GOVERNMENT OF THE PROVINCE OF ALBERTA

DEPARTMENT OF LANDS AND FORESTS

Preliminary Biological Surveys of Alberta Watersheds

1947--1949

E. S. HUESTIS,
Game Commissioner

H. B. WATKINS,
Superintendent of Fisheries

Preliminary
Biological Surveys
of
Alberta Watersheds

1947-1949

December 10th, 1949.

Fish and Game Commissioner,
Province of Alberta,
Department of Lands and Forests,
Edmonton, Alberta.

Dear Sir:—

We have the honour to submit our reports on fishing waters which we have examined during the past three years. In reading these there are certain points which should be kept in mind:—

As our title suggests, these reports are preliminary. For many years now the management procedures of our public fishing waters have been, of necessity, somewhat haphazard. Regulations written to conserve fish resources have been based not on a knowledge of local conditions, but on a mass of opinion derived from many sources, mostly outside Alberta, and of many years' standing. Many of these opinions were based originally on an improper analysis of the facts and many, though sound where they originated, do not apply to Alberta waters. The realization of these facts has led to the inauguration of these surveys. Because of the enormous area to cover these surveys must be fast and preliminary. Their main objective is to provide a broad picture of conditions in our waters and to point up the problems which have to be solved by more intensive biological work. Already, some of these problems have become clear and detailed studies have been started on the cutthroat trout, the lower Bow river trout and the Arctic grayling.

We beg the readers of this report to realize our problems and to help us by making criticisms in the form of suggestions from which we may profit and improve our work.

We wish to acknowledge, with thanks, the excellent co-operation received from the general public, and the indispensable assistance provided by members of the Department of Lands and Forests, Government of Alberta, especially by Mr. H. B. Watkins, Superintendent of Fisheries, and other members of his staff.

Yours very truly,

R. B. Miller, Associate Professor, Zoology Department,
University of Alberta.

W. H. Macdonald, Inspector of Fisheries.

TABLE OF CONTENTS

LIST OF FIGURES

BOW RIVER DRAINAGE

Report on Elbow River (1946)

The Elbow river is fairly typical of many of our eastern slope trout streams. These streams have been stocked with Rainbow trout, but there have been very poor returns to the anglers. Accordingly, a survey of the Elbow was carried out in August, 1946, to discover, if possible:—

1. Why the Rainbow trout failed to give good fishing.
2. What steps could be taken to improve fishing.

It was hoped that knowledge gained from the Elbow might be applied to the management of other similar streams pending the completion of surveys of all of them.

The Elbow river rises in the mountains and runs approximately 65 water miles to enter the Bow river in the city of Calgary. The source is at an elevation of 7,000 feet and the total descent is about 3,500 feet. This is an average slope of approximately 54 feet per mile. The gradient is, of course, steepest near the source; in the first 20 miles the drop is 100 feet per mile. The velocity of the river is high; at the time of the survey it was about 4 miles per hour.

In most places the river is over 30 feet wide, very shallow and very much braided; there is a general lack of deep quiet stretches and the wide valley is devoid of vegetation near the river margin. In narrower places boulders may be heard bouncing along the bottom and, in the spring, severe scouring of this sort must take place.

The water is clear and alkaline; the pH varies from 7.9 to 8.0.

For purposes of a more detailed description of the river it has been divided into four sections as follows:—

Section 1. From the source to the Elbow Falls, a water distance of about 23 miles;

Section 2. From the Elbow Falls to the Twin Bridges, a water distance of about 30 miles;

Section 3. From Twin Bridges to Weasel Head bridge — about 12 water miles;

Section 4. The river below the Glenmore dam in the city of Calgary. (The reservoir was not studied during this survey.)

SECTION 1. FROM THE SOURCE TO ELBOW FALLS

Only a small portion of this section of the river was examined, — the part from the falls to the junction of the Elbow and Little Elbow rivers.

Temperature—On August 23rd, the midday temperature of this section was 9.8°C. (49.6°F.). This was recorded at the junction of the Elbow and Little Elbow rivers and lower temperatures may be expected further upstream.

Current—The velocity of this section is about 4 miles per hour in August with a flow of roughly 213 cubic feet per second.

Pools and Cover—The channel in the lower reaches of this section is wide and braided. There is evidence of shift of channel with rubble bars moving from year to year. Pools are very scarce and those present are short (less than half the channel width), shallow (one to three feet)

and with no quiet water. There is absolutely no bank cover either in the form of overhanging vegetation, driftwood or undercut banks.

Food — The bottom in this section is all of coarse rubble lying in strong current. Insects beneath the stones averaged 0.6 cubic centimeters per square foot.

Fish Carrying Capacity—On the basis of Embody's planting tables (1927), as modified by Davis (1938), this upper section of the Elbow river has a carrying capacity of 600 three-inch trout fingerlings per mile per year. This figure is derived from Davis' lowest classification, namely, poor bottom food and small pools. His table does not cover streams as poor as the Elbow where there is no cover and almost no pools. Further, no provision is made for the steep gradient and high velocity with consequent scouring and shifting of the channel. Taking these facts into consideration it seems probable that the carrying capacity of the upper Elbow is only about 200 three-inch trout per mile per year, or about 100 six-inch trout.

Fish Present—Dolly Varden and native Cutthroat trout were the only fish found in this section of the river. They occur here in about the ratio of 15 Dolly Varden to one Cutthroat.

Tributaries—The following streams tributary to this section were briefly examined,—Little Elbow river, Ford creek and Prairie creek.

Little Elbow River — Conditions in this stream are almost identical with those in the Elbow in the same vicinity. There are, however, some pools; in places they occur almost every 100 yards. The ideal ratio is pools to riffles fifty-fifty. In the Little Elbow the ratio is about one yard of pool to 50 yards of riffle, but even this poor showing is better than in the Elbow. This better situation shows up in better fishing. We were able to catch Dolly Varden at the rate of 10-20 an hour and Cutthroat at the rate of about two an hour.

Ford Creek—This stream enters close to the Little Elbow; during the summer and winter it is dry at the mouth but there is always a good flow a mile or so upstream. It is three to six feet wide, has a gentle current and an abundance of shelter in the form of pools, banks, vegetation and driftwood. The water is cold, 10°C. (50°F.).

Ford creek is evidently a good spawning creek for Dolly Varden as many adults and large numbers of fingerlings of this species were seen.

A small spring creek enters the Elbow near Ford creek. It was full of Dolly Varden and captured our interest because of its low temperature, 4.5°C. (40.1°F.). Apparently the Bull trout is tolerant of very cold water.

Prairie Creek—This stream enters the Elbow about ¾ mile above the falls. At the time of our survey it was delivering approximately 6.4 cubic feet per second and flowing at a rate of 2.4 miles per hour. It is around four feet wide and six inches deep at most points. Pools are few, about ½ to ¾ miles apart; there is little bank cover but quite a lot of driftwood jams affording good fish shelter. There is evidence that severe flooding occurs in the spring.

One bottom sample, near the mouth, yielded 0.2 cc per square foot; another, about 2½ miles upstream, yielded 0.05 cc per square foot. This is a very poor food supply.

A few Dolly Varden fry and one Cutthroat were seen in Prairie creek.

In summary, Prairie creek is a poor trout stream; although providing some cover, it is subject to flooding and, as a result, is badly deficient in food.

Conclusions on Section 1

The Elbow river and its tributaries above the falls have a very low trout carrying capacity. Rainbow trout will do well only where extensive pool areas of relatively quiet water alternate with riffles. Such areas are lacking in the upper Elbow. Furthermore, the absence of vegetation along the shore cuts down on the number of insects which fall into the stream — an important source of food for Rainbow trout. This, combined with the poor supply of food on the stream bottom and the absence of algae (favoured by Rainbow trout) makes planting of Rainbow trout a futile undertaking.

The Elbow above the Little Elbow and also the Little Elbow itself are better for trout than the downstream section. As Rainbow trout would not remain in these upper waters it is suggested that Brook trout be introduced as an experiment.

Tributaries to this section offer little hope. Brook trout should be planted in Ford creek early in the year, following the spring run-off.

SECTION 2. FROM ELBOW FALLS TO TWIN BRIDGES

This portion of the river was examined at numerous points where the road gives access to it. There is very little change throughout the entire thirty-mile stretch.

Temperature—The temperature varies from 12.5°C. (54.5°F.) at the falls to 16.0°C. (60.8°F.) at Twin Bridges; on warm days it rises to 18.1°C. (64.6°F.). It is considerably warmer than Section 1.

Current, Pools and Cover—These characters remain as for Section 1, but are, if anything, even more unfavourable. There is scarcely a single pool of any value for the whole section. The channel is very much braided and completely devoid of cover of any kind. The coarse rubble bottom over which the water flows swift and shallow offers no rest or hiding for trout.

Food—Near the falls bottom samples gave from 0.4 to 0.5 cc per square foot. Bottom samples near the Elbow Ranger Station gave 0.9 cc per square foot in the rapids and 0.1 cc in quieter water. At Bragg creek rapids yielded 1.2 cc per square foot. About 24 miles below the falls (site of an army bridge) the channel shifts frequently and the bottom food is reduced to 0.05 cc per square foot in the current and zero out of the current.

Fish Carrying Capacity—The poor food supply and absolute lack of cover give this section of the river almost no fish carrying capacity. The sparse population of Dolly Varden and native Cutthroat trout now present are probably all the stream can support.

Tributaries — The three larger tributaries are Bragg creek, Canyon creek and Pirmez creek. Of these only Bragg creek was examined.

Bragg Creek—This small stream has a temperature of 15.5°C (59.9°F.), a pH of 7.7 and a gentle flow over rubble and mud bottom. The bottom food is poor — 0.5 cc per square foot — probably due to spring flooding. It might support a few Brook trout.

Conclusions and Recommendations for Section 2

Due to poor food and cover this section of the Elbow is not suitable for Rainbow trout. No species of trout can be expected to thrive here unless some stream improvement devices can be made to operate successfully. No more Rainbow trout should be planted in this section.

SECTION 3. FROM TWIN BRIDGES TO WEASEL HEAD BRIDGE

This portion of the Elbow is most promising.

