

Fishery Management in the
FISH RIVER DRAINAGE



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Fishery Management in the Fish River Drainage

by

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FOREWORD

Your Inland Fisheries and Game Department is making continuing biological studies of our lakes, rivers, and streams. The purpose of these studies is to evaluate existing and potential fisheries of our inland waters and to make recommendations to maintain the best possible management of our fisheries. As these studies on various river drainages are completed, the findings are presented to the citizens of our State.

This report summarizes information collected on the fisheries of the waters in The Fish River drainage, Aroostook County, Maine. The field investigations were made by fishery biologists of the Fishery Research and Management Division of the Maine Department of Inland Fisheries and Game over a period of 14 years, from 1950-1964.

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Ashland, Maine
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TABLE OF CONTENTS

	Page
Foreword	2
Introduction	5
Description of the Drainage	6
Lake Management	7
Brook Trout	8
Landlocked Salmon	12
The Salmon Fishery	13
Age, Growth, and Mortality	17
Reproduction	18
Early Life History	19
Food of Salmon	22
Competition	23
Blueback Trout	23
Lake Trout (Togue)	23
Whitefish	25
Smelt	25
Other Fishes	28
River and Stream Management	30
River and Stream Fisheries	30
Effects of DDT Spraying	32
Effects of Logging Practices	33
Obstructions	35
Proposed Power Developments	40
Fish Lake Dam	40
St. Froid Lake Dam.....	41
Eagle Lake Dam	41
Pollution	42
Summary	43
Recommendations	45
Acknowledgments	47
Appendices, I	49
II	50
III	51
IV	52

INTRODUCTION

Salmon and trout fishing in the Fish River drainage have attracted anglers for many years. The diversity of water areas offers a wide variety of fishing possibilities for coldwater game fish, ranging from trout fishing in small brooks and ponds to salmon and togue fishing in the larger lakes.

Early residents took advantage of the game fish populations chiefly as a source of food. Sport fishing on the larger lakes became important about 70 years ago with the advent of the Bangor and Aroostook Railroad that "opened up" the Fish River waters to sportsmen desiring fishing and canoeing in wilderness surroundings. Many waters that were previously inaccessible by improved roads have recently been made accessible by logging operations, but there are still many waters that must be reached by trail or jeep road. Fish populations and land and water conditions have changed considerably since the early days, but the Fish River drainage still boasts some of the best trout and salmon waters in Maine.

Knowledge of the physical and biological characteristics of the waters and the distribution and abundance of the fishes in the Fish River drainage was nonexistent prior to the first lake surveys made in 1953. Since that time, biological inventories have been completed on 47 lakes and ponds and most of the main rivers and streams in the drainage, comprising over 98 percent of the lake and pond area. Detailed studies have also been made on life history and management of landlocked salmon in the major lakes in the drainage. These studies will provide knowledge for better management of our salmon populations. The brook trout fisheries have also been studied in conjunction with the salmon study. A weekend creel census was operated in the spring of 1962 on Upper, Denny, and Galilee Ponds to evaluate the type of fishery being provided by trout ponds with restrictive special regulations.

The purpose of this report is to summarize available biological and physical data that have been collected from waters in the Fish River drainage and to make recommendations for management of these waters that will ensure perpetuation of their fisheries. While the majority of the waters have been surveyed, many years of continuous work will be necessary to maintain a complete picture of the fisheries of the drainage. Fish populations and fish habitat are continually changing in some respect, and only continued studies will enable us to keep pace with these changes.

DESCRIPTION OF THE DRAINAGE

Fish River is a major subdrainage of the St. John River system. The Fish River watershed has a drainage area of about 89 square miles. The river drops 100 feet from Fish Lake to its mouth at Fort Kent, a distance of 56 miles.

The main stem of Fish River arises at Clayton Lake and flows north into the main headwater lake, Fish Lake. Other major tributaries flowing from Carr Pond and Chase Ponds also enter Fish Lake. This part of the drainage is heavily wooded. From Fish Lake, the river flows southeasterly about 17 miles through wooded country into Portage Lake, and thence northerly 11 miles through forested land into St. Froid Lake.

Two major tributaries, Red River and Birch River, flow into St. Froid Lake. Red River drains a number of small lakes and ponds and flows in an easterly direction about 16 miles to its confluence with St. Froid Lake. Birch River flows in a southeasterly direction to its confluence with St. Froid Lake; there are few lakes or ponds in Birch River headwaters. St. Froid Lake flows 2.7 miles through Nadeau Thoroughfare into Eagle Lake.

A second major branch of Fish River enters Eagle Lake in its northeast corner. This branch originates in Long Lake and flows through river-like thoroughfares connecting Long and Mud Lakes, Mud and Cross Lakes, Cross and Square Lakes, and Square and Eagle Lakes.

From Eagle Lake the main Fish River flows northward 10.2 miles to its confluence with the St. John River at Fort Kent. The major tributaries of Fish River between Eagle Lake and Fort Kent are Wallagrass Stream and Sly Brook. Wallagrass Stream drains First, Second, and Third Wallagrass Lakes, and meanders through second-growth forest land 8.6 miles before entering Fish River below Soldier Pond. Sly Brook originates in First, Second, and Third Sly Brook Lakes and enters Fish River several miles below Eagle Lake.

Access and shore development vary considerably among the major lakes and ponds in the drainage. Fish Lake has only recently been made accessible by improved logging roads. Accessibility was formerly limited to either airplane travel or travel up Fish River from Portage Lake at high water levels. There are two sporting camps and several private camps at Fish Lake.

Portage Lake is accessible by highway through the Town of Portage, and cottages are abundant along the shores. St. Froid and Eagle Lakes are also accessible by highway, and there are many camps along their shores. The shores around Long Lake are probably the most heavily developed of any lake in the drainage; two towns, a considerable amount of farm land, and many cottages surround about two-thirds of the lake's shores.

Square Lake has only recently become accessible by road. Recent sale of camp lots has been responsible for development along the shores of this largest lake in the drainage. The lake was formerly accessible only by waterways from Eagle Lake or Cross Lake.

Improved gravel roads now permit access to many small ponds in the headwaters of Red River. Sly Brook Lakes and Wallgrass Lakes are accessible by unimproved logging roads. Many other waters are accessible by trail or rough jeep roads.

Lake Management

The 69 lakes and ponds in the Fish River drainage, with a total area of 34,428 acres, offer a variety of habitat for fishes, ranging from the large, deep lakes in the Fish River Chain to small trout ponds scattered throughout the drainage. Lake inventory reports, including depth maps, lists of fishes, physical characteristics, and suggestions for management have been published for 47 lakes and ponds in the drainage (Appendix I). These reports are available at small cost from the Fish and Game Department in Augusta.

The most widely known group of waters in the drainage is the Fish River Chain of Lakes, the 8 largest lakes in the drainage, which include Fish, Portage, St. Froid, Eagle, Square, Cross, Mud, and Long lakes. These waters have long been famous for their excellent salmon and brook trout fishing. Habitat conditions for salmon and trout are considered ideal in most of these lakes, because they are deep and contain large volumes of cold, well-oxygenated water in their depths in late summer. In Portage and Mud Lakes, however, water temperatures remain about equal at all depths throughout the year. During hot weather periods, salmon and trout may seek the cooler water of springs or mouths of brooks, or they may move to adjoining waters.

During the late 1800's the Fish River Lakes were well known for their excellent fisheries for lake trout (togue) and brook trout.

Many old reports commented on the large size of the game fishes and the high quality of the fishing. Large populations of lake whitefish were also reported to be present. In 1894, landlocked salmon were introduced from the Green Lake stock from central Maine. Introductions of smelts were made in the same year to serve as a forage fish for salmon. A rapid increase in the salmon population was accompanied by a gradual decline of lake trout and whitefish. At the present time, only remnant lake trout and whitefish populations remain in the lower seven lakes in the chain. Sizable lake trout and whitefish populations remain in Fish Lake, the headwater lake. Smelts have not been introduced into Fish Lake and are denied access to the lake by a natural falls at the outlet. (Warner and Fenderson, 1963).

Most of the Fish River Chain is located in north-central Aroostook County within less than 1 hour's drive of several population centers, including Caribou, Presque Isle, Fort Kent, Madawaska, and Van Buren. The fishing pressure on these lakes is considered to be moderate to heavy, and is comparable to other large Maine lakes located in central and southern Maine. Fishing activity is greatest in May and June, commencing as soon as the ice cover leaves the lakes, usually during the first two weeks in May. Surface trolling is most popular in early spring, but when surface waters warm during the summer months, deep-trolling and still fishing are common.

Brook trout

Brook trout occur in nearly every lake or pond in the Fish River drainage at some season of the year. Many of the smaller trout ponds in the drainage have only recently become accessible by gravel roads constructed for lumbering purposes. Many others are still accessible only by trail or jeep road. Fishing pressure on the smaller trout ponds varies with the ease of access and the quality of trout fishing available. Trout fishing quality in turn depends on the characteristics of each body of water and its ability to produce and support trout.

The primary requisite for a good trout pond is an abundant supply of cool water. Most of the deeper ponds stratify or separate into layers during the summer. The cool water remains on the bottom, and, if it contains plenty of oxygen, it provides a living space for trout during hot weather when surface temperatures become warm. In some ponds, oxygen may become deficient in the

deep, cold water during the summer as a result of decaying vegetation and organic matter. The volume of cold, well-oxygenated water in a pond is important in determining the number of trout the pond will support.

Many shallow ponds do not stratify during the summer, and trout must rely on springs as sources for the necessary cold water. In these situations, the amount and temperature of the spring water entering a pond has an important bearing on the number of trout the pond can support, since trout congregate in the available areas of spring influence during hot weather. Shallow ponds with abundant springs often produce and support good trout populations because of the rich food supplies usually available.

The Fish River drainage has its share of both kinds of trout ponds mentioned above. The deep, stratified ponds are exemplified by a group of waters in the headwaters of the Fish River drainage known as the Red River Ponds. Excellent trout populations living in ideal trout waters are present in Gardner, Deboullie, Pushineer, Island, Upper, Denny, Big Black, and Galilee Ponds. Other deep trout ponds in the Fish River drainage are Carr Pond, Chase Ponds, and Third Sly Brook Lake.

The better spring-fed type of trout ponds in the Fish River drainage are Blake, Ferguson, Stink, Little Black, North, Third Wallagrass and Daigle Ponds. There are many other spring-fed ponds in the drainage, but in many cases the small amount of cold spring water available limits the ability of the water to support a sizable trout population.

The trout fisheries of most of the better trout ponds in the drainage are maintained by natural reproduction. Successful trout reproduction in ponds occurs either in gravel riffles of inlets, in areas of spring influence, or along gravelly shores within the ponds. With present fishing pressure, natural spawning is sufficient to maintain the trout fisheries of most trout ponds in the drainage without the necessity of artificial stocking. However, stocking may be warranted sometime in the future in some of the more marginal trout ponds in the event of a significant increase in fishing pressure.

Besides having suitable water quality and adequate spawning areas, an ideal trout pond should be relatively free of other kinds of fish. Trout grow faster, survive better, and generally provide better fishing in ponds with no other fish present to compete for

available food and space. While trout sometimes do well in ponds with one or two kinds of small minnows, other fish are by no means necessary as food for trout. Trout will do quite well on a diet of only insects and invertebrates.

The abundance of competing species is one of the main factors limiting trout production in many ponds in the Fish River drainage. Yellow perch are present in at least 11 of the ponds surveyed, and suckers have been found in 25 lakes and ponds. Only 7 ponds of the ponds that have been surveyed contained only trout.

