Red Indian Lake, through which the mining operation effluent must pass before entering the Exploits River, appears to have dampened any consequent reduction of heavy metals in the river. A deteriorated market for newsprint caused the Price Mill to shut down intermittently throughout the summer and fall. It became apparent that the oxygen demand in the river is largely the result of suspended and dissolved solids and that the contribution of material settled on the bottom to the total river BOD is relatively lower.

Results of the 1971 sampling program for heavy metals are summarized in Table III. Sampling for lead was discontinued at the beginning of the year, because the 1970 results showed that the contribution of inorganic lead to total pollutant toxicity in the river was fairly low. More will be said later on the significance of the values recorded.

Table III. A summary of heavy metal levels and total hardness in the Exploits River, Jan. 7 to Dec. 14, 1971.

	Stn. 6	Stn. 7	Stn. 8	Stn. 9	Stn. 10	Stn. 12	Stn. 14	Stn. 15
high	300	56	42	30	66	120	51	23
Cu average (ug/l)	33	8	7	6	7	10	18	6
low	4	4	4	4	4	4	4	4
high	1050	200	106	200	129	155	138	115
Zn average (ug/l)	116	67	60	59	44	53	75	45
low	54	33	45	27	30	20	33	8
high	18	22	18	18	18	26	18	16
T.H. average (mg/l)	9	8	8	8	8	11	9	9
low	4	6	4	5	6	6	6	4

Results of the sampling for pulp mill waste concentration are given in Table IV. The wide range of SSL values can be attributed to the sporadic operation of the mill, since it is unlikely that the situation during mill operation has changed from that reported last year.

Table IV. A summary of pulp mill waste and dissolved oxygen concentrations in the Exploits River, April 29 to Sept. 30, 1971.

		Stn. A	Stn. B	Stn. C	Stn. D	Stn. E	Stn. F
	high	259	356	182	190	244	193
SSL (ppm)	average	28	112	78	105	101	95
	low	8	16	10	21	14	17
	high	-	15.7	11.7	13.3	15.4	15.7
DO (mg/l)	average	-	10.0	8.9	8.8	9.2	9.4
	low		7.5	5.7	4.8	5.8	6.9

Considerable attention was focused on the problems which might be caused by the Price (Nfld.) effluent (Table IV). The river and estuary were surveyed throughout the summer months at about one hundred sampling stations to check for the presence of low-oxygen conditions which might present a barrier to fish migration. No such barrier was found. Oxygen depletion in the estuary appears to be more severe than in the river, however, possibly as a result of the electrically-charged fibre particles sinking out when they reach the estuarial salt wedge. A diving study showed indications of a pattern in the bottom deposits which might be related to water circulation. In several areas of the estuary, these deposits are anaerobic below the sediment surface, both during the summer months and in the middle of winter under ice cover, but the high rate of oxygen transport caused by diffusion, tidal action, and entrainment from the river discharge appears to minimize the oxygen problem in the upper, overlying water throughout the year.

A comparative study of benthic macro-invertebrate populations in the river revealed a dramatic decline in the number of insects captured below the mill at Grand Falls. Organisms present above Grand Falls, but not below, included the genera Heptagenia (Ephemeroptera:Heptageniidae), Arctopsyche, Hydropsyche, and Macronemum (Trichoptera:Hydropsychidae), Mesovelgia (Hemiptera:Mesoveliidae), Naeogeus (Hemiptera:Hebridae), Gyretes (Coleoptera:Gyrinidae), Hydraena (Coleoptera:Hydraenidae), and Hyallela and Gammarus (Crustacea:Amphipoda).

Table V. Biochemical oxygen demand and total suspended solids in the effluent of Price (Nfld.) Ltd., 1971.

Parameter	Level	Sewer			
		North	South	#3	Woodroom
BOD (mg/l)	high	358	224	529	254
	average	252	148	369	143
	low	176	75	276	29
TSS (mg/l)	high	402	368	1528	538
	average	198	264	782	287
	low	20	158	244	67

Significant advances in the understanding of the effects of pollution in the Exploits River were made through the conduct of a bioassay program on Atlantic salmon parr. It had become apparent that the tentative estimate of the 96 hr - LC50 for spent sulphite liquor (SSL) reported last year was in error because of insufficient data. A revised estimate now places the value close to 2000 ppm SSL at 10 percent solids, tested in Exploits River water. This value agrees fairly well with those recorded elsewhere for Pacific salmon species.

Attempts to duplicate published experiments in copper toxicity, using Exploits River water to make up the bioassay solutions, has shown a substantial reduction in toxicity over previously reported values (Fig. 5). It is suspected that this reduction is caused by the metal-chelating activity of organic compounds present in the river water; work in the Maritimes has proven such chelation with humic acids.

The toxicity of mixtures of copper and SSL was also studied in an attempt to simulate pollution in the lower river section. It is evident that SSL reacts with copper in much the same way that humic acids do, so that the toxicity of a copper - SSL mixture cannot be predicted additively from the separate LC 50 of each component, as is normally the case with heavy metal pollutants. That the interaction is fairly complex can be seen from Fig. 6. This figure shows an approximate model of the toxicity relationship, and it should be visualized as a wooden block, representing various SSL and copper levels. The missing, complementary portion of the block, required to make it rectangular, represents the zone of non-toxic interaction. It can be seen that small amounts of SSL, which just happen to be those near the ambient levels in the river, considerably reduce copper toxicity.

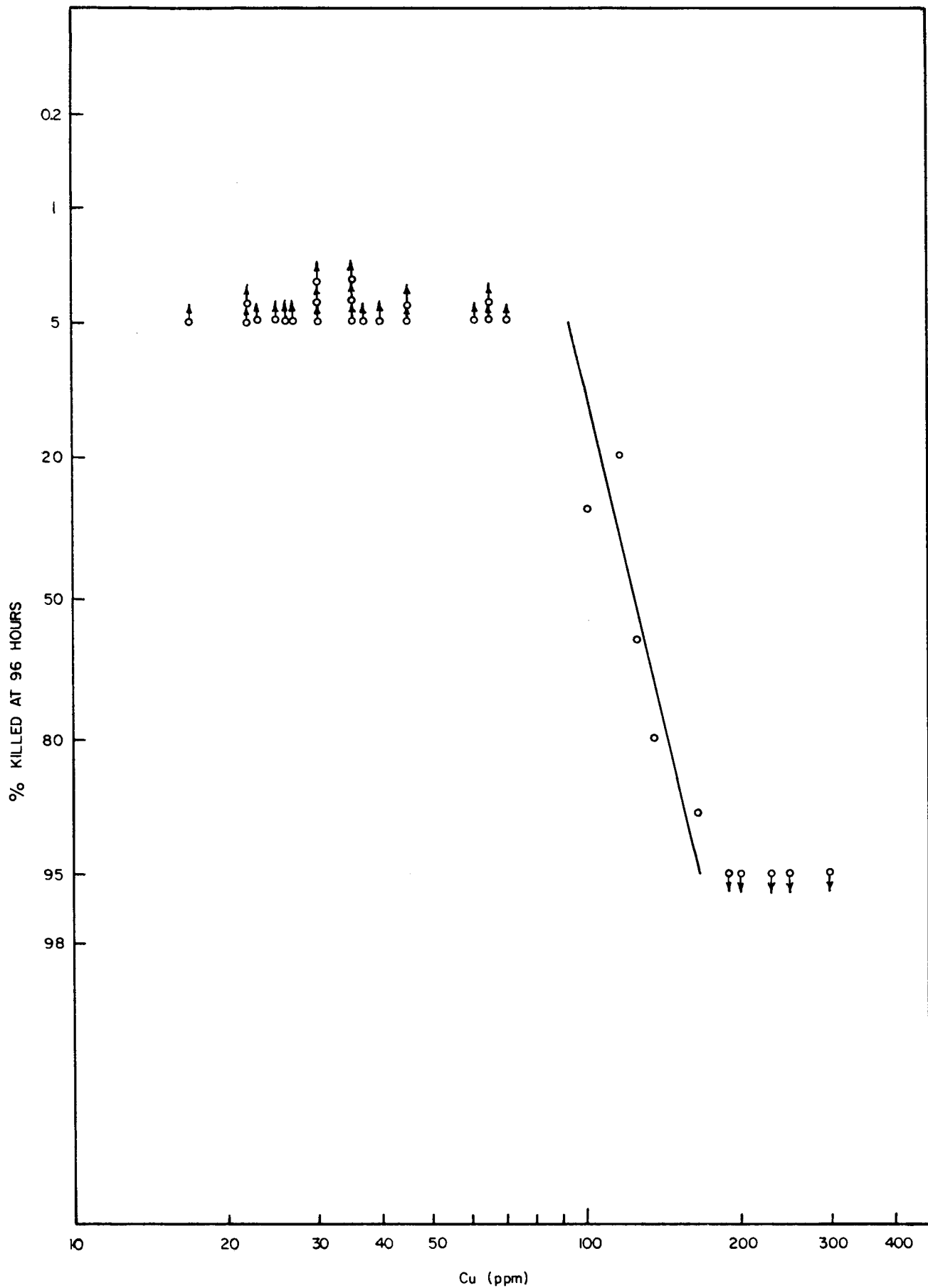


Fig. 5 The acute toxicity of copper to salmon in Exploits River water.

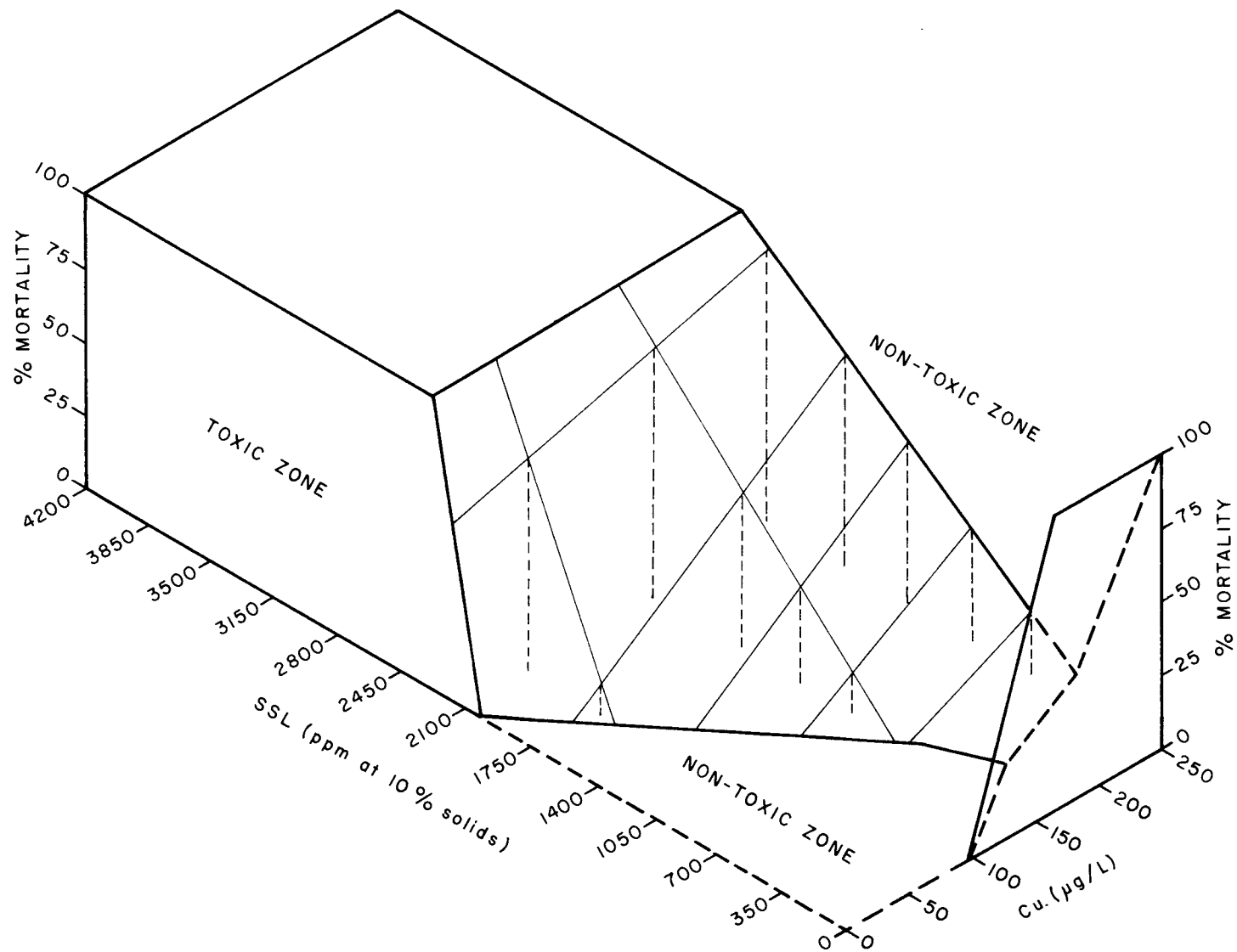


Fig. 6 The response surface defined by the antagonistic effect of SSL on copper toxicity to atlantic salmon. (See text for explanation)

Estimates of the toxicity of pollutants in the Exploits River have, therefore, been revised again for 1971. The highest toxicity measured in the river below Grand Falls was 0.83 toxic units (TU), but, ironically, this value represents an abnormal situation because the pulp mill was closed down at the time, and the river's SSL level was only "background". Equations to solve the problem posed in Fig. 6 have not yet been derived, but the average value in the lower river is probably much less than 0.4 TU. In the upper section of the river, the measured toxicity due to metals exceeded one TU on three occasions at the Millertown Dam (Stn. 5, Fig. 1). Apart from these occurrences the toxicity never exceeded 0.7 TU, and averaged 0.27 TU.

D E V E L O P M E N T

DEVELOPMENT

J. D. Pratt
Group Leader

The responsibilities of this Group involve the development and management of rivers and streams for anadromous fish resources within Newfoundland and Labrador. Assessment of existing stocks and implementation of biological techniques for improving those stocks or promoting new ones are the prime activities. Group personnel frequently use adult transfers, spawning channels, and fishways to maintain or enhance searun salmonid populations. Another priority is the tagging of Atlantic salmon in Labrador as part of Canada's effort to assess the effects of the Greenland salmon fishery on home stocks.

FISHWAY AND STREAM CLEARANCE

L. G. Riche
G. R. Traverse

The activities of this unit include the planning and implementation of development and management programs for salmonids in insular Newfoundland, conduct of an Island stream inventory, compilation of an up-to-date stream catalogue, operation of existing fishways, and investigation of fish migration problems related to stream clearance and fish-pass facilities.

Fishway Counting Traps

Monitoring and assessment of adult runs is of prime importance for the management and preservation of anadromous salmonid species. Fishways with counting traps provide an ideal and inexpensive method for long-term assessments. This activity documents timing, magnitude, and duration of runs in representative rivers and provides a relative abundance index for the Island.

In 1971, counts were obtained at seven fishways, two more than in 1970. In 1972, there will be a further increase of two counting traps in fishways, at Middle Brook and Northeast Placentia River.

For the past several years fishways have been operated until October 15, or later, to document possible movement of late runs into rivers. Results indicate that most salmon runs have moved into the rivers

by mid-September and that it is possible to cease operation at all fishways near river mouths by this time unless individual circumstances, such as low water levels, prohibit salmon from entering at the usual time.

Figure 7 summarizes the salmon counts from 1962-1971 for Indian River, Upper and Lower Terra Nova fishways, and Torrent River fishway. Numbers of fish counted through these fishways decreased in 1971.

In relation to the Terra Nova River salmon run, the closure of Alexander Bay to commercial salmon fishing in 1969 was expected to result in increased counts through these fishways. However, the increase did not occur and continued monitoring will evaluate the long-term results of closure.

Although the number of fish passing through Torrent River fishway increased in 1971, the count of 55 fish was somewhat disappointing. The progeny from the 1966 escapement through the fishway was expected to produce a larger escapement in 1971, but returns from the first significant smolt run (i.e. 4-year-olds) should return in 1972.

A counting trap was operated this year in the Lomond River fishway. Only 6 fish moved upstream through the trap. Plans are being formulated and evaluated to monitor the total run to the river and to transfer a portion of this run above the fishway in 1972.

Table VI summarizes the fishway and angling counts at Salmon Brook, Gander River, from 1957-1961 and 1971. Counting was resumed at this location in 1971, after a nine-year break, to compare the magnitude of the run using this fishway. The 1971 spawning run was on a par with the 1957-1958 counts, and the run has recovered from the declining counts for the 1959 to 1960 period.

Table VI. Fishway count and angling data, Salmon Brook (Gander River), 1957-1961 and 1971.

Year	1957	1958	1959	1960	1961	1971
Fishway count	965	1574	881	474	56*	1205
Angling catch (below fishway)	240	396	220	120	-	-
Total	1205	1970	1101	594	56	1205

* Partial count only. Extremely-dry river conditions prevented fish from using fishway. Fish moved up late in season when water levels improved and counting trap was not operative.

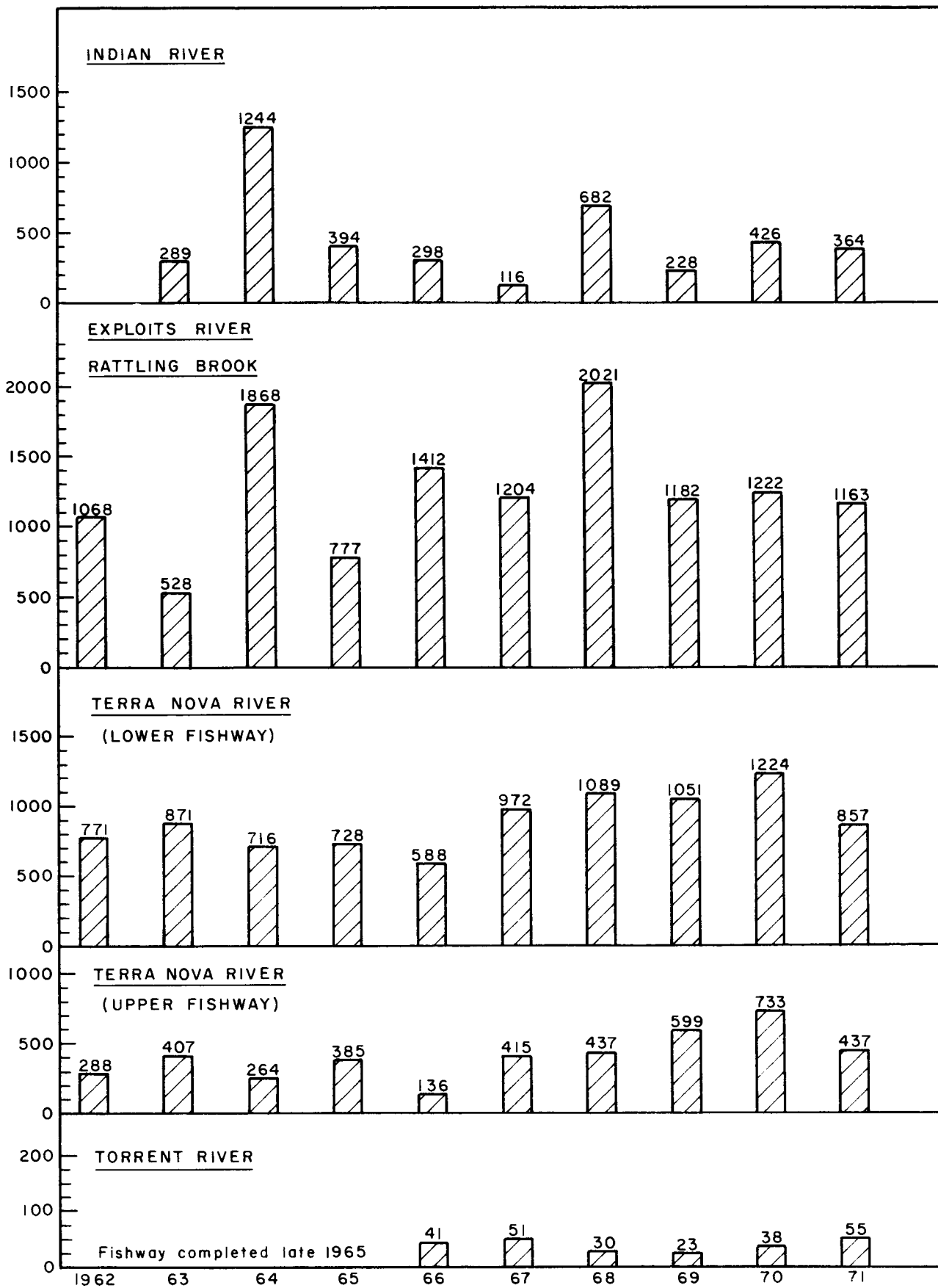


Fig. 7 Fishway counting trap data, selected rivers, 1962-1971

Population Assessment Program

An assessment activity was initiated in 1971 to search for donor populations of Atlantic salmon and anadromous brook trout for possible stocking programs that might unfold on the Great Northern or Avalon Peninsulas. Staff assessed three river stocks, using portable, metal, counting fences of a new design. At Big East River on the Great Northern Peninsula and North East Placentia River on the Avalon Peninsula, adults only were counted. At West Brook, also on the Great Northern Peninsula, both smolt and adult salmon runs were enumerated. A summary of results is presented in Table VII.

Table VII. Summary of salmon counts West Brook, Big East River, and North East Placentia River, 1971.

River	Grilse	Salmon	Total	Smolts	Sea-run brook trout
West Brook	702	94	796*	5767	141
Big East River	69	18	87	-	10
North East Placentia River	159	21	180	-	1

* Sixty-three (63) were angled below the fence.

The fences at West Brook and North East Placentia operated efficiently throughout the run, but the Big East River count was hampered by frequent washouts. No reliable estimate of the run at Big East River is possible. At West Brook, if we assume average annual runs of the magnitude counted in 1971, the apparent smolt-to-adult survival back to this river, before sports fishing, is 13.8 percent. The sport creel amounted to 140 fish or 17.6 percent of the river escapement leaving a spawning escapement of 656 fish, or a smolt-to-adult spawner survival of 11.1 percent. This high survival rate could be attributed to the limited commercial utilization on this coast, particularly in the St. Barbe area near West Brook. For stocking purposes on the Great Northern Peninsula it appears that West Brook may be used as a limited donor source with no detrimental effect to the salmon population.

West Coast River Development Program

To expedite establishment of salmon populations above the Torrent and Lomond River fishways, annual adult transfer programs will commence to these rivers in 1972. Adults will be transferred from West Brook to Torrent River, and Lower Lomond River salmon will be redistributed to Upper Lomond River. This five-year program, when complete, could realize an additional 800 and 300 fish in the Torrent and Lomond creels, respectively.

The program will also evaluate the efficiency of salmon development programs which include adult stocking by immigration to stream areas opened to spawners by obstruction removal.

Stream Inventory and Stream Catalogue

Stream inventory and obstruction surveys were completed on major Burin Peninsula rivers in 1971. Fifteen rivers were studied, their obstructions assessed, and their salmon production potential estimated. Other rivers studied in detail included Torrent and Lomond Rivers on the west coast. Stream inventory will cover major rivers on the west coast in 1972 with all major watersheds on the Island completed by 1973.

The cooperative action on the part of this Unit and the Engineering Group resulted in the removal of 24 obstructions in 1971. These obstructions had created delays to migrating salmon and, in many instances, had created serious poaching problems. Through the cooperation of the Departmental District Offices and the stream survey team, a stream clearance action list of 78 obstructions has been compiled for removal in coming years. Activities in 1972 will include the removal of 25 of these obstructions.

The results of the various 1971 surveys by this Unit and other branch teams have been incorporated into the stream catalogue and copies of this document have been sent to all District Offices for updating and correcting. A computer program is planned to make updating of vital statistics an annual procedure.

CHANNEL EVALUATION

H. J. Rietveld
A. P. Cowan

Indian River Investigations

Indian River, which flows into Halls Bay, is the site of a controlled-flow spawning channel (Fig. 8), built to compensate for the loss of spawning area due to a hydroelectric diversion of the headwaters of the river and to act as a prototype to explore the feasibility of using channels as an aid to Atlantic salmon management in Newfoundland and Labrador. During eight years of operation, the emphasis for the Indian River project has been to operate within the existing accessible watershed area using natural escapements to supply the channel with adults for fry-stocking work. During 1971, in addition to the prevailing management program, steps were taken to broaden the scope of the project, with a view to increasing the production of salmon from the Indian River drainage. Kelt tagging, commercial fishery sampling, and detailed stream surveys have served to increase knowledge about stock utilization and stream production potential.



Figure 8. Aerial photograph of Indian River showing spawning channel on the right and diversion structures.

Current Management Program

Fry and Standing Crop Assessments. In 1970, an adult stock of 145 females deposited 252,000 eggs in the channel. Egg-to-fry survival was excellent; 169,000 fry emerged, a survival rate of 67 percent. This rate is a vast improvement over that of the previous year of 15 percent and of the past seven-year average of 40 percent. The higher survival can be traced directly to our replacement of the old spawning gravel with a new, coarser substrate in 1970. As a result, 1971 was the first year since 1964 when the entire accessible watershed was adequately seeded with natural or channel fry.

Experiments to determine the natural egg-to-fry survival rate for comparison with the channel survival rate resulted in a provisional estimate of 7.9 percent for Indian River natural spawning areas. Results are provisional and experiments are continuing in order to provide a more definitive estimate in 1972.

Previous electrofishing surveys have shown that fry can be more efficiently utilized by planting into selected rearing areas, rather than by allowing them to move downstream from the channel naturally. The nursery area between the channel and Indian Pond was determined unsuitable for stocking. However, the area between Indian Pond and the counting fence (Figure 9) was found to be quite suitable and has been stocked since 1967. Channel fry introductions are maintaining a high standing crop of parr in this area. Stocking into the area from the pond to the fence will continue, as well as into Black Brook, in 1972.