Temperature—The temperature lies around 15° - 16°C. (59.0° - 60.8°F.), good Rainbow temperatures.

Current, Pools and Cover — The river is deeper here and the current less swift. The channel is less variable and braided. There are a number of fine deep pools providing good cover.

Food—There is a fair supply of bottom food running from 1.0 - 1.7 cc per square foot — the richest section of the river.

Fish Carrying Capacity—There is some chance for Rainbow trout to survive in this section of the Elbow. The river here should support about a thousand six-inch fingerlings per mile per year, or about 12,000 for the whole section annually. Once the species is established the good spawning grounds should provide amply and no further stocking would be required unless fishing were very heavy. However, the present population of pike, northern suckers and Rocky Mountain Whitefish will offer severe competition to the trout and it may well prove impossible to establish them.

Tributaries—There are no significant tributaries to this section of the river.

Conclusions and Recommendations on Section 3

These are covered under fish carrying capacity.

SECTION 4. IN CALGARY

This section of the Elbow is cut off from the rest by the Glenmore dam. Its fishes are migrants from the Bow river.

It is cool, running from 15° - 16°C. (59.0° - 60.8°F.). There are numerous good pools and some bank cover. The value of these is reduced considerably by the violent fluctuations in level caused by variations in the amount of water released at the dam. Because of these fluctuations the food supply is poor — 0.2 cc per square foot. Calgarians may be interested to know that larvae of the common blackfly are abundant below the dam.

The stones on the bottom of this part of the river are covered with mosses and algae whereas elsewhere the stones are clean. This is doubtless due to organic pollution from sewers and street drains.

The fish carrying capacity of this section is variable and inestimable because of the fluctuating water level. Rocky Mountain whitefish, suckers and trout from the Bow probably keep it stocked to capacity at all times.

BOTTOM ORGANISMS

The total quantities of food have been discussed in the previous sections; as a whole the Elbow and its tributaries are poor in food. The usual quantities range from 0.05 to 1.2 cc per square foot with an average of 0.4 cc per square foot. The only exception is below Twin Bridges in the lower stretches of the river where one spot yielded 1.7 cc per square foot. In stream survey work less than 1 cc per square foot is rated poor, 1 - 2 c¢ is rated average and greater than 2 cc is rated rich. Most of the Elbow rates poor and only one small stretch rates medium. No part of the river is rich in bottom food.

The bottom animals found belonged to the usual insect groups, — Trichoptera (caddis-flies), Ephemerida (mayflies), Plecoptera (stone-flies) and Diptera (two-winged flies). The following forms were the most common:—

Trichoptera (caddis-flies).

Hydropsyche—net building caddis.
Brachycentrus—square wooden cases.
Rhyacophila—no case.

Ephemerida (mayfly nymphs).

Epeorus.
Baetis.
Rithrogena—very common.
Ephemerella.
Leptophlebia.

Plecoptera (stonefly nymphs).

Acroneuria—very common.
Pteronarcys—lower river only.

Dipters (two-winged fly larvae).

Simulium—blackfly larvae (in Calgary section).
Eriocerca—cranefly larvae.
Tipula—cranefly larvae.
Chironomid (midge) larvae.

In addition a few worms (oligochaetes) were found.

In some places sculpins **(Cottus),** little fishes, may be found under the rocks in rapid water.

FISH CAUGHT AND STUDIED

Most of the fish we caught were from the Elbow and tributaries above the falls. We had poor luck in catching fish in the lower sections of the river.

The following have been measured and their ages estimated from their scales:—

34 Dolly Varden **(Salvelinus alpinus malma).**
8 Cutthroat trout **(Salmo clarkii).**
2 Rainbow trout **(Salmo** sp.)
1 Rocky Mountain Whitefish **(Prosopium williamsoni).**

The average growth of the Dolly Varden is shown in Table 1.

TABLE 1.

Average Length and Weight at Capture of 34 Dolly Varden Charr.

Age.	Av. Length Inches.	Av. Weight (ounces)
1	6.5	2.0
2	8.3	3.5
3	9.7	5.6
4	10.6	7.6
5	12.5	12.0
6	13.2	13.0
9	15.9	24.0

It is interesting to note that this fish, native to the Elbow, and probably the best fitted for survival in this river, has a very slow growth rate.

It takes seven years to reach a weight of one pound. At this time they likely start feeding on fish and the growth will speed up. The two nine-year-olds had eaten trout whereas all the younger fish had eaten aquatic and terrestrial insects. The scanty supply of these is what accounts for the poor growth.

The Dolly Varden spawn for the first time at the end of their fourth summer, i.e., as three-year-olds. By this time they have attained an average length of 9.6 inches and an average weight of 5.6 ounces. Three females of this size and age were found to contain 486, 506, and 595 ripe eggs, or an average of about 80 eggs per ounce of body weight.

In mounting the scales of these fish for study it took long searching to find a scale free from injury. Apparently the Dolly Varden take a severe beating during flooding in the spring.

The growth of the eight Cutthroat trout is shown in Table 2.

TABLE 2.

Lengths and Weights at Capture of Eight Cutthroat Trout.

Age.	Av. Length (inches)	Av. Weight (ounces)	No. Examined
1	9.5	4.7	3
2	11.7	11.7	4
3	13.4	16.0	1

Apparently the Cutthroat reach a pound in three years. This is very good growth considering the meagre food supply. Three of the two-year-olds were mature and probably would have spawned the following spring.

All of the Cutthroat trout had been feeding on insects which fell into the water from the air; only one had eaten an aquatic insect as well.

The two Rainbow trout taken had made very poor growth, one was a year old and had just been planted; the other was two years old; it was 9.0 inches long and weighed 5 ounces. This is nearly 3 inches shorter and 7 ounces lighter than the native Cutthroat of the same age.

Both Rainbow had been feeding at the surface.

The single Rocky Mountain whitefish was six years old, 12.2 inches long and weighed 16 ounces. This is very poor growth for this species.

Discussion and Conclusions

The Elbow river with its tributaries is a very poor trout stream. The poor food supply, almost total lack of pools and cover, swift current and variable channel all militate against trout survival. In the last ten years many trout have been planted; the record is shown in Table 3.

TABLE 3.

Plantings of Trout in the Elbow and its Tributaries since 1936
(in thousands)

	1936	1937	1938	1940	1941	1943	1944	1945
RAINBOW								
Fry	0	215	0	0	0	0	0	0
Fingerlings	312	0	0	106	160	50	93	15
Yearlings	0	0	0	0	2	3.5	0	15
Two-year-olds	0	0	0	0	0	0	0	5
CUTTHROAT								
Fry	0	0	90	0	0	0	0	0
EASTERN BROOK								
Fry	0	0	0	75	0	0	0	0
Yearlings	0	0	0	3	0	0	0	1.2

Since 1936 the plantings, in summary, have been:—

RAINBOW	
Fry	215,000
Fingerlings	736,000
Yearlings	20,500
Two-year-olds	5,000
CUTTHROAT	
Fry	90,000
EASTERN BROOK	
Fry	75,000
Yearlings	4,200

Let us examine the figure for Rainbow fingerlings alone. We can assume that all Rainbow planted in the tributaries dropped down to the main river. The figure of 736,000 since 1936 represents, then, an average of 73,600 per year or 1,200 per mile of water per year. The carrying capacity of the Elbow river is undoubtedly not more than 100 six-inch fingerlings per mile per year. We cannot state, therefore, that poor fishing in the Elbow is due to understocking. These figures support the conclusion of the survey — that the Elbow river is naturally a poor trout stream. Rainbow trout have not survived in sufficient numbers to provide angling. Many of the Rainbow trout reported by anglers are actually Cutthroat trout lacking the red slash under the jaw. We estimate that at least 98% of the angler's catches of trout from the Elbow have been Dolly Varden and Cutthroat trout. Except in the lower reaches (section 3) it would be folly to plant more Rainbow trout.

Needham and Slater (1944) have shown that when Rainbow trout are introduced into a stream poor in food their survival depends on the native population present. If a native population is present, consuming the food, scarcely 50% of the introduced Rainbow will survive until fall; about 70% of the remainder die during the winter.

The same authors have shown further (1945) that such introduced fish only grow at half the rate of the native stock and actually lose weight during their first summer. The stream where the experiments were conducted had a fair pool supply and a relatively gentle flow (2.4 cubic feet per second). If Rainbow were unable to survive in such stream as this what chance have they in the Elbow with poorer food, no pools and a tremendous velocity?

Recommendations

1. The section of the Elbow river from the falls to Twin Bridges is unsuitable for trout and no further plantings should be made.

2. The section of the Elbow from the Twin Bridges to the Glenmore reservoir appears suitable for Rainbow trout; 12,000 six-inch fingerlings, or fewer larger fish, should be planted annually. These should be scattered in as many small separate plantings as possible.

3. The upper section, above the Elbow Falls, while of a poor nature for trout, might support Brook trout. They should be planted in small bunches at the rate of about 100 six-inch fingerlings per mile. Willis King (1942, 1937) working in Great Smoky Mountains National Park (Tennessee) has found that the upper reaches of the streams, over 3,000 feet, are best for Brook trout, which remain at these higher altitudes. The Rainbows drop down below 3,000 feet and will not stay with the Brook trout.

4. The only hope of providing good fishing in most of the Elbow river is to find a successful stream improvement device, cheap enough to be installed every mile or so along the most frequently visited stretches of the river. The device must be strong enough to stand the spring floods and designed so that it forces the current to dig holes. It is recommended that an engineer be engaged to accompany the author on stream surveys to make a study of the design and practicability of such stream improvement devices.

References

DAVIS, H. S., 1938—Instructions for conducting stream and lake surveys. U.S. Bureau of Fisheries. Fishery Circular 28.

EMBODY, G. C., 1927—An outline of stream study and the development of a stocking policy. Cornell University: 1-21.

KING, WILLIS, 1937—Notes on the distribution of native Speckled and Rainbow trout in the streams of Great Smoky Mountains National Park. Journal Tennessee Acad. Science. XII (4): 351-361.

KING, WILLIS, 1942—Trout Management Studies at Great Smoky Mountains National Park. Journ. Wild Management, 6 (2): 147 - 161.