Chemical reclamation is a management measure that can sometimes be undertaken on smaller waters that have become overcrowded with competing species. Treatment with rotenone often removes all fish present, and re-introduced trout grow and survive well and provide improved fishing. To date only one water in the drainage has been reclaimed; Daigle Pond in New Canada was treated in 1963 and was stocked with trout in 1964 when the chemical had dissipated. Several other waters in the drainage should be considered for reclamation when funds become available. These waters are Black Lake (Fort Kent), Island Pond (T14R8), and First, Second, and Third Sly Brook Lakes. Construction of 4-foot barrier dams to prevent re-entry of trash fish will be necessary on the first two waters, but a high natural falls on the outlet of the Sly Brook Lakes is an impassable barrier to upstream fish movement, and no dam would be necessary there.

Several of the Red River Ponds, once free of all competing species, have recently become infested with several kinds of coarse fish. Yellow perch, suckers, and three kinds of minnows are now present in Gardner, Deboullie, and Pushineer Ponds, probably as a result of careless dumping of live bait pails by fishermen. Big Black Lake is also infested with yellow perch. Chemical reclamation will eventually be necessary in these waters if the optimum production of game fish is to be expected. These projects, however, must await availability of funds and development of some means of re-introduction of the rare blueback trout that is now present.

In 1962, a creel census was operated for 18 weekend days on Upper, Denny, and Gallilee Ponds in the Red River drainage (Warner, 1964). The purpose of this census was to determine fishing success, age composition of the trout catch, growth rate of trout, and the status of the trout fishery in ponds restricted to fly fishing only and a 5-trout limit.

A total of 318 legal trout were checked from Denny Pond for an average catch of 1.13 trout per hour. The anglers checked from Gallilee Pond caught an average of 1.22 trout per hour. The fishing success for anglers checked from Upper Pond was less than that for the other two ponds. The trout fishing success in Denny and Gallilee Ponds compares favorably with that reported for two other small trout ponds in Maine (Rupp, 1962).

The growth rate of trout in Denny and Gallilee Ponds, however, is far from optimum. Most of the catch is composed of age II and III trout that are 8-9 inches in length. Netting data indicate large populations of trout in both ponds, and an increased harvest might improve trout growth to some extent. While the fishing quality provided in these ponds is quite satisfactory, the data indicate that regulations could be relaxed to some extent without adversely affecting the trout fishery. It is significant that only 25 percent of the anglers checked from Denny Pond and 20 percent of those checked from Gallilee Pond were successful in taking limit catches of 5 trout. However, any changes in regulations should be accompanied by further studies to evaluate possible effects of these changes.

Partial creel censuses were also operated on certain of the Fish River Chain of Lakes in 1954, 1957-59, and 1961. One purpose of these censuses was to evaluate the trout fishery in these large lakes (Warner and Fenderson, 1963).

Although brook trout were formerly a dominant species in the sport fisheries of these lakes, fewer trout than salmon are now ordinarily taken by anglers. The brook trout catch also varies considerably in different years and from lake to lake. Variation in abundance of brook trout in the catch may be related to quality and extent of spawning and nursery areas available in tributaries of the various lakes and to fluctuation in spawning success and survival from year to year. During the 1957-1959 censuses, brook trout caught averaged from 12 to 14 inches in length and about 1 pound in weight. The average total catch of trout in these lakes was greatest in Square Lake (898) and least in Long Lake (61). A very high proportion of the trout catch was made up of age groups II, III, and IV. Few trout older than age IV were sampled. Annual trout mortality ranged from 55 to 69 percent. Trout in these waters are shorter lived than salmon and suffer a higher annual mortality rate. The high average mortality rate is apparently due mostly to natural causes. The fishing success for trout in these lakes was generally less than for salmon.

Landlocked salmon

Landlocked salmon were not native to the Fish River drainage; they were first introduced from the Green Lake stock about 70 years ago. Salmon are now present in 16 lakes and ponds in the drainage.

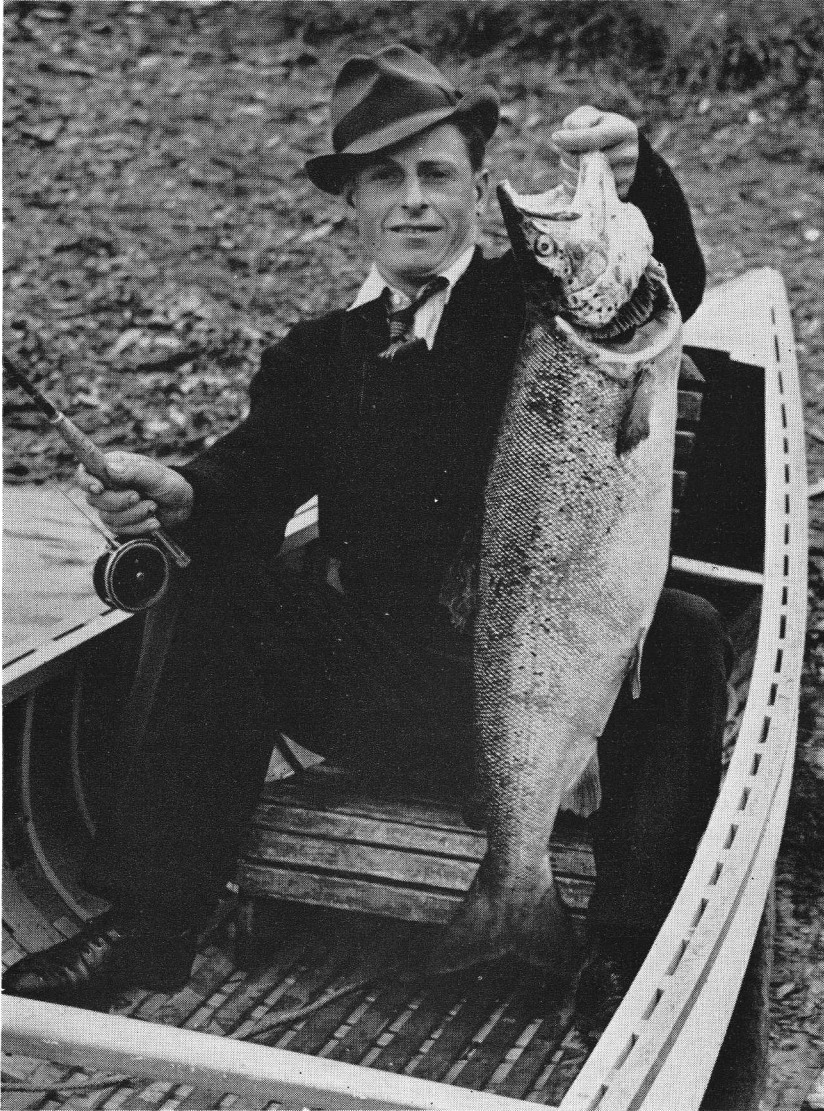


Figure 1. A female salmon weighing 19 pounds, 11 ounces caught in Long Lake by Lucien Cyr on June 13, 1941.

Sizable salmon populations are present in most of the 8 major lakes in the Fish River Chain, but in the remaining lakes the populations are less stable and salmon fishing tends to be sporadic.

Salmon in this drainage are most successful where there is a large volume of cold water with an abundant supply of dissolved oxygen and abundant natural spawning facilities. An ideal salmon water is considered to be one in which water temperatures do not exceed 70°F. and dissolved oxygen concentration is not less than 5 parts per million. Most of the larger lakes of the Fish River Chain have these attributes. However, recent observations indicate that salmon are more tolerant of higher water temperatures and lower oxygen levels than brook trout. This observation is confirmed by the presence of salmon in some of the warmer, shallower lakes in the drainage and in those that may develop an oxygen deficiency in the deep water in late summer.

The Salmon Fishery. Early reports on the Fish River Chain stressed the excellent quality of the salmon fishing and the large size of the salmon. Salmon from 10 to 21½ pounds were reportedly common 9 years after their introduction (Cummings, 1903). The largest salmon caught by an angler in recent years was taken in 1941 and weighed 19.7 pounds (Figure 1). Long Lake is well known for its large salmon. From 1945 to 1953, 66 salmon over 10 pounds in weight were registered by the Maine Fish and Game Department as trophy fish (Curtis F. Cooper, personal communication).

The salmon fishery of the Fish River Chain remains one of the best in Maine despite some recent fluctuations in fishing quality and salmon growth. A study of the salmon fishery in these waters was begun in 1954 when a weekend creel census was operated on Square Lake. Partial creel censuses were continued on Long, Square, Eagle, St. Froid and Portage Lakes from 1957-1959. A weekend creel census was operated on Square Lake again in 1961.

The results of these studies have been published elsewhere (Warner and Fenderson, 1963), and the reader is referred to this publication for detailed findings. Only a brief summary of the results will be presented here.

The average total catch of salmon per year and the average number of hours required to catch a legal salmon for the period 1957-1959 follows:

Lake	Average total catch per year	Average number of hours to catch a legal salmon
Long	1,205	12.3
Square	2,269	12.1
Eagle	828	13.6
St. Froid	374	26.6
Portage	398	17.4

It should be stressed that these are average figures including both experienced and inexperienced fishermen. The potential fishing quality available to the experienced angler is ordinarily much higher than the average fishing quality.

Before 1955, a regulation was in effect on the waters of the Fish River Chain prohibiting still or "plug" fishing in more than 25 feet of water from July 15 to September 1. This regulation was presumably sponsored by local people who feared that the catch would be excessive if fishing were allowed in the deeper water in the summer. During the 1957-1959 censuses, the following information was obtained on the relative success of still fishing and trolling:

Lake	Average number of hours required to catch a legal salmon or trout (1957-1959)	
	Still (plug) fishing	trolling
Long Lake	15.1	11.5
Square Lake	8.4	8.5
Eagle Lake	13.2	7.0
St. Froid Lake	21.1	15.8
Portage Lake	11.0	10.9

Considering the entire season, fishing success by trolling was greater than success by still fishing in three lakes, and the two methods were about equal in two lakes. In July and August, fishing success by still fishing was slightly greater than that by trolling in Square Lake, but there is little possibility that this had any adverse effect on the fish populations. These data show no justifiable reason for a regulation limiting still fishing in the Fish River Chain.

In recent years, salmon have been the dominant fish in the sport fishery. Salmon were most strongly represented in the Long Lake catch in 1957-1959 (94 percent) and least represented in catches from Portage and St. Froid Lakes (60 percent). Salmon were more



Figure 2. The author holding a male salmon taken on the fall spawning run at Cross Lake Thoroughfare.

abundant than trout in the Square Lake catch except in 1961 (Warner and Fenderson, 1963).

The average salmon caught by fishermen in all lakes in 1957-1959 was 17.9 inches long and weighed 1.9 pounds. For Long, Square, Eagle, St. Froid, and Portage Lakes during the 3 years' creel census from 1957-1959, the total catch of salmon was 15,222 with a total weight of 29,175 pounds. Another way to look at these figures is that during the 3 years in these 5 lakes, fishermen caught 4.3 miles of salmon that weighed 14.6 tons.

For many years, salmon have been taken from the thoroughfares¹ during their fall spawning runs and artificially "stripped" of their eggs. These eggs were hatched in the hatchery, and the young fry were then stocked in the lakes and thoroughfares. Salmon were stocked in the Fish River Chain in this manner for over 50 years, and no attempt was made to evaluate their contribution to the salmon fishery.