Smolt Assessments. A major portion of the 1971 smolt run was produced from the 1967 adult escapement, fifty percent of which spawned in the Indian River Channel. Channel survival to the fry stage was three to four times that of the natural river, and standing crops from that spawning are considered to be composed of 70 percent channel progeny and 30 percent natural spawning production. The estimated egg-to-smolt survival rate for the entire river is 2.3 percent. This figure is somewhat higher than the egg-to-smolt survival rate estimate determined for a Maritimes watershed where the stocking technique used was an adult transfer, an alternate stocking method. It is therefore thought that channel fry stocking has a positive influence on smolt production.

Adult Assessments. The adult run lasted from June 27 to October 18 and consisted of a regular summer run (July and August) and a later fall run (October). Peak of the main run occurred on July 25 with a smaller peak in October. The run consisted of:

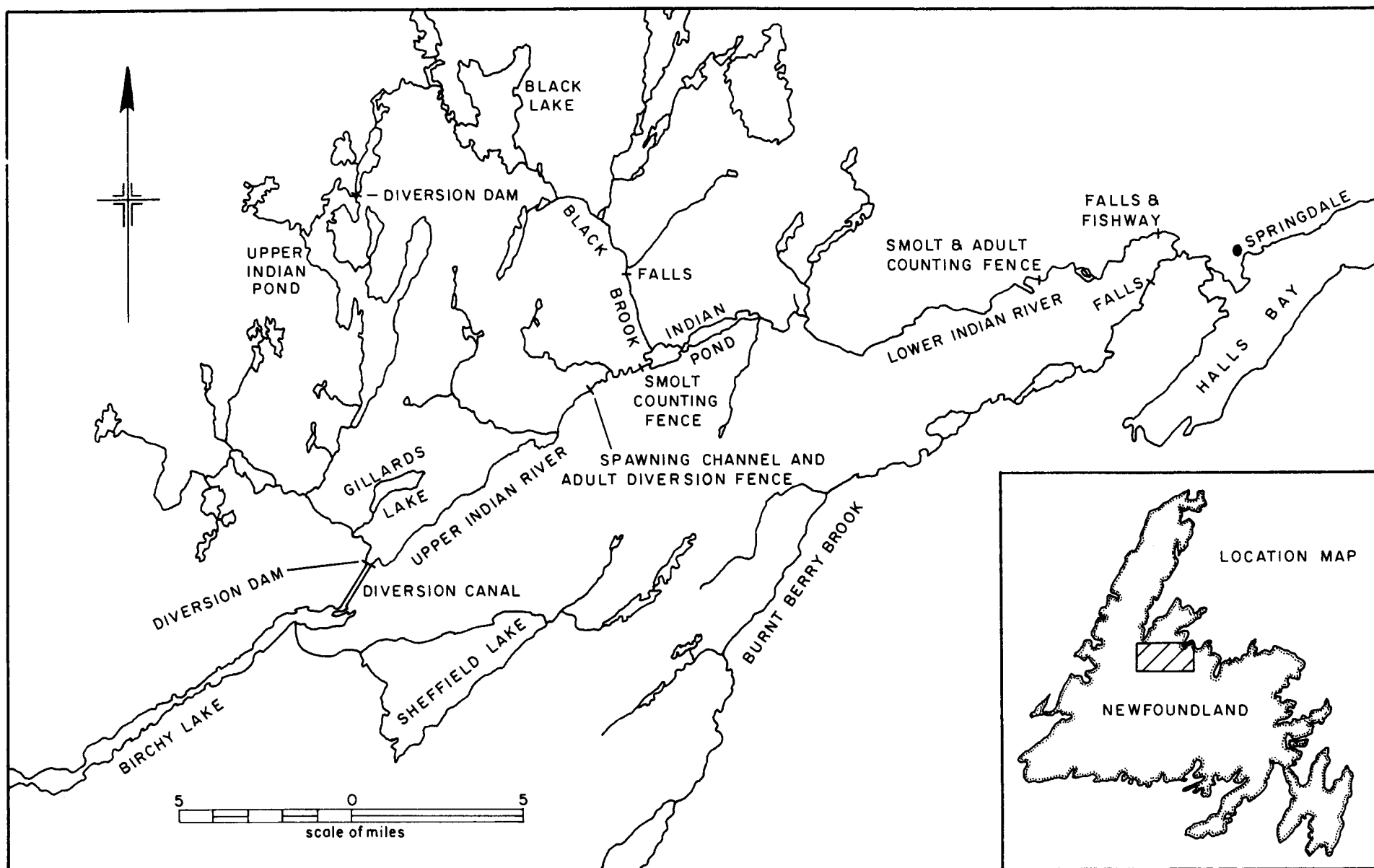


Fig. 9 Map of Indian River and its drainage area.

Channel escapement	342 fish	Total spawning
River escapement	119 fish	escapement
Sports fishery	<u>268 fish</u>	
Total run to the river	729 fish	

This stock resulted in a channel deposition of 450,000 eggs, and a natural river deposition of 161,000 eggs. These depositions are expected to produce 300,000 fry from the channel and 13,000 fry from the riverbed.

The 1971 adult run is mainly the result of the 1966 spawning escapement, which consisted of 295 fish, half of which spawned in the channel. It is interesting to note that this escapement reflects an increase of 56 percent over the 1966 adult run and should result in a record smolt run of about 15,000 fish in 1975.

Management Expansion Program

Commercial Fishery Sampling. During the 1971 commercial salmon fishing season, sampling of the commercial fishery in the inner 15 miles of Halls Bay was carried out from South Brook. The object of this study was to determine to what extent Indian River fish contribute to this local fishery and whether restrictions would substantially increase the run to the river. An increased river escapement could be utilized for stocking presently inaccessible rearing areas located in Black and Burnt Berry Brooks.

The results of the commercial fishery sampling in 1971 and of the smolt tagging in 1969 indicate that the South Brook fishery operates on a mixed stock and that the catch is composed of one quarter Indian River fish. That amount represents about 60 percent of the Indian River adult production. These fish would double the escapement to the river in some years if allowed to escape the fishery and would serve as ample additions to the brood stock for an expansion program.

River surveys. To expand the Indian River salmon resource investigations were carried out to determine the potential spawning and rearing areas of two tributaries heretofore unused by anadromous fish, Black and Burnt Berry Brooks. The results of walking, flying, electro-fishing and engineering surveys are summarized in Table VIII.

Black Brook is to be stocked with native channel fry and Burnt Berry Brook with transferred adults. The expected smolt production will double or triple the present production level and should be attained within five years. Increased adult returns can be expected into the now-inaccessible spawning areas pending removal of obstructions.

Table VIII. Results of surveys conducted on Black Brook and Burnt Berry Brook.

	Black Brook	Burnt Berry Brook
Linear miles of stream	13	10
Av. width (yds)	23.2	21
Total spawning area (yds) ²	29,260	171,400
Total rearing area (yds) ²	501,000	154,950
Obstructions	1 impassable falls	2 impassable & 4 partial falls
Av. no. salmonids per 100 sq. yds.	8.75	1.85
Potential smolt production	10,000	8,000

1972 Operations. Plans for 1972 include channel fry stocking followed by electrofishing to determine resulting young-of-the-year populations in Black Brook.

Comparison of quality and survival of fry produced within channel and natural environments will be continued.

LABRADOR MANAGEMENT AND DEVELOPMENT

R. F. Peet
H. P. J. Murphy

Activities in the Labrador area during 1971 included; the tagging of Atlantic salmon smolts and adults, investigations into the potential production of Labrador rivers in relation to anadromous fish (especially Atlantic salmon), and an inventory of rivers and fish populations.

Tagging Operations

Tagging of Atlantic salmon smolts and adults continued at Sand Hill River (Fig. 10) during 1971. This project is part of the Canadian investigation into the origin of salmon stocks being exploited by the large commercial fishery off West Greenland. Sand Hill River

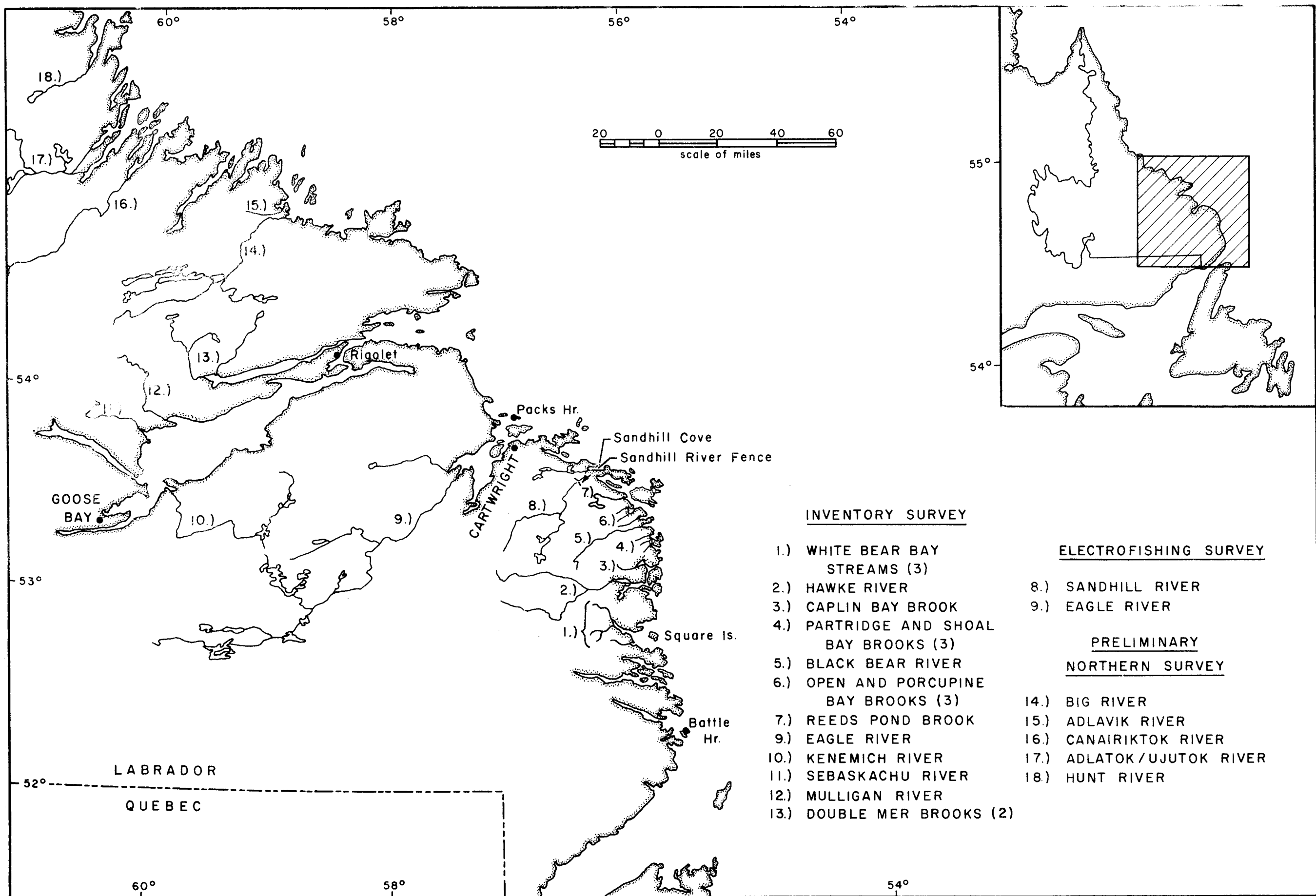


Fig.10 Labrador survey area, 1971

was chosen as the project site after evaluation of reconnaissance surveys of several rivers along the coasts of Labrador and northern Newfoundland during 1966 and 1967. Construction of facilities began in 1968 and the first tags were applied at Sand Hill in 1969. Figure 11 shows the general layout of the fence and Figure 12 shows a wing of the counting fence being installed during the spring highwater period just before commencement of the smolt run.

Table IX gives a summary of tagging activities and tag returns up to January 31, 1972. The percent of year 1 returns from smolt tagging showed a substantial increase in 1970 over those of 1969. This increase may be partly due to the fact that fence facilities were not complete in 1969 and fyke nets were used to trap smolts for tagging. Use of nets probably resulted in a larger mortality of tagged smolts after release, although holding tests lasting up to 3 days showed no significant difference between years in immediate mortality. In 1970, permanent trap and fence facilities were used, greatly reducing the handling of fish and physical damage caused by traps.

Of special interest is the large return of both Carlin and Atkins tags from Greenland in 1970, a substantial increase over 1969. Whether this can be attributed specifically to better tag recovery by authorities, increased availability of tagged fish because of better survival, or to an increase in exploitation of northern Canadian fish stocks has not been determined. Most probably it is a combination of these factors since preliminary reports of the 1971 Greenland landings show an increase of approximately 500 metric tons over previous years. It is felt that the major factor is the permanent fence facility which promotes better survival of tagged smolts.

Estimates based on 2 years of returns from the 1969 smolt tagging show that the adult population of Sand Hill River is composed of approximately 66 percent grilse and 33 percent 2 seayear or older fish. In compiling this percentage for the 1969 tagging, the 1970 Greenland year 1 returns were grouped with 1971 year 2 returns because these fish were destined to be 2 seayear or older salmon. This proportion of 2 seayear fish is a much larger than was determined by sampling the adult spawning run to the river (Table X). River samples show that the spawning run is composed of an average of 93.8 percent grilse and 6.2 percent two seayear or older fish. Estimates of exploitation by commercial fisheries based on tag returns show that approximately 66 percent of the grilse return to the river to spawn, 2 percent are angled, while 32 percent are taken by commercial fisheries. Only 10 percent of the 2 seayear or older fish return to the river while 90 percent are taken by commercial fisheries.



Fig. 11. General layout of Sand Hill River counting fence. The fence is approximately 500 feet long and the river is 410 feet wide. There are three adult traps and three smolt traps.



Fig. 12. Installation of Sand Hill River fence during the spring highwater period (June 10). (Note collapsible pipe A-frames being raised from slots in the fence platform and the water levels at which installation is possible).

Table IX. Summary of Atlantic salmon tagging operations, Sand Hill River (1969-1971). Returns are compiled to January 31, 1972.

Year	Type tag & series	Stage and no. tagged	Returns		Returns				Returns			
			Yr. of tagging		Year 1				Year 2			
			Home R. angled	Home fishery	Home river angled/fence		Comm. Fishery Home/Greenland *Other		Home river angled/fence	Comm. Fish. Home/Greenl.		
1969	Green Carlin (L8000-14643) (L14700-14915)	Smolt (6741)		15		32	15	4		4	34	2**
	Blue Atkins (L500-902)	Adult (399)					12	3		1	2	
1970	Green Carlin (L14644-14699) (L14916-22999)	Smolt (8016)		40	2	71	34	33	1			
	Blue Atkins (L165-199) (L902-1399)	Adult (516)					17	12				
1971	Green Carlin (L23000-33699)	Smolt (10511)		169								
	Blue Atkins (L1400-1799)	Adult (391)										

* Includes strays and place of recapture not known.

** 1 of these fish was counted through Sand Hill fence in 1970.

Table X. Summary of Atlantic salmon counts, Sand Hill River, 1967-1971.

Year	Period of count	Smolt count	Adult count		
			Number	% grilse	% salmon
1967	July 2 - Aug. 30 (90 days)		641*	87.5	12.5
1968	Permanent facility under construction no counts				
1969	June 18 - Aug. 28 (103 days)	8690*	942*	95.2	4.8
1970	June 8 - Oct. 16 (131 days)	50494	3759	94.7	5.3
1971	June 13 - Oct. 3 (113 days)	52607	3754	92.9	7.1

* Partial counts

In 1971, the majority (Table IX) of 2 seayear fish tagged as smolts in 1969 were taken by the local commercial fishery while only 4, also destined to become 2 seayear salmon in 1971, were taken the previous year (1970) in Greenland. It will be interesting to anticipate the number of 2 seayear fish taken in local waters in 1972, considering the large 1971 Greenland return of fish destined to be 2 seayear salmon which were tagged as smolts in 1970. If the catch of these fish is small in comparison to those returns in 1971, then it is possible that there is a direct relationship between exploitation in Greenland and subsequent exploitation in home waters. It is now known that the 1971 catch of salmon off West Greenland is the highest on record. However, several consecutive years of tagging and tag returns will be required to establish the exploitation rate and its fluctuations. One conclusion which is quite clear is that not many 2 seayear fish will survive to return to Sand Hill River for spawning.

Another point of interest is the distribution of tag returns in the local commercial fisheries. The distribution of recoveries from the 1969 and 1970 taggings show that the majority are taken by commercial fisheries along the east coast of the Great Northern Peninsula of Newfoundland, mostly from north of Canada Bay, and along the Labrador coast as far as Sand Hill Cove in Table Bay (Fig. 10). Very few tags were returned from the large commercial fishery in the Packs Harbour area just north of Sand Hill River, a fishery which accounts for an average of 35 percent of the total Labrador catch. These results indicate that the path of migration of returning fish is northwards of the White Bay area along the Labrador coast to Sand Hill and are in agreement with the hypotheses of previous authors about the probable migration routes

of salmon caught in the various commercial fisheries along the northern coast of Newfoundland and of Labrador. Also, the 1971 catch of tagged salmon was divided such that most of the 2 seayear fish were taken during mid-June to early July, while the 1 seayear fish (i.e. grilse) were taken from the second week in July to late July.

Tag recaptures in Greenland were distributed from Disko Bay in the north to Cape Farewell in the south and fish were taken from early August to late October. Most fish (43 percent) were taken in September and the main concentration was south of Godthab where 62 percent of the tags were taken in ICNAF areas 1D, 1E and 1F. That fishery is divided into two components, the offshore drift net fishery and the coastal set gill net fishery. At present it is not possible to give an accurate breakdown of the catch by component as 65 percent of the returns did not list the method of capture.

Counting Fence Operations and Population Sampling

Table X summarizes the counts of smolts and adults obtained from Sand Hill River in 1971. Approximately 95 percent of the smolt run and the entire adult run were enumerated. The smolt and adult runs were sampled to determine length, weight, and age characteristics.

In addition, the commercial salmon fishery at the mouth of Sand Hill River and the angling catch at Eagle River were sampled for comparison with the Sand Hill River adult population in terms of age, length, and weight to determine if the Sand Hill Cove commercial catch is typical of the river run and if the Sand Hill River population is typical of the runs to other rivers in the area.

Reconnaissance Surveys

The inventory of Labrador rivers continued in 1971 with the survey of 16 coastal streams from Hawke River in the south to Eagle River in the north (Fig. 10), plus 6 streams in the Hamilton Inlet area. This effort will complete the inventory of all major watersheds from Forteau to Pamiulik River, north of Hamilton Inlet. In addition preliminary surveys of five rivers north of Hamilton Inlet were completed (Fig. 10).

Electrofishing Census

As part of a programme to measure the Atlantic salmon production capability of Sand Hill River, 13 river stations throughout the watershed were electrofished. Four stations were also electrofished on the Eagle River (Fig. 10), to gain information on this large watershed in the event of industrial development and to provide a comparison with Sand Hill River.

1972 Operations

In 1972, smolt and adult tagging operations, assessment and sampling of the Atlantic salmon population, and an electrofishing survey will continue at Sand Hill River. Stream inventory will be extended north of Hamilton Inlet.

POLLUTION CONTROL

POLLUTION CONTROL

S. G. Pond
Group Leader

INTRODUCTION

This annual report is the last that this Group will make as a traditional part of the Fisheries Service. A new Service of the Department of the Environment devoted entirely to pollution control has been formed, and 11 of the 14 members of the Pollution Control Group will become the nucleus of the Environmental Protection Service in Newfoundland and Labrador. We all hope and expect that this change will result in even better control of pollution in the province.

The Environmental Protection Service is already functioning at the Ottawa headquarters level. This function has resulted in expert assistance during negotiations with Newfoundland Refinery Co. (Come-by-Chance) and Javelin Paper Corp. (Stephenville).

The Pollution Control Group has grown considerably in the past three years and it has apparently reached the size where emergencies no longer disrupt our ongoing planned work. This year we acquired the competence needed for a fully-equipped pollution control organization, with the addition of Dr. Hari Samant, a chemist, and Mr. James Osborne, a professional diver.

The project reports which follow reflect the fact that we have been able to accomplish many studies this year which had previously been postponed for lack of manpower. Studies have been classified as either Abatement projects, when the purpose has been to solve a pollution problem, or as a Baseline or Monitoring project, where the purpose is to define a problem or to monitor a problem.

Pollution Abatement Programs

Application of Regulations under the Fisheries Act. Sections 33 and 34 of the Fisheries Act empower the Governor in Council to set regulations for the discharge of deleterious substances. Regulations regarding Pulp and Paper mill wastes have been set and are being applied to the new mill in the province, Javelin Paper Corp., at Stephenville. Application of the standards to the two older mills, Price (Nfld.) at Grand Falls and Bowaters (Nfld.) at Corner Brook, is a matter for negotiations. Talks have been held with the provincial Clean Air, Water and Soil Authority on the matter, and it is hoped that a schedule for compliance with the regulations will be worked out with those mills this coming year.

Regulations are also being developed by headquarters staff for a range of other industries, including Fish Processing, Oil Refining, and Mining, all of which will have application in our province.

Application of the Canada Water Act. This act empowers the Federal Government to join Provincial Governments in the management of river basins under authorities somewhat analogous to the River Authorities of England. A Canada-Newfoundland Consultative Committee has been formed to examine the feasibility of instituting such an arrangement on the Exploits River. The Pollution Group has participated in hearings before a Task Force of this committee. The report of the Task Force has been completed but it has not yet been made public.

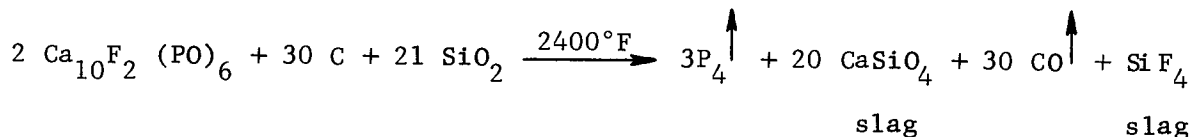
Oil Pollution. Talks have been held between the Department of Transport, the Newfoundland and Labrador Clean Air, Water and Soil Authority, and the Department of the Environment to arrange a system that will ensure that oil spills, from whatever source, will not adversely affect the environment. Prompt reporting of oil spills, clear responsibility for action, knowledge of proper techniques, and availability of equipment are important aspects of this problem.

POLLUTION ABATEMENT

P. Chamut
H. Wong
F. Hicks
J. Osborne

Electric Reduction Company of Canada Ltd. - Long Harbour

This industry, established at Long Harbour, Placentia Bay, in late 1968, produces elemental phosphorus from imported phosphate rock, coke, and local silica by an electrical reduction process. The general formula for this endothermic reaction is:



The carbon monoxide is burned in a flambeau to carbon dioxide. The elemental phosphorus, gaseous at temperatures over 280°F, is cooled and maintained as a liquid. The approximate yield of phosphorus in this process is 13 percent.

Negotiations between this Department and the Company regarding disposal of wastes were conducted prior to the plant becoming operative in 1968. Information made available to the Department did not mention that elemental phosphorus would appear in the effluent. Shortly after the plant commenced operations, a localized fish kill occurred, which was attributed to an accidental spill of elemental phosphorus. In early February, 1969, reports of "red" herring were received. More kills were reported in April. Work carried out by this Branch and by staff of the Fisheries Research Board indicated that elemental phosphorus was the causative agent. Plant operations were halted in May, 1969, to construct an effluent treatment system that would eliminate elemental phosphorus from the effluent.

The treatment system, composed of two separate settling ponds, was designed to act on a use-reuse basis, with no wastes from the plant entering the waters of Long Harbour. Pond No. 1 contained "phossy" wastes, which include all effluents which had been in contact with elemental phosphorus. Pond No. 2 contained effluents from the pelletizing plant, which are generally low in elemental phosphorus. In addition, the plant was required to dredge the high-phosphorus-content bottom sediments in the vicinity of the plant outfall, prior to resuming operation in August, 1969.

Problems encountered in 1971 were similar to those experienced in 1970. A large portion of the staff's time and energy was devoted to finding a successful method for removing, or otherwise neutralizing, the elemental phosphorus remaining in the bottom sediments of Long Harbour, since three dredging programs had not adequately reduced that hazard. In addition, the settling ponds continued to be unable to operate on a closed circuit, necessitating bleed-offs to the sea during periods of above-average rainfall. Such effluent discharges were accompanied by an intensive biological-chemical monitoring program to detect any elemental phosphorus concentrations in Long Harbour. The purchase of a gas-liquid chromatograph in early 1971 simplified and expedited the analysis of tissue and water samples for elemental phosphorus concentrations.

Problems were encountered early in 1971 when pond levels increased to critical levels. A controlled discharge of 50 g.p.m. of effluent from Pond No. 2 was instituted and continued until late in March, spilling approximately 5 million gals. of effluent into Long Harbour. During this discharge, elemental phosphorus concentrations were generally less than 2.0 ppb (range 0.1 - 10.0 ppb) after dilution by 5000 g.p.m. of sea water. Levels of phosphorus contained in water samples collected in the harbour ranged from non-detectable values up to 2.5 ppb. This discharge produced no obvious deleterious effects on fishes in the area. A second discharge of approximately 4 million gals. of Pond No. 2 effluent, was carried out in November and December and, though somewhat higher levels of elemental phosphorus were detected in Long Harbour, no fish kills occurred. In

addition to monitoring the controlled effluent discharges, the investigation of accidental spills occupied a large portion of staff time. Events such as a split storage tank, the loss of 1 million gals. of Pond No. 2 effluent to Conway Cove when a temporary dyke collapsed, and occasional spills of "phossy" effluent into the Pellet Plant required intensive sampling to ascertain possible hazards to the marine life of Long Harbour.

Two coring surveys of the "phossy" sediments in the vicinity of the ERCO wharf were carried out in February and September, 1971. The first survey was to determine extant phosphorus concentrations to define the area of the bottom requiring further attention. The second survey was conducted to determine the efficiency of the dredging program.