NEEDHAM, P .R., and D. W. SLATER, 1944—Survival of hatchery-reared Brown and Rainbow trout as affected by wild trout populations. Journ. Wild. Management, 8: 22 - 36.

NEEDHAM, P. R., and D. W. SLATER, 1945—Seasonal changes in growth, mortality and condition of Rainbow trout following planting. Trans. Am. Fish. Soc. 73: 117 - 124.

ADDED NOTES ON THE ELBOW RIVER — 1947

Following the recommendations made in the report of 1946, Eastern Brook trout were planted this past summer in two places on the Elbow drainage. On August 7th, 8th and 9th, a week after these plantings, our survey party visited the planted areas to try and discover what had become of the planted fish.

Prairie Creek. One tank of Eastern Brook trout was released into Prairie Creek several hundred yards above its entrance to the Elbow. This spot is on the trail leading to the abandoned oil camp and is just downstream of this old campsite. The party spent one evening angling in the stream; 17 Cutthroat, 7 Brook trout and 2 Dolly Varden were caught. The 7 Brook trout were, of course, yearlings of the recent plant. They appeared to have moved upstream about 1 mile from the point of release.

The following day was spent in carefully seining all the pools from the mouth of Prairie Creek upstream for about 2 miles. **We found no Eastern Brook below the point of release.** There was a good number of them in each pool from the point of release **upstream for a full mile.**

Elbow River. A second tank load of Eastern Brook was released at the same time into the Elbow river about one-quarter mile above the mouth of Prairie creek upstream for about one mile. **Again we found no Brook Trout below the point of release.** Instead we found them well scattered along the sides of almost a mile of the Elbow, from the point of release upstream. These fish appeared perfectly at home and in fine condition.

These findings are in marked contrast to what we know of recently planted Rainbow yearlings. These tend to school in large pools and

gradually drop **downstream.** Those planted in the Elbow last year were coming over the Elbow Falls the same day they were planted. We believe the prospects for these Eastern Brook are very good.

Bragg Creek. While in Calgary, early in August, the survey party was told of wonderful Rainbow trout catches in Bragg Creek. Accordingly, we visited Bragg creek on August 9th and spent part of that day fishing about two miles of the stream. We caught about six trout and examined several others. These were all Cutthroat trout, though well coloured and provided with a strong "Rainbow" mark. As we have reported elsewhere, we believe all such "Rainbow" catches are, in reality, Cutthroat trout.

MUSKEG CREEK (ELBOW RIVER) (1948)

On July 16 we paid a visit to Muskeg creek, which we reached by walking from Prairie creek, up an old trail on the left bank of the Elbow, and then crossing to the right bank at Muskeg creek.

We examined the lower mile of Muskeg creek. Unlike the Elbow, the water is distinctly brown and the bottom rubble is covered with silt. At the mouth the creek is 30 feet wide, shallow and stony and flows at about 1.4 miles per hour. pH is 7.8. It is 3° warmer than the Elbow (60°F. at 6.00 p.m., Elbow only 57°F. at same time). The stream is liberally grown with willow and spruce which provide an effective cover. There are no pools in the area we examined.

A bottom sample in a riffle yielded only 0.2 cc per square foot -- a very small amount. This was made up of:—

1 blackfly larva.
30 small mayfly nymphs.
1 Caddis larva.
4 beetle larvae.
1 cranefly larva.
10 midge larvae.
6 stonefly nymphs.

It has been reported that Muskeg creek was overrun by Dolly Varden. In a mile of water we caught 4 Cutthroat trout and one Dolly Varden, about the same ratio as elsewhere on the upper Elbow system.

The Cutthroat trout were very small, 1 - 3 ounces, and were in their second and third summers. This poor growth is to be expected in a stream with such a poor food supply.

Report on the Glenmore Reservoir (1947-48)

At a meeting in Calgary, in February, 1947, the Fish Committee of the Calgary Fish and Game Association pointed out to the Game Commissioner and the writers some of the sport fish problems presented by the Glenmore dam. It was agreed that the Fisheries Branch would undertake work on this reservoir as soon as possible.

The Calgary Fish and Game Association stated that they believed that:—

(1) The trout population of the Elbow river which, before the dam was built, wintered in the Bow river, now winters in the reservoir.

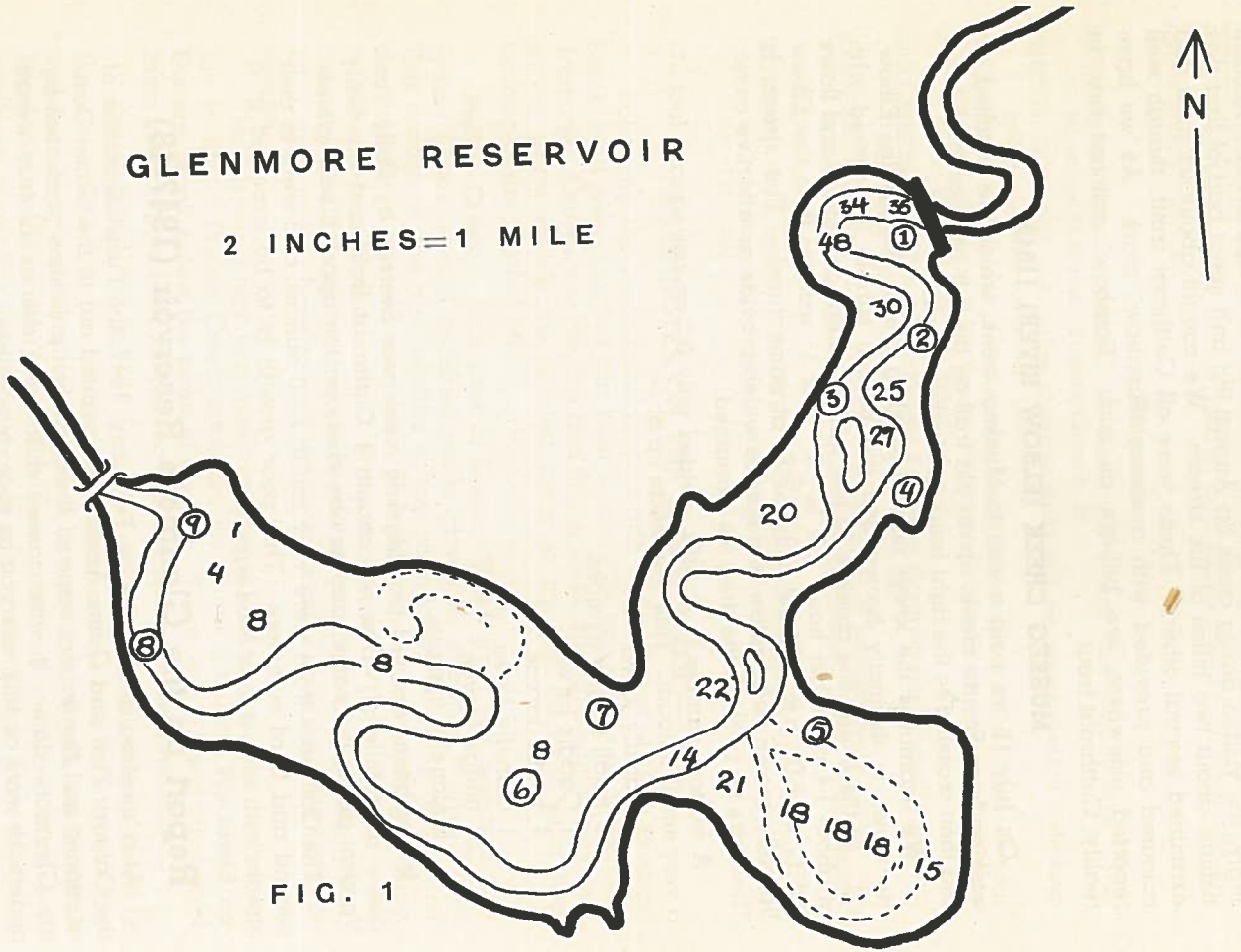

GLENMORE RESERVOIR
2 INCHES=1 MILE
N
34
35
48
1
30
2
3
25
27
4
20
9
1
4
8
8
8
22
7
5
8
6
14
21
18
18
18
15

FIG. 1

(2) A large population of northern pike preys upon these trout over the winter and seriously reduce their numbers.

The Fisheries Branch agreed to conduct an investigation which would, firstly, establish the truth or otherwise of these allegations and, secondly, seek for a remedy if one proved to be necessary.

This report gives an account of the progress to date in pursuing the first objective. It is broken into two parts, a biological survey of the reservoir, and a study of the fish population in it. The work was done in the last half of May, June 1st - 8th, August 30th and 31st, October 21st - 23rd and October 28th - 30th. Ice conditions on the reservoir prevented an earlier start than May. It was hoped to get further work done in November, but the party which arrived there on November 14th was unable to work because of an early ice cover. Gill nets were again set December 12th, 13th and 14th and March 27th - 29th, 1948.

BIOLOGICAL CONDITIONS IN THE RESERVOIR

An outline map of the reservoir is attached to this report. At full level the area is approximately 1.5 square miles.

Depths. A series of soundings was taken on June 6th. These are shown on the map. The deepest water, 48 feet, is about 1/4 mile above the dam. Right at the dam there is 35 feet of water. The middle stretch runs from 20 - 30 feet. The large area at the southern end is quite shallow, mostly from 8 - 15 feet. The dam is flushed out at intervals to prevent the accumulation of silt.

Temperature, Oxygen and pH. The temperatures recorded are shown in Table 4.

TABLE 4.

Temperatures Recorded in the Glenmore Reservoir °F.

Depth (ft.)	June 4	Aug. 31	Oct. 21,	23,	29,	Aug., '38 (Rawson)	Sept., '38 (Rawson)
0	53.6	62.6	44	42	37	64.8	61.5
15	51.8	---	--	--	--	---	---
30	49.6	---	--	--	--	64.1	---
37	---	57.2	--	--	--	61.5	---
42	49.8	---	--	--	--	---	---
52	---	---	--	--	--	60.6	59.7

The reservoir is quite warm, but not too warm for trout. There is no thermal stratification and warming proceeds pretty well to the bottom.