During the original survey of the Fish River Chain in 1953, excellent natural spawning and nursery areas were found in the thoroughfares connecting the lakes (Figure 3). It appeared that these areas were sufficient to maintain the salmon populations in the lakes without artificial stocking. To determine the contribution of hatchery-reared salmon to the fishery, all salmon stocked in the Fish River Chain in 1955, 1956, and 1957 were marked by removal of one or more fins. The contribution of these marked, hatchery-reared fish to the fishery was evaluated by a creel census operated from 1957-1959 (Warner, 1962). For the 3-year census period, the total recovery of the salmon stocked was less than 2 percent in all lakes. In the age groups of fish that they represented, hatchery-reared salmon contributed less than 5 percent to the catch in Square, Eagle, St. Froid, Portage, and Cross Lakes. The contributions to the catch in Long Lake were somewhat greater. For the first stocking (1955), hatchery salmon in Long Lake comprised 4.9 percent of the age III fish in 1957, 12.7 percent of age IV fish in 1959, and 3.5 percent of the age V fish in 1959. The 1956 stocking contributed up to 50 percent to its age group as age III fish in 1958. The higher contribution of hatchery-reared salmon to the Long Lake catch probably represented a situation not typical of other lakes in the chain. Most of the salmon taken for artificial propagation were from Long

¹The word thoroughfare as used in this report refers to a river-like waterway connecting two lakes.

Lake, and there may have been a smaller-than-normal population of naturally produced fish in the lake. Reduction in natural population density as a result of reduced natural reproduction could be an important factor in the stronger representation of hatchery-reared salmon in the Long Lake fishery. Further studies are now in progress to evaluate the contribution to the Long Lake fishery of various sizes of salmon stocked in spring and fall.

The low representation of hatchery-reared salmon in waters other than Long Lake indicates that natural reproduction is adequate to maintain the salmon fishery without artificial stocking at the present time.

Age, Growth, and Mortality. During the 3-year creel census from 1957-1959, the salmon catch in the Fish River Lakes was composed almost entirely of age groups III-VII. Salmon reached the legal length of 14 inches in Long Lake at ages III and IV, and in St. Froid and Portage Lakes at ages IV and V. Over 50 percent of the catch from all lakes in all census years was composed of age IV and V salmon. The oldest landlocked salmon on record was an age XIII fish caught by an angler in Long Lake in 1960 (Warner, 1961).

The age composition of the Square Lake catch changed considerably from 1954 to 1961. The principal change was the disappearance of age III salmon from the catch and a stronger representation of age IV and V salmon in 1961.

The average lengths of salmon at each age from 5 lakes in the Fish River Chain and from the Cross Lake thoroughfare spawning run are given in Table 1. The growth rates of salmon were about the same in all the lakes up to age III. After this age, salmon growth was fastest in Long Lake, followed by Square, Eagle, St. Froid, and Portage Lakes, in that order. The data in Table 1 indicate a serious slow-down in the growth rate of Square Lake salmon from 1954 to 1960. This change in growth rate resulted in delaying the age at which salmon reached the legal length: from age III in 1954 to ages IV and V in 1961. The reduced growth rate was reflected in the increase in the percentage of "short" salmon from 49 percent of the total reported catch in 1954 to 89 percent in 1961. The fishing success (catch-per-hour) for salmon declined about 62 percent as a direct result of the slower growth rate. Considering these findings, a reduction in the length limit of salmon from 14 to 12 inches was recommended, and a regulation to this effect was

Table 1. Calculated total lengths of salmon from the Fish River Lakes
(Table from Warner and Fenderson, 1963)

Water and year	Number of fish	Calculated total length (inches) at annulus						
		I	II	III	IV	V	VI	VII
Long Lake (1957-59)	367	2.6	6.7	11.0	14.8	17.4	20.9	21.8
Eagle Lake (1957-59)	356	2.7	7.0	11.1	13.9	16.2	18.5	22.1
St. Froid Lake (1957-59)	188	2.7	6.4	10.2	13.0	15.8	18.4	21.3
Portage Lake (1957-59)	153	2.7	5.9	9.8	12.6	14.0	16.9	17.4
Square Lake								
1954	195	2.8	8.0	12.8	15.7	18.0	21.5	—
1957-59	1,058	2.7	7.3	11.5	14.5	16.8	18.8	—
1961	103	2.8	6.9	10.8	10.8	14.9	15.7	—
Cross Lake								
Thoroughfare								
1955	310	2.5	6.6	11.8	15.6	18.4	21.5	23.7
1960	300	2.5	5.9	10.8	13.9	17.0	19.7	20.9

passed by the 1963 Maine Legislature. A creel census will be operated in 1964 and 1965 to evaluate the effects of the reduced length limit on salmon growth and catch. The reduced length limit will allow fishermen to keep salmon of the same age as those caught in 1954 but at a smaller size because of the reduced growth rate. The new length limit may also favor an increase in growth rate by reducing the high population density of small salmon.

From the age composition of the salmon catch it is possible to calculate the average annual mortality rate of salmon from all causes. In the 5 lakes censused, the average mortality of salmon each year ranged from 46 percent in Eagle Lake to 58 percent in Square Lake. By tagging 811 salmon on the fall spawning run in 1953 and 1954, it was possible to obtain an estimate of the exploitation rate by anglers. In 1954, 1955, and 1956, 28 percent of the tagged fish were voluntarily reported by anglers. All tagged fish caught by anglers were not reported, but it is estimated that the reported recoveries were about 80 percent complete. If this is approximately correct, it would mean the exploitation of tagged salmon by anglers after spawning probably approached 35 percent (Warner, 1959).

Reproduction. Activity associated with salmon movement to spawning areas may occur many weeks prior to egg deposition. Salmon

usually begin to congregate at the mouths of the thoroughfares in the last two weeks in September. In years with heavy rainfall and high water, salmon approaching spawning condition may be caught by anglers in the vicinity of the thoroughfares in late August and early September. Most of the actual spawning activity, however, occurs between October 20 and November 10 (Warner, 1962).

Male salmon commonly move into the spawning areas prior to the females and linger on the spawning grounds after the females have left (Figure 2). Male and female salmon are present on the spawning run in about a 1:1 ratio. A female salmon, attended by one or more males, excavates a depression in the gravel bottom using her tail. As the eggs are deposited in the depression, they are fertilized by the male, and then covered with gravel by the female. The eggs are buried from 4 to 12 inches below the surface of the salmon nest or "redd". A female may deposit her eggs in several different depressions or egg pits in this manner. A 3-pound female will lay about 1,800 eggs, which make up 25 percent of her body weight.

Salmon spawning runs in Cross Lake thoroughfare from 1953-1955 were comprised of age groups I to X, but over 90 percent of the spawning fish were ages III to VI. Salmon over age VII contributed little to the spawning runs. Age I and II precocious males are common on the spawning grounds. Most of the salmon appearing on the Cross Lake thoroughfare spawning runs had never spawned before; on the 1953, 1954, and 1955 spawning runs, less than 30 percent of the salmon had spawned previously. The majority of the female salmon spawn first at age IV or V, and most males spawn first at ages III, IV, and V. The majority of repeat spawners spawn in alternate years, although some may spawn for several consecutive years. During the 1953-1955 spawning runs male salmon averaged from 18.7 to 19.9 inches and from 2.5 to 2.9 pounds. Female salmon averaged 20.3 to 21.5 inches and 3.4 to 3.9 pounds (Warner, 1962).

Early Life History. Spawning and nursery areas for salmon in the lakes of the Fish River Chain are excellent. As mentioned previously, most of the salmon spawning and nursery areas are located in the river-like thoroughfares connecting the lakes (Figure 3). To reproduce successfully, salmon require swift, clean water, flowing over a gravel bottom. A good flow of well-oxygenated water percolating through the gravel assures adequate aeration for development and hatching of the eggs. Studies on survival of naturally spawned salmon eggs in these waters (Warner, 1963) have shown

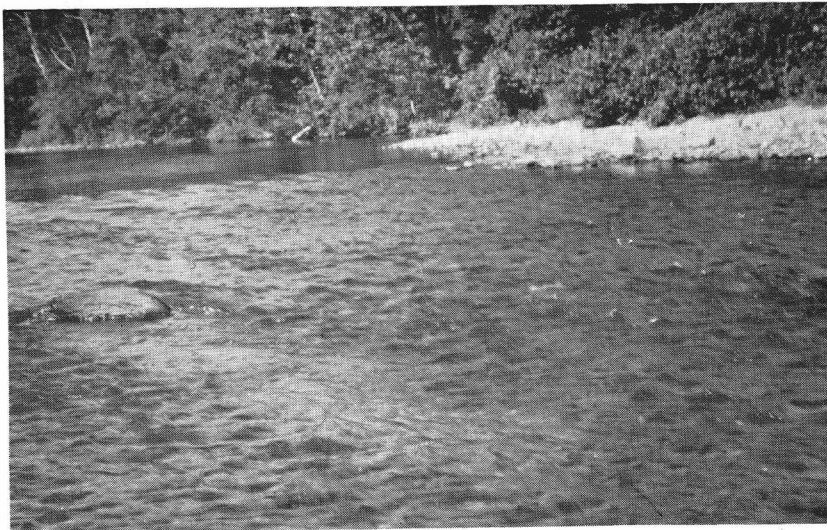


Figure 3. Typical salmon spawning and nursery area in Nadeau Thoroughfare, between St. Froid Lake and Eagle Lake.

that, on the average, about 93 percent survive to a point just before hatching in late April (Figure 4). The water temperature determines the length of time required for the egg to develop. During the incubation period of about 6 months, the temperature of the thoroughfare water remains between approximately 32° and 35°F. The thoroughfares remain largely free of ice during this period as

a result of the warming influence of outflowing lake water. This condition and lack of severe fluctuations in water level favors good survival of eggs in the gravel. After hatching, the young salmon remain in the small crevices among the gravel particles for a period of about 6 weeks. During this period, they are fed by absorption of nutritive material from an attached yolk sac. When the yolk-sac is absorbed, the young salmon "fry" work their way upward between the gravel particles and emerge at the gravel surface.



Figure 4. Salmon eggs excavated from Cross Lake Thoroughfare just before hatching. The gravel shown is the typical size used by spawning salmon.

The young fry soon begin feeding on minute insects and crustaceans. The food supply for young salmon in the thoroughfares is excellent because of enrichment from the lakes above and because of water temperatures that permit optimum development of insect and invertebrate populations. Young salmon "parr" in these nursery areas usually reach 2 to 3 inches in length by the end of their first summer of life. Growth in the nursery areas is probably regulated by the density of the salmon populations. Slower growth occurs where more salmon are present to compete for available food and space. Populations generally range between 44 and 90 salmon parr per 100 square yards of nursery area.

Young salmon usually remain in the nursery areas for 1 or 2 years before moving into the lakes (Figure 5). From the information available, it appears that the majority of salmon spend 1 year in the thoroughfare and move into the lake in the spring of the second year. Young salmon remaining in the nursery areas for more than 1 year are most often found in a different type of habitat. The 2-year-old parr and occasional 3-year-olds seem to prefer the shelter of small pools or pockets behind boulders or debris, whereas first-year parr are distributed widely over shallow gravel riffles. The scarcity of habitat for older parr may be one reason why most parr move to the lakes as 1-year-olds.