Some reports of "red" fish were received during 1971 and, in most cases, analysis of the affected fish revealed no detectable phosphorus. Small concentrations (3.0 ppb) of elemental phosphorus were detected in two cod captured near St. Brides. Subsequent analysis of more cod from the St. Brides area, and from Long Harbour, did not reveal any contaminated fish. It is unknown how two contaminated cod came in contact with elemental phosphorus.

During 1970, numerous meetings with officials of ERCO were held to resolve the problems regarding effluent management and the remaining phosphorus-laden sediments. The one "bright spot" of 1970 was that a suitable resolution to the bottom sediment problem had been achieved. In late 1970, the Company agreed to lay a concrete mat over the affected area. All concerned agreed that this was the best solution to a difficult problem. However, a conflict of interests arose with the shipping company which supplies ERCO with phosphate rock, forcing ERCO to cancel the plans to lay concrete. The shipping company objected to the concrete mat, since it might hinder docking manoeuvres. As an alternative to covering the "hot" sediments, ERCO proposed that these sediments be removed using a conventional clam dredge. The Department objected to this method of dredging as it was feared that it would re-suspend the elemental phosphorus throughout the water column. Agreement was given to ERCO in June to carry out a small-scale test. A closed-top dredge was used and a number of water samples were collected by this Department to monitor elemental phosphorus levels in the immediate dredging area. This test operation showed that dredging would present no great hazard to marine life in Long Harbour. A number of safeguards drawn up by this Department were agreed to by ERCO. The dredging operation was carried out from August 16 - September 1 and was closely monitored to ensure that agreed levels of phosphorus in the water were not exceeded. A total of 75,000 cubic ft. of sediment was dredged and disposed of on the plant site. An estimated 2,500 lbs. of elemental phosphorus was removed during this operation. Following dredging, another coring survey showed improvement, but some "hot spots" of phosphorus remained. An examination of the remaining depth of sediment revealed that insufficient depth remained to permit

further dredging. A decision was made to leave the remaining sediments, with the proviso that, if any future problems developed, the Company will be required to take further action.

As discussions regarding the removal of bottom sediments progressed, concurrent discussions were carried on for a solution to ERCO's water management problems. Bleed-offs during the rainy season became routine because the ponds were inadequate to cope with both process wastes and rainfall.

A formal proposal designed to eliminate the need for bleed-offs was received from ERCO in February, in response to a directive to the Company from our Minister. This proposal, after careful review by regional and headquarters officials and an independent consultant, was deemed inadequate. In a following meeting, the ERCO proposal was rejected, because the success of the scheme was predicated upon the plant operating at a constant annual production rate of over 50,000 tons of elemental phosphorus and on the attainment of a surge capacity in Pond No. 2. Such surge capacity was to be attained by a discharge of effluent to the sea. The Company was informed that our requirement has always been that the ponds operate as closed systems, with no discharges to the sea. Additionally, ERCO was requested to present a further report which would detail interim and long-term (or final) solutions to their effluent problem and was informed that the Department intended to move according to an established abatement schedule.

A report submitted in June gave some cause for optimism. The interim solution proposed that bleed-offs of Pond No. 2 effluent be carried out when elemental phosphorus levels were low (less than 0.5 ppb). This discharge would last until Jan. 1, 1973, at which time a chemical treatment system would be installed. In the interim, an evaluation of four methods of chemical treatment would be studied. The final treatment system initially planned was to be designed to treat 50 g.p.m. of Pond No. 2 effluent, reducing the phosphorus content below 0.5 ppb. A status report was issued by the Company in December, and it is expected that a final evaluation of all methods of treatment will be ready by early 1972.

Newfoundland Refining Company - Come-by-Chance

Newfoundland Refining Co. and its affiliates have been planning to construct an industrial complex consisting of an oil refinery, ammonia plant, and a pulp and paper mill at Come-by-Chance, Placentia Bay. Oil refinery construction is proceeding, with approximately 20 percent completion, and 95 percent of the materials procured. No information has been received to indicate, however, that either the ammonia plant or the pulp and paper mill will be constructed in the near future.

The oil refinery is scheduled to process 105,000 bbls. per day of Middle East crude oil. Products will be propane, naptha, high octane and regular grade gasoline, kerosene, stove oil, jet and diesel fuel, and bunker fuel. Components of the waste effluent, deleterious to fish, will include oils, phenols, cyanide, sulphide, ammonia, and a number of metals in trace amounts. The effluent will also contain suspended and dissolved solids and will exert a high biological and chemical oxygen demand. Negotiations have been held with Nfld. Refining Company and Procon (Great Britain designers of the refinery complex) to ensure that the effluent receives the best possible treatment to protect the fishery resources of upper Placentia Bay. To this end, regional staff have been aided by E.P.S. staff experienced with oil refineries and by a consultant retained by the Department. During 1971, work also progressed on the collection of biological and chemical pre-production baseline data on the upper bay.

Negotiations. In 1970, attempts to obtain information on proposed effluent treating facilities were unsuccessful. More satisfactory results were obtained during 1971. A meeting was convened early in January which allowed representatives of government and the industry to meet face-to-face and discuss their respective attitudes towards pollution abatement facilities at the Come-by-Chance oil refinery. Representatives of Newfoundland Refining Company gave assurances that the refinery effluent would meet the proposed new oil refinery effluent standards and described in general terms the facilities for handling the effluent.

A second, more technical, meeting was convened in June at which time Procon presented a verbal proposal outlining treatment planned for the two major waste streams. In the interval between January and June, information regarding the federal oil refinery standards had been delivered to Procon, enabling them to design the waste control facilities around these standards. The two major effluents will be the oily water stream and the stormwater drainage system. The oily water stream will be composed of process wastes and ballast water. These wastes will be screened and passed to a demulsifying tank, where a chemical will be added to enhance the separation of the oil fraction from the water. Floating oil and heavy sludge will be removed in an IMCO floatater equipped with surface and bottom skimmers. All liquids will pass to an activated sludge system, where phenols and other organic compounds will be biologically degraded. The resulting sludge will be vacuum-dried to produce a dry cake which will be either burned or buried. Following biological treatments, all liquid effluent will be passed to a clarifier to remove suspended solids. It was estimated that the effluent, prior to discharge, would have an average BOD load of 20 mg/l, suspended solids load of 30 mg/l, and contain no visible oil. Normal effluent volume for this stream will be 600 g.p.m. The stormwater drainage system will entail a collection system of ditches to direct run-off and oil spills from the process area and tank areas into one of two holding basins. These basins will have

capacities of 330,000 and 660,000 bbls. The only treatment the drainage will receive will be separation of the oil fraction from the water.

The departmental reaction to this proposal was that the treatment system, as described, would not meet the federal standards. However, it was difficult to evaluate the efficiency of the entire waste treatment facility because little detail on processes and equipment was available. The remaining months of 1971 were spent requesting additional information from Newfoundland Refining Company and Procon. Little success was achieved in obtaining the desired information. Requests for the necessary drawings, plans, and specifications were reinforced in early 1972 by a directive to Newfoundland Refining Co. from the Minister of Environment Canada. It is expected that problems regarding the final design of the effluent treatment facilities will be resolved in meetings scheduled for early 1972.

Discussions on another facet of the refinery complex, the design and construction of the wharf, were held with the Department of Public Works. The wharf will consist of 2,800 ft. of rock-fill causeway, 800 ft. of trestle, and 1,600 ft. of docking face. The wharf will carry pipes up to 42 in. in diameter and will be able to accommodate tankers up to 326,000 dead weight tons. Evaluation of the wharf plans and specifications by headquarters personnel has revealed that further design work may be necessary to protect the environment from oil spills. Negotiations are continuing in this regard with the Department of Public Works.

Iron Ore Company of Canada - Labrador City

Negotiations with I.O.C.C. in 1971 revolved primarily around the operation of the chemical flotation pilot plant. A meeting in May between Technical Services of I.O.C.C., Clean Air, Water and Soil Authority, and the Fisheries Service was held to discuss the proposed use of hydroxamic acid as a flotation reagent. The use of the former reagent, hydroxamate, was discontinued due to its demonstrated high toxicity to fish and the inability to reduce this toxicity through recirculation.

The toxicity of hydroxamic acid, on the other hand, can be reduced considerably through ozonation. I.O.C.C. presented a report prepared by T.W. Beak Consultants Limited on the chemistry and toxicity of this reagent. The report was thorough, but as yet some of the breakdown products of ozonation are unknown. To guard against detrimental effects from such unknowns, the Service requested the conduct of bioassays on the effluent from the pilot plant. In compliance, I.O.C.C. employed the services of the consultant to carry out this work. A biologist from the Pollution Control Group observed the bioassay program at frequent intervals to assure that it followed accepted procedures and fulfilled the requirements of the Service.

The pilot plant became operational in the latter months of 1971. The bioassays were a static operation due to the high solids content of the effluent and followed A.P.H.A. "Standard Methods" procedure as closely as possible. Bioassays were to include test fish that were exposed to flocculated and non-flocculated ozonated effluent. Flocculation of the effluent was tried even though it is not incorporated in the present tailings disposal, because it was felt best at this time to have both tested.

The acquisition of test fish presented some problems. Originally, fish were to be imported from an Ontario hatchery with disease free certification as required by the Service. The pathologist's report indicated a high infestation of kidney disease, and certification was refused. I.O.C.C. captured native brook trout from local streams. Some equipment and expertise was provided to I.O.C.C. by the Service for this purpose.

An alternate use of the flotation column was devised by I.O.C.C. in order to extract "Ankerite" from the tailings. Ankerite is similar in composition to limestone and could be used as a replacement for limestone in the pelletizing process in Sept Illes. The reagent in the flotation is "Aero 825", a sulphonate, that is extremely toxic. Realizing the short duration of the flotation run and its experimental nature, the Service agreed to its use, if the tailings waste were impounded. A tanker truck was used for this purpose.

As of December, 1971, the pilot plant operation should be terminated, and it is likely that the process will be upscaled to 20 long tons per hour. At this point it should be noted that the successful installation of this flotation system with its environmental safeguards could be beneficial to Wabush Lake. Upon completion, 15 percent of "Fe" presently deposited in the tailings would be removed. This extraction amounts to 1-2 million long tons annually under the present operating regime and will have even more significance when the Carol Lake mine doubles production.

Another area of endeavor in cleaning up Wabush Lake is an examination of the 5050 U.S. g.p.m. that is pumped into Beaver Bay. Results from the summer survey of Wabush Lake indicate that 83 percent of the "Fe" pumped into this area is soluble "Fe" in the form of slimes, a major contributor to the reddish hue of the lake. By recycling waste in the pelletizer process, substantial amounts of useful ore can be prevented from entering the lake.

Wabush-Scully Mines - Wabush, Labrador

On one occasion in 1971, personnel from the Fisheries Service met with the Mine Manager for the purpose of examining the tailings disposal.

Since the disposal procedure is generally in accordance with the proposal agreed upon in 1965, there has been little cause for negotiation. At this time, however, a dyke constructed at the lowlands northwest of the tailings disposal area had failed and silty water was mixing with a stream flowing into Wabush Lake. There was evidence of iron tailings on the banks of the stream and total suspended solids were 4 or 5 times higher than adjacent Wabush Lake. The dyke was to be fixed as soon as possible.

Bowaters Nfld. Co. - Corner Brook

This pulp and paper mill produces approximately 1050 tons per day of bleached newsprint by a sodium-base pulping process. A total of 36.4 million gals. of effluent is produced daily and discharged to Humber Arm without treatment. These wastes are characterized by a high BOD₅ and suspended solids loading.

Hydrographic surveys of Humber Arm were carried out in 1968, 1969, and 1970 to determine the effects of the mill discharge on the valuable marine resources of the estuary. Humber River, which drains into Humber Arm is the most productive salmon river in insular Newfoundland, with an annual river escapement ranging 12,000 - 20,000 adults.

The surveys demonstrated that much of the bottom of Humber Arm has been destroyed by the deposition of fibre, essentially eliminating macroscopic benthic life. Except in the immediate area of the mill outfall, dissolved oxygen values were generally near saturation. BOD values as high as 7.35 mg/l were found near the outfall but they were generally within acceptable limits in other areas of the estuary. The distribution of spent sulphite liquor (SSL) followed that of BOD and appeared generally to be concentrated on the south shore of Humber Arm. In the vicinity of the outfall, SSL concentrations reached a maximum of 800 mg/l.

It was concluded from these surveys that there is little likelihood that pulp mill wastes are directly harmful to salmon migrating through Humber Arm. Consequently, no further field work was carried out by Resource Development staff during 1971. Some monitoring, however, was carried out by Bowaters staff. Data was collected on bottom sediments and BOD values in the estuary. Results collected essentially corroborate work conducted by pollution control staff.

During 1972 the attention of this department will again be focused on the Bowaters Mill for negotiating the application of the new pulp mill regulations to this operation.

Kraft Linerboard Pulp Mill - Stephenville

Construction of this pulp mill, begun in 1969, is now approximately 60 percent complete. Utilizing black spruce harvested in Labrador, this mill will produce 1000 tons per day of unbleached linerboard, using the Kraft pulping process. Eighteen million gallons of effluent will be produced daily, containing an estimated suspended solids load of 85,000 lbs. per day and a BOD₅ load of 40,000 lbs. per day, before treatment. Staff efforts during 1971 were directed toward two facets. Baseline investigations were conducted to document present biological and chemical conditions in St. George's Bay. Information collected during these studies will be used to assess the impact of mill wastes on the marine environment. In addition to these studies, extensive negotiations were carried out with Javelin Paper Corp. to ensure that effluent from the linerboard mill would receive the "best possible treatment". Implicit in this philosophy of "best possible treatment" was that the final effluent meet the requirements of the new pulp and paper mill standards and that waste discharges from the mill not impair the water quality of St. George's Bay.

Negotiations. Since mill construction proceeded rapidly, great efforts were made early in 1971 to initiate discussions with the designated consultants regarding effluent disposal practices. No success was achieved until July, when two documents were received in response to a specific directive to Javelin Paper Corp. from our Minister. These reports included a pre-design study of St. George's Bay (by Dr. R. E. Warner) and a pre-engineering report on requirements for effluent treatment (by Van Loven Consultants). Dr. Warner's report contained a review of the toxicity of Kraft mill effluents, an evaluation of the fishery resources of St. George's Bay, and a description of the effects of hydrography on effluent disposal in St. George's Bay. Conclusions reached on effluent treatment practices in the consultant's report were, for the most part, based on recommendations made in the Warner report. It was recommended that the effluent receive only primary treatment (to remove settleable solids) prior to discharge to St. George's Bay through a 4000 ft. outfall and that a pilot plant be installed to study methods of biological treatment.

This proposal was studied in depth by headquarters and local staff. Discussions were held with Mr. G. Siebert, oceanographer in charge of a study of the hydrography of St. George's Bay. Additionally, Resource Development Branch, Halifax, carried out bioassays to determine the toxicity of unbleached kraft mill wastes to lobster larvae and young salmon. On the basis of available information, the initial proposal was rejected because it was inadequate to meet the pulp mill standards and would not satisfactorily protect the marine resources of the bay. Concern was expressed that the clarified effluent would create a local oxygen demand and possibly be toxic to pelagic adult and larval organisms. Oceanographic considerations, though incomplete at that time, stressed the need for

secondary treatment. Although Javelin Paper Corp. recommended most strongly that a period of up to two years would be necessary to design a satisfactory secondary treatment facility, departmental officials unanimously agreed that such a period would not be required. Javelin was requested to provide satisfactory primary as well as secondary treatment in an aerated lagoon with a retention time of five days. Approval was also given for the construction of a 2000 ft. outfall pipe with diffuser.

At this juncture, new consultants were retained by Javelin Paper Corp. to design the effluent treatment facilities. Late in 1971, a proposal was received which, after considerable discussion and amendments, was tentatively approved. Primary treatment will be provided by a clarifier (120 ft. in diameter, 2-hour retention time), and two settling ponds (one of which will be used on a standby basis only). Additionally, screening of the wood room effluent will be provided to reduce the solids load reaching the clarifier. It is estimated that this primary treatment will remove 75 percent of the suspended solids. Secondary treatment will consist of two aerated lagoons, operated in parallel, with a 5-day retention time. This system will result in a 75 percent reduction in BOD. It is difficult to predict toxicity reduction, but it is felt that toxicity will be lowered sufficiently to meet the pulp mill standards. A meeting scheduled early in the new year will likely approve these treatment facilities in principle.

Problems for discussion in the New Year involve design of the outfall and diffuser and determination of the departmental attitude for the storage of pulpwood in Stephenville Pond. Indications are that wood storage in the pond is not compatible with present water utilization of the pond. The mill is scheduled to commence operation in late 1972.

Thermal Generating Plant (N.L.P.C.) - Holyrood

This 300 M.W. thermal generating plant was completed in the latter part of 1970 and put on the Newfoundland power stream. Anticipated industrial power demands did not materialize for 1971 and the generating station was utilized mainly on a standby and emergency basis. On an occasion when the plant was at peak production, a biologist from the Fisheries Service took surface water temperatures from stations established in a grid to estimate the effluent dispersal area. His results indicate that the thermal plume did not vary from estimates determined by personnel from the Service and Mr. G. H. Seibert, Bedford Institute of Oceanography, in an earlier study.

Industries - St. John's Metropolitan Area

Canadian Liquid Air Limited. Canadian Liquid Air Ltd. (CLA) is the largest user of calcium carbide in St. John's. Approximately 4,500 pounds are required daily in the manufacture of acetylene, which produces a large quantity of waste residue, slaked lime. Prior to May, 1971, the process wastes containing slaked lime were discharged into a 5200 gal. mobile tanker and the slaked lime was allowed to settle overnight. Then the liquid waste was decanted from the tank once or twice daily into a storm sewer, thence it entered Learys Brook, then Long Pond. The liquid waste had a pH above 10, which was lethal to fish. During decantation of the liquid portion of the waste, suspended slaked lime was discharged with the liquid. Then the slaked lime also found its way into Learys Brook and Long Pond where it settled out.

In March, 1971, approximately 500 dead fish (mostly brown trout) were found in the Rennie's River, the outlet of Long Pond. Field investigation suggested that high pH was instrumental in the fish kill.

A large quantity of slaked lime was found below the Thorburn Road culvert into Learys Brook. Sediments in the brook near Long Pond and in Long Pond also contained calcium hydroxide (lime). It seemed that the lime was the prime factor for increasing the pH.

Investigation of industrial sources of limes led to the conclusion that the CLA Ltd. was the polluting source causing the high pH in Long Pond system. CLA was required to install a settling tank and to discharge the liquid waste into a sanitary sewer instead of the storm sewer. Slaked lime is held in the mobile tanker and dumped at the city sanitary landfill site.

Gaden's Limited. This Company uses large quantities of caustic compound (sodium hydroxide), trade name "Relion", in the bottle wash. A total of 56 drums is used annually, each drum weighing 400 pounds.

Since "Relion" is lost in the washing process, chemical must be added to the washer every day in order to maintain the desired concentration. The rinse was discharged into a storm sewer to Learys Brook. A serious problem occurred during cleaning of the bottle washer when approximately 2½ drums (900 lbs.) of caustic compounds could be discharged in a day's operation. This cleaning took place twice a year.

Recommendation was made to Gaden's Ltd. to connect the waste discharge into the sanitary sewer. This connection was carried out in July. It was also recommended that the 900 pounds of caustic compound used in cleaning the bottle washer should be neutralized before it is discharged into the sanitary sewer.

Browning Harvey Limited. This Company utilizes about 8000 pounds of "Briltak" (a type of caustic compound) in their bottle-wash plant annually. Rinse water containing Briltak is discharged into a storm sewer. As a result, a sample collected from the storm sewer at Ropewalk Lane had a pH of 11.4. The bottle washer is cleaned twice a year. During cleaning of the washer, approximately 850 lbs. of Briltak are discharged into the storm sewer, thence into Rennies River. It has been recommended that all the rinse water and water from the washer room be discharged into the sanitary sewer.

Engineering Services of the St. John's Municipal Council has asked without success that the Company connect their waste line into the sanitary sewer. The Department may be required to consider the case a violation of Section 33(2) of the Fisheries Act, an act forbidding the discharge of deleterious substances into fish-bearing waters.

Russwood Farm, Roaches Line. The Russwood Farm, located off Roaches Line, has an operating capacity of 80,000 hens and 600 pigs. This farm is one of the larger in Newfoundland. Approximately 9 acres of land are used for the waste disposal system, which now has three lagoons operating in series.

During the first half of 1971, only one lagoon was in operation. Another two lagoons were planned for construction in July, 1971. In mid-July, the site had been cleared for the two new lagoons. At the same time, the lagoon which had been in operation for the past few years was also cleaned out by flushing. Scums, sludges, and sediments found their way into South River. The adverse effects in the receiving stream lasted for more than a month. Fortunately, the natural flow in the stream at that time was very great. During the first month, white fungi were found on the river bed as far as 1/4 mile from the outfall. Solids were trapped on the south bank. Thirty yards downstream river water had a biochemical oxygen demand (B.O.D.) loading of 58.6 mg/l after one month. Table XI summarizes the data for the lagoon effluent and the receiving water quality. At the end of October, the new lagoons began operation, and conditions in the river have been improving since.

J. Kavanagh & P. Paul Farms, Ferryland. J. Kavanagh and P. Paul Farms, located at Ferryland, each hold six hundred pigs on the average. Lagoon treatment is used for their waste disposal systems.

J. Kavanagh's lagoon is located on high land. Most of the water will infiltrate into the ground. During heavy rain, some effluent overflows and runs into a small brook. The system is considered in fair condition.

Table XI. Water quality analyses near the Russwood Farm, 1971.

Sampling stations	pH	Turbidity (JTU)	Total alkalinity (mg/l)	B.O.D. (mg/l)	D.O. (% sat.)
1st lagoon effluent	6.86 - 7.49	30 - 64	330 - 426	246 - 800	0
2nd lagoon	7.15 - 7.74	45 - 64	326 - 448	232 - 440	20 - 26
Effluent into stream	7.44 - 7.74	33 - 48	286 - 406	99 - 234	30 - 69
Upstream	6.49 - 6.63	0.4 - 2.0	2 - 6	0.6 - 1.7	94 - 105
Downstream 30 yds.	7.32 - 7.42	3.5 - 8.4	48 - 68	14 - 58.6	85 - 95
Downstream 1/4 miles	6.84 - 7.25	1.4 - 2.7	10 - 20	3.3 - 4.7	86 - 101
Downstream 2 miles	5.70 - 6.89	0.7 - 1.3	4 - 7	0.8 - 5.7	84 - 88
Downstream 3 1/2 miles	6.44 - 7.21	0.6 - 1.1	5 - 6	0.7 - 3.1	83 - 108

P. Paul has two units separated about 1/4 mile, each unit is serviced by two lagoons operating in series. One unit was erected recently. The first lagoon situated on high land is not filled up, no overflow yet enters the second lagoon. It is believed that much of the water has infiltrated into the ground. This lagoon appears to be operated satisfactorily. The lagoons at the older unit, located on low land were not functioning very well. The effluent from these lagoons showed no dissolved oxygen, high suspended solids, dark color, and obnoxious odor.

Analytical data showed that the receiving brook water recovered fairly well. B.O.D. was recorded at 11.9 mg/l about 300 yards downstream from the farms and 5.6 mg/l about 500 yards distant.

American Smelting and Refining Company Ltd. - Buchans

This base metal mine, located in Buchans and operated by the American Smelting and Refining Company Ltd. (ASARCO), began production in 1927. A strike in 1971 from June 21 - November 12, reduced the annual production to about half that of previous years.

The company had planned to complete the new tailings pond by September, 1971, but the strike advanced the completion date by about one year. The proposed new tailings system, located on Jackson's Pond, will provide approximately 51.5 million cu. ft. of storage. The estimated retention time of this new pond will be 40 days at the beginning and 13 days at the end of mine operation. The capacity of the system is sufficient to meet demands up to 1979. The new tailings pond, when completed, will receive the mill tailings and the mine drainage. At present, it appears that the mine drainage will require additional chemical treatment in order to achieve effluent standards.

The 1971 sampling results (Table XII) showed that the concentrations of zinc and copper in the mine drainage were as high as 150,000 ug/l and 9,600 ug/l, respectively. Median values were 80,000 ug/l and 3,200 ug/l, respectively. If expressed as Incipient Lethal Level (ILL), the combined toxicity ranges from 12.49 - 33.0 ILL, with a median value of 18.33 ILL. The mine drainage, 500 gallons per minute, is now discharged into Buchans Brook without any treatment. The old tailings ditch water had similar characteristics. The tailings effluent exhibited a lower toxicity level, with only 14 per cent of the results exceeding 1 ILL.

Mine drainage and the old tailings ditch are the main polluting sources from this mine. A comparison of the results of Upper Buchans Brook station with Station #2 (about 4 miles downstream from Buchans), shows the extent that the ASARCO discharges have affected the water quality of Buchans Brook (Figure 13). Median values of copper increased from 4 ug/l to 29 ug/l between the two stations. Zinc had an even more significant increase than copper, 20 ug/l to 720 ug/l. At station #2, 60 percent of the results exceeded 1 ILL and 95 percent exceeded 0.5 ILL.

Gullbridge Mine - South Brook

During 1971, water quality studies were continued in South Brook with additional sampling stations established in the Gullbridge mine area. The 1971 water quality results reflected those of 1970 very closely. Twelve percent exceeded 1 ILL and 20 percent exceeded 0.5 ILL (Table XIII). It was pleasing to note that the toxicity level for Gullbridge's tailing effluent only ranged from 0.03 to 0.24 ILL. Since the expression of ILL is mainly affected by hardness, the high hardness found in the tailings effluent reduced the toxicity of copper and zinc to fish. With a hardness of 8 mg/l (median value) in South Brook, the toxicity was somewhat higher than in the effluent and ranged from 0.20 to 2.27 ILL.

As a result of high acid readings in the effluent, pH was monitored in the tailings and South Brook (Table XIV). In 1971, summer readings of tailings pH were recorded at 3.44 - 3.66. This activity must have been caused by summer temperatures which increased the rate of pyrite

Table XII. Range of physical and heavy metal concentration in ASARCO and Buchans Brook, 1971.