The pH was 7.8 at the surface and 7.6 at the bottom. Dr. Rawson found 8.1 and 7.9. (The difference may be only the result of a different type of test.)

The water is alkaline like all the east slope drainage.

The present examination and that of Dr. Rawson both showed plenty of oxygen at all depths (4.9 - 5.7 cc/l).

Transparency. The transparency was 7 1/2 feet in June and much more in August.

Plankton. Two plankton hauls were made with a standard silk net from 30 feet to the surface. The volume collected was so small that it

could not be accurately measured. In 1938 Rawson took 0.3 cc in a similar haul, a quantity of the same order of magnitude. The following animals were found in the plankton:—

Crustacea	Protozoa
Daphnia longispina	**Ceratium**
Cyclops bicuspidatus	**Anurea**
Rotifera	
Polyarthra platytpera	

This is a very poor plankton. It is very interesting to note that in 1938 Dr. Rawson found almost exactly the same plankton. At that time the reservoir was but six years old and Rawson suggested it might improve as it got older. Such has not been the case.

Bottom fauna. A series of six dredgings was taken to measure the amount of food on the bottom. The analysis of these dredgings is shown in Table 5.

TABLE 5.

Analysis of Six Dredgings Taken in Glenmore Reservoir, June, 1947.

Depth	Midges	Other Insects	Clams	Worms	Shrimps	Vol./sq. ft.
3	64	4	--	1	19	3.6
8	91	-	--	4	2	1.2
*12	1	-	22	-	8	0.8
14	36	-	--	7	1	2.8
35	23	-	19	-	--	negligible
39	40	-	23	3	--	"

*In addition 2 leeches were taken. Other insects are mayfly nymphs (Ameletus) and stonefly (Pteronarcys).

At 3 feet and 8 feet the bottom was of silt with a heavy growth of the alga, **Chara.**

At the other depths the bottom was of clay with a layer of silt on top.

Dr. Rawson's two dredgings of 1938 yielded a similar fauna. Except in the very shallow water the fauna is very poor, possibly because of silting.

Conclusions on Biological Survey. The production of food is very poor and conditions have not improved in the nine years since 1938. The low plankton and bottom fauna production is possibly due to the silt carried in by the river. This reservoir is not likely to support a large fish population.

THE FISH POPULATION OF THE GLENMORE RESERVOIR

The main objective of this preliminary study was to determine the kinds and relative abundance of fish in the reservoir with particular reference to pike and trout. And also to determine, if possible, the seasonal movements of these fish into and out of the reservoir. Our original intention was to catch pike, mark them by fin-clipping, and then liberate them. The ratio of marked to unmarked fish in subsequent catches would enable us to calculate the total pike population. This was done but only to a very small extent as very few pike were captured.

The fishing was done with gill nets; gangs of graded sizes from 2¾-inch mesh to 5½-inch mesh were used, in order that fish of all sizes might be captured. Altogether approximately 5,200 yards of net were set. Fishing was done over the whole reservoir; the general location of the sets is shown by the numbers on the map (1 - 9). The record of the dates, localities and catches is shown in Table 6.

TABLE 6.

Catches of Fish in Glenmore Reservoir.

No.	Date	Locality	N. Sucker	C. Sucker	Pike	Burbot	Trout
1	May 1, 2, 3, June 3		183		7	27	0
2	July 5	2	--	--	3	1	0
3	" 5	3	11	4	7	0	0
4	" 6	9	16	1	1	0	0
5	" 6	8	33	4	6	0	0
6	Aug. 31	2	5	5	10	0	0
7	" 31	4	2	--	0	0	0
8	" 31	5	6	0	0	0	0
9	" 31	8	11	1	5	0	1
10	" 31	8	8	3	2	0	1
11	Oct. 22	3	0	0	1	0	0
12	" 22	4	0	0	0	0	0
13	" 22	4	0	0	0	0	0
14	" 23	6	1	0	1	0	0
15	" 23	7	1	1	0	2	0
16	" 23	7	12	0	0	1	0
17	" 30	9	9	2	3	0	0
18	" 30	8	20	4	11	0	1
19	" 30	8					
20							
21	Dec. 12	8 & 9	38		17	0	1
22	" 13						
23	Mar. 27, 29	8 & 9	0	0	1	0	0

Nos. 2 - 19 represent 100 yards each.
No. 1 is a composite of one week's fishing.
Nos. 20 - 21 represent 700 yards.
No. 23 was 300 yards.

Total Catches. Altogether the catch consisted of 381 suckers (ratio of common to northern of 1:5), 74 pike, 31 burbot (ling) and 4 trout.

Pike. Of the 74 pike, 17 were marked by fin-clipping; the remainder were dead or dying at the time of capture. No recaptures of marked pike were made. A study of the places and dates of capture of these pike gives some clue of their movements.

Thus in May only one pike was caught near the dam. In June six were caught near the dam, ten in the middle of the reservoir and seven near the river mouth.

In August ten pike were caught near the dam and seven near the river mouth. Distribution in August was fairly even.

In October one pike was caught near the dam, two about the middle and 14 near the river mouth. Most of the pike were near the river.

In December, 17 pike were caught near the river mouth, and in March one was caught in this region.

From this it is tentatively concluded:—

1. Pike enter the reservoir in the spring and stay during the summer.
2. In the fall the pike concentrate near the river and perhaps leave the reservoir.
3. There is at no time during the summer, at least, a large pike population in the reservoir.

The stomachs of 43 pike were examined: 30 of these were empty; of the remainder 3 contained suckers; 3 contained young pike; 6 con-

tained Rocky Mountain whitefish; one contained fresh water shrimp and damselflies.

The pike ranged from 20 - 25.5 inches in length — young, small fish.

Suckers. The 381 suckers were caught at all localities in the reservoir. There is no evidence that they move in or out to any large extent. 195 suckers were marked by fin-clipping; 4 recaptures have been made to date. This is too small a return to make an accurate estimate of the total population. A preliminary estimate may be attempted as follows:—

Out of the 186 suckers caught after marking operations were completed, 4 were marked fish. Therefore, 186 suckers represent 4/195 of the population. The population is approximately 9,000 suckers.

Burbot. The burbot or ling appears to have pronounced seasonal migrations into and out of the reservoir. In May, 27 burbot were taken near the dam. In June only one was found in settings at both ends of the reservoir. None was taken at any locality in August. Three were taken near the centre of the reservoir in October. It is probable that ling leave the reservoir in the spring and return again in the fall, probably to spend the winter. The winter population may be quite large.

The stomachs of a few ling were examined; these had been eating shrimps. Normally this fish eats other fish and, if they winter in the reservoir, they undoubtedly eat fish, probably suckers.

Trout. Only four trout were taken; two in August in the river mouth, one in October in the same place and one in December in the same place. At this spot the current of the incoming river is still perceptible. On the basis of this evidence it is concluded that trout do not use the reservoir to any great extent. Those captured in the reservoir are probably casual visitors from the river. The distribution of food in the reservoir supports this view. There is no trout food in the main reservoir, but there is a good feeding ground in the shallow area near the river entrance.

The trout taken were of the Rainbow-Cutthroat hybrid type, like the "steelheads" of the Bow. It is not yet definitely shown that these fish are hybrids but the evidence is fairly convincing.

Rocky Mountain Whitefish. None of these Whitefish was taken in our nets. We found a few young ones in the stomachs of pike caught near the river mouth. Probably these pike had eaten the Whitefish in the river.

CONCLUSIONS.

Tentative conclusions have been suggested here and there throughout the report. These are:—

1. The productivity of the reservoir is very low; the plankton and bottom fauna are poor. There has been no change since Dr. Rawson's party examined it in 1938. Trout food is almost absent except for the shallow area near the river mouth.

2. The gill nets yielded 381 suckers, 74 pike, 31 burbot and 3 trout. The sucker is the dominant fish of the reservoir. A rough estimate of the sucker population is 9,000.

3. Pike are not abundant in the reservoir. There is some evidence that they frequent the reservoir mainly during the summer.

4. There is no evidence that the pike are feeding on trout.

5. Burbot apparently leave the reservoir in the summer and return in the fall to spend the winter.

6. Trout are rare in the reservoir; they were found only in or near the river mouth. There was no evidence of a migration into the reservoir in the fall or out of it in the spring.

We wish to acknowledge the courtesy of Mr. W. E. Robinson, Calgary Waterworks' Engineer, who permitted us to use the City's boat on the reservoir and who supplied maps and information.

Inglewood Sanctuary as a Possible Location For Trout Brood Stock (1947)

It has been suggested that the stream at Inglewood Sanctuary would serve as brood stock water for trout. Its advantage is its convenient location close to the fish hatchery at the Calgary Brewery.

On June 16th, at the request of the Fishery Branch, we made an examination of the Inglewood water, particularly that portion between the 9th Avenue sewer and the upper end of the present trout rearing ponds. The findings were as follows:—

Depth. Near the 9th Avenue sewer there is a small area of water with a maximum depth of 11 feet. The remainder of the water is three feet deep. (The soundings were made from a boat.)

Temperature. Around the shores at the upper end the water had warmed to 53.6°F. Elsewhere, in the current, the temperature was uniformly colder — 48.2°F. (On August 17, 1942, the temperature in the current was 52°F.).

Dissolved Oxygen. The quantity of oxygen was the same at the upper and lower ends of the area. It amounted to roughly 80 per cent. of saturation or 7.7 p.p.m. This is an ample oxygen supply.

pH. The pH was 7.4 at all points.

Food. The bottom of the stream is everywhere of sand. Near the upper end there are a few patches of the alga, **Spirogyra,** in which a few food organisms occur. Elsewhere the sand is bare and almost totally devoid of food animals. The stream could scarcely support a single adult trout.

Pollution. On August 19, 1942, an examination was made of the Inglewood rearing ponds following a heavy mortality of fry. The ponds were found to have been polluted by oil wastes which entered the stream from springs along its west bank. At that time there was no evidence that the pollutants were entering the stream above the rearing ponds for any distance. It is possible that the upper part of the stream was unaffected, but since this is not a certainty, the threat of pollution exists.

We could detect no evidence of pollution from the 9th Avenue sewer or from the private one-family sewer either during the present examination or the previous one in August, 1942.