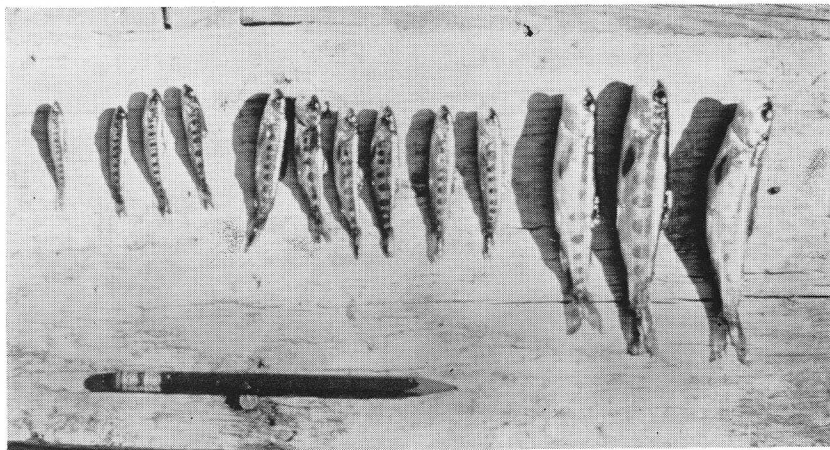


Figure 5. Young of the year (left) and yearling (right) salmon seined from a thoroughfare nursery area in August.

Food of Salmon. Smelts are the main food of salmon in the Fish River Chain. Smelts occurred in 31 to 82 percent of the salmon stomachs examined from 1953-1957. Unidentifiable fish remains occurred in up to 52 percent of the salmon stomachs analyzed. In 1958 and 1959, smelts occurred less frequently in salmon stomachs in most lakes. This observation parallels the reported decline of smelt populations in the lakes at about that time. During all years of the study, sticklebacks were found in up to 20 percent of the stomachs examined. Minnows occurred less frequently than either smelts or sticklebacks. Smelts made up the greatest volume of food in salmon stomachs by far. Insects occurred in from 11 to 30 percent of the salmon stomachs examined from all lakes throughout all years of the study.

Competition. Competition is often a serious limiting factor to cold-water game fish populations. Salmon would probably be most successful in this drainage if they were the only species present besides a suitable forage fish, even though present information indicates that salmon are somewhat more tolerant of competition than brook trout. All the fish species noted in Appendix II undoubtedly compete with salmon to some degree for the available food supply in the lakes. The most serious salmon competitors for insect food are probably yellow perch, fallfish, suckers, and hornpout. The degree to which brook trout and lake trout, where abundant, compete with salmon for the forage fish supply is unknown.

Fortunately, the Fish River drainage lacks many of the competing species present in lakes in southern and central Maine. At the present time, no bass, white perch, or pickerel and few eels are present in the drainage. It is important that no new kinds of fish be introduced that might reduce salmon production by competition.

Blueback trout

The rare blueback trout occurs in only a few Maine waters at the present time (Everhart, 1958). This fish was found in Pushineer, Deboullie, Gardner, and Big Black Lakes when these waters were surveyed in 1954. Bluebacks are found exclusively in deep lakes with cold water and abundant oxygen. Blueback trout are commonly taken by anglers in these waters on worms, flies, or spinning gear. The usual food of bluebacks is aquatic insects and invertebrates. Bluebacks do not attain a large size in these waters. The average blueback caught runs about 7 to 9 inches, although one fish about 15 inches in length and weighing one pound was netted in Pushineer Pond.

The spawning habits of this fish are not well known, but reports by Kendall (1914) indicate that bluebacks spawn in late October and often ascend tributaries for this purpose.

Unfortunately, the waters containing bluebacks in the Red River drainage have become over-crowded with trash fish, as was mentioned previously. Chemical reclamation of these waters and reintroduction of brook trout and bluebacks would assure perpetuation of this rare species in its native environment.

Lake Trout (Togue)

Togue were once abundant in the large lakes of the Fish River Chain, but gradually disappeared after salmon and smelts were in-

troduced about 70 years ago. The reason for the disappearance of togue from these waters is not definitely known, but it is probably related to increased competition from both salmon and smelts. Togue now occur commonly in only 6 waters in the drainage: First, Second, and Third Chase Ponds, Fish Lake, Carr Pond, and Third Sly Brook Lake. Occasional togue have been taken by anglers in the larger lakes in the chain within the past 10 years. The most notable catch was a 16 $\frac{3}{4}$ -pound togue taken at Soldier Pond in 1963.

Togue are very abundant in the Chase Ponds, but the growth rate is poor, and the fish are generally small. Togue were introduced in Third Sly Brook Lake in the early 1940's, and a small population is currently being maintained by natural reproduction.

A fairly sizable togue population exists in Fish Lake, even though water quality conditions are not ideal and the growth rate is slow. Few togue that exceed 3 to 4 pounds in weight are taken in Fish Lake. Carr Pond provides ideal water quality conditions and apparently supports a good togue population, and angler catches of togue over 5 pounds in weight are not uncommon.

To provide a thriving, self-sustaining population and a good fishery, togue require a sizable volume of cold, well-oxygenated water, suitable spawning rubble along the lake shores, and an adequate food supply. Except for Fish Lake, lakes in the Fish River drainage containing togue have an ample supply of suitable togue water. Water temperatures in Fish Lake become somewhat above optimum levels in the summer months, as the lake does not stratify into warm and cold layers but remains about the same temperature at all depths because of extensive wind-mixing. Most of the togue waters in the drainage appear to have adequate spawning areas. Togue normally spawn in October in the shallow water along rubble-strewn, wind-swept shores. To obtain optimum growth, togue need an abundance of small fish as forage. Both Carr Pond and Fish Lake contain whitefish, which are commonly utilized as food by togue. Suckers, sticklebacks, sculpins, and minnows are also available as togue food in most of the lakes.

Smelts do not occur in any of the waters in the drainage with significant togue populations. While smelts are an excellent forage fish for togue, introduction is not recommended in togue waters until more is known about the relationships between these two species in various waters.

Whitefish

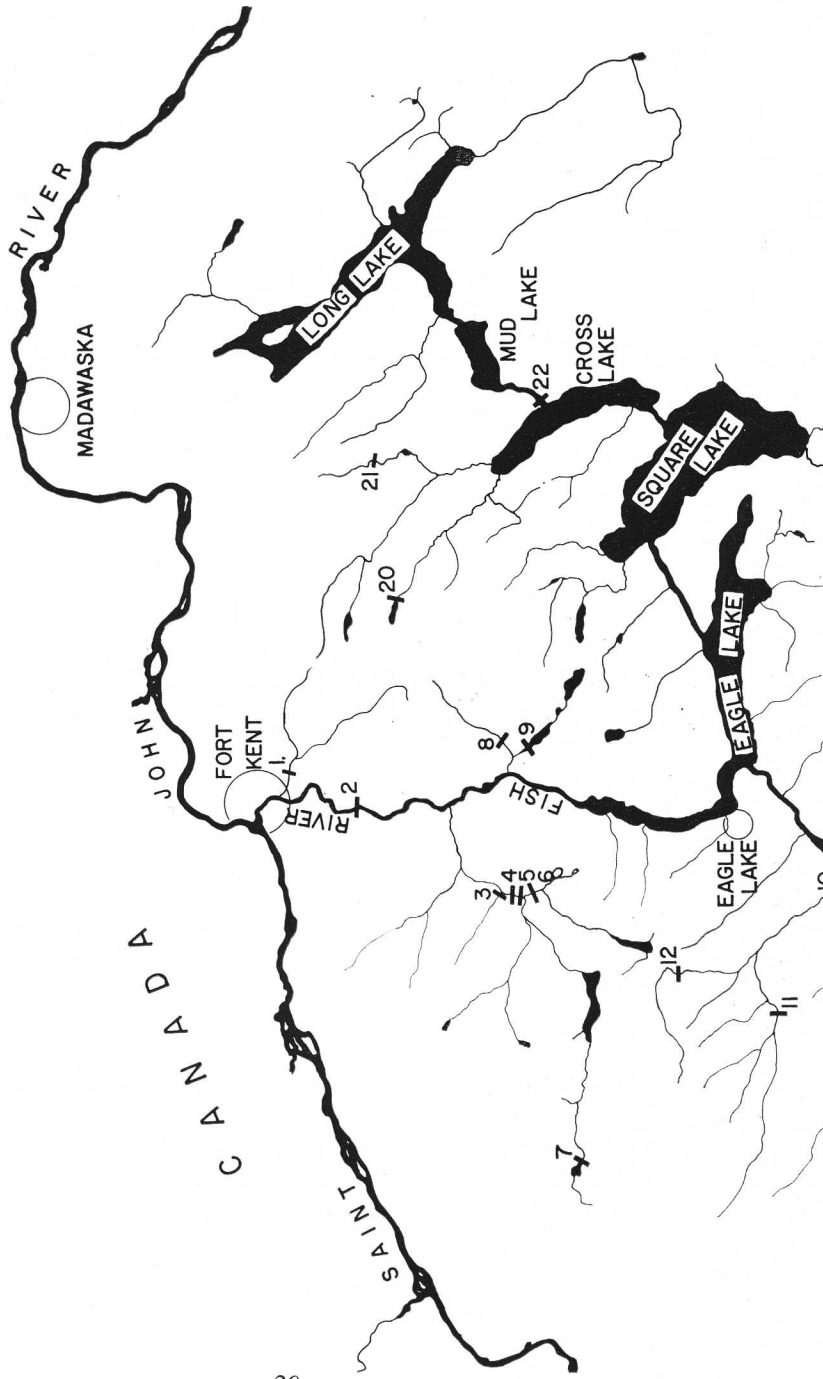
Two kinds of whitefish occur in certain waters of the Fish River drainage; the larger species is the lake whitefish and the smaller, more cylindrical-shaped fish is the round whitefish (see Everhart 1958). The lake whitefish was once reportedly very abundant in the larger lakes of the Fish River Chain, but after introduction of salmon and smelts, the whitefish populations gradually diminished. At the present time, whitefish occur in only 9 waters in the drainage (Appendix I). Sizable whitefish populations exist only in Fish Lake and Carr Pond, but a few are present in other waters and occasionally are found in the rivers and thoroughfares. There is practically no sport fishery for whitefish in the lakes in the drainage, but lake whitefish are sometimes caught on dry flies at the surface or by still fishing with a small live minnow or a small piece of cut bait. The principal role of whitefish in waters of the Fish River drainage is that of a forage fish for game fish, principally in Fish Lake and Carr Pond.

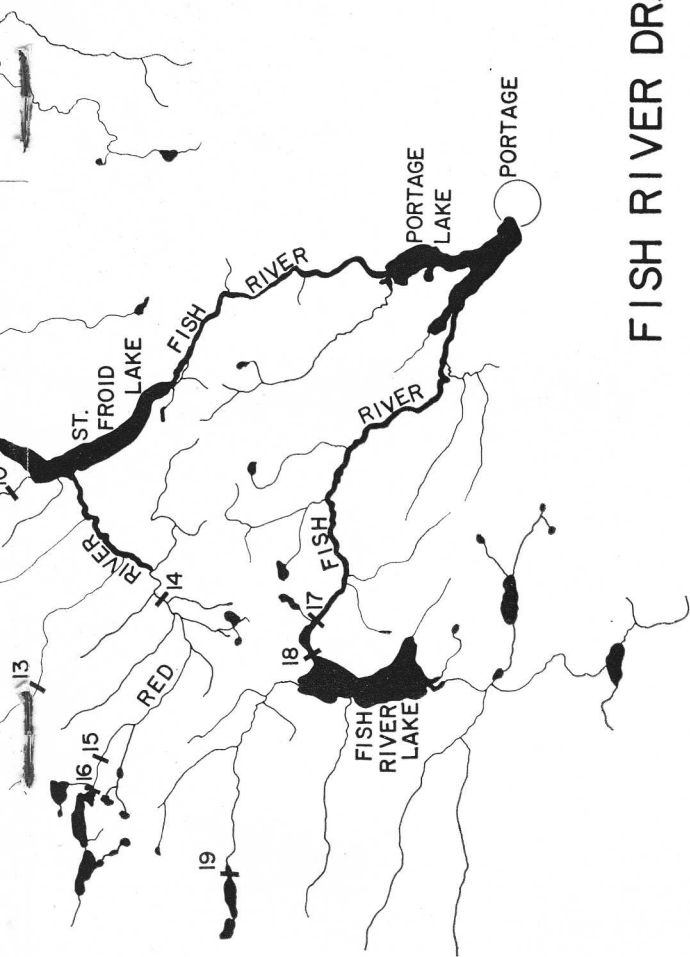
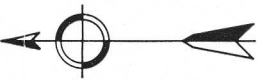
Smelt

Smelts were first introduced in the Fish River drainage in about 1894 to serve as a forage fish for salmon. Smelt populations soon became abundant in the lower 7 lakes in the Fish River Chain, but this species was denied access to Fish Lake and tributary waters above by an impassable natural falls. Impassable natural barriers also prevented smelts from ascending into ponds in the Sly Brook, Wallagrass Stream, and Red River drainages. Smelts are now known to occur in only 8 lakes and ponds in the drainage (Appendix I).