		Upper Buchans Brook	Mine drainage	Old Tailings ditch	#1 (Tailings effluent)	#2 approx. 4 miles downstream
pH	(pH unit)	6.06 - 6.60	3.35 - 6.42	4.36 - 9.18	6.21 - 7.35	6.12 - 6.95
Total hardness	(mg/l)	4 - 14	346 - 734	108 - 236	2 - 216	6 - 32
Turbidity	(JTU)	65 - 15	31 - 93	3.1 - 570	1.7 - 190	0.8 - 24
Copper (dissolved)	Concentration (ug/l)	4 - 15	1600 - 9600	40 - 1700	20 - 52	18 - 44
	ILL	0.11 - 0.25	3.05 - 6.55	0.01 - 4.82	0.01 - 0.60	0.06 - 0.70
Zinc (dissolved)	Concentration (ug/l)	10 - 106	8000 - 150,000	1800 - 54,000	60 - 5300	42 - 2000
	ILL	0.02 - 0.23	9.09 - 28.45	1.37 - 23.15	0.11 - 2.64	0.02 - 2.85
Total ILL		0.14 - 0.44	12.49 - 33.	1.39 - 23.19	.21 - 2.70	0.13 - 2.98
No. of results exceeding 1 ILL		0	22 or (100%)	22 or (100%)	5 or (14%)	22 or (60%)
No. of results exceeding 1/2 ILL		0	22 or (100%)	22 or (100%)	19 or (53%)	35 or (95%)

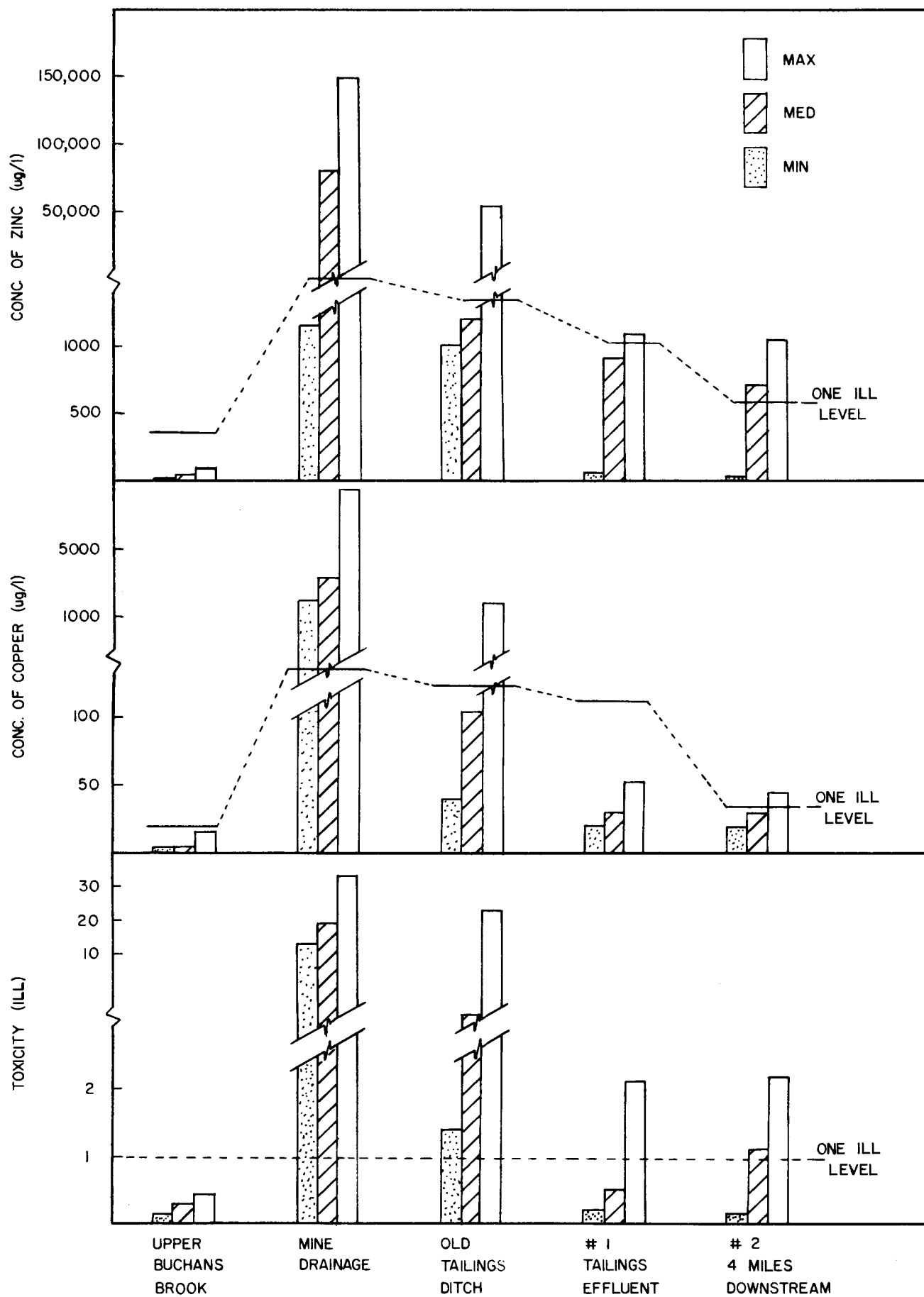


Fig.13 The toxicity path for zinc and copper from ASARCO and Buchan's Brook, 1971.

oxidation and increased the activity of sulphur bacteria. Readings of pH for spring and fall were above 7. Mine drainage was slightly alkaline (7.41 - 8.00). In South Brook pH was normal for all stations (6.57 - 7.08) which would indicate that the discharge of tailings effluent and mine drainage has not affected water quality in South Brook with respect to acidity.

Table XIII. Water quality analysis at Gullbridge mine and South Brook, 1971.

Station	pH	Total hardness mg/l	Copper ug/l	Zinc ug/l
Tailings effluent	3.44 - 7.91	102 - 250	4 - 90	18 - 35
Mine drainage effluent	7.41 - 8.00	250 - 260	4 - 13	5 - 14
# 7	6.44 - 6.87	6 - 30	6 - 100	10 - 173
# 8	6.30 - 7.04	5 - 20	4 - 100	5 - 53
# 9	6.50 - 6.85	6 - 32	4 - 20	10 - 98

Gullbridge Mine ceased production in December, 1971, after being in operation for only five years. In its final year of production, 2,000 tons of ore were mined daily. The tailings disposal system was considered satisfactory, except for stability of the tailings dyke.

The impoundment area is located west of the mine site and receives about 2,000 tons of tailings daily. In use since 1968, the area has nearly filled with solids. To accommodate more tailings, the dyke was raised by about 8 feet. Due to poor planning in construction, the resulting dyke is very unstable. Fill was dumped on the upstream side into the liquid tailings mass or on top of the old dyke and received little or no compaction. Embankment slopes varied from 1 on 1.1 to 1 on 1.4 (average 1 on 1.3) whereas a slope of 1 on 3 is most desirable. As a result of improper construction, a portion of the dyke slipped into the pond and a number of crack-lines were evident in the main dyke.

In view of the permanent mine shutdown and the condition of the dyke, it was recommended that the water level in the tailings pond be dropped to a minimal level. To reduce the volume of mine acid seepage, the abandoned tailings area, if feasible, should be covered with vegetation. The most effective way to minimize the acid and dissolved heavy metal problems is to reduce the volume of effluent that leaves the mine property. Limestone placed below the decanting outlet as a filter bed may be useful for neutralizing acid drainage occurring during the summer period.

Table XIV. pH values at Gullbridge Mine, 1971.

Place	Sample taken	Days after samples were collected									
		0	1	2	3	4	5	6	7	8	9
Gullbridge Pipe Outlet	Sept. 14/71	8.8	-	6.8	7.18	7.20	-	6.71	6.90	6.91	7.00
	Sept. 16/71	10.6	10.89	10.61	-	8.62	8.09	7.26	7.25	-	-
Gullbridge Tailing Eff.	May 12/71							7.54			
	June 3/71							3.44			
	Aug. 10/71							3.58			
	Sept. 14/71	4.5	-	3.8	3.88	3.95	-	3.61	3.75	3.62	3.64
	Sept. 16/71	3.8	3.70	3.70	-	3.50	3.74	3.69	3.62	-	-
	Oct. 6/71	5.8	6.04					3.66			
	Nov. 23/71							7.91			
Upstream (100')	Oct. 6/71	6.5	6.91					7.08			
Downstream (100')	Oct. 6/71	6.3	6.71					6.58			
Eff. into South Brook	Oct. 6/71	6.3	6.60					3.58			
#8 (approx. 7 miles downstream)	May 12/71							6.57			
	Aug. 10/71							7.04			
	Sept. 15/71							7.08			
# 9 (approx. 17 miles downstream)	May 12/71							6.60			
	Aug. 10/71							6.80			
	Sept. 15/71							6.82			

Newfoundland Fluorspar Mines Ltd. - St. Lawrence

This mine, located at St. Lawrence, is a subsidiary of Canadian Alcan Aluminum Ltd. The waste disposal system appears to be inadequate. The Company utilizes two small settling basins for the mill waste for retention of materials which are greater than size 325 mesh. The waste liquid, containing less than 325 mesh particles, is discharged into a small brook without further treatment. The backfill wash water is occasionally pumped into a settling pond to allow the clay and fine particles to settle out. Most of the time, however, the backfill wash water is discharged directly into a brook.

The concentration of solids in the backfill wash water was as high as 20 percent in the 1971 samples. The receiving brook water was always silted. During the low flow period, dilution was small and solids settled onto the river bed. At times of high flow, settled solids were carried downstream. Unless the discharge of backfill wash water ceases or is treated, the brook will be silty all the time. Although siltation was the main problem, other chemical parameters were found below an acceptable level in 1971. There was no significant fluoride content in the mill waste.

The Company had planned to carry out improvements on their waste disposal system in 1971. Unfortunately, a strike of mine workers caused delay of the project. At the end of 1971, construction of two larger settling basins and a clarifying pond were underway. The completion date was scheduled for January 1972.

Consolidated Rambler Mines - Baie Verte

This Company began its operation in July, 1964. Current production is about 24,000 tons of copper concentrate annually with 1200 tons of ore being mined daily. A new ore body containing a fairly good grade of copper was found in early 1971. However, the content of sulphide in the new ore is about 75 percent as compared to only 3 percent in the old mine.

A flooding problem was repeated again this year. During the spring runoff in May, the old tailings dam was washed away and Little Rambler Dam and the diversion channel bank from England's Brook had a number of breaks. As a result of excessive water, tailings were carried away from the pond, and the retention time was reduced considerably. Water in the brook below the tailings pond was very turbid and oily in appearance. These effects were not limited to South Brook, but extended to the waters of Baie Verte, causing a brown discolouration in an area extending from the town to Tin Pot Island at the outer end of Baie Verte.

In order to determine the effects of this pollution on marine life, the departmental diving team examined the bottom from near the mouth of South Brook out to a depth of sixty feet. They reported that the bottom was covered with a fresh, greyish silt. On the day of the dive, visible discolouration was confined to the south end of the bay in the upper meter of the water column (the fresh water layer). Below that depth, visibility was about six meters. The divers could find no dead organisms, apart from a few sand dollars and scallops. Numerous other live animals and plants were present. It would appear that the overflow of Rambler's tailings pond down South Brook was not immediately lethal to marine life in Baie Verte.

Negotiations with representatives of Rambler Mine were conducted for the purpose of preventing repetition of the flooding problem. The Company agreed to carry out the following work:

- 1) The main tailings dam to be raised by 5 feet with additional dykes constructed in the lower area near the dam and diversion ditches.
- 2) The old tailings dam, Little Rambler Dam, Upper Rambler Brook Dam, and several breaks at the bank of the diversion ditch to be repaired.

Analytical data (1971) showed that the Rambler Brook system remained very much the same as in 1970, except for the discolouration, turbidity, and oily appearances during the spring runoff period. Table XV summarizes the range of heavy metal concentrations in Rambler Brook system since 1964.

Table XV. Range of heavy metal concentrations (ug/l) in the Rambler Brook System, 1964 - 1971.

Year	Copper	Zinc
1964	Trace - 5	5 - 120
1965	9 - 95	35 - 760
1966	Trace - 6	10 - 395
1967	4 - 40	3 - 70
1968	3 - 18	4 - 37
1969	2 - 695	0 - 640
1970	4 - 36	10 - 24
1971	6 - 40	5 - 102

Whalesback Mine - Little Bay

The tailings disposal system of Whalesback Mine was considered to be satisfactory except for high turbidity in the tailings effluent. Whalesback Pond is used as a tailings disposal area. Copper ore, which is underlying the south portion of this pond was made accessible by lowering the water level of the pond by 52 feet. After lowering, the pond was divided into two separate bodies. Mine tailings are discharged into the upper pond and overflow into the lower pond before entering a brook.

Turbid mine drainages are pumped directly into the lower pond, about 75 yards away from the lower pond outlet. As a result, final effluent from the lower pond is much more turbid than the upper pond. It is suggested that the mine drainage should be pumped to the upper pond together with the tailings in order to remove the suspended particles. The turbidity in the final effluent ranged from 5 - 350 JTU.

Analysis of the 1971 samples showed that there was insignificant copper and zinc in the tailings effluent. The maximum toxicity level was 0.07 ILL.

Advocate Mine - Baie Verte

This open-pit asbestos mine commenced operation in June, 1963, with an initial capacity to mill 5,000 tons of asbestos ore per day. Daily capacity has been increased to the current level of 7,500 tons.

The ratio of the asbestos ore and waste rock is about 1 to 4, resulting in about 30,000 tons of waste rock being disposed of daily. This waste rock presents little pollution problem.

Approximately 3.0 percent of asbestos is obtained from the ore, 0.6 percent being lost to the tailings. The tailings are carried by belt conveyor and dumped east of the mine site. These tailings have accumulated to form the highest hill in that area.

Since the tailings contain fine asbestos fibres, heavy rain and seepage water easily carries such particles into the brook to the bay about half a mile below the dump site. A white discolouration was evident in the bay during the wet season.

As a result of the dry process employed in the mill, the chronic dust problem exceeds that encountered in most other mines or industries. This problem may have long-term harmful effects to human lungs. Dry tailings, containing fibre can easily be made airborne by wind. Generally, air pollution is more relevant to this mine than water pollution.

BASELINE AND MONITORING

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Come-by-Chance Baseline Study

The Department began an intensive study of pre-development conditions in Come-by-Chance Bay during the summer of 1971. The study had two main facets, water quality and biological communities.

The water column was sampled at four stations (Fig. 14) for D.O., BOD₅, phytoplankton, zooplankton, hydrocarbons, and organic particulate matter (Tables XVI, XVII, XVIII, XIX). Phytoplankton analysis followed the method of Strickland and Parsons, and zooplankton was collected with a 60 ft. vertical haul of an 18" diameter oceanic plankton net (Fig. 15). Water samples were collected with a three-liter Van Dorn sampler. Hydrocarbons were extracted from the water using carbon tetrachloride, and particulate matter was filtered by means of silver-treated filters; both analyses were done for us by Dr. D. Gordon at Bedford Institute of Oceanography. We hope, next year, to analyze bottom sediments for the presence of hydrocarbons. Next year, the water column will be further analyzed for sulfides, phenols, cyanides, and ammonia, as well as continuation of the present monthly sampling.

The communities of bottom organisms were studied at 12 stations (Fig. 14) with the use of SCUBA equipment. Two divers, each carrying a 0.5m x 0.5m aluminum quadrat, descended to depths of 3, 6, and 9 fathoms at each station; the quadrat was randomly dropped when the diver was approximately 3 meters off the bottom. All the organisms enclosed within the quadrat were collected into a plastic bag, brought to the surface, and preserved in 10 percent formalin. Six samples were collected at each depth.

Because of the dominance of Lithothamnion-based communities, sorting and identification of organisms is tedious. To date, 39 macro-invertebrate species and over 2,500 individual organisms have been encountered. Analysis of the data will take two forms, a cluster analysis using Fager's Index and four species - diversity indices. The cluster analysis, based on the presence and absence of species at each station, will give a good representation of community organization and station similarity. The McIntosh diversity index will show equitability, the Shannon Index equitability and variety, the Margalef Index variety, and the Simpson Index dominance (Table XIX). Year-to-year comparison of the cluster analysis and species diversity indices should show post-development changes in community organization, if any. This sampling program will be continued next summer.

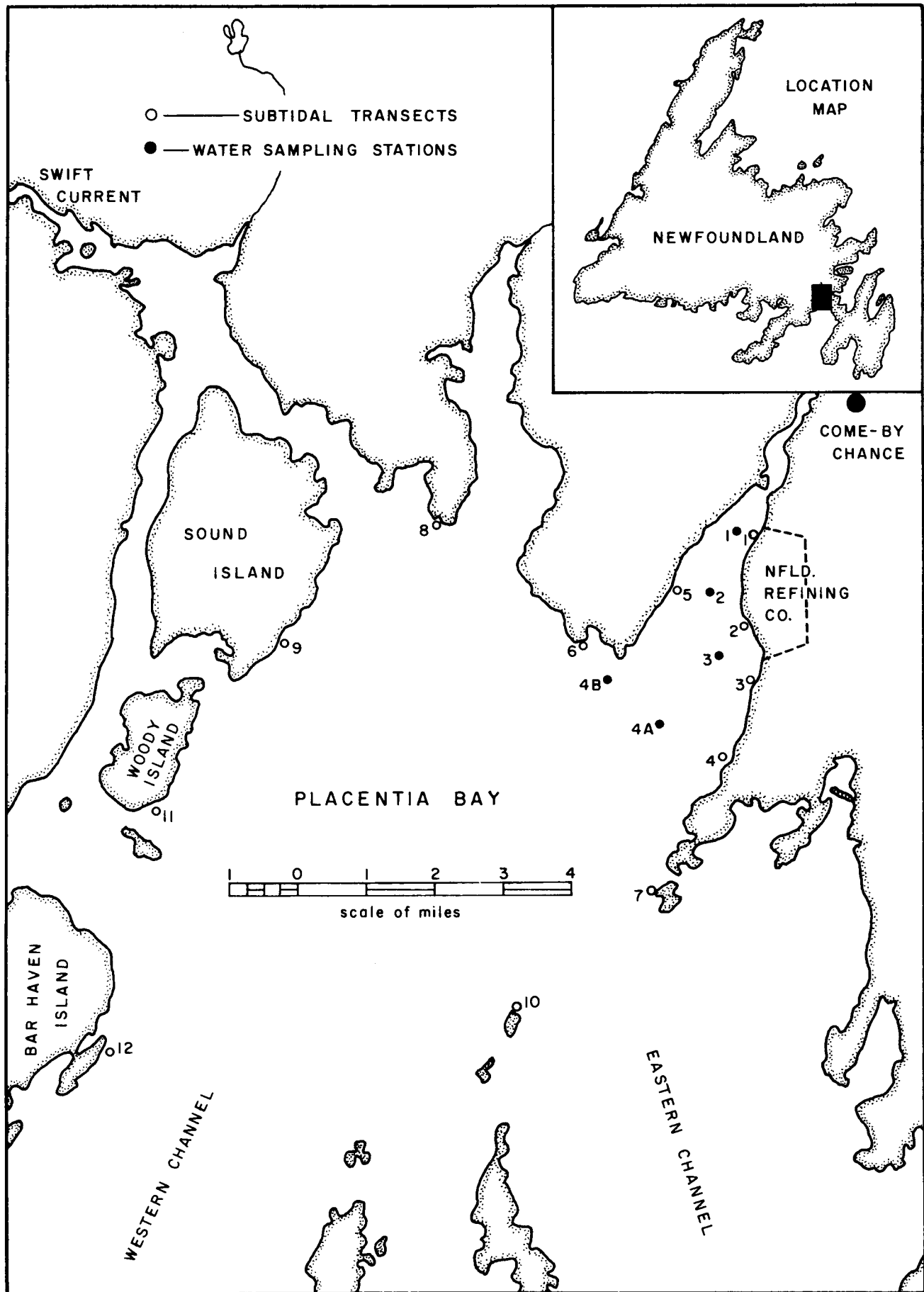


Fig.14 Come-By-Chance baseline study showing locations of transects and water sampling stations.
(Station 4B was used for water quality after November 1971)

Table XVI. Summary of the water quality data collected from Come-by-Chance Bay, 1971.

Station	Depth	D.O. (ppm)				% Saturation				BOD ₅			
		July	August	November	January	July	August	November	January	July	August	November	January
1	Surf.	9.25	7.97	9.8	10.5	100.54	101.31	96.55	93.08	0.9	***	0.55	0.80
	1m	9.17	7.97	10.2	10.7	104.44	100.26	-	-	0.65		0.50	0.30
	2	9.21	-	-	-	103.36	-	102.51	94.94	0.2		-	-
	5	9.28	8.09	10.2	10.9	104.03	101.98	102.51	96.88	0.0		0.2	0.80
	Bott.	9.29	8.06	10.1	10.7	102.20	100.26	101.50	98.16	-		-	0.50
2	Surf.	10.3	8.07	9.9	11.0	116.51	104.63	99.85	97.34	0.55		0.30	0.30
	2	9.2	8.10	9.8	10.6	103.37	101.96	97.51	94.05	0.25		0.50	0.30
		10.4	8.09	10.2	11.1	115.94	111.68	103.34	98.49	0.05		0.65	0.20
	10	9.5	8.06	9.7	10.8	105.32	106.41	98.47	99.08	0.15		-	-
	15		8.11	-	-	115.68	104.45	-	-	0.5		-	-
	25	10.2	-	10.1	10.5	101.39	-	102.74	96.33	-		-	-
	Bott.	10.6	8.04	9.55	10.3	91.93	96.71	94.55	86.19	0.15		0.60	1.05
3	Surf.	9.1	8.11	9.5	10.8	103.64	103.26	95.95	95.82	0.5		0.60	-
	2	9.2	8.09	10.1	10.7	103.65	104.84	101.50	94.77	0.25		0.50	0.20
	5	9.25	8.07	9.6	10.7	103.12	103.35	96.48	94.85	0.9		0.45	0.40
	Bott.	9.4	8.04	9.6	10.5	103.75	102.56	96.67	96.33	0.15		0.55	0.40
4	Surf.	9.1	*	9.55	11.4	102.36	*	98.45	98.70	0.05		0.60	1.20
	2	9.2		9.6	11.9	103.60		96.48	102.58	0.2		0.30	0.20
	5	9.45		9.7	11.5	105.35		97.48	99.13	0.2		0.30	0.30
	10	9.9		9.8	10.5	109.63		98.98	90.90	-		-	-
	20	9.8		**	**	102.02		-	-	-		**	**
	40	10.7				97.09		-	-	-			
	Bott.	10.5		9.5	10.7	92.51		95.76	92.48	0.0		0.37	0.40

* Station not sampled because of weather.

** Station 4 changed as shown on Figure 1.

*** BOD had irregular results and were discarded.

Next summer we are planning to sample littoral communities in appropriate areas of the bay. This program will take a form similar to that for the study of the bottom communities, and the data obtained will be useful in the case of an oil spill. Beaches at the head of Placentia Bay will be sampled during the coming year to determine the residual concentrations of hydrocarbons.

Table XVII. Results of hydrocarbon sampling in Come-by-Chance Bay, November 24, 1971.

Station	Depth	Hydrocarbons (ppb)
1	1 m	0.4
	5 m	0.5
	9 m	0.1
2	1	0.5
	5	0.2
	10	0.0
3	1	0.1
	5	3.6 (1.1)
	18	2.9
4	1	0.1
	5	0.6
	10	0.7

Table XVIII. Phytoplankton sampling data from Come-by-Chance Bay,
January 24, 1972.*

Station	Depth	a (mg/m ³)	Chlorophyll		Carotenoids
			b (mg/m ³)	c (mg/m ³)	(M-SPU)
1	Surf.	0.2119	0.1309	0.8177	0.0737
	5m	0.2340	0.1103	0.8066	0.0806
	10m	0.2021	0.1579	0.8822	0.0502
2	Surf.	0.2529	0.1505	0.8215	0.0669
	5m	0.2452	0.2186	1.5027	0.1178
	10m	0.1849	0.1647	0.9904	0.0015
3	Surf.	0.2180	0.1591	0.8905	0.0319
	5	0.2761	0.2721	1.0622	0.0106
	10	0.2211	0.2110	0.7031	0.0730
4	Surf.	0.3540	0.1957	0.7786	0.8588
	5m	S A M P L E	L O S T		
	10m	S A M P L E	L O S T		

* The values for chlorophyll are higher than expected and may indicate an irregularity in the method used.

Table XIX. Summary of the bottom community data examined to date from the Come-by-Chance Bay.*

Station	Depth	No.of species*	No.of individuals	Diversity Indices			
				McIntosh (equitability)	Shannon	Margalef (variety)	Simpson (Dominance)
2	3 fath.	6	23	0.4394	1.0445	1.5946	0.4253
	6 fath.	5	52	0.1955	0.6875	0.3163	0.6915
4	6 fath.	14	241	0.5307	1.5824	2.3701	0.2536
	9 fath.	11	156	0.5130	2.1796	1.9802	0.3134
10	3 fath.	14	123	0.6419	1.9437	2.7014	0.1729
	6 fath.	23	430	0.6459	2.2428	3.7930	0.1484
	9 fath.	20	735	0.4579	1.6762	2.8788	0.2977
11	3 fath.	2	44	0.2779	0.6085	0.2642	0.5837
12	6 fath.	13	161	0.5876	1.8885	2.3615	0.2104
	9 fath.	14	417	0.5956	1.9659	2.1547	0.1883

* 39 species of macro-invertebrates have been found.