Discussion and Conclusions. The presence of the fry of wild trout above and below the 9th Avenue sewer was noted and proves it is used as a spawning area by Bow river trout, which enter by a small outlet just above the rearing ponds. The water is, therefore, obviously suitable for trout as the favorable oxygen content, low temperature and satisfactory pH would suggest. There are, however, two serious objections to the use of Inglewood for brood stock purposes:—

The first is the threat of pollution by oil wastes; a more detailed account of this may be found in the report of August, 1942.

The second is the absence of food. Beyond any doubt the brood stock would have to be fed. Many believe the eggs from artificially

fed fish are not as satisfactory as those from naturally fed fish. There is a further, perhaps more serious, angle — the large cost of feeding adult trout. From the work of James S. Gutsell (Progressive Fish-Culturist, May-June, 1940) we have estimated that it will require about 6.5 lbs. of food for every 1,000 eggs obtained. Thus to produce a half million eggs would require more than 1.5 tons of food. With the present high cost and scarcity of suitable food this 1.5 tons becomes a formidable item. And to this must be added the salary of a full-time pond attendant to prepare the food and feed it to the fish.

Because of the threat of pollution and the necessity of supplying total rations for the fish, we would not recommend the establishment of brood stock ponds at Inglewood.

The Jumping Pound and Tributaries (1947)

The survey party visited the Jumping Pound and some of its tributaries from June 8th to 12th, 1947; June 17th to 20th, ,1947, and August 5th to 7th, 1947.

The Jumping Pound. The Jumping Pound rises at 6,000 feet and flows approximately fifty water miles to join the Bow river at 3,700 feet. This is an average fall of 46 feet per mile, a moderate gradient. More than half the total fall takes place in the first eight miles, so that most of the Jumping Pound is a fairly gentle stream. Three sections of the river are recognized for purpose of this report:—

Upper section—from the source to boundary of the Forest Reserve, about fifteen water miles;

Middle section—from the Reserve boundary to the mouth of the Little Jumping Pound, about twenty water miles;

Lower section—from the mouth of the Little Jumping Pound to the Bow river, about fifteen water miles.

UPPER JUMPING POUND

(Source to Forest Reserve Boundary)

This section of the river was examined from Sibbald creek upstream for six miles, at the mouth of Moose creek and vicinity and at the reserve boundary.

Velocity, Pools and Cover. The water is moderately fast, from 2 to 2.5 miles per hour. The channel varies from 12 to about 50 feet wide. The bottom is coarse rubble and boulders. Pools are very few and not deep. At the normal water level the channel may be waded anywhere.

On June 8th the stream was still two feet above the normal level. After rain on June 8th and 9th the water rose another two feet and the stream became very dirty. During the next week the level fell 14 inches. By August 5th the stream had dropped another three feet, and the whole upper section was only about one-third its spring width. The average velocity in August falls to one mile per hour.

pH and Temperature. The pH is 7.6 — fairly alkaline. The maximum summer temperature of the section is about 60°F. During most of every day it is about 10° cooler.

Food. Bottom samples were taken at intervals along the section. The average of six is 0.2 cc of food per square foot. This is exceedingly poor; the small quantity is probably due to spring flooding and low temperature.

The animals present in the six samples are shown in the following table:—

	Sample	1	2	3	4	5	6
Mayflies	**Rithrogena**	122	23	7	4	30	86
	Baetis	76	47	5	3	11	40
	Iron	21	19	-	1	1	--
Stoneflies	**Acroneuria**	22	17	3	-	9	14
	Altoperla	--	--	-	-	2	--
Caddis flies	**Hydropsyche**	--	1	-	2	-	--
	Rhyacophila	--	1	1	1	-	--
Miscellaneous		--	4	-	-	3	--

Fish. No fish were found in the Upper Jumping Pound in early June. On June 19th a few small Cutthroat were found near the Forest Reserve boundary. In August Cutthroat trout were quite numerous in this section. A few Dolly Varden were also found. The ratio of Cutthroat to Dolly Varden trout is about 30 Cutthroat to one Dolly Varden. A very few Rocky Mountain Whitefish ascend to the vicinity of Sibbald creek. No suckers or minnows were discovered. No Rainbow trout were taken by us or by anglers whose catches we examined.

All the Cutthroat we examined were small — from six to ten inches. They were from two to four years old, and mainly immature. A detailed report on the Cutthroat is being presented separately.

Remarks. The Upper Jumping Pound is poor in food, pools and cover. It will support a few Cutthroat trout but it is unsuitable for Rainbow trout. It should receive not more than 4,000 fingerling Cutthroat from the hatchery each year.

MIDDLE JUMPING POUND

(Forest Reserve Boundary to Mouth of Little Jumping Pound)

This section of the river was examined near the Forest Reserve boundary and a two-mile stretch upstream from the mouth of Muskeg creek; the visits were made on June 19th and 20th.

The river is wider here and rather shallow, with a rubble bottom. There are few pools and not much bank cover. Considerable braiding has occurred. The temperature is still low—47°F. to a maximum of about 60°F.

At least two beaver dams occur in this stretch and there is considerable beaver activity all along the stream.

At the time of our visit the only fish we could find were a few young Cutthroat trout and Rocky Mountain Whitefish. Suckers were seen but none was taken.

The bottom food is somewhat richer than in the upper section, but still poor, running about 0.5 cc per square foot.

The bottom animals collected were:—

Mayflies		Stoneflies	
Rithrogena	42	**Perlinella**	2
Baetis	20	**Acroneuria**	2
Leptophlebia	1		
Blasturus	10	Bugs	
Iron	2	**Hebrus**	2

This section of the stream should not receive more than 6,000 Cutthroat trout per year.

We were informed that trout were plentiful in this part of the river until two years ago when, during a severe winter, the stream froze to the bottom and the trout were winterkilled.

LOWER JUMPING POUND

(From the Mouth of Little Jumping Pound to the Bow)

This section of the river was examined briefly at two places — where the trail from the Forest Reserve crosses it and at the mouth on the Bow river.

The river in this section is not very different from the middle section. It is wider and deeper and carried a greater load of silt. One beaver dam near the bridge was examined. It has caused the deposition of silt on the rubble upstream which has killed much of the bottom life.

Temperature is about five degrees higher.

The bottom food is poor — 0.5 cc per square foot. The following forms were found:—

Caddis Larvae		Mayflies	
Brachycentrus	10	**Habrophlebia**	3
Others	3	**Baetis**	2
	Stoneflies		
Perlinella	3		

No trout were seen in the lower section; instead many suckers, chub and Rocky Mountain Whitefish were observed.

Severe flooding — up to seven feet above the normal level — occurs in the spring.

Small plantings with Cutthroat trout are suggested for this stretch of the river.

JUMPING POUND TRIBUTARIES

Examinations (some brief) were made of Sibbald creek, an unnamed creek and its headwater lake, Moose creek, Muskeg creek and Little Jumping Pound creek.

Sibbald Creek. This little stream is about 3 miles long. Most of it was examined by the survey party. Visits were made June 10, 17 and 18, and August 5 and 6.

The stream is from 2 to 4 feet wide; it has numerous deep pools and a dense bank cover of tangled alders and willow which entirely conceal the stream for most of its length. The bottom is silty and deficient in food.

The temperature is from 48°F. to 53°F. and, because of the dense cover, varies but little. We were told that Sibbald creek normally stays open in the winter.

About 2 miles up from the mouth there is a beaver dam and large pond. In early June Sibbald creek was over its banks and no fish could be found. Both Cutthroat and Dolly Varden were found in the beaver pond. A week later Cutthroat were numerous in the stream, apparently having moved down from the beaver dam. In August these Cutthroat and a few Dolly Varden were still present.

We examined carefully 28 trout from Sibbald creek. Twenty-five of these were Cutthroat trout and 3 Dolly Varden. The Cutthroat were all small, 3 to 8 ounces; 12 were 3 year-olds, 11 four-year-olds and 2 five-year-olds.

In 1941, 4,000 Rainbow trout were planted in Sibbald creek; in 1944 15,000 Rainbow and in 1946, 10,000 Rainbow were planted. This is a small stream and it was thoroughly examined. Not one Rainbow was found in Sibbald creek or in the Jumping Pound above or below it. The

native trout, the Cutthroat, was found in Sibbald and the adjacent Jumping Pound.

From 500 - 1,000 Cutthroat per year are all that should be planted in this stream. No more plantings of Rainbow should be made.

Unnamed Creek and Its Headwater Lake

On a meadow, high above Sibbald Park, lies a small lake of several acres. In the spring this drained to the Jumping Pound below Sibbald creek. Later in the summer the level falls so that the creek does not run from the lake.

This little lake was thoroughly examined as a possible Rainbow trout lake. A series of soundings showed it to be mainly 15 - 16 feet deep with steeply sloping contours. In August these depths were about 2 feet less.

A plankton haul from 12 feet to the surface yielded a moderate quantity which included:—

Crustacea
- **Cyclops bicuspidatus**
- **Bosmina**
- **Diaptomus**

Rotifers
- **Anurea**
- **Noteus**
- **Polyarthra**

Alga
- **Anabaena**

In the deeper parts dredgings yielded a rather poor fauna (2.4 cc per square foot) consisting of midge larvae. Around the shore there was an enormous fauna of fresh-water shrimps, Gammarus. Also in the shallow water a large fauna of Caddis larvae was living.

In June the temperature ranged from 54°F. at 15 feet to 60°F. at the surface. In August the bottom had warmed to 60°F. and the surface to 61°F.

The only fish now present in the stickleback, **Eucalia inconstans.**

It is recommended that a small, experimental planting of Rainbow trout be made in this lake.

The outlet of the lake runs about 3 miles to the Jumping Pound. It is a swift little stream, very narrow, with many fine pools and good cover. It has a fair food supply and could probably support a small number of Cutthroat trout.

Moose Creek. Moose creek is a small stream which enters the Jumping Pound about three miles below Sibbald creek. It is approximately five miles in length and, near its mouth, from eight to 12 feet wide. It is composed of a lovely series of pools and riffles offering excellent cover for trout. It is slightly colder than the Jumping Pound. The velocity of the current is approximately two miles per hour.