Smelt populations in the Fish River Chain serve a dual purpose. This species is the principal forage fish for landlocked salmon and larger brook trout, and smelts support an important hook and line fishery in periods of their abundance. Smelts are commonly caught still fishing with a small piece of cut bait in deep water during the summer months. Intensive ice fishing effort is exerted for smelts during the winter months in St. Froid, Eagle, and Long Lakes. Most of the ice fishing for smelts is done from small, portable shacks, and it is not uncommon to observe from 50 to 100 shacks on the ice of any of these lakes during the period of peak fishing.

Ice fishing success for smelts is highly variable among years, among lakes, among months, and among various locations within





FISH RIVER DRAINAGE

AROOSTOOK CO., MAINE



any lake. Fishing success is generally highest within the first month after freeze-up, but success also varies with the abundance of smelts present.

Smelt populations in the Fish River Chain, as in other waters, are susceptible to extreme natural variations in abundance. The reasons for these variations are not fully known, but they are quite probably related to year to year variations in spawning success or survival of the young. Smelts in these lakes spawn in May either in tributaries or along the lake shores. Fluctuations in stream flows and other adverse conditions that might affect spawning success are common. The tributaries of several of the larger lakes in the Fish River Chain were closed to the taking of smelts for several years beginning in 1955 in an attempt to increase smelt populations in the lakes. After closure, the smelt populations began to decline rather than to increase. Observations on the spawning tributaries of Long Lake showed heavy concentrations of smelt eggs located below the first obstacle to upstream smelt movement. In most cases, egg deposition was so heavy that adequate aeration of the eggs was not possible, and a heavy mortality resulted as indicated by a thick mat of dead, fungused eggs covering the bottom. Long Lake tributaries are now open to smelt dipping, but the thoroughfare between Mud and Cross Lakes was closed again by the 1963 Legislature.

Smelt dipping pressure during the spawning season is extremely heavy on the tributaries of some of the Fish River Chain. Smelt dipping is probably heaviest on Long Lake tributaries, and on Cross Lake thoroughfare, the main inlet to Cross Lake. It is not conceivable that smelt dipping would have any effect on Cross Lake thoroughfare because of its large size and high volume of flow at spawning time. The thoroughfare averages 70 to 80 feet in width and 5 to 6 feet deep in early spring. The principal effect of smelt dipping on Long Lake tributaries is probably destruction of stream habitat by fishermen. Bottom gravel scooped up in attempts to dip smelts is usually deposited on the stream bank, and these gravel piles often reach several feet in height. Further study is needed to determine the precise effects of dipping on smelt spawning success.

Other fishes

Twenty-six species of fish are known to occur in the Fish River drainage (Appendix II). The primary role of other fishes in the lakes of the drainage is that of competition with game fish for avail-

able food and space. The chief competitors are yellow perch, suckers, minnows, and sometimes burbot (cusk) and bullhead (hornpout).

Yellow perch are known to occur in 12 lakes and ponds in the Fish River drainage (Appendix I). Yellow perch are not native to the drainage; they were apparently introduced about 25 years ago by fishermen using them as live bait in the Red River Ponds. The source of the perch was nearby Perch and Togue Ponds in the lower Allagash drainage. Since their introduction, perch have spread into the 7 lower lakes of the Fish River Chain and Soldier Pond. Yellow perch have become very abundant in Mud Lake and Portage Lake, the two shallowest waters in the Fish River Chain, and in Pushineer, Big Black, Deboullie, and Gardner Lakes in the Red River drainage. Fortunately, the natural spread of perch into some waters has been inhibited by natural barriers, and in some cases, probably by beaver dams. High natural falls have prevented upstream movement of perch into the Sly Brook Lakes, Wallagrass Lakes, and the Fish River drainage above Fish River Falls at the outlet of Fish Lake.

One of the chief means of spreading yellow perch and other undesirable species is by unauthorized dumping of bait pails by fishermen. It is unlawful to introduce fish in any waters of the State without written permission from the Commissioner of Inland Fisheries and Game. A recent statute was designed to curb further the spread of spiny-finned fishes such as perch; this law prohibits the use or possession of these fishes for bait in the inland waters of the State.

Suckers are known to occur in at least 25 lakes and ponds in the drainage, and there are two kinds of suckers represented (see Everhart, 1958). The most widely occurring species, the white or common sucker, is more abundant than the longnose sucker which occurs chiefly in the deeper lakes. Suckers are very prolific and are considered a serious competitor with game fish, especially trout, for bottom-living food organisms.

Ten kinds of minnows or chubs are known to be present in the lakes and ponds of the drainage (Appendix II). The fallfish (chub) is the largest minnow represented, and it sometimes reaches a weight of 1 to 2 pounds. Creek chubs (mud chubs) are widely distributed in the drainage. Of the minnows present, these two species are probably the most serious competitors with game fish. The lake chub

commonly occurs in the larger lakes and sometimes serves as food for game fish.

The several other kinds of smaller minnows are commonly found in many of the lakes in the drainage (Appendix II).

The American eel does not occur in any numbers in the drainage, because upstream movement is practically blocked by a natural falls and power dam at Grand Falls, New Brunswick, on the St. John River. Nevertheless, a few eels apparently negotiate the barrier, as several have been reported caught by fishermen, and a few were picked up dead on the screen at Eagle Lake outlet in past years. The virtual absence of eels in the drainage is fortunate, because this species has been reported to be a serious predator on young game fishes as well as a competitor for food and space.

Hornpout (bullheads) occur in at least 11 lakes and ponds in the drainage, including the 8 lakes in the Fish River Chain. This species was apparently native to some waters in the drainage, and it is especially abundant in Mud and Portage Lakes. The hornpout is considered an important competitor with game fish for food and space. Hornpout are primarily night feeders and are sought by local anglers in some areas.

RIVER AND STREAM MANAGEMENT

River and Stream Fisheries

One of the first considerations in any river management study is the potential for supporting runs of anadromous fishes. Atlantic salmon once ascended the Aroostook River (Warner, 1956) and other major tributaries of the Upper St. John River system, but apparently this species has never passed above the natural falls and power dam at Grand Falls, New Brunswick. The present salmon run into the Tobique River, New Brunswick, and into the main Upper St. John must pass through the fish lift in the Beechwood dam, below. In addition, a new dam is being planned on the St. John above Fredericton. This would mean that for sea-run salmon to reach the St. John River above Grand Falls and the Fish River drainage, three major obstructions would have to be negotiated, and the young "smolts" would have to pass through many miles of impounded water on their journey to the sea. At the present time, there are no fish passage facilities in the Grand Falls Dam, and construction of such facilities would be very difficult and expensive.

Plans for fish passage at the proposed dam near Fredericton (Mac-taquac) are indefinite at present.

The potential spawning and nursery areas available to sea-run salmon above Grand Falls have not been calculated, but they are known to be very extensive, not only in Fish River, but also in the Allagash and upper St. John Rivers and their tributaries. Despite this vast potential, the upstream fish passage and downstream smolt passage problems and the costs involved create nearly insurmountable obstacles to possible establishment of an Atlantic salmon run above the Grand Falls Dam. This also holds true for establishment of other anadromous fishes such as shad.

The river and stream areas in the Fish River drainage are eminently important for two reasons: they support excellent resident populations of game fish, principally brook trout, and they are the main spawning and nursery areas for landlocked salmon and brook trout residing in the larger lakes and ponds. Nearly every brook and stream in the drainage contains brook trout at some season of the year. Permanent residency by trout and maintenance of a brook fishery for trout depends in large measure on the potential of the water to support this species. The potential is determined by the availability of adequate spawning, nursery, and adult resident area, and maintenance of suitable temperature and oxygen levels.

Many of the larger streams, rivers, and thoroughfares become too warm to support trout during hot weather periods, and trout are forced to move into the cooler depths of lakes or seek areas of spring influence or mouths of brooks to survive. In fact, some of the better trout fishing is enjoyed in waters that become too warm for trout in hot weather, but are attractive to trout when waters are cool in the spring and fall. Thus, trout occurring in the rivers and thoroughfares of the drainage may be either residents or transients from another body of water.

In addition to the larger rivers, streams, and thoroughfares, many miles of excellent smaller trout brooks occur in the drainage. Most trout in most of these brooks are permanent residents that were spawned in the brook and live there most of their life, moving no more than a few hundred feet from the place of their birth. However, part of the populations of the major river and lake tributaries are the young of lake or river dwellers that may live in a smaller tributary for a year or two before moving into larger waters. Ex-

amples of some of the better trout brooks in the drainage are: Big Goddard, Little Goddard, Sly Brook, Mud Brook (Long Lake), Chase Brook (Fish Lake), Fox Brook, Smith Brook, Pennington Brook, Rocky Brook (Red River), and several tributaries of Wallagrass Stream.

Population index data have been collected from some of these brooks using electrofishing apparatus. The population index is the number of trout collected by electrofishing in one run through a 500-foot sample section expanded to a per-mile basis (Table 2).

Table 2. Brook trout population index data from Fish River tributaries as determined by electrofishing inventory

Water	Trout population index per mile			
	1-3.9 inches	4-5.9 inches	6 inches & larger	All sizes
Little River	137	167	11	315
Sly Brook	443	74	63	580
Rocky Brook	1,182	1,480	206	2,868
Mud Brook	473	267	144	884
Little Goddard Brook	134	41	62	237

These data indicate good trout populations. Trout over 6 inches, however, comprise a relatively small part of the total populations. This situation also holds true for the many other brooks studied in northern Maine (Warner, 1962). Trout in brooks grow slower than those in lakes, and few trout live to be over 3 years old because of an annual natural mortality rate of over 70 percent. Age analysis showed that most trout in these brooks do not reach the legal length of 6 inches until age II. Because of the slow growth rate and high natural mortality rate in brooks, the 6-inch limit serves no useful purpose; most of the trout die of natural causes before reaching legal size.

Effects of DDT spraying

Since 1954, periodic infestations of spruce budworm have been responsible for severe damage to spruce and fir stands in northern Maine. DDT has been applied to control these infestations in various sections of Aroostook County in 1954, 1958, 1960, 1961, 1963, and 1964. Parts of the Fish River drainage were sprayed with 1 pound per acre DDT in 1958, 1960, and 1963. Most of the Big Goddard and Little Goddard Brook drainages were sprayed in 1958 and 1963, and the headwaters of Little Goddard Brook were covered in 1960. Portions of the main Fish River drainage (Portage Lake Inlet

and Outlet) were treated with DDT in 1960, 1963 and 1964. Other parts of the drainage that have been sprayed with DDT are Mud Brook (Long Lake) in 1958, Chase Brook (Portage Lake) in 1960, and part of the Three Brooks drainage (Eagle Lake) in 1958.