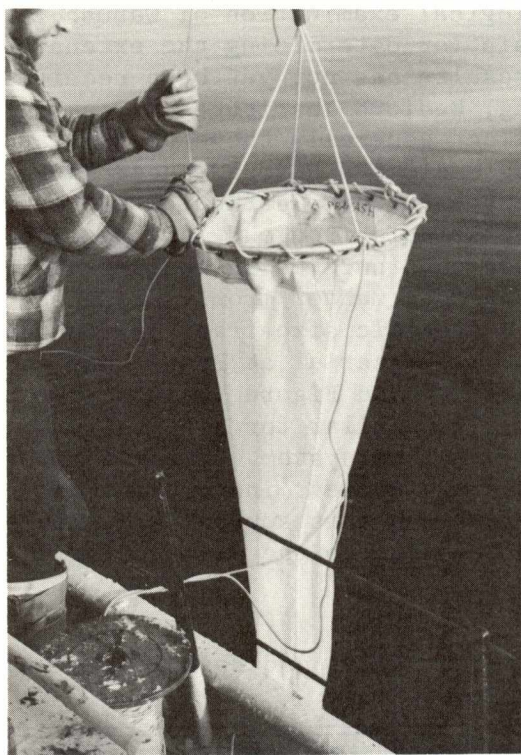


Figure 15. The oceanic plankton net being lowered from a meter block on the M.V. Porella.

Wabush Lake

Several studies in past years have indicated that harmful effects of the tailings, other than aesthetic implications, are difficult to document. The 1971 study of Wabush Lake attempted to examine more closely some of the subtle changes that may be affecting fish populations, as a result of the tailings discharge. These changes may include; smothering of benthic invertebrates or aquatic flora, impairing fish spawning success or the development of young fish, modifying natural movement or migrations of fishes, or interfering with light penetration. The investigation was oriented towards lake sedimentology and biology.

Sedimentological examination of Wabush Lake in 1966 and March, 1971, formed the basis for determining the extension of tailings dispersal. Report of the 1971 results has not yet been received, but communication with Dr. D. H. Loring, Bedford Institute of Oceanography, has indicated that the results reflect generally those of 1966 and, in some cases, show that the tailing sediments have advanced farther down the lake. To assess this dispersal further, dithonite extraction procedures, the means for determining soluble iron and manganese as mineral coatings i.e. "Fe" and "Mn" not incorporated in the geology of the area, were used on filtered, suspended matter from various stations throughout the lakes. Material of a specific size fraction from each station was compared to the same size material at Beaver Bay and at the tailings outfall. Data in Table XX and Figure 16 show that the percent soluble iron of the total iron is similar for all stations, indicating tailings dispersal throughout the lake system. The high total "Fe" values measured in Beaver Bay are a clear indication that substantial quantities of iron are originating from this source. The violent red coloration of this bay is striking compared to the dull red of the lake adjacent to the tailings.

Table XX. Distribution of total and soluble iron in Wabush and Shabogamo Lakes, 1971.

Station	% total "Fe" in suspended matter	% soluble "Fe" dithonite extraction	% soluble "Fe" of total "Fe"
Wabush tailings	2.67	2.42	90.64
Wabush middle	4.95	2.88	58.18
Wabush north	2.85	1.75	61.40
Julienne	2.37	1.67	70.46
Shabogamo	3.87	2.34	60.46
Beaver Bay	88.0	72.7	82.61

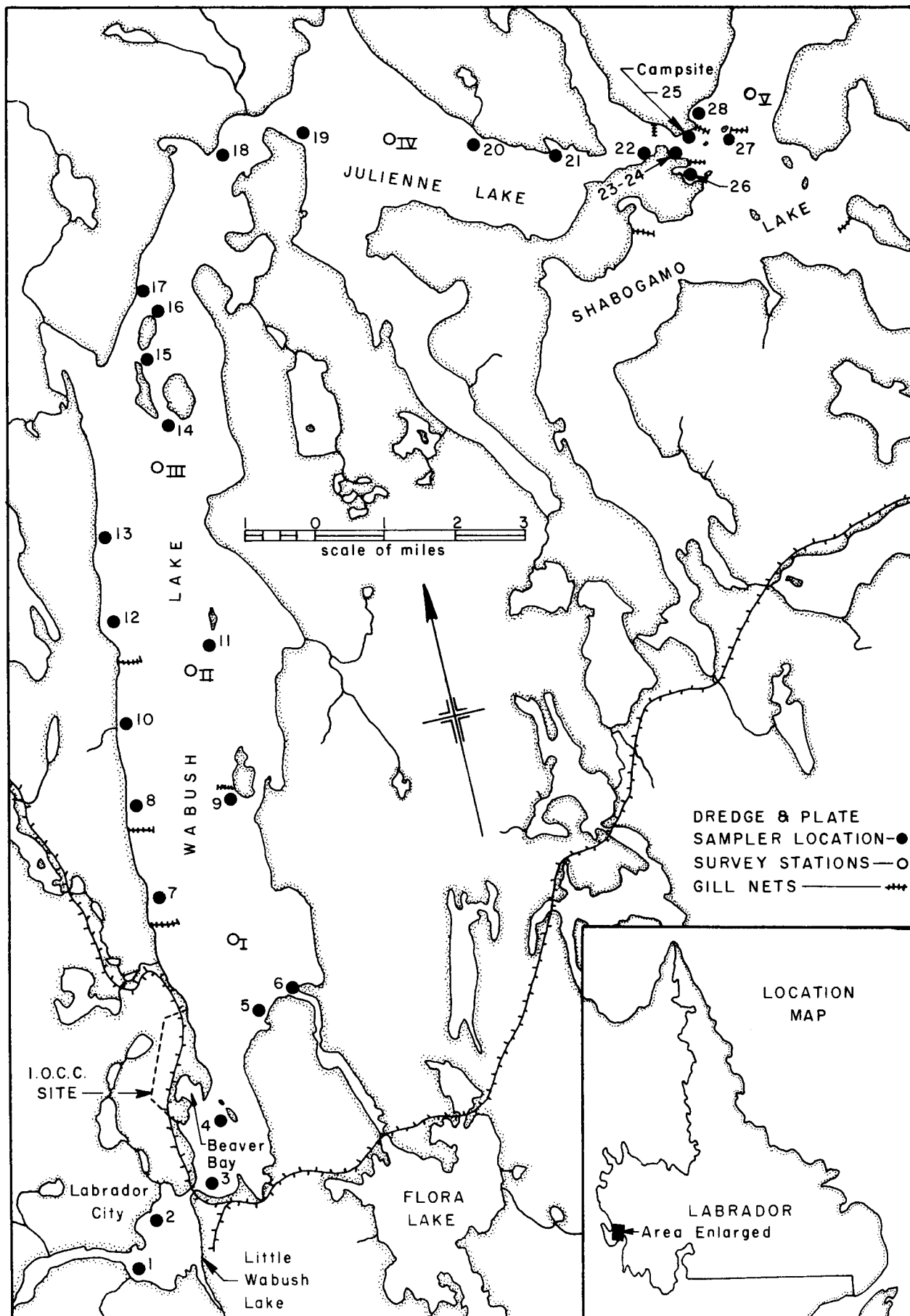


Fig. 16 Sampling sites, Wabush and Shabogamo lakes, 1971

Gillnets in gangs (1½", 2", 2½", 3", 4" mesh) 140 yds. long and a 50 - foot seine were used to collect fishes from Shabogamo and Wabush Lakes. Morphological data, including scales, were taken to provide the basis for a comparative age-and-growth study of fishes in the two bodies of water. Data from the most common and readily-available species of fish, lake whitefish Coregonus clupeaformis, were analyzed in a Fortran IV computer program for stock analysis. Preliminary scrutiny of the results indicates that the length-weight relationships for fish from the two areas are similar, but, that the growth rates are variable. Whitefish up to age 5 - 6 years from Wabush Lake grow fastest, but then a change occurs and the growth rate falls behind that for Shabogamo Lake.

Samples of benthic invertebrates, a primary source of food for some fishes, were collected by using multiple-plate samplers of the Dendy type, modified as in Fullner. Manufactured by Department personnel, these samplers were placed in selected areas of the study lakes in order to make comparative estimates of benthic invertebrate productivity. To augment the plate sampler results, a Petersen dredge was used in a series of hauls near each sample site.

A Wisconsin-style plankton net (12 cm. 20 mesh) was used to collect quantitative and qualitative data on the zooplankton populations of the lakes. Data are still being analyzed.

Construction of a 24-hour diurnal curve of dissolved oxygen concentration using the hypolimnetic method to assess net production by photosynthesis was attempted. Results were inconclusive because high winds and the thermal structure of the lake brought about thorough mixing.

Results of a synoptic survey are recorded in Table XXI and Figure 16. The various investigations, unfortunately, do not show conclusively that the disposal of tailings is detrimental to Wabush Lake. That such disposal is aesthetically displeasing goes without saying. Slight differences are apparent in the growth rates of the whitefish populations. Examination in depth of all the factors may be more revealing.

Tailings dispersal appears to have reached the Shabogamo Lake narrows since fine slimes are evident there. Elimination of the 5050 U.S.g.p.m. of finely-crushed ore from the pelletizer would go far in removing the red color and the fine slimes from the lake. Initiation of the chemical flotation project would remove another 15 percent of the iron presently entering the tailings, or about 1 - 2 million long tons/year. The expansion of I.O.C.C. planned for 1972 will make this greater recovery rate even more significant since the tailings volume will be even greater.

Table XXI. Data from synoptic survey of Wabush and Shabogamo Lake, 1971.

Station	Depth	Total suspended solids (mg/l)	Total dissolved solids (mg/l)	Total hardness (mg/l)	Total alkalinity (mg/l)	Specific conductivity (22.2°C)	pH	Turb. (J.T.U.)	Secchi disc average (m)
Wabush tailings	Surface	3.0	59.0	63.0	31.0	63.0	7.42	2.6	1.55
	bottom	4.0							
Wabush middle	Surface	4.0	141.0	96.0	34.0	63.0	7.5	1.3	2.5
	bottom	3.0							
Wabush north	Surface	4.0	43.0	42.0	31.0	63.0	7.27	1.1	3.5
	bottom	4.0							
Julienne Lake	Surface	2.0	9.1	36.0	33.0	53.0	7.46	1.4	5.0
Shabogamo Lake	Surface	4.0	4.5	49.0	25.0	49.0	7.4	1.1	6.9
Beaver Bay	Surface	1.0	3.4	-	-	-	-	-	-

Deer Lake Baseline Survey

In July, a chemical and physical baseline survey was carried out on Deer Lake to assess the effects of the Bowaters wood-driving practices on the lake. The lake was thermally-stratified at a depth of about 15 to 25m, and the bottom water temperature varied upward from 6.2°C. Deep water oxygen profiles indicated dystrophic conditions in the lake. Tests were carried out to determine if the lake were concentrating decomposition products from the sunken pulpwood logs and to examine the oxygen conditions near the bottom. Results showed that adverse effects of the lake-transport of pulpwood were limited to sunken logs and to deposition of a thin covering of silt and wood fibre in areas of the lake where wood was collected in booms. The survey uncovered areas of oxygen depletion in the Humber River entering the lake and in the northeast end of the lake near the Deer Lake sewage system outfall.

Baie Verte Larviciding - Abate

Between April and August, 1971, we monitored an application of the organophosphate insecticide Abate to four streams around Baie Verte. The four streams treated were Baie Verte River, Southwest Brook, Rattling Brook, and Lower Duck Island Cove Brook. They appear to be typical, fast-water, Newfoundland streams, with soft water flowing 0.5 - 2 m/sec. over a coarse gravel or rock bottom. Rattling Brook was treated once, and this application was quickly washed out after 12 hours by a flash flood. The other streams were each treated twice, with a two-week interval at Lower Duck Island Cove Brook, and a six-week interval at Southwest Brook and Baie Verte River. In each case, second treatments produced essentially the same results as the first treatment.

The temperature and velocity of each stream was recorded daily, and bottom fauna was collected by duplicate Surber-sampling once a week at six stations in each stream. Five sampling points were arranged to cover about 300m below each larviciding point, while the sixth was placed upstream from the larviciding point as a control. During larviciding with Abate, sampling was intensified to six sets of duplicated samples per station over a 48-hour period. The effect of the insecticide application on fish in each stream was checked by placing brook trout and ouananiche in two holding cages at each of the six stations and by placing a barrier net at the lowest station to catch natural mortalities.

The Abate formulation was a wettable powder dissolved in water. Application rates were calculated on the basis of stream flow and ranged from 0.058 - 0.091 ppm averaged over an 18-23 minute period. The lowest dosage which was effective was 0.061 ppm. At this level, 20 percent of the manufacturers' recommended dosage of 0.3 ppm, blackfly larvae released from the substrate but were still alive in drift samples.

However, populations of mayflies (Ephemeroptera:Baetidae) and midges (Chironomidae) were decimated. At higher dosages, blackfly larvae were found dead in the drift samples. A dosage of 0.091 ppm was sufficient to eliminate blackflies, mayflies, and midges and to reduce caddis flies (Trichoptera) by about 50 percent. Stoneflies (Plecoptera) were not present in sufficient numbers in the control samples for any information to be gained about their mortality during larviciding. Maximum effect of the insecticide occurred 100-200m below the larviciding point, and the effectiveness tapered off considerably downstream from the 300m point.

Insect communities showed the inhibitory effect of Abate for 2-3 weeks, after which the affected orders of insects began to reappear in the weekly bottom fauna samples at an exponential rate. Blackflies were the exception to this pattern, but larviciding dates roughly coincided with the natural disappearance from control samples, possibly through emergence. An analysis of diversity showed the maximum reduction in community stability 200m below the larviciding point. Nevertheless, the reduction was slight, and the community organization appeared to reapproach normal within six weeks of larviciding.

No significant mortalities were observed among the caged ouananiche and brook trout, although in one instance we recorded a 40 percent kill of the brook trout fry held at the 10m station on Southwest Brook. These fish showed a residue of 1.75 ppm Abate. Several dead fish were removed from the barrier nets at the lower end of the study stretch at Baie Verte River, but we feel that their mortality was caused by poor placement of the net. Tissue analyses of these fish for Abate showed residues less than 0.5 ppm, apparently decreasing with the time the fish survived after larviciding. Stomach analyses showed that fish had been feeding on all of the major faunal groups sampled.

Based on our analysis of community organization, we feel that single applications of Abate at levels less than 0.091 ppm cause no long-term environmental change. Applications at levels higher than that are evidently unnecessary in softwater streams, and the manufacturers' recommended dosage of 0.3 ppm would be excessive in such circumstances. Multiple applications spaced at intervals of less than 6 weeks during the blackfly season should be viewed with suspicion, especially if long sections of streams are to be treated. A greater frequency of application would, in our view, result in a drastic reduction in major components of the fish food crop and risk lasting environmental damages.

Stephenville

During the summer of 1971 a study was initiated to evaluate the pre-development environmental conditions in St. George's Bay.

Opening of the Javelin Paper Corporation 1000 TPD unbleached kraft linerboard mill is rescheduled from late summer 1971 to summer 1972. Data from the bay were collected on water quality, bottom sediments, and bottom communities.

Six stations (Figure 17) were chosen for monthly sampling of water quality (D.O., B.O.D., phytoplankton, zooplankton, S.S., sulfides, mercaptans, etc.). Because of the heavy work load, only zooplankton was sampled during the summer; winter weather has also prevented regular monthly sampling. One complete set of samples was taken from Stephenville Pond (St. 5 and 6) in mid-December (Table XXII). Phytoplankton production was estimated by measuring the concentrations of chlorophyll a, b, c and carotenoids by the Strickland and Parsons method. Zooplankton was collected by a 60 ft. vertical haul using an 18" diameter oceanic plankton net.

Bottom sediments were collected, with the use of SCUBA gear, at the 15 stations shown (Fig. 17). At each station two divers took a total of 4 cores (a core was 1½" diameter by 6" long) at 3, 6 and 9 fathom depths. The cores were obtained by forcing a hollow, plexiglass pipe into the sediment. The contents were analyzed for total organic carbon and total organic nitrogen. When we compare the percent organic carbon and percent organic nitrogen, we obtain an Organic Sediment Index (OSI) which is very convenient in demonstrating the deposition of pulp and paper wastes (especially wood fibers). Annual core sampling will be continued.

Detailed studies of the communities of bottom organisms were undertaken at Stations 4, 5, 12 and 13. A grid containing thirty 0.5m x 0.5m squares was laid on the bottom and ten of the squares were randomly selected and sampled. In sampling, all the organisms enclosed within the square were collected into a plastic bag, brought to the surface, and preserved in 10 percent formalin. At Station 4 only one set of samples was taken in the low littoral region; at Station 5, samples were taken at 100, 300 and 500 yards from the low tide mark on a line perpendicular to the shore; and at Stations 12 and 13, samples were taken at 6 and 9 fathom depths.

Sorting and identification of the organisms is 95 percent complete, and thus far we have encountered 27 species of macro-invertebrates and 22 species of algae. Final analysis of these data will take two forms, cluster analysis using Fager's Index and several species diversity indices. The cluster analysis is well suited to such a study because it is based on the presence or absence of species; therefore, all the species including sessile, colonial, and algal can be incorporated into this system. The results will be a convenient way of comparing pre and post-development species associations in the bay. The four species diversity indices,

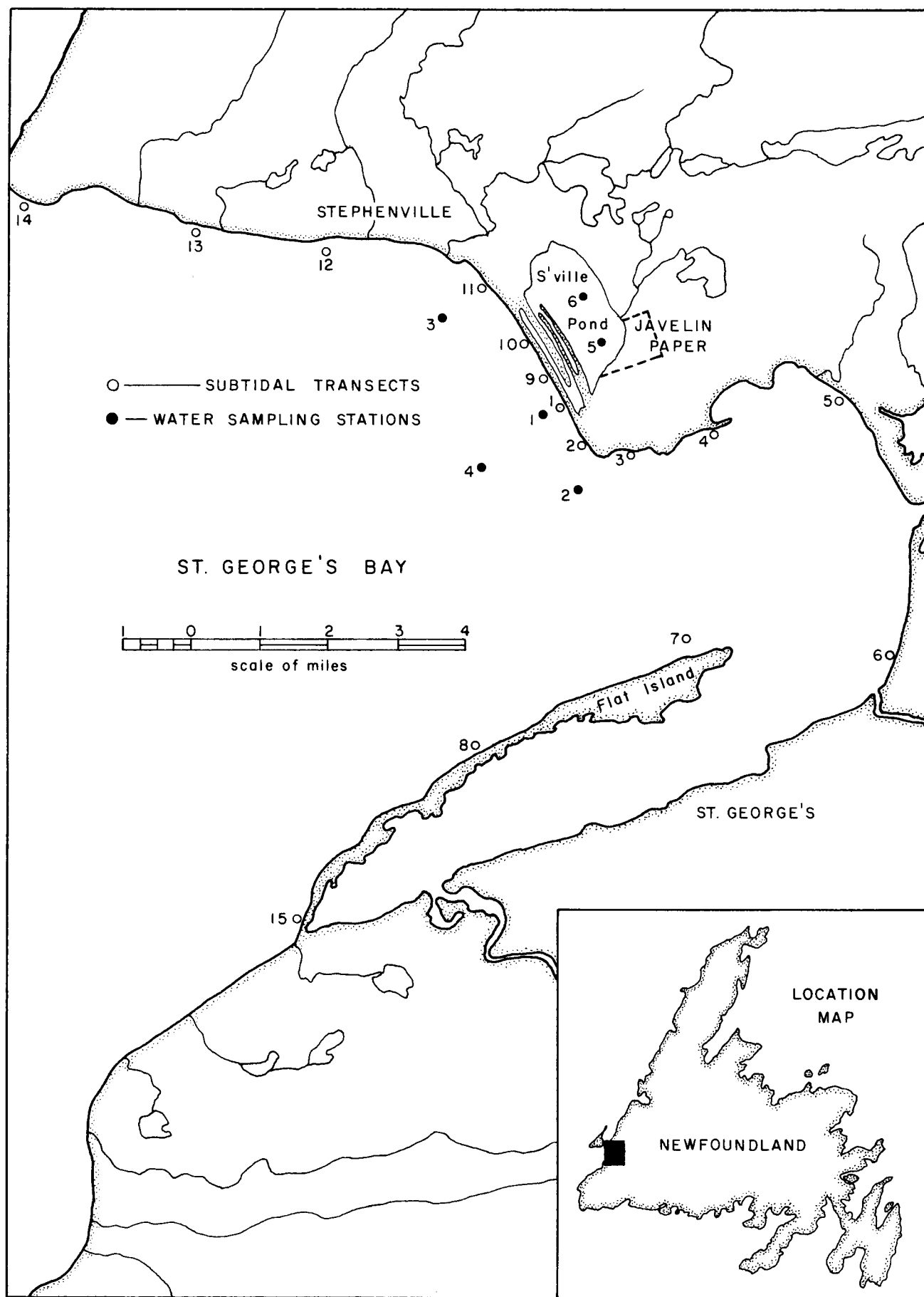


Fig.17 Stephenville baseline study showing locations of transects and water sampling stations.

Table XXII. Water quality conditions in Stephenville Pond December 14, 1971.

Station	Depth (meters)	pH	D.O. (mg/l)	B.O.D. (mg/l)	Chlorophyll a (mg/m ³)	Chlorophyll b (mg/m ³)	Chlorophyll c (mg/m ³)	Carotenoids (M-SPU)
5	Surf.	7.95	10.5	0.5	0.1337	0.0219	0.0109*	0.0988
5	2	7.90	10.6	0.6	0.3385	0.1525	3.4964	0.775
5	5	7.85	10.6	0.4		SAMPLE LOST		
5	10	7.85	10.4	0.1	0.1			
6	Surf.	7.8	10.4	0.3	0.3	0.1963	0.7339	0.5670
6	2	7.2	10.6	0.3	0.3	0.5212	1.3747	0.5244
6	5	8.0	10.5	0.2	0.2	0.4323	0.9473	0.5951

* Accuracy of the phytoplankton sampling (chlorophyll) is in doubt because of the high chlorophyll 'c' readings.

calculated for free-living, non-colonial invertebrates, are also useful in demonstrating changes in community organization. Simpson's Index shows dominance, McIntosh's Index shows equitability, Margalef's Index shows variety, and Shannon's Index shows equitability plus variety (Table XXIII). By examination of sets of data sampled in years to come, changes in community organization should be very apparent.

Table XXIII. Number of species and diversity indices for the four bottom fauna sampling stations in St. George's Bay, 1971.

Stn.	Grid	Invert. species	Algae species	Diversity Indices			
				(Dominances)		(Equitability)	(Variety)
				Simpsons	Shannon	McIntosh	Margalef
4	Low Littoral	13	-	0.3864	+ 1.0999	0.3958	1.2836
5	100 yd.	7	5	0.3815	+ 1.1533	0.4027	1.0082
	300 yd.	16	9	0.3040	+ 1.7691	0.4850	1.8424
	500 yd.	3	-	0.6270	+ 0.6265	0.2336	0.4513
12	3 fathom	11	-	0.1732	+ 1.8666	0.6230	1.4468
	6 fathom	12	9	0.3912	+ 1.2865	0.3934	1.3203
13	3 fathom	5	10	INSUFFICIENT ORGANISMS			
	6 fathom	9	10	0.2988	+ 1.4243	0.5099	1.5929

Golden Eagle Refining, Holyrood

This oil refinery commenced operations in December, 1961. In the past decade, production has doubled to the present daily capacity of 15,000 barrels. Total water consumption is about 4.46 million U.S. gallons per day. Less than half a percent of the water consumption is used for process and sanitary purposes, 99.5 percent of the water being utilized for cooling.

Oily waste is discharged into a 25 ft. x 75 ft. A.P.I. separator. Oil is trapped in the separator and waste liquid passes under the oil barrier, it then overflows a weir and is pumped into a retaining pond. Cooling water is also discharged into the latter pond to mix with the waste liquid. A skimmer and a number of "hay-basket" strainers near the outlet of this retaining pond trap the remaining oil. The effluent from this pond overflows into another small pond before discharging by culvert into Holyrood Bay.

Table XXIV summarizes the parameters measured for the waste effluent. Four sampling runs were made in 1971. Water temperature difference between water intake and effluent outlet was about 15°C. Since the process waste was diluted with cooling water (1:30), most values were below the acceptable level, except for the dissolved oxygen. Dissolved oxygen saturation in the effluent ranged from 26 - 51 percent compared with the proposed standard of 60 percent.

Table XXIV. Analysis of samples of Golden Eagle Refinery wastes effluent, 1971.

pH (pH unit)	7.5-7.6	D.O. (% Sat.)	26-51
Turbidity (JTU)	1.6-3.3	B.O.D. (mg/l)	6.1-8.4
Suspended solids (mg/l)	3.5-17.1	Ammonia (N)	0.2
Specific cond. (micromhos)	3900-7250	Phenol (mg/l)	.036-.089
Chlorinity (ppt)	15.83-15.96	Sulphide (mg/l)	1.0
Salinity (ppt)	28.09-28.84	Oil (mg/l)	0.5

Oil Pollution Incidents

In concert with the policy of the Fisheries Service towards the prevention of oil spills, several incidents were investigated in 1971.

Holyrood. The largest and most-potentially-destructive spill occurred at the Golden Eagle Refinery, Holyrood, during April. When a pump operator fell asleep, 1500 barrels of crude oil were spilled from a storage tank, but about 1300 barrels were recovered. The storage tank sewer failed to prevent oil from running into a second pit and from there into the sea. An onshore wind drove the oil back onto the cobble beach,

affecting 400-500 yards of shoreline. A commercial absorbant (Dri-Spot) was used to hold the oil, no emulsifiers were permitted. Mechanical means was the most feasible method employed in the clean-up and was successfully used in previous spills.

The Department recommended to the refinery manager that the sewer be made operational and that a contingency plan be made ready in case of future incidents. The fishery and recreational values of the Holyrood area can be seriously affected by a major spill. More importantly, Fisheries personnel should be informed of these incidents immediately to ensure most effective clean-up.