The bottom food is meagre — only 0.2 cc per square foot. The usual mayflies and stoneflies were the chief bottom animals.

This stream appears suitable for Cutthroat trout; it is probable, however, that in some summers it dries up or nearly so. Two other streams which enter near Moose creek quite obviously are only seasonal streams.

Muskeg Creek. The creek is not named on the map and Muskeg creek is a local name for it. It rises in the Forest Reserve and flows east about eight miles to enter Jumping Pound some six miles outside the Reserve. It was examined at and around the point where it crosses the Reserve boundary and upstream about a mile from its mouth.

In its upper parts this is a clear, fast stream from six to eight feet wide with a boulder bottom and many pools and little falls. It is overgrown with bank bushes and offers lovely trout cover. It is very cold, 45°F. at the time of our visit (June 19th).

The lower part is less clear and has silted to some extent. It still provides good and frequent pools with very fast water between them. It is subject to floods of three feet above normal level in the spring.

The food in Muskeg creek is the best in the Jumping Pound area, amounting to 1.0 cc per square foot (still a meagre quantity). This food consists of:—

Mayflies		Stoneflies	
Rithrogena	26	**Acroneuria**	4
Ephemerella	11	**Planarian**	1
Boetis	57		
Caddis larvae	7		

The lower reaches of Muskeg creek have been taken over by beavers. The whole stream used to be swarming with Cutthroat trout. The winterkill two years ago (previously mentioned) apparently took all the Muskeg creek trout except those in the beaver dams. A few are to be found in these now.

Muskeg creek should be planted with cutthroat. An accessible place for planting is the point where it crosses the Forest Reserve boundary. We suggest a planting of 1,000 fingerlings.

Little Jumping Pound. This stream was examined only at the point where it is crossed by the trail from the Forest Reserve. Here it is considerably warmer than other streams in the area (53 - 60°F. in June to 70°F. in August). The water is brownish and the bottom heavily silted. Good pools and cover were found above and below the bridge. We were informed that good trout water was found in its upper reaches (the stream is about 13 water miles long).

The bottom food at the bridge is poor — only 0.2 cc per square foot. Forms collected were mayflies (Blasturus, Ecdyonurus, Baetis, Rithrogena), Caddis flies (Brachycentrus and Hydropsyche), chironomid larvae, cranefly larvae and blackfly larvae.

On June 20th a few Cutthroat trout were present and numerous other fish; these included:—

Chub — **Couesius plumbeus.**
Stickleback — **Eucalia inconstans.**
Northern suckers — **Catostomus catostomus.**

These last were very numerous.

In August the Little Jumping Pound, at least in its lower reaches, is reduced to a trickle and appears unsuitable for trout. Good conditions may still prevail upstream.

In 1946 it was planted with 5,000 Cutthroat trout. The fish we examined in June were young enough to be survivors of this planting.

In the absence of definite knowledge of the upper reaches, a recommendation on this stream cannot be made.

General Remarks on the Jumping Pound and Its Tributaries.

The main stream is a cool, moderately swift river, subject to spring flooding and poor in pools and cover. It is deficient in food in most parts. The tributaries, though smaller, are essentially the same. Muskeg and Sibbald are the best because of good pools and cover which they offer.

A too rapid run-off in the spring results in frequent low-water conditions in the fall with consequent winterkills, both in the main stream and the tributaries.

We examined 90 trout from the area. With the exception of three Dolly Varden, these were all Cutthroat trout.

No trace of the 34,000 Rainbow planted since 1941 was found. All these Cutthroat were young fish and have probably grown up in the stream since the winterkill.

For further details of trout see separate report which covers this species in all streams examined in 1947.

Continued planting with Cutthroat trout is recommended. No further plants with Rainbow appear advisable.

The Sheep River Survey (1947)

The survey party worked on the Sheep River drainage from June 22nd to July 9th, 1947, and August 24th to 26th, 1947. During the period the following were examined, some fairly thoroughly, others rather briefly:—Sheep river at several points, Junction, Bluerock, Gorge, Dyson, Coal, Wolf, Macabee and Lineham creeks; the North Fork and Ware and Fisher creeks. These waters are described in the report in this same order.

The Sheep River. The Sheep river rises west of Cougar Mountain at an elevation of 7,000 feet. It runs approximately 70 water miles eastward to enter the Highwood river at an elevation of 3,000 feet. This is an average fall of 75 feet per mile. Half of the total descent occurs in the first 12 miles where the gradient is 167 feet per mile. This is a steep stream gradient, almost torrential; it is slightly steeper than the Elbow river and considerably steeper than the Jumping Pound. Considerable stretches of the upper Sheep run through narrow gorges; this, combined with the steep gradient, make many reaches of very fast water.

The river was examined in the vicinity of Junction creek, at intervals between Junction and Gorge creeks, in the vicinity of Gorge creek in the vicinity of Coal creek and near Black Diamond.

Upper Sheep. At Junction creek the Sheep river is flowing at approximately 4 miles per hour — very swift. It is also cold — 47°F.— and completely lacking in pools or cover. The bottom is a uniform depth of 3 - 4 feet and composed of coarse rubble. Just above the mouth of Junction creek a low dam blocks the channel. We could find no fish between this dam and the Sheep river falls below. We were informed that there were no fish above the dam, in the Burn's mine area.

Two bottom samples taken from near Junction creek yielded an average of 0.5 cc per square foot. The bulk of the samples consisted of mayflies, **Ecdyonurus** and **Baetis,** stoneflies, **Acroneuria,** caddis larvae, **Hydropsyche** and miscellaneous fly larvae, oligochaetes and planarians.

About 1.5 miles below Junction creek the current is still 4 miles per hour. The channel is 100 feet wide with a few large and several small pools. The temperature is still very low — 47°F. The bottom food amounts to 0.9 cc per square foot and includes the same forms as found at Junction creek.

In the vicinity of Gorge creek the stream is braided in channels 80 - 90 feet wide which unite at Gorge creek to one channel about 120 feet wide. The water runs at 4 miles per hour over a bottom of rubble, without pools or bank cover.

The food supply amounts to 0.55 cc per square foot. The same animals were found and, in addition, the mayfly, **Rithrogena.**

From Gorge creek to Coal creek the river runs through a deep gorge for about five miles. It is swift, braided and exposed. Pools occur only at the turns in the channel, about every 200 yards. The next 1.5 miles to Coal creek (Camp McNab) see the Sheep come out of the Gorge and widen and become shallower. There are no pools or bank cover.

At Coal creek temperatures are still below 50°F. The river is about 120 feet wide and too swift and deep to wade. No fish were seen at the time of our visit (early July).

The bottom food at Coal creek amounted to 0.3 cc per square foot. The following organisms were found in the sample:—

Mayfly nymphs		Stonefly nymphs	
Iron	1	**Aconeuria**	12
Ephemerella	10	**Brachycentrus** (caddis)	1
Baetis	12	Midge larva (fly)	1
Rithrogena	56	Midge pupa (fly)	1

Lower Sheep. Aside from brief observations at Black Diamond, no work was done on the lower Sheep. At Black Diamond the river is cold, swift and somewhat braided, with little cover and few pools.

Remarks. The Sheep is a very swift, open river lacking in pools and bank cover. Large stretches of rubble bottom provide good shelter for trout. Food conditions are generally poor. The temperature is very low 40° - 50°F. and no good growth of trout may be expected. In June and July only a very few trout may be caught but in August the fishing improves and Cutthroat trout appear to be fairly plentiful.

We believe the Sheep river is too cold for Rainbow trout; the lower parts should be planted with Cutthroat and the upper parts might be planted with brook trout on an experimental scale, at least in the beginning.

Junction Creek. This little stream is about six miles long; it enters the Sheep river approximately twelve miles from its (the Sheep's) source.

During its course it drops from 7,000 to 4,700 feet, about 380 feet per mile. In spite of this very steep gradient, it is a rather gentle stream as the descent takes place over a series of high falls. In the lower three miles these falls have been covered over and built up with logs to make the stream suitable for floating logs. These structures have been in place about thirty years. They appear to make a thoroughly effective barrier to upstream fish migration, although we were told fish were seen occasionally in the upper parts.

The survey party examined almost all of Junction creek. The water is very clear; there are many excellent pools, undercut rocks and isolated boulders which provide wonderful fish habitat. The temperture varies from 42°F. to about 50°F.

Two bottom samples were taken in the first three miles; these averaged 0.4 cc per square foot. A third sample in the upper reaches revealed a much richer fauna — 1.9 cc per square foot.

All samples found the same organisms. The third contained:—

Mayfly nymphs		Stonefly nymphs	
Rithrogena	65	**Acroneuria** (large)	2
Ephemerella	3	**Acroneuria** (small)	14
Baetis	255	Caddis larvae	
Midge larvae	4	**Hydropsyche**	3
		Others	3

Remarks. Junction creek is perhaps too cold for Cutthroat and Rainbow trout. Since 1941 it has been planted with 12,900 Rainbow and 10,000 Cutthroat; these fish have disappeared.

It appears to be an ideal Brook trout stream. It is strongly recommended that Brook trout be planted above the last falls. This place may be easily reached by a sawmill road.

This recommendation, made verbally to Mr. Watkins during the summer, has already been acted upon; 4,700 eastern Brook yearlings have been planted.

Blue Rock Creek. Blue Rock creek, about six miles long, enters the Sheep river less than a mile below Junction creek. It descends from 6,000 to 5,000 feet or approximately 170 feet per mile.

The survey party examined most of this stream. It is quite similar to Junction creek with the same beautiful clear water. There is a series of 12 large and many small falls. Between the falls the flow is fairly gentle, 1 - 1.5 miles per hour. At the mouth the stream is 15 feet wide but at most points it is only 5 - 10 feet wide.

About 1.5 miles of the stream runs through a narrow gorge; elsewhere it is more open and quite shallow — 6 inches.

Up to the sawmill there are 21 pools; all but one of these is lacking in cover. Above the mill the valley broadens and there are very few pools and no cover.

The stream is spring-fed and subject to flash floods which subside over night.

The water is very cold, seldom reaching 50°F.