It is well known that DDT in sufficient quantity can cause fish mortality. Rudd and Genelly (1956) have published a detailed summary of studies on the effects of DDT on fish. Studies were made of the effects of DDT on fish populations in areas sprayed in northern Maine in 1958 (Warner and Fenderson, 1962). It was found that populations of brook trout, minnows, suckers, and other species were reduced considerably as a result of DDT spraying. The most serious effect was the reduction in population of young-of-the-year trout of the 1958 year class, but a strong 1959 year class was responsible for rapid population recovery by 1960. In addition, reductions of some types of trout food organisms were noted.

These data indicate that while reductions in trout populations occurred in the waters in the Fish River drainage sprayed with DDT, these reductions were temporary if repeated spraying was not carried out in successive years. The effects on salmon may be different (Keenleyside, 1959), because landlocked salmon in these lakes mature later, live longer, and have a longer life cycle than trout. The main inlet and outlet (Fish River) of Portage Lake are important spawning and nursery areas for salmon from St. Froid and Portage Lakes. After hatching, young salmon (parr) remain in the river for one or two years prior to moving into the lakes. Thus, several age groups of salmon were exposed to DDT by the 1960 and 1963 spraying. The effects of spraying on salmon in these areas have not been thoroughly evaluated, but electrofishing operations in Portage Inlet in the fall of 1960 indicated that salmon parr populations were much lower than expected.

Effects of logging practices

The logging industry has been important in the Fish River drainage since the early days. Driving of long logs on the waterways was common in the past, but no longer occurs. The most recent pulpwood driving operations took place in the Red River and Birch River drainages. All log-driving operations have now been discontinued in the Fish River drainage, because trucking has become more economical and practical.

Detrimental logging practices that alter fish habitat have been noted by Warner (1956) for the Aroostook River drainage. These practices include building of driving dams that are obstructions to fish movement, bulldozing of streams, detrimental cutting practices, and fluctuation of water levels. Obstructions to fish movement will be considered later in this report.



Figure 6. A section of Birch River bulldozed in 1954 in preparation for driving pulpwood.

Bulldozing of streams in conjunction with pulpwood drives has taken place in the Red River and Birch River drainages. The effects of bulldozing on trout stream habitat have been summarized by Bond and DeRoche (1950) and Warner (1956). Severe alteration of stream habitat occurred when Birch River was bulldozed in 1954 (Figure 6). Trout habitat was virtually destroyed when the stream was transformed into a flattened ditch by removing all protective cover, filling in pools, cutting off loops and turns, and silting of trout spawning and feeding areas. No attempt has been made to restore original stream conditions. Except for the initial section below Pushineer Pond, bulldozing in the Red River drainage was not as detrimental as that in Birch River. The section below Pushineer Pond was widened and flattened considerably, but restoration work in cooperation with the Great Northern Paper Company has improved conditions considerably.

Fluctuation of stream and lake levels has not been a serious problem in the Fish River drainage, with a few exceptions. The water level of Big Black Pond was lowered about 6 feet to obtain auxiliary water for pulp driving, but the level was partially restored by damming the outlet several years later.

Cutting on stream and river banks can be detrimental to trout stream habitat by removing shade and warming the water, felling of tops in the stream, and by siltation as a result of using bulldozers and other mechanical equipment on the banks. It has recently been recommended by the Department of Inland Fisheries and Game that an uncut strip about 2 chains (132 feet) wide be left on both sides of waterways and around lakes and ponds. This would provide considerable protection for stream habitat. Most of the larger landowners have agreed to follow this recommendation where possible.

Obstructions

Fortunately, the Fish River drainage has relatively few man-made obstructions to fish movement on its main waterways. Remnants of old log-driving dams are still evident on stream banks and at lake outlets, but most of these old dams are no longer hindrances to fish movement. Few new dams have been built in recent years, principally because log and pulp drives on the main river and its tributaries have been discontinued. Fortunately, no power dams or storage dams for water power are presently in existence in the Fish River drainage. Several man-made obstructions to fish movement have been made passable since 1950. The 800-foot fish screen at Eagle Lake outlet washed out in 1951 and was not replaced, and several dams in the Wallagrass Stream drainage were removed.

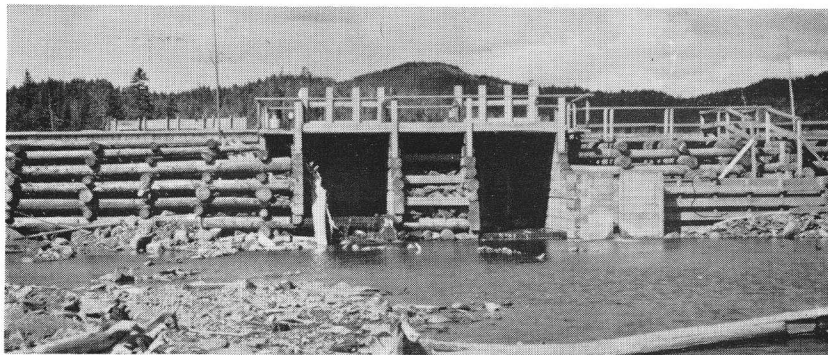


Figure 7. Pulpwood driving dam and fishway (at right) at the outlet to Pushineer Pond, T15 R9.

A survey of obstructions and potential obstructions to fish movement was carried out in the drainage between 1950 and 1963. Twenty-two obstructions that were surveyed are now in existence. Of these, 13 are man-made structures and 9 are natural falls. Only two fishways are present in the 13 man-made structures studied (Figure 7). A summary of the recommendations for these structures follows:

- Keep fishways operable—2
- Dam removal—4
- Now passable—5
- No recommendations—2

Many of the 9 natural falls studied are either of no consequence to the fishery of the water involved or are of value in preventing the spread of undesirable fishes and should not be made passable (Figure 8).



Figure 8. Fish River Falls below Round Pond, T14 R8. This falls is typical of natural obstructions to fish movement in the Fish River drainage.

The individual obstructions studied, pertinent data, and recommendations are presented in Appendices III and IV. Each obstruction will be considered separately in the text below.

Perley Brook Falls (1). This 8-foot natural falls located 2 miles above the mouth of Perley Brook is impassable to upstream fish movement. Fish passage is not necessary above this structure because of the abundant spawning and nursery area and adult trout habitat above.

Lower Fish River Falls (2). This series of turbulent cascades has a total drop of about 4 feet and is passable to game fish at most water levels, but it is probably a hindrance to upstream movement of smaller salmon and trout at certain water levels.

Martin Brook Cascades (3). This obstruction is a series of boulder cascades that is impassable to upstream fish movement. Spawning and nursery area above are sufficient to maintain the trout fishery.

Wallagrass Stream Dam (4). The remains of an old 6-foot logging dam are now completely passable to fish movement through a 10-foot channel in the center of the dam.

Wallagrass Falls (5). These natural falls were the site of an old logging dam that is no longer in existence. The lower falls presents an abrupt 8-foot drop that is impassable to upstream fish movement. The upper falls drops a total of 6 feet in 3 steps and is passable. These falls should remain intact to prevent upstream movement of yellow perch into the Wallagrass Lakes.

Drake Brook Dam (6). The remains of this old logging dam are passable to fish movement at the present time.

Third Wallagrass Dam (7). This 8-foot logging dam was altered several years ago, making it passable to upstream fish movement. The structure should be kept clear of beaver dams.

Fall Brook Dam (8). An old sawmill dam on this tributary to Sly Brook has become clogged with debris and beaver dams making it impassable to fish movement at most water levels. Removal is recommended.

Sly Brook Falls (9). A series of three natural falls at the outlet of First Sly Brook Lake is an impassable barrier to upstream fish movement. The old dam built on the falls is inoperable. It is recommended that this falls be maintained as a barrier to upstream movement of yellow perch. In the event that the Sly Brook Lakes are eventually chemically reclaimed, these falls will serve as a barrier to upstream movement of undesired fishes.

Birch River Dam (10). This concrete dam was built to impound a water supply for a now-abandoned fish rearing station. The concrete fishway needs some minor repairs to work properly. It is recommended that the fishway be kept in workable order.

South Branch Dam (11). An old 8-foot logging dam at this site has fallen into complete disrepair and is a serious obstruction to both upstream and downstream fish movement (Figure 9). Removal is recommended.



Figure 9. An abandoned log driving dam creating an obstruction to fish movement on the South Branch Birch River, T16 R8.

North Branch Dam (12). The remains of this old logging dam are completely passable to fish.

Rocky Brook Falls (13). A 12-foot and a 15-foot impassable falls at this location are obstacles to upstream fish movement. The abundant trout spawning and nursery area above and below the falls are sufficient to maintain trout populations in both sections of the brook.

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Red River Falls (14). A long series of falls an about $6\frac{1}{2}$ miles above St. Froid Lake is impassable to fish movement. Construction of fish passage facilities is not recommended. These falls currently prevent movement of salmon into the Red River trout ponds above.

Fish Pond Falls (15). A natural falls at the foot of a logging dam presents a 5-foot obstacle to upstream movement. In the event the ponds above are eventually reclaimed, the falls would serve as a barrier to upstream movement of fishes.

Pushineer Dam (16). The Pushineer Dam was originally a workable fishway at the time of construction, permitting movement of trout between the pond and outlet stream. The dam is no longer operated, and the sluice gate is closed so that no head of water is being held. Since there is no dam between the pond and outlet, trout can swim through at most water levels. Installation of plank baffles at the dam, however, would permit easier fish passage.

Upper Fish River Falls (17). This series of natural falls below Round Pond and Fish Lake, is a partial barrier to fish movement at some water levels (Figure 8). The point is divided into two channels. An 8-foot wide main channel is a serious obstacle to upstream fish movement. In the smaller back-channel, a series of low falls are present, except for one falls with a 4-foot drop, which is not a barrier. Movement of larger salmon is probably prevented by any of these falls. At the present time removal of these falls is recommended, because they serve as a barrier to upstream dispersal of yellow perch and smelt, which are present in the waters above.

Fish Lake Dam (18). The remains of this old logging dam are completely passable to fish movement.

Chase Ponds Dam (19). The remains of this old dam have fallen into the stream and have become clogged with debris, creating a barrier to fish movement at some water levels. Removal of the debris and beaver dam is recommended to permit fish movement.

Daigle Pond Dam (20). An old sawmill dam built in 1880 is a complete barrier to upstream fish movement.

Red River Falls (14). A long series of falls and cascades located about 6½ miles above St. Froid Lake is impassable to upstream fish movement. Construction of fish passage facilities is neither feasible nor recommended. These falls currently prevent upstream movement of salmon into the Red River trout ponds above.

Fish Pond Falls (15). A natural falls at the former site of an old logging dam presents a 5-foot obstacle to upstream fish movement. In the event the ponds above are eventually reclaimed for trout, this falls would serve as a barrier to upstream movement of undesirable fishes.

Pushineer Dam (16). The Pushineer Dam was provided with a workable fishway at the time of construction, permitting free movement of trout between the pond and outlet stream (Figure 7). The dam is no longer operated, and the sluice gate has been lifted so that no head of water is being held. Since there is little drop between the pond and outlet, trout can swim through the sluiceway at most water levels. Installation of plank baffles in this sluiceway, however, would permit easier fish passage.