Shoal Harbour. An incident occurred in October when Bunker "C" oil came ashore coating rocks, derelict timbers, and shore vegetation for 200-300 yards. Inspectors from Ministry of Transport (M.O.T.) believed the oil originated from shipping in the area, but the elapsed time before reporting made the source difficult to check. Managers of local industries were contacted and made aware of the situation. In one case, at Newfoundland Hardwoods, a steam pipe spilling hot water over asphalt exposed at low tide resulted in an oily film. This situation has since been corrected.

The sheltered waters of N.W. Arm of Random Sound make it a particularly suitable location for waterfowl use, especially Canada Geese. Dr. L. M. Tuck, Canadian Wildlife Service, was concerned that the oily vegetation may be detrimental to the geese in the area. At his urgings, M.O.T. cleaned up some of the more-heavily-coated areas.

Laboratory Services

The laboratory was very active during the past year in both routine and development work associated with water pollution problems. This activity was made possible by the expanded facilities in the trailer laboratory. Permanent staff was helped by four students during the summer months (May to September, 1971). Work carried out in the laboratory during the past year may be described under the following headings:

Routine analyses: This work concerned the component analysis of monitoring samples from different pre-selected sites and bio-assay tests. Table XXV shows the number of samples analyzed for different tests.

Voluntary work: Samples for the following organizations were analyzed as a voluntary cooperative service.

1. Mount Pearl Municipality - B.O.D., D.O., total and suspended solids, pH, total hardness, alkalinity, turbidity, and specific conductance.

2. ShawMont Newfoundland Limited - Total and suspended solids, pH, total hardness, alkalinity, turbidity, and specific conductance.
3. Baie Verte Town Council - xanthates and cyanides.
4. Newfoundland and Labrador Clean Air, Water and Soil Authority - B.O.D.

Development Work:

1. Cyanide estimation - the specific-ion electrode method was selected and standardized for estimating cyanides in minute quantities. This method, if necessary, may be available for measuring cyanides on a routine basis.
2. Identifications and estimation of xanthates: Thin layer chromatography was tried for identification and estimating small quantities of xanthates. However, the method did not appear adequate for the analysis of these samples and further work is required to improve this technique.

Xanthates were also identified and estimated quantitatively by examining the absorption spectrum of the sample. The technique consists of comparing the absorption spectra of the standard solutions and of the samples.

Additional Related Investigations:

1. Atomic Absorption spectrophotometry - This project was undertaken to study the interference by foreign species in the determination of the minute quantities of copper by atomic absorption spectrophotometry. The project is well underway, and conclusions are to be drawn when the investigations are completed.
2. Oxidation (?) of "phossy" water - The stability of "phossy" water which contains elemental phosphorus is being studied under different conditions. The work has progressed well. Preliminary investigations show that atmospheric oxygen does not oxidize the "phossy" water in any significant degree. The so-called oxidation or deterioration of "phossy" water by aeration is due mostly to physical adsorption rather than to chemical oxidation.

However, "phossy" water is chemically oxidized by acidified potassium permanganate. Detailed analysis of the experimental data is in progress.

Table XXV. Summary of the analyses done during 1971 by the Laboratory Services Unit, Pollution Control Group.

Tests	No. of samples	Method
pH	900	Glass electrode
Total Hardness	750	Hach Man Ver Hardness Test
Alkalinity	850	Titrametric Determination
Turbidity	750	Nephelometry
Specific Conductance	700	Conductimetry
Copper	1200	Atomic Absorption
Zinc	800	Atomic Absorption
Lead	40	Atomic Absorption
Iron	25	Atomic Absorption
Calcium	20	Atomic Absorption
Fluoride	25	Specific Ion Meter
Chloride	70	Mercuric Nitrate Method
B.O.D. Test	200	5-Day BOD Dilution Method
D.O. Test	30	Winkler Method
Sulfite Waste Liquor	400	Standardized Pearl-Benson
Total Solids	60	Gravimetric Determination
Suspended Solids	115	Gravimetric Determination
Elemental Phosphorus ("phossy" water, mud, fish extracts, etc.)	770	Gas Chromatography

LAKES MANAGEMENT

LAKE MANAGEMENT

R. J. Wiseman
Group Leader

SPORT FISHERY

R.J. Wiseman
W.G. Whelan

Activities of this Group are directed at effective management and development of resident freshwater fish stocks in the standing waters of Newfoundland and Labrador, with reference to existing and potential recreational and commercial fisheries. The major activities during 1971 included:

- (a) The problem of "overfishing" on lakes near the Metropolitan area of St. John's, particularly lakes near the Trans-Canada Highway.
- (b) Investigation and management of fish stocks in hydro-electric reservoirs.

Sport Fishery Investigation

Evaluation of the intensity and other characteristics of a sport fishery conducted near an urban area was completed during 1971 with intensive investigations at Thomas and Paddys Pond located near the Metropolitan area of St. John's. During 1971, a start was made on the intensive management of these two lakes with initiation of a forage fish introduction-and-evaluation program. In addition, surveys were carried out at South-west Pond, Nine Island Pond South, Gull Pond, Little Soldiers Pond, Loon Pond, Soldiers Pond, Finnies Pond, and Harbour Main Pond to estimate the potential of these lakes for future sport fishery development. The main objective of the sport fishery investigation program is to effectively manage and develop stocks of resident sport fishes in the standing waters near the Province's major growth centers.

Population Estimates

This activity consisted of monitoring changes in the sport fish populations of Thomas and Paddys Ponds by the conduct of population estimate experiments. These twice-yearly experiments (spring and fall) are part of a continuing project begun in 1968.

Thomas Pond. Brook trout and ouananiche (landlocked salmon) standing populations were estimated by a mark-recapture program using live-trapping by lake fyke nets. The spring estimate was made during the period April 26 - May 14, while the fall estimate was made from September 8 - 21.

The brook trout population has apparently declined somewhat during the period of study (1968-71), and this decline is attributed to over-harvesting and to low reproductive success in certain years. The ouananiche population, on the other hand, has shown a slight increase. This stability is attributed to increased survival resulting from reduced inter-specific competition with brook trout. This pattern of species succession may very well become general as fishing pressure increases on the Province's landlocked salmon-trout lakes, because angling is generally selective for trout.

Paddys Pond. Estimates of the standing populations of brook trout, ouananiche, and brown trout were made during 1971. The spring estimate was made during the period May 15 - June 4, while the fall estimate was made from September 22 - October 12.

The spring estimates indicated that population levels for all three species were comparable to those of the previous year. Fall estimates indicated that, despite the extremely high angler harvest during the 1971 season, relatively large stocks of spawners remained following season closure. Table XXVI summarizes data on population levels for all three species during the period 1969-71. It is noteworthy that, unlike Thomas Pond, the stocks of Paddys Pond fish have shown no decline but rather somewhat of an increase.

Table XXVI. Estimates of the total number and biomass (lb.) of brook trout, ouananiche, and brown trout present in Paddys Pond during the falls of 1969, 1970, and 1971.

Species	1969		1970		1971	
	No.	Wt.	No.	Wt.	No.	Wt.
Brook trout	131,000	3,359	153,600	3,775	143,600	3,668
Ouananiche	24,000	1,397	43,600	2,324	47,200	2,800
Brown trout	43,700	5,334	71,500	8,579	46,400	5,884
Total	198,700	10,090	268,700	14,678	237,200	12,352

Creel Census

During 1971, winter and summer creel censuses were carried out at Paddys Pond. The winter ice fishery harvest, unlike previous years, was very successful and approximately 1,100 sport fishes were harvested. That catch was composed of 1,000 brook trout, 75 ouananiche, and 25 brown trout. Total daily fishing effort on the pond averaged 7 man-hours, and the total daily catch averaged 18 fish, or 2.6 fish per man-hour.

The substantial numbers of sport fishes in Paddys Pond, together with some reduction in the Thomas Pond populations, have resulted in unprecedented angling pressure at Paddys Pond during this past year. During the May - September period, some 14,258 man-hours of fishing effort resulted in a total catch of 7,264 sport fishes comprised of 3,398 brook trout, 2,899 ouananiche, and 967 brown trout. The projected total weight of those fish was 1,600 pounds, combining this total with an estimated 208 pounds harvested during the winter fishery gives a total annual harvest of 1,808 pounds for 1971. The estimated annual maximum sustained yield for Paddys Pond is 1,730 pounds.

The intensity of this year's fishery is best demonstrated by some examples of the effort and harvest during May when some 3,400 fishes were harvested. This number is more than three-fourths of the total 1970 harvest and almost one-half the annual maximum sustained yield. During the May 24th weekend, 1,481 man-hours of angling effort were exerted at Paddys Pond, almost 20 percent of the total effort exerted at Paddys Pond during five months in 1970. This effort was expended in 641 angler-trips to the lake at some time during the three-day weekend. On Monday, May 24, 268 anglers fished at Paddys Pond.

Table XXVII summarizes the catch per man-hour from May to September for the three sport fish species by boat and by shore fishermen. The boat fisherman was again much more successful during 1971, taking over twice as many fish per effort as the shore fisherman.

Table XXVII. Catch per man-hour at Paddys Pond, May to September, 1971, for shore and boat fishermen angling for brook trout, ouananiche, and brown trout.

	Fishing site		Fishery mean total
	Boat	Shore	
Brook trout	0.46	0.16	0.24
Ouananiche	0.26	0.17	0.19
Brown trout	0.16	0.04	0.07
Total	0.88	0.37	0.50

Table XXVIII summarizes the mean daily man-hours of effort and the catch of the three species from May to September, and a comparison of angling statistics and stock exploitation during 1970 and 1971 is given in Table XXIX.

Table XXVIII. Mean daily man-hours of angling effort per day of the week and resulting catch at Paddys Pond, May to September, 1970.

Day of week	S	M	T	W	T	F	S	Weekly total
Man-hours	203	158	38	54	43	44	160	700
Species catch								
Brook trout	40	15	14	27	10	19	41	166
Ouananiche	27	21	8	18	14	20	30	138
Brown trout	16	5	3	4	4	5	10	47
Total	83	41	25	49	28	44	81	351

Table XXIX. Statistics for angling intensity and exploitation of the fish stocks of Paddys Pond, during the 1970 and 1971 open-water seasons.

Statistic	1970	1971
Total man-hours fished	7,450	14,528
Man-hours fished per acre	14.1	27.6
Number of fish creeled	407.3	7264
Pounds of fish creeled	846.2	1600.3
Number of fish per acre	7.7	13.8
Pounds of fish per acre	1.61	3.04
Estimated production (lb./acre)	3.29	3.29
Post-season stock (lb./acre)	27.9	23.5
Number of fish per man-hour	0.55	0.50
Pounds of fish per man-hour	0.11	0.11
Number of fish per man-trip	1.0	1.1
Percent of successful anglers	35.5	38.2
Percent anglers taking 50 percent of the catch	6.1	6.8
Length of average fishing day (hours)	1.79	2.26
Average fork length of fish creeled (in.)	7.9	8.1
Average weight of fish creeled (lb.)	0.21	0.22

Forage Fish Introduction

In an attempt to improve growth and survival rates of sport fishes in Thomas and Paddys Ponds, a program of forage fish introduction and evaluation was begun during 1971. The species being used is the three-spine stickleback, and to date approximately 22,000 have been stocked into Paddys Pond and 9,500 into Thomas Pond. Initial observations indicate the sticklebacks are appearing in the diet of the sport fishes and have become generally distributed throughout the two lakes. Stockings of at least equal magnitude are planned for both lakes during 1972.

Proposed Development of Boat Access

Limnological investigations were made on several metropolitan-area lakes having limited accessibility for boat fishermen. These lakes are South-west Pond, Nine Island Pond South, Gull Pond, Little Soldiers Pond, Loon Pond, Soldiers Pond, Finnies Pond and Harbour Main Pond. The objective was to determine whether under-utilized, fishable populations of sport fishes are present in these relatively-inaccessible lakes. If so, consideration will be given to the development of boat access.

To determine which of these waters possess the better, harvestable-size fish populations, information on such parameters as abundance, growth rate, size and age composition, and species composition was collected. Chemical and physical limnological data were also collected to determine the suitability of these various lake environments for sport fish production.

Completion of this work during 1972 will provide a complete inventory of all significant-size lakes located along a 50 mile stretch of the Trans Canada Highway extending westward from St. John's.

RESERVOIR STUDIES

G. D. Barbour

J. P. Davis

Bay D'Espoir Power Development

Field studies continued on the Long Pond Reservoir during 1971. Long Pond is the lowermost lake in the chain of impoundments that retain water for the Bay D'Espoir Power Development. Impoundment in 1967 inundated four separate lakes (Long Pond, Soulis Pond, Brazil Pond, and Little Burnt Pond) with a total area of 25.4 square miles. The new reservoir has a total area of 71.0 square miles. Bathymetric work completed during 1971 shows that the reservoir has a maximum depth of

242 feet and averages 52.7 feet in depth (Figure 18). The total storage capacity of the reservoir is 104 billion cubic feet, approximately 6.5 times the live storage capacity of 16 billion cubic feet.

Water quality analysis of samples collected from each of the four original lake basins indicated that rather-uniform conditions existed in all four areas (Table XXX).

Table XXX. Water quality analysis of surface waters from selected areas of the Bay D'Espoir Reservoir and Round Pond (samples collected August, 1970, and July-September, 1971).

Area	pH		Dissolved oxygen(ppm)		Total hardness		Spec.cond. (77°F)		Turbidity (J.T.U.)	
	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971
Long Pond	5.75	5.68	8.6	10.0	4.0	3.6	9.0	14.0	0.95	1.1
Soulis Pond	6.10	5.59	8.6	9.5	4.0	4.1	9.0	12.1	0.43	1.3
Brazil Pond	5.80	5.19	8.8	9.6	5.0	3.4	17.0	15.4	0.48	1.3
Little Burnt Pond	5.75	-	8.3	-	5.0	-	10.0	-	0.56	-
Round Pond	-	5.49	-	9.4	-	3.4	-	11.6	-	1.0

A comparison of specific conductance values during 1970 and 1971 indicates a slight increase in dissolved nutrients occurred during this past year. This may very well indicate that improvement in water quality, and therefore reservoir productivity, may have begun. To document further changes in water quality arrangements have been made to collect and analyze monthly water samples over the next several years.

Qualitative sampling of the fish populations in the reservoir was continued in 1971 using two gangs of nylon gill nets (stretched-mesh size 1½", 2", 2½", and 3"). In addition, the populations in Round Pond, an unflooded lake in the drainage system, were also sampled. Samples of landlocked salmon and brook trout were obtained, as well as small samples of Arctic char.

Comparisons of the growth rates of Long Pond brook trout and landlocked salmon, based on samples collected during 1965 and 1971 are given in Tables XXXI and XXXII.

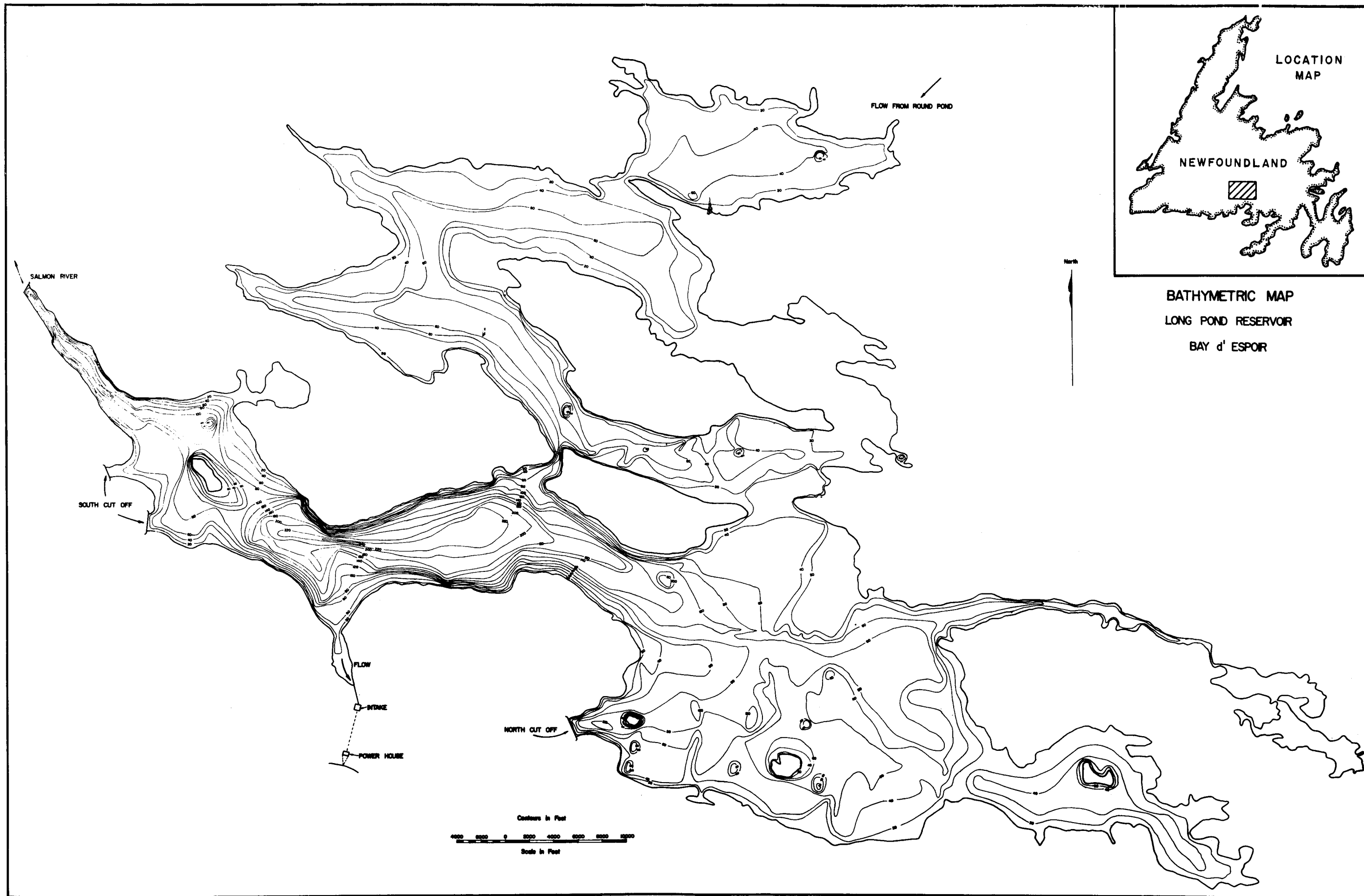


Fig.18 Bathymetric map of Long Pond reservoir, Bay d'Espoir.

Table XXXI. Back-calculated growth (fork length, cm.) for brook trout from Long Pond (1965 and 1971) and Round Pond (1971).

Area and year	Mean fork length (cm.)	Annulus							
		I	II	III	IV	V	VI	VII	VIII
Long Pond, 1965	23.8	5.6	11.7	17.0	22.9	32.9	39.6	41.4	54.1
Long Pond, 1971	24.7	6.1	12.7	18.8	24.4	29.4	30.9	-	-
Reservoir, 1971	24.7	6.3	12.9	18.7	24.1	29.8	32.7	40.9	-
Round Pond, 1971	22.2	6.0	12.3	17.5	23.2	33.8	38.7	-	-

Table XXXII. Back-calculated growth (fork length, cm.) for landlocked salmon from Long Pond (1965 and 1971) and Round Pond (1971).

Area and year	Mean fork length (cm.)	Annulus										
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Long Pond, 1965	21.4	2.5	5.5	9.2	14.0	18.1	21.5	25.6	27.6	27.6	29.6	-
Long Pond, 1971	34.8	3.1	6.9	12.6	19.0	25.1	31.0	35.5	39.6	42.0	46.8	45.1
Reservoir, 1971	32.1	3.2	7.1	13.1	19.4	25.8	31.0	33.0	36.7	42.0	46.8	45.1
Round Pond, 1971	23.3	2.5	5.2	8.7	13.3	17.5	20.6	24.7	29.2	35.2	41.4	-

Comparison of the growth rates of brook trout in Long Pond during 1965 and 1971 indicates some increase in growth rate by younger fish over the period being considered; however, the growth rate of older trout is poorer. Combining the growth rates of trout from the several areas of the new reservoir indicates, though, that there has been no appreciable change in older ages during the post-impoundment period. In fact, mean size of fish taken during the gill netting was remarkably similar. Growth rate of brook trout in the reservoir is also remarkably similar to that of fish in Round Pond. Round Pond is a natural lake receiving the outflow from several impounded waters via the Ebbegunbaeg Reservoir and emptying directly into the Long Pond Reservoir.

Consideration of the growth rate of landlocked salmon in Long Pond during 1965 and 1971 indicates a marked increase in growth rate of fish of all ages since pre-impoundment. The growth of fish from the entire reservoir is remarkably similar to that of fish occupying the Long Pond portion of the reservoir. The average size of landlocked salmon taken by gill nets in Long Pond and throughout the rest of the reservoir during 1971 is significantly larger than that of fish taken in 1965. Note that the growth rate of fish in Round Pond sampled during 1971 is remarkably similar to that of fish in Long Pond in 1965.

Generally, then, landlocked salmon have increased their growth rate significantly during the 1965 to 1971 period, while brook trout have maintained a consistent rate of growth. Growth rates of both trout and salmon in Long Pond during 1965 are almost identical to those of Round Pond fish during 1971. Since the water quality of both Round Pond and the reservoir is the same, for all intents and purposes, it must be concluded that increased growth rate of salmon in the reservoir is perhaps totally unrelated to the slight increase in water quality, but rather to some other factor such as increase in habitat area.

A spawning survey conducted in early November, 1971, indicated that all the major tributaries of the reservoir appeared unsuitable for spawning purposes. However, unconfirmed reports suggest there may be significant spawning activity in some of the smallest inlet streams. Shore spawning of reservoir stocks is also a likelihood and shore spawning activity was observed near Salmon River Dam. At present only very limited areas of the reservoir are available for shore spawning. In the future, as ice erosion removes much of the forest debris from the reservoir shoreline, shore spawning habits will undoubtedly become more widespread and successful.

In summary then, water quality and reservoir productivity appear to be slowly rising. The growth rate of landlocked salmon in the reservoir is significantly higher than that of fish in pre-impounded Long Pond. Brook trout in the reservoir appear to be growing slightly faster at the younger ages only. Limited availability of stream spawning

areas may adversely affect stock recruitment during the next several years; however, suitable shore spawning areas will likely become available in the near future.

ENVIRONMENTAL PROTECTION

ENVIRONMENTAL PROTECTION

B. R. LeDrew
A/Group Leader

Maintaining fish stocks in the face of industrial activities which produce physical changes in the aquatic environment is the prime concern of this Group. Activity areas include:

- (1) Recommending and monitoring requirements for the protection of fish stocks affected by hydroelectric development. Field activities in 1971 were undertaken at the two major hydroelectric developments in the province - Churchill Falls and Baie D'Espoir.
- (2) Establishing the need for fish passage and other protective measures at industrial and domestic water supply schemes. Studies are underway to monitor the effect of water supply schemes at the Come-by-Chance and Stephenville Industrial complexes. Many DREE-funded municipal water supply schemes have been checked this past year as well.
- (3) Communication is maintained with companies engaged in offshore oil and gas exploration.

HYDRO-ELECTRIC DEVELOPMENT

B. R. LeDrew
H. J. Shea

Bay D'Espoir Hydro

White Bear River. Fifty-eight percent of the headwaters of White Bear River (456 of 790 sq. mi.) have been diverted to form part of the Baie D'Espoir Power Development (Figure 19). As a consequence, flows in the river will be significantly reduced. Because of the nature of the terrain which obstructs most tributaries at or near their mouths, the estimated run of 600 - 1,500 Atlantic salmon must utilize the main stem of the river for spawning and rearing. Twelve miles of main river are presently accessible for this purpose.

On September 9, 1971, agreement was reached between this Department and the Newfoundland and Labrador Power Commission on measures to protect the salmon stocks of White Bear River.

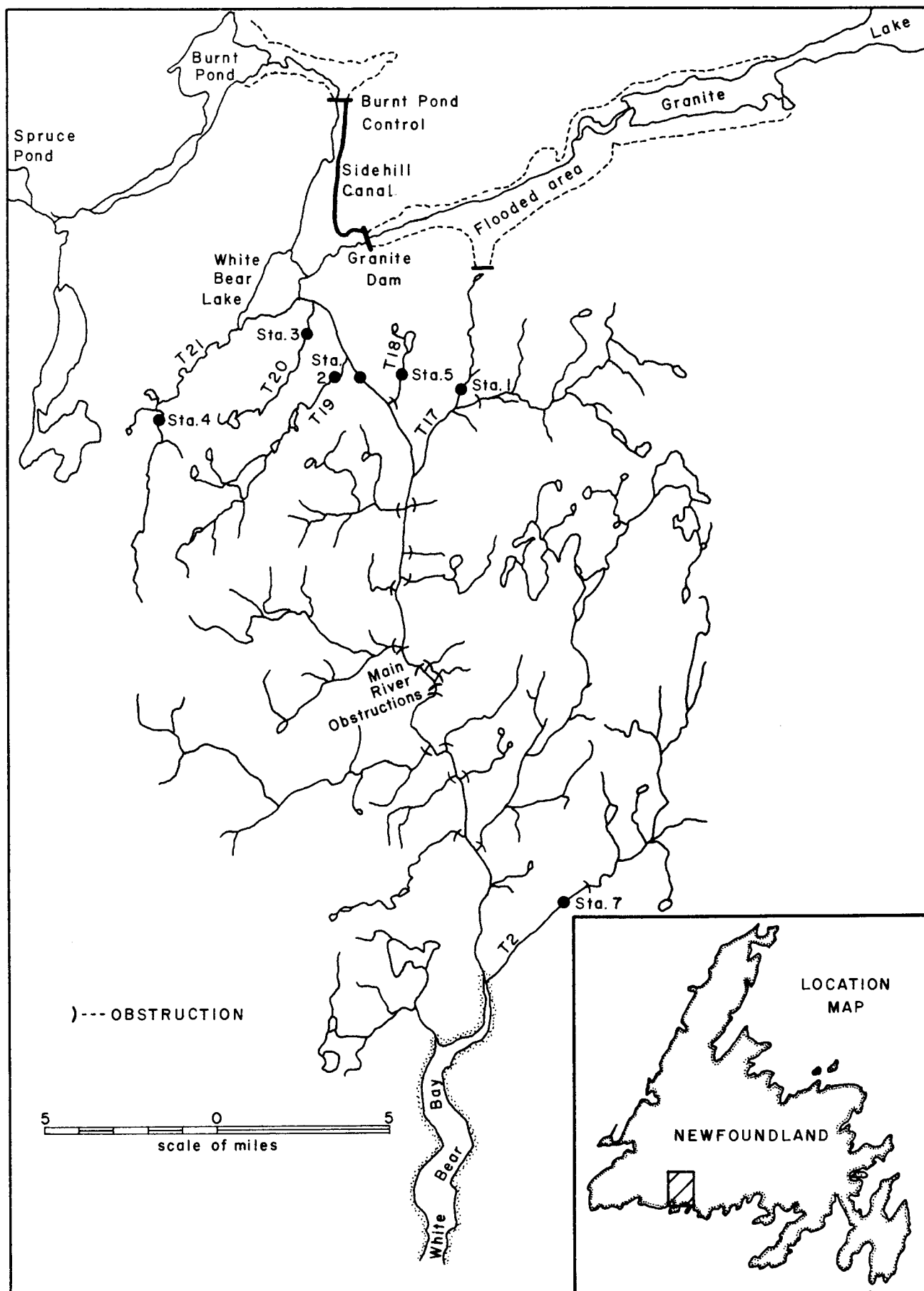


Fig.19 White Bear River showing sites of 1971 electrofishing stations.