Food samples were taken near the mouth, midway and in the upper waters. At the mouth there was almost no food; 0.5 cc per square foot and 0.35 cc per square foot were found at the other points. The samples included: Mayflies **(Baetis, Ephemerella, Rithrogena),** Stoneflies **(Acroneuria, Altoperla),** midge larvae, caddis larvae **(Hydropsyche, Rhyacophila, Glossosoma).**

No fish were seen.

Remarks. Like Junction, Blue Rock creek appears too cold for Cutthroat or Rainbow. Possibly these species (again as in Junction) gradually get below the falls and cannot get up again. No trace of 15,000 Rainbow planted in 1944 was found. We recommend trying Brook trout in this stream.

Gorge Creek. Gorge creek, about eight miles long, enters the Sheep approximately 4.5 water miles below Blue Rock. It descends from 6,000 to 4,800 feet. The upper half is swift and precipitous, but the gradient in the lower four miles is moderate and the velocity from 1.5 - 2 miles per hour. The survey party made a thorough study of the lower four miles.

The stream runs through a narrow gorge, in places only six feet wide, to within a quarter mile of its mouth. Two tributaries enter in this stretch. There are numerous small falls, none of which appears impassable. The average width of the creek is 10 - 15 feet. There are a large number of fine pools with undercut banks and boulders forming good cover.

The temperature runs from 47° - 66°F., much warmer than Junction or Blue Rock.

Bottom samples were taken at three places in the stream. They averaged 0.5 cc per square foot. A typical sample contained:—

Mayfly nymphs	
Ephemerella	5
Baetis	14
Rithrogena	15
Siphlonurus	3

Stonefly nymphs	
Acroneuria	6
Hydropsyche (Caddis)	3
Fly larvae	
Tipulid	1
Midges	2

A large population of Cutthroat trout is present in Gorge creek. In a separate report on Cutthroat trout we show how it was calculated through marking experiments that there are from 790 - 1,600 Cutthroat trout per mile in Gorge creek. These are small fish, two-, three- and four-year-olds (mostly three) with an average weight of approximately 2.5 ounces. They are possibly a little stunted through over-crowding.

Remarks. Gorge creek, warmer than Junction or Blue Rock, is a better stream. It has a large population of Cutthroat trout and should be open to fishing next year. It should remain open for one year only and then be closed for one and maybe two years, depending on results of tests during the first closed year. It should be stocked with Cutthroat trout once during each closed period.

In 1944 this stream received 15,000 Rainbow trout. No trace of these was found. No further plants with Rainbow should be made as they undoubtedly move downstream to the Sheep and, probably, ultimately to the Bow river.

Dyson Creek. Dyson creek, about five miles long, enters the Sheep river 1.5 miles below Gorge creek. It descends from 6,000 to 4,700 feet, an average drop of 260 feet per mile. Like Junction and Blue Rock creeks, most of the descent is in the form of abrupt falls and the average stream velocity of 1 mile per hour is not great. The survey crew examined about two miles of the stream, mainly from the sawmill down stream.

Much of Dyson creek runs through a rocky gorge, but some places have sloping banks with willow cover. The pools are numerous, but lack cover and are badly polluted with sawdust from the mill. The sawdust was found in pools one mile below the mill's sawdust pile which is on the stream bank. Falls near the mill are jammed with logs and may prevent fish movements.

At least two permanent springs enter the creek.

The temperature fluctuates around 50°F.

The bottom samples yielded 1.7 and 0.4 cc per square foot, quite rich for streams of this region. The richer sample contained:—

Mayfly nymphs	
Ephermerella	39
Rithrogena	46
Baetis	61
Midge larvae	4

Stonefly nymphs	
Small nymphs	14
Caddis larvae	
Hydropsyche	4
Rhyacopila	15

A quantity of sawdust and chips.

Cutthroat trout were found in the pools which had cover. Unshaded pools were empty. The trout are not numerous or large.

Remarks. Since 1944 Dyson creek has received 20,000 Rainbow trout; none of these has been seen. The stream is too cold for Rainbow. The Rainbow probably would move down to large waters even were the creek warmer. We would suggest trying Brook trout in Dyson creek.

This recommendation was made verbally to Mr. H. B. Watkins, Superintendent of Fisheries, during the summer and 6,500 Brook trout yearlings were planted.

Coal Creek. Coal creek rises at 5,500 feet and descends to the Sheep river at 4,600 feet, an average gradient of 100 feet per mile. The north and south branches are each about 3 miles long and the main branch about six miles. Coal creek enters the Sheep river approximately five miles below Dyson creek, and directly across the Sheep from Camp Sandy McNab. On the Dominion map of 1926 it is labelled Dyson creek.

South Branch. The stream was examined from the Junction with the North Branch upstream for one mile. It is about 15 feet wide with a gentle flow of 1.5 miles per hour. There were 13 pools in the mile, 4 - 5 feet deep, and 10 - 15 feet long. The bottom is of small stones. There is a good bank cover of willows and spruce.

The food supply is moderate.

The temperature was 52.5°F.

The stream is well supplied with Cutthroat trout; 60 were hooked in one mile of stream.

North Branch. A stretch from the junction with the South Branch and upstream two miles was examined. It is ten feet wide, well provided with pools and dense bank cover of willow and spruce. The flow is about one mile per hour.

One mile from the junction are six abandoned beaver dams, now filling with mud.

The temperature was 50°F.

The food supply was poor, only 0.2 cc per square foot. The samples contained:—

Mayfly nymphs		Stonefly nymphs	
Rithrogena	11	**Acroneuria** (stonefly)	7
Baetis	5	Midge larvae	1
Ephemerella	2		

The stream is well stocked with Cutthroat trout.

Main Branch. This was examined near the Junction of the North and South branches and near the Sheep river. It ranges in width from 20 feet at the source to 40 feet at the mouth. Big pools are present every 50 - 60 yards. Good bank cover is present. The temperature was 51°F.

The bottom samples averaged nearly 1.0 cc per square foot—a fairly rich fauna for the district. One sample was taken near the source and the other about 100 feet above the mouth, the two samples contained:—

Mayfly nymphs		Stonefly nymphs	
Rithrogena	86	Large **Acroneuria**	6
Ephemerella	12	Small **Acroneuria**	37
Baetis	56	Caddis larvae	
Unidentified	1	**Hydropsyche**	3
Midge larvae	5	Unidentified	4
Midge pupa	1	Tipula larvae	2

The upper portion contained many Cutthroat trout.

Remarks. Although rather cold, Coal creek is a beautiful Cutthroat stream. Most of the trout present are two- to three- and four-year-olds; the three-year-olds comprised nearly 70% of our sample. These fish average only 2.5 ounces; they are smaller for their age than the Gorge creek fish and less than a third the size of three-year-olds from North Fork Sheep. We conclude that these fish are overcrowded and, therefore, stunted.

We recommend that Coal creek be opened to fishing next year and thereafter every other year or one year of every three, whichever experience shall prove to be better.

Since 1941, 9,200 Rainbow trout have been planted in Coal creek. It is not suitable for Rainbow and no further plants with this species should be made. In view of the present crowding, no Cutthroat plant is recommended for 1948. It is doubtful if the 3,000 planted in 1946 were really needed.

Wolf Creek. Wolf creek enters the Sheep river about 1.5 miles below Coal creek. It rises at 5,000 feet and descends about five miles to the Sheep at 4,400 feet, an average descent of 120 feet per mile. The survey party examined only the part near the mouth and upstream for one mile.

The stream averages about 12 feet wide and 8 inches deep with a boulder and rubble bottom. Pools are numerous and provide good cover both from trees and undercut banks.

The temperature was 56°F.

Two bottom samples yielded an average of 0.45 cc per square foot. The following organisms were found:—

Mayfly nymphs		Stonefly nymphs	
Leptophelbia	1	Small **Acroneuria**	32
Ephemerella	1	Medium **Acroneuria**	2
Baetis	30	Midge larvae	6
Ecdyonurus	64		
Rithrogena	6		

At the time of our visit the stream was murky and it was difficult to observe fish. A few Cutthroat trout were seen.

Remarks. Wolf creek appears to be a good Cutthroat stream.

Macabee Creek. This small creek rises at 4,800 feet and flows approximately five water miles to enter the Sheep at 4,200 feet, nearly seven miles below Wolf creek. The average gradient is 120 feet per mile.

In its upper reaches, Macabee creek is too small to be of much value as a trout stream. The last mile or so of the stream, however, is six to eight feet wide, with beautiful pools and excellent cover.

The food supply is very rich. The temperature is 52°F.

No fish were seen.

Remarks. Macabee creek probably goes dry in some summers, but, as it now is, it is suitable for Cutthroat trout.

Lineham Creek. Lineham creek rises at 4,500 feet and flows about seven miles to enter the Sheep river approximately four miles below Macabee creek at an elevation of 4,100 feet. The average gradient is 57 feet per mile. It was examined only briefly at the bridge on the road from Forest Reserve. Here it is a slow brown stream with nice pools and shelter and a dirty rubble bottom. The temperature was 56°F.

It is probably too slow and seasonal in its flow to be of much consequence as a trout stream.

North Fork of Sheep River. The North of the Sheep rises at 6,000 feet and descends for 37.5 water miles to enter the Sheep river at 3,700 feet. The average gradient is 98 feet per mile; a good deal of the drop is in the first 10 or 12 miles; the lower two-thirds has a more gentle gradient of about 30 feet per mile.

The survey party examined this stream as follows: A three-mile stretch just within the Forest Reserve, at the bridge on the Kew trail, and in the vicinity of Millarville.

The North Fork in the Forest Reserve is from 20 - 50 feet wide, shallow and fairly swift (two miles per hour). The bottom is of coarse rubble with many shallow riffles and fine pools; the pools are up to 20 yards long and 4 - 6 feet deep. Cover is provided by boulders and undercut banks.

The temperature varies from 51 - 70°F.

The bottom food is not rich; one sample yielded 0.25 cc, and another 0.1 cc per square foot. The organisms found in both samples were:—

Mayfly nymphs		Stonefly nymphs	
Rithrogena	60	Small **Acroneuria** (stonefly)	9
Baetis	12	**Hydropsyche** (Caddis)	1
Ecdyonurus	3	Midge larvae	1

In its lower reaches the North Fork gets very slow, murky, braided and shallow, with pools shallow and exposed.