Upper Fish River Falls (17). This series of natural falls, located below Round Pond and Fish Lake, is a partial barrier to upstream fish movement at some water levels (Figure 8). The river at this point is divided into two channels. An 8-foot sliding falls in the main channel is a serious obstacle to upstream fish movement. In the smaller back-channel, a series of low falls are mostly passable except for one falls with a 4-foot drop, which is considered a serious barrier. Movement of larger salmon is probably not seriously impaired by any of these falls. At the present time, no alteration of these falls is recommended, because they serve as an effective barrier to upstream dispersal of yellow perch and smelts, which are not present in the waters above.

Fish Lake Dam (18). The remains of this old logging dam are now completely passable to fish movement.

Chase Ponds Dam (19). The remains of this old logging dam have fallen into the stream and have become clogged by a beaver dam, creating a barrier to fish movement at some water levels. Removal of the debris and beaver dam is recommended to permit free fish movement.

Daigle Pond Dam (20). An old sawmill dam built on a ledge falls is a complete barrier to upstream fish movement. Daigle Pond has

recently been reclaimed to permit more intensive management for trout. This dam and falls should be maintained to prevent upstream movement of undesirable fishes into the pond.

Dickey Brook Dam (21). The remains of an old mill dam have become clogged with debris and are an obstruction to fish movement at some water levels. Removal is recommended.

Cross Lake Thoroughfare Dam (22). This dam was used to maintain a low head of water during salmon spawn-taking operations by the Department of Inland Fisheries and Game. Splash boards are removed to allow free fish movement when the dam is not in use.

Proposed power developments

During the early 1950's, the International Joint Commission (IJC) and the New England-New York Inter Agency Committee (NENYIAC) carried out investigations to determine, "what projects for the conservation and regulation of the waters of the Saint John River system above tidewater near Fredericton, New Brunswick, would be practical in the public interest."

The two plans considered for the Fish River drainage involved the use of Fish River Falls (lower) and the Fish River, and St. Froid, Eagle, and Fish Lakes. The first plan provided for storage dams on Fish Lake and St. Froid Lake and construction of a power plant and regulating dam at Fish River Falls. The second plan included provisions for storage dams at Fish Lake, Eagle Lake, and St. Froid Lake.

Fish Lake Dam. This proposed concrete structure would be about 550 feet long and would extend 42 feet above the stream bed, raising the existing lake level 29 feet. The flowage area would be about 5,500 acres. Several adverse effects on the fishery could be expected, including :

- 1) Creation of a vast amount of shallow water that would be subjected to warming and would provide additional habitat conducive to thriving populations of coarse, competing species.
- 2) Large amounts of suitable spawning and nursery areas in several inlets would be inundated and rendered useless.
- 3) Fluctuations in reservoir water levels would have an adverse effect of all spawning of salmon, trout, and togue.

St. Froid Lake Dam. The concrete dam for this site would be about 320 feet long with a height of above 52 feet above the stream bed, and the existing water level would be raised 28.5 feet. The resulting reservoir would flood out the swift riffle areas between St. Froid Lake and Portage Lake and would markedly increase the already abundant shallow water of Portage Lake by flooding much additional low-lying swampland. The area of the proposed reservoir would be 9,200 acres. Severe damage to the St. Froid Lake coldwater fishery could be expected by the proposed dam. These detrimental effects could be expected:

- 1) Upstream salmon movement would be blocked unless a workable fishway were provided in the dam.
- 2) Valuable salmon spawning and nursery areas in Red River, Birch River, and Fish River (main inlet) would be inundated and rendered useless.
- 3) Creation of additional shallow water would be conducive to an increase in competing coarse fishes.
- 4) Drastic water level fluctuation would be damaging to fall-spawning salmonids.

Eagle Lake Dam. The proposed storage dam at Eagle Lake would be 390 feet long and 18 feet high. The dam would raise the existing water level of Eagle Lake 6 feet, that of Square Lake 3 feet, and that of Cross Lake 2 feet. The thoroughfares connecting these lakes would be inundated. A fishway would be provided in the dam.

Lake survey studies in 1953 showed that excellent salmon spawning and nursery areas exist in the thoroughfares that would be flooded by the proposed Eagle Lake Dam. In the fall of 1953, further studies were made to evaluate relative utilization of thoroughfare and other inlet salmon spawning areas to determine the probable magnitude of loss by elimination of thoroughfare spawning grounds (Warner, 1953). Salmon nests (redds) were counted to obtain an index of spawning ground utilization. Redd counts were made at low water, and observation conditions were very good in most cases. Tributaries and thoroughfares that were found to contain suitable salmon spawning areas during the 1953 summer surveys were included in the redd check.

A total of 1,533 salmon redds were counted in spawning areas of Long, Cross, Mud, Square, Eagle, and St. Froid Lakes. Ninety-eight

percent of all salmon spawning in 1953 took place in the thoroughfares or outlets of the six lakes, while 2 percent of the spawning occurred in other inlets. If Long Lake thoroughfare was not flooded, 88 percent of the salmon spawning areas utilized in 1953 in the six lakes would be destroyed (Warner, 1953). Excluding Long Lake, 98 percent of the utilized spawning areas in the remaining five lakes would be destroyed. Thus, construction of the proposed Eagle Lake Dam would prove disastrous to natural salmon reproduction in these lakes.

Pollution

Water pollution must be considered in any evaluation of the fish-producing capacity of a river drainage. Fortunately, pollution is not a serious factor in reducing fish production in the Fish River drainage, with several exceptions. According to the Maine Water Improvement Commission Revised Statutes of 1954 (Chapter 79, as amended), the majority of the Fish River drainage has been designated as "Class A". This is the highest possible classification, and it means that the water must remain suitable for fish life at all times. All waters above the highway bridge on Route 11 at the outlet of St. Froid Lake have been placed in "Class A". Most of the other waters in the drainage that do not qualify under Class A have been placed in either B or B2 Classification. Waters in the B Classifications are also capable of supporting fish at all times. Some of the B waters occasionally reach C quality because of natural pollution. Waters in the C Classification will still support fish life, but they are the lowest quality that will do so.

The most serious pollution in the drainage occurs near the mouth of Fish River, between the bridge at Fort Kent Mills and the confluence with the St. John River. Wastes from two starch factories and several lesser sources have lowered the water quality to Class D or less, which is unsuitable for fish. The main problem is introduction of a considerable amount of organic waste which uses up oxygen necessary for fish respiration. The problem is most serious when water temperatures rise during periods of low river flow. The Water Improvement Commission (1957) has recommended upgrading the classification of this section of the river from D to C. This upgrading would improve conditions for fish survival.

Another source of pollution that has caused problems in the past and is a potential hazard to fish is the starch factory at St. Agatha

on Long Lake. Organic wastes from this factory are discharged directly into the lake without treatment, often causing noxious conditions in the north end of the lake. Sludge banks of the waste material several feet thick have been observed along the lake shores for several miles adjacent to the plant.

Because of the large water volume of Long Lake the wastes are eventually oxidized without serious effects on the lake's fish populations, except possibly in the immediate vicinity of the plant. However, oxygen analyses in the deepest water of Long Lake have shown oxygen deficiencies that might be attributed to pollution, and this could become a serious problem in future years.

Summary

1. Fish River, a major subdrainage of the St. John River system, has a drainage area of 890 square miles. The 69 lakes and ponds in the drainage have a total area of 34,428 acres and offer a wide variety of habitat for fishes. Lake survey reports have been published for 47 waters, comprising over 90 percent of the lake area.

2. The major sport fisheries in the drainage are for landlocked salmon and brook trout. Less important fisheries are available for lake trout (togue), blueback trout, smelts, and whitefish.

3. The 8 lakes of the Fish River Chain are the most widely known waters in the drainage. The waters, including Long, Mud, Cross, Square, Eagle, St. Froid, Portage, and Fish Lakes, supported thriving fisheries for brook trout and togue about 70 years ago. Since the introduction of salmon and smelts in 1894, togue populations have gradually disappeared in all except Fish Lake. Salmon now dominate the lake fisheries, with brook trout generally of less importance.

4. Brook trout occur in nearly every lake and pond in the drainage at some season of the year, and 7 of the ponds that have been surveyed contain only trout. The capacity of the ponds to support trout fisheries depends on the available supply of cool water, the presence of adequate spawning areas, and the abundance of competing species. Natural reproduction appears to be adequate to maintain the trout fisheries of most ponds in the drainage at the present time. Opportunities for chemical reclamation to improve trout fishing are discussed.

5. A creel census of three trout ponds in the Red River drainage revealed good fishing quality in ponds with special restrictive regulations. However, slow growth rates, high natural mortality rates, and the small percentage of anglers successful in taking limit catches of 5 trout indicate that the regulations might be relaxed to some extent without endangering the trout fisheries.

6. A creel census in 5 lakes of the Fish River Chain revealed that trout are generally less abundant in the catches than salmon. The average sizes of the trout caught (12-14 inches and 1 pound), the age compositions of the catches, and the high annual mortality rates indicate that death of trout in these lakes is mostly from natural causes and that the present length limit (6 inches) serves no useful purpose.

7. The salmon fishery in the drainage remains one of the best in Maine despite recent fluctuations in fishing quality and growth rate. Fishing quality (hours per legal salmon) compared favorably with other Maine waters from 1957-1959. The average salmon caught in these years was 17.9 inches long and weighed 1.9 pounds. The total catch of salmon in the 3 years for 5 lakes was 15,222 salmon measuring 4.3 miles in length and weighing 14.6 tons.

8. Hatchery-reared salmon, because of excellent natural spawning areas, contributed negligibly to the catch except in Long Lake. Salmon stocking has been discontinued in all lakes except Long Lake, where experimental stocking is being continued.

9. From 1957-59, nearly the entire catch of salmon in these lakes was of age groups III-VII; one record-breaking age XIII salmon was caught in 1961. Salmon growth was fastest in Long Lake, where salmon reached the legal length of 14 inches at age III and IV, and growth was progressively slower in Square, Eagle, St. Froid, and Portage Lakes.

10. A serious decrease in salmon growth rate in Square Lake by 1961 reduced fishing quality by 62 percent as a result of delayed attainment of legal length from age III in 1954 to ages IV and V in 1961. The effects of an experimental reduction in the length limit in 1964 are being evaluated.

11. Salmon reproduction occurs mainly in the river-like thoroughfares in October and November. Survival of naturally spawned eggs was found to average 93 percent. Various aspects of spawning and early life history are discussed.

12. The main food item of salmon in the Fish River Chain is smelts, but smelts occurred less frequently in salmon stomachs after 1958, paralleling a reported decline in smelt populations.

13. Distribution, abundance, fisheries, and ecological importance of blueback trout, lake trout (togue), whitefish, smelts, and other fishes are discussed.

14. Even though the potential is extensive, there is little hope of establishing an Atlantic salmon run in the Fish River drainage because of nearly unsurmountable obstruction problems.

15. The importance of river and stream areas in maintaining the salmon and trout fisheries of the drainage is stressed.

16. Population index data for smaller trout streams, however, indicate that the 6-inch length limit serves no useful purpose.

17. The effects of DDT Spraying for spruce budworm on trout populations are significant but temporary, provided repeated spraying is not done in the same area. The effects on the longer lived salmon may be more serious.

18. The effects of logging practices on fisheries of the Fish River drainage are less serious than in other northern Maine river drainages, except for serious damage done by bulldozing Birch River. Discontinuation of river driving will reduce damage to fish habitat.

19. A total of 22 obstructions were surveyed in the Fish River drainage, including 13 man-made structures and 9 natural falls. Only 2 fishways are present in the 13 dams studied.