The agreement consists of two main points:

- (1) The Power Commission has agreed to maintain a minimum flow of 250 cfs at the mouth of the river during the months of June, July, August, and September of each year.
- (2) Equivalent salmon-rearing waters will be made accessible as compensation for rearing area lost as a result of flow reduction in the main river. To achieve this goal the Commission has agreed to contribute up to a maximum of \$75,000 toward the cost of installation of fish passage facilities at natural obstructions on the main river. It is the Department's job to ensure the establishment of salmon production above these obstructions.

During July, 1971, a field survey was undertaken to determine present levels of fish utilization. As well, a detailed stream survey was undertaken. Figure 19 shows the sites of electrofishing stations. Even at low summer flows it was impossible to electrofish in the main river below the obstructions, and only one main river station was fished above the obstructions. Table XXXIII shows the results of that census. Standing crops are extremely low compared to other Newfoundland waters. The higher level in Tributary 21 is probably due to the stream's status as a spawning and nursery area for the ouananiche population in White Bear Lake. Tributary #2 provides much-needed rearing area for juvenile salmon, however, a dearth of spawning gravel probably limits the utilization of this stream. Specific conductance was measured at all but one of the electrofishing stations. Except for Station #1 values were much the same, the mean being 18.1 m.mhos. Station #1 had a value of 27.2 m.mhos.

The upstream areas of White Bear River are apparently under-utilized and hence offer additional salmon production potential. Installation of fish passage at the natural falls on the main stem and initiation of salmon development are directed toward utilization of that unused potential.

Churchill Falls Hydro

Naskaupi River. Lake Michikamau forms the headwaters of the Naskaupi River. It lies on the Labrador Plateau and is the largest of several bodies of water that are now flooded to form the Smallwood Reservoir. A series of dykes has been constructed to contain the reservoir, one of these being at Orma Lake (Figure 20). With the construction of this dyke and its closure on April 28, 1971, water flows in the upper Naskaupi River were reduced by approximately 90 percent at a point 22 miles downstream from the dyke.

Table XXXIII. White Bear River electrofishing census results in weight (gms) per unit.* Estimated number of fish per unit in parentheses.

Species	Below main river obstructions		Above main river obstructions					
	<u>Tributary</u>	<u>Main stem</u>	<u>Tributaries</u>					
	<u>Accessible</u>		<u>Inaccessible</u>	<u>Accessible</u>				
	Trib.# 2		Trib.#18	Trib.#21	Trib.#20	Trib.#19	Trib.#17	
	Sta. # 7	Sta. # 6	Sta. # 5	Sta. # 4	Sta. # 3	Sta. # 2	Sta. # 1	Mean
<u>Salmo salar</u>	116 (7.0)	10 (0.4)	0 (0)	91 (5.6)	6 (0.8)	65 (2.1)	19 (1.5)	45 (2.5)
<u>S. fontinalis</u>	0.1 (0.1)	0 (0)	121 (14.0)	17 (1.5)	102 (4.1)	17 (1.8)	27 (1.3)	41 (2.2)

* 1 unit = 100 sq. yds.

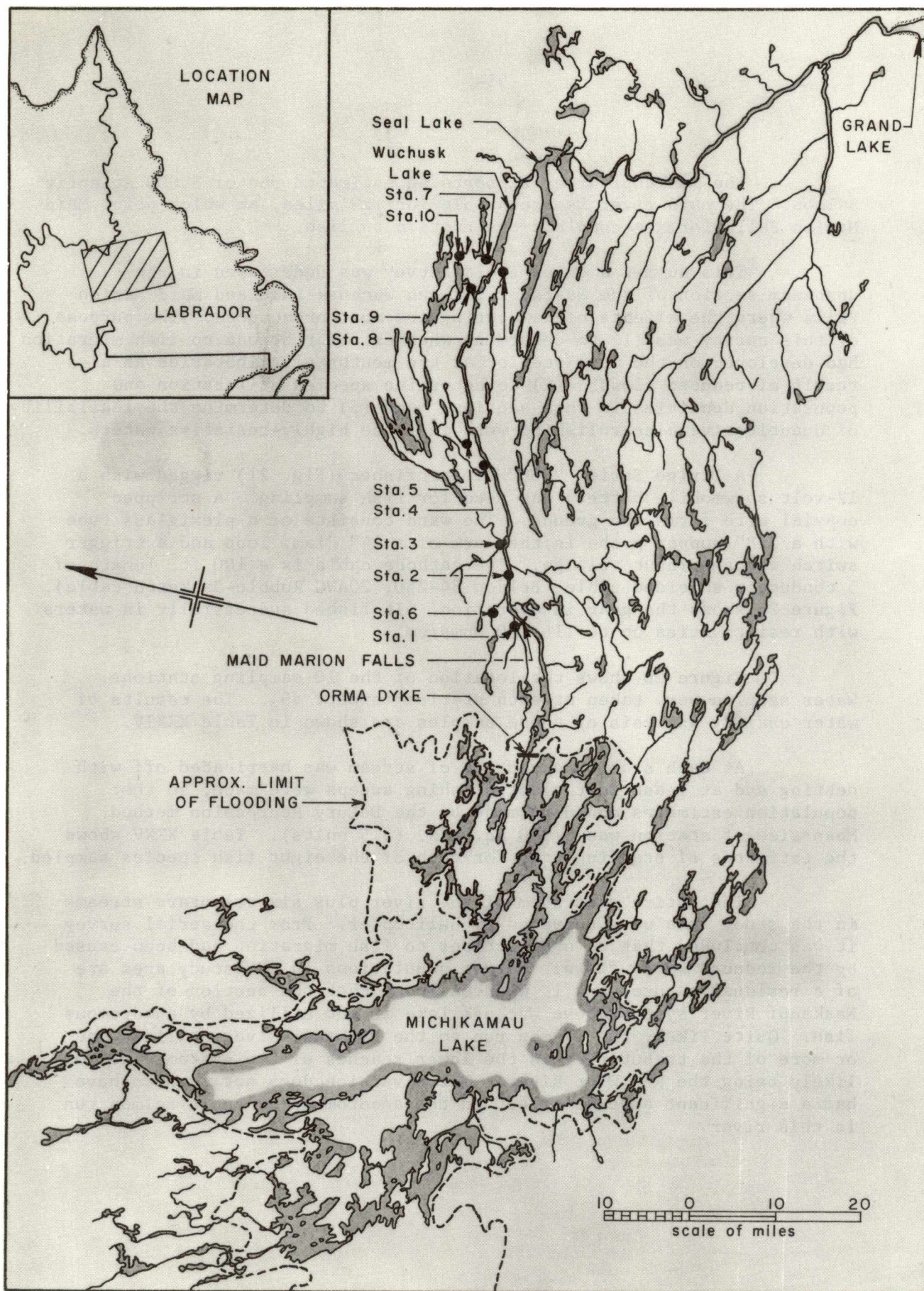


Fig.20 Naskaupi River showing sites of 1971 electrofishing stations.

The Naskaupi River supports an estimated run of 5,000 Atlantic salmon. The main river is accessible for 122 miles, at which point Maid Marion Falls forms a complete obstruction to fish.

This summer a brief field survey was undertaken in the upstream section of the Naskaupi between Wuchusk Lake and Maid Marion Falls where the effects of dewatering are most pronounced. The purpose of this survey was (1) to determine whether obstructions to fish migration had developed on the main stem or at the mouths of tributaries as a result of reduced flows; (2) to determine species utilization and population densities in this section; and (3) to determine the feasibility of quantitative electrofishing work in those highly-resistive waters.

A Dirigo Series "400" electrofisher (Fig. 21) rigged with a 12-volt snowmobile battery was used for fish sampling. A stripped coaxial wire forms the ground. The wand consists of a plexiglass tube with a 3/8" copper probe in the form of a 14" diam. loop and a trigger switch for the input voltage. The cathode cable is a 100 ft. length of 5 conductor shielded cable (Beldon 84-250, 20AWG Rubble-Jacketed cable). Figure 22 shows the gear in operation. It fished successfully in waters with resistivities up to 116,000 ohms/cm.

Figure 20 shows the location of the 10 sampling stations. Water samples were taken at each station (except #9). The results of water quality analysis of these samples are shown in Table XXXIV.

At each station a section of stream was barricaded off with netting and at least four electrofishing sweeps were made, so that population estimates could be made by the DeLury Regression method. Mean size of station was 5,500 sq. yds. (5.5 units). Table XXXV shows the estimates of standing crop for each of the eight fish species sampled.

The entire main stem of the river plus six tributary streams in the study area were surveyed by helicopter. From the aerial survey it was concluded that no obstructions to fish migration had been caused by the reduced water flows. Salmon populations in the study area are of a residual nature, and it was concluded that the section of the Naskaupi River system above Wuchusk Lake is not utilized by anadromous fish. Quite likely the salmon run to the Naskaupi River utilizes one or more of the tributaries in the lower reaches of the system, the most likely being the Red Wine River. The diversion does not seem to have had a significant adverse effect on the anadromous Atlantic salmon run in this river.



Anode Cable

12 V. Battery

Dirigo Electrofisher

Figure 21. Dirigo Series "400" Electrofisher.

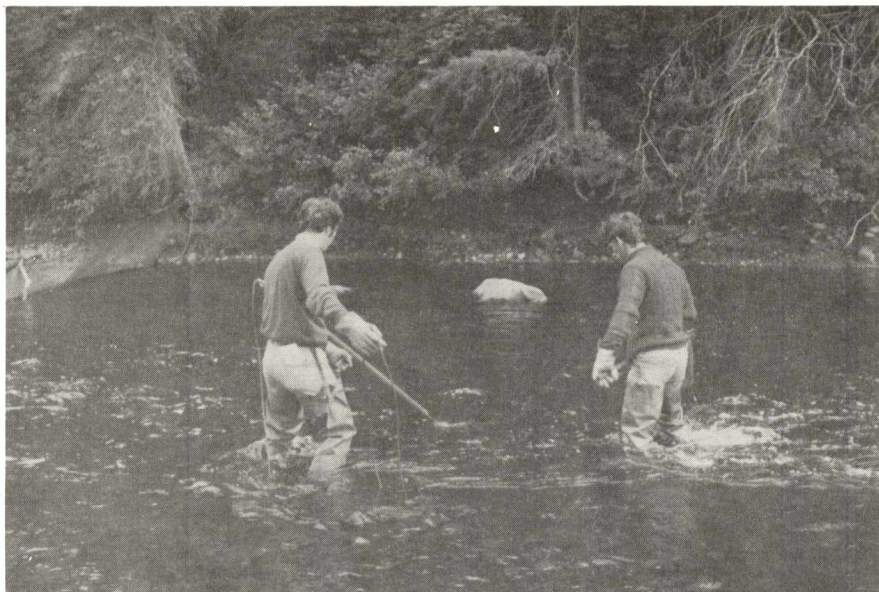


Figure 22. Electrofisher in operation.

Table XXXIV. Water quality analysis on samples taken at electrofishing stations, Naskaupi River, 1971.

Station	1	2	3	4	5	6	7	8	10	Mean	Range
pH	7.25	7.24	7.26	7.26	7.25	6.90	6.82	6.51	6.91	7.04	6.51 - 7.26
Total Hardness (ppm)	10.0	11.0	11.0	21.0	12.0	6.0	8.0	9.0	10.0	10.9	6.0 - 21.0
Turbidity (JTU)	0.70	0.65	0.73	0.52	1.30	0.90	0.71	2.50	0.69	0.97	0.52 - 2.50
Total Alkalinity	10.0	11.0	10.0	11.0	10.0	6.5	5.0	6.0	7.0	8.5	5.0 - 11.0
Specific Conductance at 25°C (micro mhos/cm)	20.4	19.3	20.9	21.5	19.3	8.6	12.9	23.6	14.0	17.8	8.6 - 23.6
Specific resistance (ohms/cm X10 ³)	49	52	48	46.5	52	116.5	77.5	42.5	71	61.7	42 - 116.5
Total dissolved solids	21.7	20.9	22.0	22.5	21.0	13.2	16.3	24.0	17.1	19.9	13.2 - 24.0

Table XXXV. Population estimates by electrofishing, Naskaupi River, 1971.

Species	Salmo salar		Salvelinus fontinalis		Rhinichthys cataractae		Cottus cognatus		Lota lota		Catostomus catostomus		Prosopium cylindraceum		Catostomus commersoni		Total	
Station #	gms/ unit*	no/ unit	gms/ unit	no/ unit	gms/ unit	no/ unit	gms/ unit	no/ unit	gms/ unit	no/ unit	gms/ unit	no/ unit	gms/ unit	no/ unit	gms/ unit	no/ unit	gms/ unit	no/ unit
																	(lbs/acre)	
1	0.5	0.1	9	2	28	7	8	4	0.6	0.1	0	0	0	0	0	0	46 (5)	13
2	9	1.0	0	0	33	5	14	6	2.5	0.1	0	0	0	0	0	0	59 (6)	12
3	11	0.4	192	14	87	9	15	7	0	0	2	0.1	27	0.8	0	0	334 (36)	31
4	0	0	113	3	16	3	8	4	13	0.7	22	0.6	1	0.3	5.6	0.4	179 (19)	12
5	0	0	300	29	49	8	0	0	11	0.7	0	0	0	0	0	0	360 (38)	38
6	0	0	90	6	7	1	0	0	0	0	32	0.8	0	0	0	0	129 (14)	8
7	0	0	87	5	0	0	15	10	5	0.2	0	0	0	0	0	0	107 (11)	15
8	0	0	33	6	40	7	27	17	128	4	7	4.5	7	1.1	0	0	242 (26)	40
9	2	0.2	26	4	18	3	15	6	19	1	0	0	0	0	0	0	80 (9)	14
10	0	0	326	19	112	21	0	0	0	0	3	0.3	0	0	0	0	441 (47)	40
Mean (lbs/acre)	2 (0.2)	0.2	118 (13)	9	39 (4)	6	10 (1)	5	18 (2)	1	7 (0.7)	1	4 (0.4)	0.2	0.6 (0.06)	0.04	198 (21.1)	22

* 1 unit = 100 sq. yds.

INDUSTRIAL WATER SUPPLIES

Come-by-Chance Industrial Complex

Come-by-Chance River Survey. The proposed industrial development in the Come-by-Chance area includes plans for the integration of the Come-by-Chance River into a water supply system (Figure 23). In effect, the river would become a partially-controlled-flow canal to deliver water toward the industrial site.

A program to monitor the effects which such a development would have on the stream's fish populations was initiated in the late summer of 1969 with the completion of a detailed stream survey. The stream comprises 3,700 rearing units (1 unit = 100 sq. yds.), all of which is accessible to anadromous fishes.

During 1970 and 1971, an electrofishing census program was carried out. As well in 1971, a count was made of downstream migrants utilizing the portable conduit-type counting fence developed by the Engineering Services Group (Figure 24). Washouts caused by unstable stream material prevented a complete upstream count.

Figure 23 shows the location of electrofishing stations. The results of the census for both years are given in Table XXXVI. In 1970, nine stations were electrofished (#3 was omitted) comprising a total of fifty 100 sq. yd. units. This area represents 1.35 percent of the total river area. In 1971, ten stations were completed for a total of 72 units, or 1.9 percent of the river area. Based on stream survey information, each station was taken to represent different sections of the river based on bottom types and location. Thus a different quality factor was applied to each station in compiling the estimate for the drainage.

Total standing crop has remained relatively stable over the past two years. Survival from 1⁺ to 2⁺ is approximately 50 percent. The older year-classes (3⁺ and 4⁺) are probably overestimated because of electrofishing gear selectivity.

A total of 3,542 smolts was counted during operation of the counting fence. The actual run was somewhat larger, since on the first day of operation (May 5) 50 smolts were counted. The fish were predominantly age 4⁺, the mean age being 3.74. As well, 3,379 sea trout (Salvelinus fontinalis), some as large as 3 lbs., were counted going downstream. It is hoped that some evaluation of the sea trout population can be incorporated into the study, since this species forms the basis of most of the angling on the river.

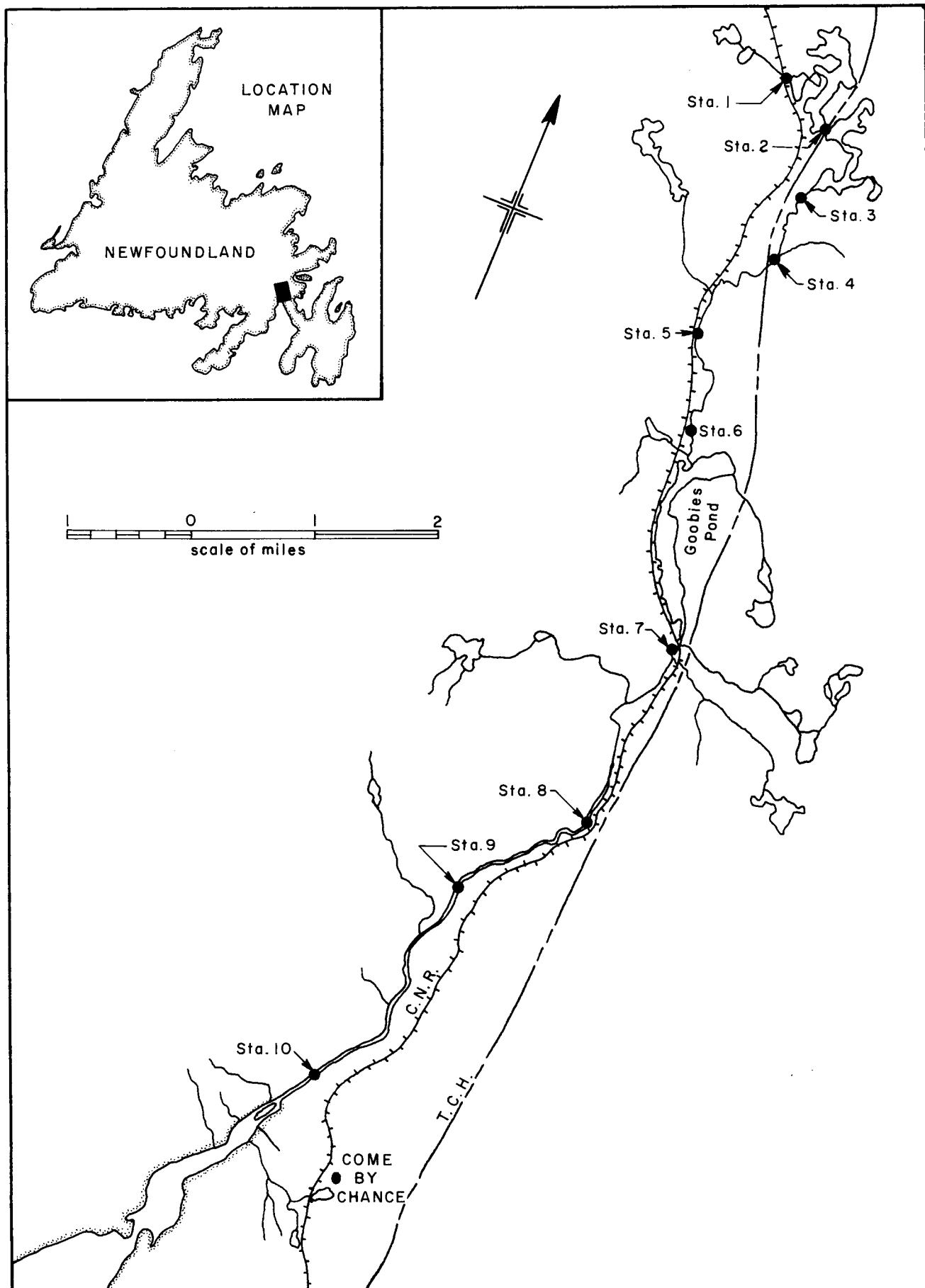


Fig.23 Come-By-Chance River showing sites of electrofishing stations.



Figure 24. Conduit-type counting fence
Come-by-Chance River, 1971.

Table XXXVI. Estimates of the standing crop of juvenile salmon (Salmo salar) in Come-by-Chance River, 1970-1971.

Age	1970 (June 25 - July 30)			1971 (June 10 - July 5)		
	No. fish	Wt.(kgs.)	Wgt. (gms)/unit**	No. fish	Wgt. (kgs.)	Wgt.(gms/unit)
0 ⁺	37,200*	26	7	37,400*	26	7
1 ⁺	18,600	85	23	18,700*	119	32
2 ⁺	7,250	102	28	9,350	107	29
3 ⁺	4,900	113	30	5,690	123	33
4 ⁺	4,360	117	32	2,560	77	21
TOTAL	72,300	443	120	73,700	452	122

* Extrapolated from estimates of older year-classes.

** 1 unit = 100 sq. yds. The river has 3700 units.

OFFSHORE OIL EXPLORATION

B. R. LeDrew

A great increase in exploration activities in the offshore areas of Newfoundland and Labrador was witnessed during 1971. A total of 30 oil exploration companies and contractors were involved in seismic and associated surveys, some of these being quite extensive. Other surveys included a pipeline reconnaissance survey and an iceberg-towing experiment to test the feasibility of removing these bodies from a collision course with stationary drill rigs.

Three companies received permits to conduct exploratory drilling on their holdings, and two programs were started in 1971. Amoco Canada Petroleum Co. Ltd., in a joint drilling program with Imperial Oil Ltd., engaged the Halifax-built Sedco I (Southeast Commonwealth Drilling Company) to drill a series of exploratory holes approximately 100 miles southeast of the Avalon Peninsula. The rig has been operating continuously since mid-April and plans are to continue operations throughout the winter. In July the Storm Drilling Company drillship "Typhoon", under contract to Tenneco Oil and Minerals Ltd., commenced operations on the Hamilton Banks off Labrador.

The responsibilities for maintaining liaison with companies to ensure that proper procedures to protect the environment are adhered to will pass over in 1972 to the newly-formed Environmental Protection Service.

E N G I N E E R I N G S E R V I C E S

ENGINEERING SERVICES

B. R. Bauld
Chief Engineer

CONSTRUCTION

K. Powell
E. L. Tulk
D. B. Stone
R. Fitzpatrick

Facilities for Greenland Salmon Fishery Investigations

The Construction Unit assisted the Development Group during June in the installation of the smolt-adult counting fence and other facilities at Sand Hill River, Labrador. The crews moved to the site in early June to prepare for the season. The unfinished accommodations were completed. The accommodations and the fence platform withstood the effect of the winter very well, and little maintenance work was required.

The Development Group reports that the fence operations went along very smoothly, and the enumeration of smolts and adults was very satisfactory. The design used for this fence has proven very successful during the three years of operations. It appears that any additional permanent counting facilities to be installed in the future should be based on this design and on any modifications indicated from our further experience.

Stream Remedial Work

A small construction crew, consisting of three men under the supervision of one of our Technicians, carried out remedial work on a number of obstructions on various rivers on the Island of Newfoundland. The work consisted of blasting rock and installing concrete weirs to control the flow of water. The following is a list of the rivers and the work done at each location:

Lomond River. Remedial work in the form of blasting at the obstruction known as Glory Hole was carried out. This work proved only partly successful because of the difficulty in drilling and blasting in the most advantageous places.

Renews River. As a follow-up to work carried out in 1970, which consisted of installation of concrete weirs to control the flow of water, a large boulder was removed from the top of the falls. The boulder was hindering the passage of salmon and trout.

New Bay River. Work was carried out at two locations on this river. At Walker's Falls the pool below the falls was enlarged and a large boulder was removed from the top of the falls. At the Upper Falls, blasting was carried out to confine the flow of water to one side of the river. A hole was filled below the falls by blasting the river bank. This improvement work should eliminate the poaching problem at this location.

Northern Arm Brook. Work was carried out at the upper falls to channel the flow of water above a small falls during periods of low flow.

Middle Brook. Work was carried out at the partial obstruction located several hundred feet below the fishway. Work consisted of rock removal and installation of small weirs to divert water at medium and low flows into the channel on the left side of the river bed. This effort should eliminate a serious poaching problem and permit the salmon and trout to move upstream without being held up at this obstruction.

Cooks Brook. The work at this location consisted of filling in a pool with large rocks so that salmon and trout will not rest in the pool. It might be necessary to channel the river bed near the mouth of the river to assist the fish at extreme low flows.

Barry's Brook. The work consisted of removal of log jams, channeling the flows, and general clearing of a one-mile section of river bed.

Conne River. Work was carried out at several locations on this river system. Control of water flow at the obstruction known as Brin Bag Hole was affected by blasting a channel around the hole. Martin's Hole was blasted and a channel was formed to the left of the obstruction to ease passage for fish. At Bernard's Falls a large boulder, which had slipped into river behind one of our baffles, was removed.

West Brook (St. Barbe Bay). A channel was blasted through porous rock at a falls located approximately 8 miles from the mouth of the river. Due to high water levels, all the work necessary to eliminate the holdup could not be completed. It may be necessary to enlarge the pool below falls at a future date.

Salmonier River. Work consisted of blasting a channel at Metcalf Falls to increase water flow in the center channel at period of low flow. Several large boulders were removed from the pool below the falls.

Spread Eagle Brook. Work consisted of blasting a channel through the falls in order that salmon and trout can migrate without hold up. A deadwater pool at bottom of the falls was removed by channelling.

Pipers Hole River. The flow of water was confined to one run at the second falls by blasting. This should eliminate the problem at low water levels.

North West Brook (Trinity Bay). Work consisted of removing rock at the top of falls, near the Trans-Canada Highway.

Branch River. The mouth of the river was channelled by bulldozing a deep channel to confine the flow. This deepening should allow fish to enter the river without being held up due to shallow water.

Fishway Maintenance

An extensive maintenance program was carried out in May and June to ensure that all fishways would be in good operating condition when the migrating salmon entered the rivers. Routine repairs to Lomond River, Indian River, Salmon Brook, and Camp One fishways were carried out. The work was required due to damages received from high water during the spring runoff. At Salmon Brook fishway a channel was blasted to obtain better attraction at the fish entrance.

Maintenance work was carried out at Indian River Spawning Channel. The diversion dam was resurfaced and a new apron was installed on the downstream side of the dam. Rock ballast was placed downstream of the dam to prevent river bed scouring.

DEVELOPMENT

G. B. Scott
B. J. Flynn
L. Goulding

Exploits River

Bishop's Falls. Construction of the fishway at the south end of the dam at Bishop's Falls continued during the year and was completed by late October. Again this year, high water levels hampered the progress of the project.

An access road was constructed into the site during the summer. This road speeded up completion of the project. The fishway is now ready for operation and should prove valuable in passing the 1972 salmon run.

Grand Falls Fish Facility Investigations. The Engineering Group continued investigations on the flow and depth patterns on the section of the Exploits River in the vicinity of the powerhouse and falls at Grand Falls. The report prepared by the consulting engineer firm was received but was not completed due to adverse weather conditions experienced during the winter months. Our own forces carried out further surveys during the summer. A decision was made in October to proceed with the immediate design of fish collection and transfer facilities at Grand Falls. Consultant Engineers were hired to complete the design. A contract was awarded in November for the design. Work has been progressing quite well and a completed design will be available by March, 1972.

Counting Fences

The Engineering Group provided assistance, as requested, in the installation of the nine counting fences operated during 1971.

Access Roads

The program of surveying for access roads into inaccessible lakes along the section on Trans-Canada Highway on the Avalon Peninsula was continued during 1971. Several additional plans have been prepared and are ready for tender call.

Stream Clearance Program

The Engineering Group worked closely with the Development Group in carrying out investigations on numerous obstructions which required remedial work. A list of rivers on which work will be carried out in 1972 is being compiled.

General

The Engineering Group provided engineering advice to the Pollution Control and the Environmental Protection Groups in reviewing plans submitted by various agencies. Considerable time and effort was directed towards the activities of the Dept. of Highways in an effort to prevent serious siltation of rivers during highway construction. Plans for the installation of water and sewer systems were reviewed, as well as carrying out on-site inspections during construction.

The Newfoundland and Labrador Power Commission requested our assistance in designing suitable fish passage facilities for their dam on Quarry Brook, Conception Bay. Quarry Brook is the source of fresh water for the thermal generating station located at Indian Pond. The Commission was presented with a proposed design of a fishway

from which they developed the final construction drawings. The Commission had the fishway constructed under contract during the fall of 1971. The Engineering Group maintained close control throughout the construction period. The fishway will be opened during 1972.

Workshop and Storeroom, Bishop's Falls

A contract for installation of a water connection and preparation for paving around the building was awarded in late 1971. A tender call for paving was issued but, due to the lateness of the season, it was impossible to have the paving completed. The contract for the water line and preparation of site was completed in November.

1972 Engineering Programs

The Development Program for the Exploits River will be accelerated in 1972 with the start of the construction of fish passage facilities at Grand Falls. It is hoped that two contracts will be let in early 1972, for the construction of the access road and for the collection and transfer facilities.

Plans also call for alterations to be carried out at the Camp One fishway, Great Rattling Brook. Tenders for paving the lot around the Workshop-Garage at Bishop's Falls will be called.

Investigations and surveys for various facilities required by the biological staff will be continued, with emphasis being maintained on carrying out the stream remedial program. Maintenance of fishways, counting fences, spawning channels, and other facilities on the Island of Newfoundland and in Labrador will be completed as required.

R E S O U R C E M A N A G E M E N T

RESOURCE MANAGEMENT

R. E. Cutting
A/Group Leader

INTRODUCTION

The major responsibility allocated to this work unit is the development and implementation of information for determining proper management of the Newfoundland and Labrador Atlantic salmon resource. In spite of the urgent need for confirmation, or modification, of present utilization methods, it was not possible to allocate significant financial resources or fulltime staff to this Group during 1970.

The Group responsibility can be divided into three work segments. These areas are: the development of accurate statistics for landings and for gear usage, the determination of biological parameters of the commercial salmon landings in various key localities, and the identification of stocks in relation to timing and location near the operating fisheries.

Commercial Salmon Fishery Statistics

In 1970, mainly through the effort of the Economics Branch of this Region, a computer program was developed. That program provides the landings by month, by statistical area (15), by statistical district (53), by type of gear, and by two size-classes. In 1971 the program was expanded to provide an annual printout of the monthly landings by settlement (about 682).

The present system has two areas of inadequacy. Input data for size-class is not complete because all fish buyers are not using 6 pounds round weight as a separating line between large and small. Fortunately, the proportion of buyers using this criterion is increasing. Secondly, the landings by settlement are available only on an annual basis when availability on a monthly basis early in the following month is a requirement under intensive management. Realization of a system for providing "current" landings monthly by settlement appears attainable for 1973 if trials in 1972 uncover no problems.

Establishment of a program to describe fishing gear quantities and utilization is also necessary. Quantities of gear licensed are now known, but it is impossible to quantify units of effort with present knowledge. Hopefully, catch-effort figures can be developed after some refinement of the present system of tabulating gear used in the salmon fishery.

Biological Sampling of Salmon Catch

In recent years, some of our sampling effort has been expended on landings from the Port-aux-Basques drift net fishery. In 1971, our limited effort was directed to the fishery in inner St. George's Bay in anticipation that the catch there would be representative of a "local" stock. Based on mean smolt age, the preliminary results in St. George's Bay show the expected older smolt age (3.3) than fish in the Port-aux-Basques drift net fishery (2.8 - 3.0) where FRB tagging studies show 80 percent mainland origin.

Limited sampling of the salmon catches took place at South Brook, Halls Bay, and at Sand Hill Cove, Labrador.

Identification of Salmon Stocks

The separation of mixed stocks can be achieved only by identification and quantification of the individual components. Three techniques, at least, seem available in the immediate future: smolt tagging; tagging of adults, particularly before the fishery commences; and biochemical methods involving serum and/or electrophoretic techniques. All these approaches will be utilized as soon as resources can be mobilized and cooperative programs established.

Additional fund and manpower resources have been made available for fiscal 1972. Staffing this Group has first priority. The next annual report will describe significant progress in development of a factual foundation for future salmon management recommendations.

S U M M A R Y

SUMMARY

EXPLOITS RIVER DEVELOPMENT PROGRAM

Development of the Exploits River watershed will realize an adult spawning escapement of approximately 30,000 fish plus a commercial and recreational fishery of another 55,000 fish, the largest potential of any single island river. Implementation of the full salmon development program is hampered by current uses of the water. Cooperation and coordination of federal, provincial, and private agencies with interests in the watershed is prerequisite to establishment of an Atlantic salmon population above Grand Falls.

Grand Falls, fishway and obstructions

Funds for construction of the fish collection facility at Grand Falls were approved in 1971. Site work will start in early 1972 and structure will be ready for operation in 1973.

Studies of the Grand Falls powerhouse indicated that passage of fish through the turbines will result in substantial mortalities. A guaranteed-spill arrangement at the forebay seems to lead migrants away from the turbine intake. At the Bishop's Falls forebay, concern is expressed over the delay of migrating smolts and kelts. Tagged fish entering this forebay in mid-June were present until early July. To prevent turbine mortalities and excessive delay of migration a surface-spill opening will be incorporated at Bishop's Falls forebay for the 1972 migration. If this remedy results in free passage of smolts and kelts, there may be no need for further turbine mortality studies or costly turbine screening.

Commercial and Recreational Fisheries

Analysis of the commercial fishery statistics and tagged kelt data reveals that the Bay of Exploits catch is composed mainly of homewater stock. Kelts recovered in the commercial fishery amounted to 91 percent of the total returns, of which 30 percent were taken in the Bay. It was concluded that regulations aimed at protecting or exploiting only Exploits River fish would have to be restricted to the area within fifteen miles of the river mouth.

The recreational fishery in the years 1961 - 1971 took an average 23 percent of the spawning run. Fishing intensity is heaviest in the tailrace and pools below the Bishop's Falls Dam. Further investigation may indicate the desirability of moving the present "no-fishing" boundary to protect more of the fish in this vulnerable area.

Noel Pauls Brook

The Noel Pauls Brook Spawning Channel plays a major role in the Exploits River salmon development program. Channel-produced fry will be used to establish adult salmon in Noel Pauls Brook. Phasing-in of this production will enable adults to utilize the Grand Falls fishway as soon as it is completed and to reduce the time needed to bring the central Exploits area into salmon production.

The first major smolt run, resulting from stocking of channel fry, produced an estimated 4,000 migrants. This production is the progeny of 365 salmon transferred from Adies Stream, Humber River, in 1968. Survival from egg-to-fry was 70 percent.

In 1970, 502,446 eggs were deposited and had a survival of 302,769 fry, or 63 percent. In 1971, 479 adults were transferred to the channel. The calculated egg deposition is 627,500.

Spawner density in the channel has been increased from one female per 12 sq. yds. to one female per 3 sq. yds. Preliminary results from experiments completed in 1971 indicate that a density of one female per 4 sq. yds. may be the most practical one.

Channel fry stocking has substantially increased standing crops of all year-classes, at the same time decreasing the resident trout populations. To achieve maximum survival a seeding density of 40 - 45 fry per 100 sq. yds. at release intervals of $\frac{1}{2}$ to $\frac{3}{4}$ mile should be used.

Pollution Exploits River

Investigations into all aspects of pollution of the Exploits River system continued in 1971 with a regular sampling program and with further studies on the effects of pollution on the biota. Estimates of the toxicity of pollutants in this watershed have been revised. The highest toxicity measured was 0.83 toxic units (T.U.) recorded below Grand Falls. This value represents an abnormal situation because the pulp mill was closed down at the time, and the river's SSL level was only 'background'. The average toxicity value in the lower river is less than 0.4 T.U. In the upper section of the river, the measured toxicity, due to heavy metals, exceeded 1.0 T.U. on three occasions at the Millertown Dam. Apart from these occurrences the toxicity never exceeded 0.7 T.U. and averaged 0.27 T.U.

The river and estuary were sampled continuously to check for the presence of low oxygen conditions which might present a barrier to fish migration. Although oxygen depletion is more severe in the deep waters of the estuary, no such barrier was found.

DEVELOPMENT PROGRAMS

Fishway Counting Traps

In 1971, counts were obtained at seven fishways, two more than 1970. There was a slight decrease in the fish counts at most fishways in 1971. Counting was resumed at Salmon Brook, Gander River, after a 9-year break. The enumeration showed that spawning run to be on a par with previous years.

West Coast River Development

To expedite establishment of salmon populations above the Torrent and Lomond fishways, adult transfer programs are proposed for these rivers in 1972. Adults will be transferred from West Brook to Torrent River, and a percent of the lower Lomond River salmon will be re-distributed to the upper Lomond River. This five-year program, when complete, could realize an additional 800 and 300 fish in the Torrent and Lomond creels, respectively.

Stream Inventory

Cooperative action on the part of biological and engineering stream-clearance crews resulted in the removal of 24 minor obstructions, many of which caused serious poaching problems. A list of 78 obstructions has been compiled for appropriate stream-clearance action.

Indian River Spawning Channel

In 1970, an adult stock of 145 females deposited 252,000 eggs in the channel. A survival of 67 percent, or 169,000 fry, emerged. This rate is a vast improvement over the previous year's survival of 15 percent and the past seven-year average of 40 percent. The high survival results from the replacement of the old gravel with new, coarser channel substrate in 1970.

Commercial Fishery Sampling

Results from the commercial fishery sampling in 1971 and smolt tagging in 1969 indicate that the South Brook fishery operates on a mixed stock and that the catch is composed of one-quarter Indian River fish. The latter represents 60 percent of the Indian River production.

Greenland Fishery Investigations

In 1971, 10,511 smolts were Carlin-tagged and 391 adults were tagged with Blue Atkins at Sand Hill River, Labrador. The total count of

smolts was 52,607. One hundred and sixty-nine smolt tags were recovered in the local commercial fishery. Adult return to the river in 1971 was 3,754 fish, five fewer than the 1970 count.

Estimates based on two years of returns from the 1969 smolt tagging show that the adult population of Sand Hill River is composed of approximately 66 percent grilse and 33 percent 2 seayear or older fish. In compiling this percentage for the 1969 tagging, the 1970 Greenland year 1 returns were grouped with the 1971 year 2 returns. The proportion of 2 seayear fish is much larger than was determined by assessing the adult spawning run into the river. River sampling showed the run to be composed of 93.8 percent grilse and 6.2 percent 2 seayear or older fish. Based on tag returns, the grilse utilization shows; commercial fishery 32 percent, angled 2 percent, and 66 percent return to the river to spawn. Whereas only 10 percent of the 2 seayear or older fish return to the river, while 90 percent are taken by commercial fisheries.

The distribution of tag recoveries from 1969 and 1970 taggings show that the majority of fish are taken by the commercial fisheries along the east coast of the Great Northern Peninsula, mostly north of Canada Bay, and along the Labrador coast as far as Sand Hill Cove. These results indicate that the path of migration of returning fish is northwards of the White Bay area then along the Labrador coast to Sand Hill River. This finding is in agreement with the hypothesis of other authors about the probable migration routes of northern salmon stocks.

LAKE INVESTIGATIONS

Metropolitan Area Studies

Evaluation of the intensity and other characteristics of a sport fishery, conducted near an urban area, was completed in 1971. A start was made on the intensive management of Thomas and Paddys Pond, located near the Metropolitan Area of St. John's. In an attempt to improve growth and survival rates of sport fishes in these ponds, forage food introduction and evaluation was begun in 1971. Approximately 22,000 three-spined sticklebacks were stocked into Paddys Pond and 9,500 into Thomas Pond. Stockings of an equal magnitude are planned for 1972.

Limnological investigations were made on several lakes having limited accessibility for boat fishermen. The objective was to determine whether under-utilized, fishable populations of sport fishes are present and, if so, consideration will be given to the development of access for fishermen with boats.

Reservoir Studies

Investigations at the Long Pond Reservoir (Bay D'Espoir) continued in 1971. This study was to monitor and document changes in the sport fish populations resulting from reservoir formation and to formulate management policy for this large water area.

Results indicate that the landlocked salmon has increased its growth rate significantly since the 1965 pre-flooding survey. The brook trout maintained a constant rate of growth over the same time period. Growth rates of both trout and salmon in Long Pond in 1965 are similar to the present ones of Round Pond fish. Since water quality in both Round Pond and the Long Pond Reservoir is now similar, the increased growth rate of the salmon is attributable to some other factor, such as increase in habitat area.

ENVIRONMENTAL PROTECTION

Studies to evaluate changes in the aquatic environment brought about by industrial activities were the main areas of work for this group in 1971. Intensive field surveys were undertaken to determine present levels of fish utilization in the White Bear River (Bay D'Espoir Power Development) and Naskaupi River (Churchill Falls Power Development).

In addition, monitoring of the fish populations at Come-by-Chance River by weir counts and electrofishing continued in 1971 in anticipation of the industrial complex to be located nearby. Some assessment of the effects on fish populations in the Stephenville water supply area were also initiated.

Offshore Oil Exploration

A great increase in exploration activity in offshore areas was witnessed in 1971. A total of 30 oil exploration companies and contractors were involved in marine seismic and associated surveys. A series of exploratory holes were drilled by Sedco I, approximately 100 miles southeast of the Avalon Peninsula.

Responsibility for maintaining liaison with companies to ensure that proper procedures for protection of the environment are adhered to will pass over in 1972 to the newly-formed Environmental Protection Service.

ENGINEERING ACTIVITIES

Stream Remedial

A small construction crew supervised by a Technician was successful in removing 24 minor obstructions variously located throughout the island in 1971. In addition an extensive maintenance program was carried out at all fishways to ensure proper operation for the 1971 runs of salmon and sea trout.

Exploits River

The Bishop's Falls fishway was completed in late October, preceeded by development of an access road to the fishway in early summer. This facility is now ready to pass fish for the 1972 migration.

Investigations of the flow and depth patterns in the Exploits River at Grand Falls were continued in 1971. Consulting engineers were engaged to design fish collection and transfer facilities at the Grand Falls obstruction. Construction of this facility will start in 1972 and the completion is expected before the 1973 run.

RESOURCE MANAGEMENT

Commercial Salmon Fishery Sampling

In 1971, sampling efforts were directed toward the fishery in inner St. George's Bay in anticipation that the catch there would be representative of a local stock. Based on mean smolt age, the preliminary results show the expected older age (3.3) than fish in the Port-aux-Basques drift net fishery (2.8 - 3.0), where FRB tagging studies show 80 percent mainland origin.

Through the efforts of our local Economics Branch, a computer program was developed to provide landings by month, by statistical area, by statistical districts, type of gear, and two size classes. The expansion of this group in 1972 will describe significant progress in development of a factual foundation for future salmon management recommendations.

POLLUTION INVESTIGATIONS

The pollution staff in recent years has reached a size where emergencies no longer disrupt ongoing planned work. This fact is reflected in this year's output, when we accomplished many studies previously

postponed for lack of manpower. Studies have been classified as either Abatement projects, when the purpose is to solve a pollution problem, or Baseline or Monitoring, where the purpose is to define or monitor a potential problem.

Electric Reduction Company - Long Harbour

Problems encountered in 1971 were similar to those experienced in 1970. A large portion of the staff's time and energy was devoted to finding a successful method for removing, or neutralizing, the elemental phosphorus remaining in the bottom sediments of Long Harbour, since three dredging programs have not completely reduced that hazard. In addition, the settling ponds continued to be unable to operate on a closed circuit, necessitating bleed-offs to the sea during periods of above-average rainfall. No fish kills occurred as a result of those bleed-offs. A formal proposal designed to eliminate the need for bleed-offs was received from ERCO in February, in response to a directive to the Company from our Minister.

Newfoundland Refining Company - Come-by-Chance

Negotiations have been held with the Company and Procon (designer of the complex) to ensure that the refinery effluent receives the best possible treatment to protect the fishery resources of upper Placentia Bay. To this end, regional staff have been aided by E.P.S. staff experienced with oil refineries and by a consultant retained by the Department. Final design of the effluent treatment facilities will be resolved in meetings scheduled for early 1972.

Iron Ore Company of Canada - Labrador City

Negotiations with I.O.C.C. in 1971 revolved primarily around the operation of the chemical flotation pilot plant. The discussions centered around the use of hydroxamic acid as the flotation reagent. To guard against possible detrimental effects from this reagent, the Service requested the conduct of bioassays on the effluents from the pilot plant. The Service observed the bioassay program at frequent intervals. Results of the program will be analysed in early 1972. Successful installation of this flotation system will remove 15 percent of the "FC" presently deposited in the tailings.

Kraft Linerboard Pulp Mill - Stephenville

Staff efforts in 1971 were directed toward two facets of this problem. Baseline investigations were conducted to document present biological and chemical conditions in St. George's Bay. Information collected will be used to assess the impact of mill wastes on the marine

environment. In addition to these studies, extensive negotiations were carried out with Javelin Paper Corp. to ensure that effluents from the linerboard mill would receive the best possible treatment. The final effluent must meet the new pulp and paper mill standards and waste discharges must not impair the water quality of St. George's Bay.

Mines - Monitoring

Baseline monitoring of all possible pollution problems continued in 1971. Extensive studies on biota were initiated and bioassay work on toxic pollutants continued at the Bishop's Falls lab. The acquisition of new equipment at the St. John's lab considerably increased the quantity and quality of sample analysis results.

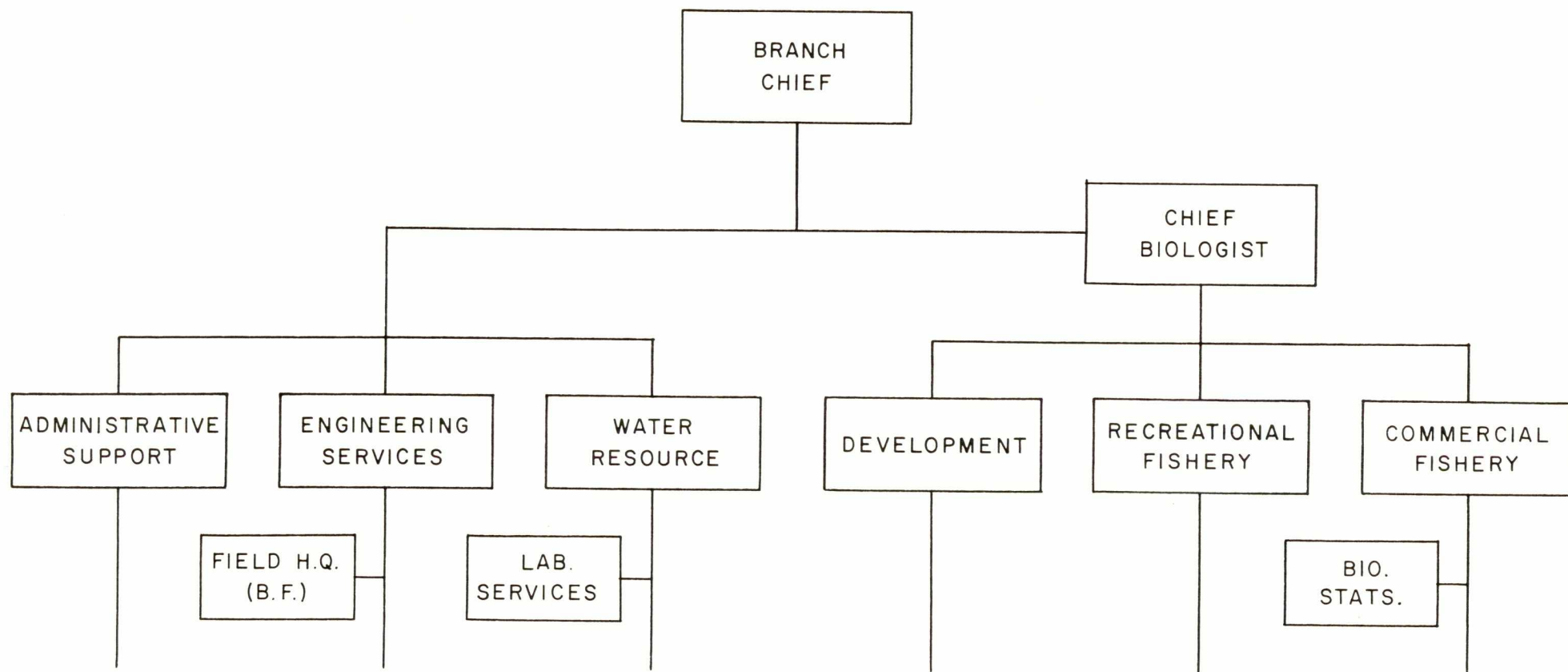
A P P E N D I C E S

APPENDICES

Appendix 1. Branch Organization Chart.

Appendix 2. List of Reports and
Reports in Preparation.

APPENDIX I
BASIC ORGANIZATION CHART



(Effective April 1st. 1972)

APPENDIX 2

REPORTS and PUBLICATIONS

- ADDISON, A.F. & M.E. ZINCH, R.G. ACKMAN & P.S. CHAMUT and A. JAMIESON, 1972. Results of elemental phosphorus monitoring program Long Harbour, Nfld. (July 1970 - April 1971). In Press, Tech. Rept. F.R.B.C.
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- WISEMAN, R.J. 1971. The limnology, ecology and sport fishery of Thomas Pond: A multi-use reservoir. Prog. Rept. 73. Res. Dev. Br., St. John's, Nfld.

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- LEDREW, B.R. 1972. Standing crop estimates and stream survey of the Upper Naskaupi River. Res. Dev. Br., St. John's, Nfld.
- MURPHY, H.P. 1972. A helicopter reconnaissance survey of Eagle Paradise, and White Bear River, Sandwich Bay, Labrador, 1970. Res. Dev. Br., St. John's, Nfld.
- MURPHY, H.P. 1972. Report of biological operations Sand Hill River, Labrador, 1971. Res. Dev. Br., St. John's, Nfld.
- PEET, R.F. 1972. A preliminary analysis of tagging operations Sand Hill River, 1969-1970. Res. Dev. Br., St. John's, Nfld.
- PEET, R.F. 1972. A report on the biological operations at Salmon River, 1967-1970. Res. Dev. Br., St. John's, Nfld.
- RICHE, L.G. 1972. An outline of methods used in stream surveys and estimation of salmon production: With a suggested value for Atlantic salmon sports fish in Newfoundland. Res. Dev. Br., St. John's, Nfld.
- RICHE, L.G. 1972. Resume of enumeration studies at West Brook, Big East and Northeast Rivers, 1971. Res. Dev. Br., St. John's, Nfld.
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