20. The effects of proposed water storage on the fisheries of Fish Lake, St. Froid Lake, and Eagle Lake are discussed. The Eagle Lake Dam would cause serious loss of salmon spawning areas by flooding thoroughfares where the majority of salmon spawning occurs.

21. The water pollution problem in the drainage is minor at the present time except for industrial pollution in Long Lake and at the mouth of Fish River in Fort Kent.

RECOMMENDATIONS

The following recommendations are offered after careful evaluation of data presented in this report:

1. Management of waters in the Fish River drainage should be exclusively for existing populations of coldwater game fishes. Where feasible, management should be to improve fisheries for brook trout, landlocked salmon, lake trout (togue), blueback trout, and smelts. No new species of fish should be introduced in the Fish River drainage.

2. To establish the best possible fisheries for brook trout, chemical reclamation should eventually be carried out in Black Lake (Fort Kent), Island Pond (T14 R8), First, Second, and Third Sly Brook Lakes, Pushineer Pond, Gardner Lake, Deboullie Lake, and Big Black Lake (T14, R9). The last 4 ponds should be reclaimed only when some means can be devised to reintroduce the rare blueback trout now present.

3. A regulation prohibiting the use of live fish as bait should be established on those waters containing only brook trout. The 6-inch length limit serves no useful purpose in the drainage and should be eliminated. A 5-trout bag limit should be established as necessary on small trout ponds receiving heavy fishing pressure. The present bag limit of 15 fish should be retained in other waters as long as present fishing pressure continues.

4. The experimental reduction in the length limit of salmon from 14 to 12 inches should be studied to determine the effects on the fishery. The length limit most appropriate for salmon should be established based on results of these studies.

5. Stocking of hatchery-reared fish of any species in the drainage should follow recommendations based on continued studies of the fisheries.

6. Rivers, streams, lakes, and ponds should be maintained, insofar as possible, in their natural conditions. Construction of any dams that might adversely affect natural habitat conditions should be strongly opposed. Landowners should follow Department recommendations and avoid lumbering operations within 2 chains of brooks, rivers, and streams. Pollution conditions in the lower part of Fish River should be improved to a point where fish life can be maintained at all times. Waters in the drainage should be maintained at the highest possible classification, and no new pollution should be introduced. Spraying of chemical pesticides should be kept to a minimum, and necessary operations should be planned to avoid water areas.

7. Two fishways in man-made dams should be kept operable. Four man-made obstructions to fish movement should be removed. Natural falls should be maintained in several instances to prevent spread of undesirable fishes.

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APPENDIX I

LIST OF SURVEYED LAKES IN THE FISH RIVER DRAINAGE
AND DISTRIBUTION OF MAJOR FISH SPECIES

Distribution of major species

Lake	Township	Area (acres)	Brook trout	Salmon	Togue	Blueback trout	Smelt	Yellow perch	Whitefishes	Suckers	Cusk	Hornpout
Basil Pond	Fort Kent	19	x	x								
Black Lake	Fort Kent	51	x	x								
Black Lake (Big)	T15 R9	147	x	x		x		x				x
Blake Lake	T16 R6	128	x	x								
Carr Pond	T13 R8	307	x	x	x						x	
Clayton Lake	T12 R8	264	x	x	x				x	x		
Cross Lake	T16 R5, T17 R5	2,515	x	x			x	x	x	x	x	x
Daigle Pond	New Canada	36	x									
Deboullie Lake	T15 R9	262	x			x		x		x		
Denny Pond	T15 R9	25	x									
Dickwood Lake	Eagle Lake	96	x							x		
Dimock Pond	New Canada	4	x									
Eagle Lake	Winterville, etc.	5,581	x	x			x	x	x	x	x	x
Ferguson Pond	T14 R8	51	x									
First Chase Pond	T14 R9	12	x		x					x		
First Sly Brook Lake	New Canada	90	x	x						x		
Germain Lake	Madawaska	122	x									
First & Second Wallgrass Lakes	T16 R8, etc.	281	x	x					x	x		
Fish Lake	T13 R8, T14 R8	2,642	x	x	x				x	x	x	x
Galilee Pond	T14 R9	9	x									
Gardner Lake	T15 R9	288	x			x		x		x		
Island Pond	T14 R8	27	x							x		
Island Pond	T15 R9	32	x									
Long Lake	St. Agatha, etc.	6,000	x	x			x	x		x	x	x
Lucifee Pond	T14 R8	13	x									
Moccasin Pond	T14 R8	32	x									
Mosquito Brook Pond	T14 R7	10	x									
Mud Lake	T17 R4	972	x	x			x	x		x	x	x
Mud Pond	Stockholm	45	x									
North Little Black Pond	T15 R9	6	x									
North Pond	T14 R9	15	x									
Pennington Pond	T15 R6	45	x									
Portage Lake	Portage Lake	2,474	x	x			x	x	x	x	x	x
Pushineer Pond	T15 R9	45	x			x		x	x	x		
Round Pond	T14 R8	90	x	x					x	x	x	x
St. Froid Lake	Winterville, etc.	2,400	x	x			x	x	x	x	x	x
Second Chase Pond	T14 R9	182	x		x					x		
Second Sly Brook Lake	New Canada	13	x	x						x		
Soldier Pond	Wallgrass	96	x	x			x	x	x	x		x
South Little Black Pond	T15 R9	6										
Stink Pond	T15 R9	16	x									
Square Lake	T15 R5, T16 R5	8,150	x	x			x	x		x		x
Third Chase Pond	T14 R9	102	x		x					x		
Third Sly Brook Lake	New Canada	141	x	x	x					x		
Third Wallgrass Lake	St. John	45	x									
Upper Pond	T15 R9	17	x									

APPENDIX II
FISHES OF THE FISH RIVER DRAINAGE

Common name	Scientific name
Landlocked salmon	<i>Salmo salar</i>
Brook trout	<i>Salvelinus fontinalis</i>
Blueback trout	<i>Salvelinus oquossa</i>
Lake trout (togue)	<i>Cristovomer namaycush</i>
Yellow perch	<i>Perca flavescens</i>
Brown bullhead (hornpout)	<i>Ictalurus nebulosus</i>
American smelt	<i>Osmerus mordax</i>
Round whitefish	<i>Prosopium cylindraceus</i>
Lake whitefish	<i>Coregonus clupeaformis</i>
White sucker	<i>Catostomus commersoni</i>
Longnose sucker	<i>Catostomus catostomus</i>
Burbot (cusk)	<i>Lota lota</i>
Banded killifish	<i>Fundulus diaphanus</i>
Threespine stickleback	<i>Gasterosteus aculeatus</i>
Ninespine stickleback	<i>Pungitius pungitius</i>
Slimy muddler (freshwater sculpin)	<i>Cottus cognatus</i>
Blacknose dace	<i>Rhinichthys atratulus</i>
Redbelly dace	<i>Chrosomus eos</i>
Finescale dace	<i>Chrosomus neogaeus</i>
Pearl dace	<i>Semotilus margarita</i>
Lake chub	<i>Hybopsis plumbea</i>
Creek chub	<i>Semotilus atromaculatus</i>
Fallfish (chub)	<i>Semotilus corporalis</i>
Golden shiner	<i>Notemigonus crysoleucas</i>
Common shiner	<i>Notropis cornutus</i>
Blacknose shiner	<i>Notropis heterolepis</i>

APPENDIX III. Obstructions surveyed in the Fish River, 1950-1962

Obstruction Number	Stream	Township	Location	Use	Landowner or operator
1	Perley Brook	Fort Kent	2 miles above mouth	Natural falls	—
2	Fish River	Fort Kent	3½ miles below Soldier Pond	Natural falls	—
3	Martin Brook	Wallagrass	At confluence with Wallagrass Stream	Natural falls	—
4	Wallagrass Stream	Wallagrass	1 mile below Drake Brook bridge	Logging	International Paper Co.
5	Wallagrass Stream	Wallagrass	Just below entrance of Drake Brook	Natural falls	—
6	Drake Brook	Wallagrass	¼ mile above Wallagrass road	Logging	International Paper Co.
7	Wallagrass Stream	St. John	Outlet of Third Wallagrass Lake	Logging	Great Northern Paper Co.
8	Fall Brook	New Canada	1 mile above entrance to Sly Brook	Water storage for sawmill	W. Stadig, Soldier Pond
9	Sly Brook	New Canada	Outlet of First Sly Brook Lake	Natural falls	—
10	Birch River	Winterville	At Birch River rearing station	Water storage	Maine Dept. Inland Fish. & Game
11	South Branch Birch River	T16 R8	At Birch River camp	Logging	?
12	North Branch Birch River	Eagle Lake	½ mile below Cotes Camp	Logging	?
13	Rocky Brook	T15 R8	3 miles above entrance to Red River	Natural falls	—
14	Red River	T14 R8	6½ miles above St. Froid Lake	Natural falls	—
15	Red River	T15 R9	1 mile downstream from Pushineer Pond	Natural falls	—
16	Red River	T15 R9	Outlet to Pushineer Pond	Logging	Great Northern Paper Co.
17	Fish River	T14 R8	Outlet of Round Pond	Natural falls	—
18	Fish River	T14 R8	Below outlet to Fish Lake	Logging	Great Northern Paper Co.
19	Chase Brook	T14 R9	Outlet of Second Chase Pond	Logging	Great Northern Paper Co.
20	Daigle Brook	New Canada	Outlet of Daigle Pond	Water storage for sawmill	?
21	Dickey Brook	St. Agatha	East Fork at Corriveau Mill	Water storage for sawmill	Fred Corneault, St. Agatha
22	Cross Lake Thoroughfare	T17 R4	½ mile above Cross Lake	Water storage	Maine Dept. Inland Fish. & Game

APPENDIX IV. Recommendations for obstructions studied in the Fish River Drainage, 1950-1962

Obstruction Number	Operable	Fish jump (feet)	Fishway	Passable to fish						Recommendation
				Upstream			Downstream			
				High water	Low water	High water	High water	Low water	High water	
1	—	8	No	No	No	Yes	Yes	Yes	None	
2	—	4	No	Yes	Yes?	Yes	Yes	Yes	None	
3	—	5+	No	No	No	Yes	Yes	Yes	None	
4	No	0	No	Yes	Yes	Yes	Yes	Yes	Passable	
5	—	8	No	No	No	Yes	Yes	Yes	None	
6	No	0	No	Yes	Yes?	Yes	Yes	Yes	Passable	
7	No	2	No	Yes	Yes?	Yes	Yes	Yes	Passable—Keep clear	
8	No	12	No	No	No	No	No	No	Remove	
9	—	17	No	No	No	Yes	Yes	Yes	None	
10	Yes	—	Yes	Yes	Yes	Yes	Yes	Yes	Passable	
11	No	6	No	No	No	Yes	Yes	No	Remove	
12	No	0	No	Yes	Yes	Yes	Yes	Yes	Passable	
13	—	12	No	No	No	Yes	Yes	Yes	None	
14	—	27	No	No	No	Yes	Yes	Yes	None	
15	—	5	No	No	No	Yes	Yes	Yes	None	
16	Yes	—	Yes	Yes	Yes	Yes	Yes	Yes	Keep fishway operable or remove	
17	—	8	No	Yes?	No?	Yes	Yes	Yes	None	
18	No	0	No	Yes	Yes	Yes	Yes	Yes	Passable	
19	No	3	No	Yes?	No	Yes?	Yes?	No	Remove	
20	Yes	12	No	No	No	Yes	Yes	No	None	
21	No	2	No	Yes	No?	Yes	Yes	No?	Remove	
22	Yes	3	No	Yes	Yes?	Yes	Yes	Yes	Remove splash boards when not in use	