The North Fork (in and near the Forest Reserve) has a fine population of Cutthroat trout. A marking experiment which we carried out gave a rough estimate of 400 trout per mile of stream (this experiment is described fully in the report on Cutthroat trout). We examined trout from 0 - 4 years old. Most of the trout were three- and four-year-olds and averaged six to eight ounces in weight. These are the fastest growing Cutthroat we found.

Remarks. Since 1941 close to 70,000 Rainbow trout have been planted in the North Fork. We carefully examined 136 trout from this stream and another 30 less carefully; all except one were Cutthroat trout; the one exception was a Dolly Varden. The only other fish seen in the stream were common and Northern suckers. The Rainbow have had a fair trial here and have not "taken". Only Cutthroat trout should be planted in the North Fork.

The present abundance of trout warrants an open season in 1948. After a year's fishing the stream should be again examined and future policy based on the findings.

Ware Creek. Ware creek rises at 5,000 feet and descends for 11 water miles to enter the North Fork at 4,200 feet. The average gradient is about 70 feet per mile. The survey party examined only a small stretch near the Forest Reserve boundary. Here the stream runs at about 1.3 miles per hour; it is 18 - 25 feet wide, shallow and slightly muddy. Pools occur every 75 - 100 yards and are small and shallow. The banks are well shaded.

The bottom food amounted to 0.2 cc per square foot. The following animals were found:—

Mayfly nymphs			
Rithrogena	29	Midge larvae	1
Ecdyonurus	1		
Baetis	9	**Brachycentrus** (Caddis)	2
Ephemerella	3		

The temperature at noon was 59°F.

No trout were seen; large shoals of common suckers were observed.

Remarks. The region examined does not look promising as a trout stream. We were informed by the ranger that trout are present in the upper reaches.

Fisher Creek. Fisher creek rises at 5,250 feet and descends for 16 water miles to enter North Fork about five miles below Ware creek at an elevation of 4,000 feet. The average gradient is 78 feet per mile. The survey party examined only a small stretch near the mouth. Here the stream is 20 - 30 feet wide, very slow and very dirty, but with a rich food supply. Few pools are present. The temperature at 1:00 p.m. was 66°F.

No trout were found.

Remarks. In its lower reaches Fisher creek is not a trout stream. The ranger informed us that trout (presumably Cutthroat) are present in the upper waters.

The North Fork and its tributaries dried to mere trickles in 1934-35, and froze to the bottom in the winter. In Ware and Fisher creeks this is probably a common occurrence.

SUMMARY OF RECOMMENDATIONS

1. The main Sheep river should be planted with Cutthroat trout over most of its length. Above Junction creek it would be worth while to try Eastern Brook (speckled) trout.

2. Junction creek should be planted with Eastern Brook trout, above the sawmill site.

3. Blue Rock creek is another possibility for Speckled trout.

4. Gorge creek should be opened to fishing in 1948. It should be closed the next year and examined again. On the basis of the findings it may be opened again for 1950, or left closed for two years of every three. The necessity for plantings with Cutthroat trout may be determined after a season's fishing.

5. Dyson creek is a possibility for Eastern Brook trout.

6. Coal creek — recommendations as for Gorge.

7. Wolf creek — probably should be opened in 1948. Plantings with Cutthroat only.

8. Macabee creek — uncertain. If plenty of Cutthroat available, some should be tried.

9. Lineham creek — no plantings recommended.

10. North Fork — A Cutthroat stream. Recommendations as for Gorge creek.

11. Ware and Fisher creeks. Cutthroat streams in upper reaches. Does not appear practical to plant fish in the lower accessible parts.

The Highwood Survey (1947)

The party spent the period July 9th to 18th inclusive on the Highwood and its tributaries. The large main river and its many tributaries admittedly are deserving of more time than this, but pressure of demands to investigate other waters forced the survey party to cut its time on the Highwood. It is hoped that there will be time in other summers to make further studies of this important valley.

Observations were made at several points on the Upper Highwood, and studies, less complete on some than on others, were made of the following tributaries:—

Storm, Mist, McPhail, Lantern, Odlum, Picklejar, Loomis, Bishop, Lineham, Carnarvon, Cat, Etherington, Cataract, Trap (Flat), Sullivan, Ings, and Pekisko. Our observations on these waters now follow in the same order as here listed.

The Highwood River. The Highwood river may be described as beginning at the foot of Mist Mountain (5,700 feet) at the junction of Storm and Mist Creeks. It flows eastward through a broad valley for about ninety water miles to enter the Bow river at an elevation of 3,100 feet. The average gradient is about 30 feet per mile. The Highwood is thus much less torrential than the Sheep and, with its broader valley, presents quite a different aspect.

The Upper Highwood valley, once heavily timbered, is now without living timber. The slopes are covered with fire-killed deadfall and very little regeneration is taking place. The soil is dry and friable, almost ashy; the river becomes dirty within a few minutes after the beginning of a rain storm. We believe dangerous erosion is occurring here; the cattle pastured on the Upper Highwood valley are certainly not helping the situation, but appear to be delaying recovery of the vegetative cover.

The survey party examined much of the Upper Highwood in detail; the entire stretch from Loomis creek upstream to the junction of Storm and Mist was waded and sampled at various points for food, temperature and fish. The stretch from Loomis to Cataract creek was also examined at numerous places. Further observations were made near the mouth of Sullivan creek and at Longview. The Lower Highwood was not studied.

The twenty water miles of the Highwood which lie within the Forest Reserve are all of swift, shallow river, broad, badly braided, with shifting bottom and changing banks. Pools are very few, shallow and wholly exposed. The bottom food is very meagre; the quantity per square foot is about 0.2 cc. A sample from the mouth of Loomis creek contained:—

Mayfly		Stonefly	
Rithrogena	2	**Acroneuria**	4
Ecdyonurus	21	Caddis larvae	4
Baetis	6	Cranefly	
		Eriocerca	1

The water is very cold; the range observed by us was 44°F. to 57°F. For most of each day the temperature is about 50°F.

A few Dolly Varden were caught in this part of the river; no other fish were seen.

Outside the Forest Reserve the river improves a great deal. The stretch from Sullivan creek to Longview is much deeper, with less braiding and many fine pools. The water is warmer, reaching about 60°F. by noon and a maximum of 63°F. by evening. Several miles of the river were examined upstream from Longview. There are many excellent pools here, with good cover. These pools are well provided with fish. We found Cutthroat trout were the most numerous; Dolly Varden, suckers and Rocky Mountain whitefish were also plentiful. Two small, recently planted Rainbow trout were also taken here.

The pH of the Highwood is 8.0.

Remarks. The Highwood within the Forest Reserve is a poor stream and is not worthy of intensive planting. An experimental planting with Eastern Brook trout is recommended.

(This recommendation has been carried out; 1,200 Eastern Brook trout were planted this past summer.)

Outside the Forest Reserve the Highwood looks suitable for Rainbow trout. However, it is doubtful if this species will remain when the Bow river is so easily accessible. Cutthroat trout will probably continue to provide most of the fishing.

Storm Creek. This stream, about ten miles long, descends from 7,000 feet at an average drop of 130 feet per mile. It flows at 5 miles per hour and is too swift and torrential to make a good trout stream. There are no pools, no cover and the channel is braided, shallow and exposed. Almost no bottom food was found. One sample, of negligible volume, contained only five mayflies and one stonefly. The water temperature was 50°F.

A few Dolly Varden inhabit this stream.

Remarks: Storm creek should not be planted with trout.

Mist Creek. This creek, about five miles long, descends at the same rate as Storm; the average stream velocity is less — 3 miles per hour. The twenty-foot channel is without pools or cover, except bottom boulders. The bottom food is more plentiful than in Storm and amounts to 0.3 cc per square foot. The temperature was 47°F.

Dolly Varden are present.

Remarks. This stream might do for Eastern Brook trout. It is too cold for Cutthroat.

Lantern and Picklejar Creeks. These two streams were examined briefly at their mouths. Both are between two and three miles long and descend at a rate of 600 - 1,000 feet per mile. Both are cold — 50°F.

Remarks. These streams are really mountain torrents and cannot provide homes for trout.

Odlum Creek. This stream enters the Highwood about two miles below Storm and Mist creeks. Four and a half miles long, it descends from 7,000 feet at an average rate of 300 feet per mile. While this is a rapid fall, there are long, fairly quiet stretches with fine pools and excellent overhanging bank cover. It is very cold — 47°F. The food supply is good.

Remarks. Odlum creek is too cold for Cutthroat trout but appears suitable for Eastern Brook. A planting of fry of this species is recommended.

Loomis Creek and Bishop Creek. Loomis creek enters the Highwood about 1.5 miles below Odlum. Approximately four miles long it descends at an average rate of 350 feet per mile. The creek is 10 - 15 feet wide below Bishop creek. The average velocity is 3.5 miles per hour. There are no pools or quiet water, but there is abundant bank cover. The food supply is fair amounting to 0.6 cc per square foot.

The following organisms were found:—

Small Mayflies	13	Stoneflies	
Mayflies		**Acroneuria**	15
Ecdyonurus	14	Caddis larvae	10
Ephemerella	13	Midge larvae	8
Baetis	13	Planarian	1

The water temperature was 44°F.

Above the entrance of its tributary, Bishop creek, Loomis is only 3 - 4 feet wide, but still swift. This stretch is provided with pools and dense bank cover. No fish were found.

Bishop creek, two miles long, is about the same as the part of Loomis above Bishop. It also is very cold — at 3:30 p.m. the temperature was only 40°F.

Remarks. Loomis and Bishop appear to be too cold for Cutthroat trout, (although a few trout are present in beaver dams on upper Loomis

— we did not catch one of these but believe they were Dolly Varden). We believe Eastern Brook would do well in these streams. They may be easily reached by a sawmill road.

Lineham Creek. Lineham creek, about four miles long enters the Highwood six miles below Storm and Mist. It has an average gradient of 350 feet per mile and a velocity, near the mouth, of 2.5 miles per hour. The average depth is 6 - 8 inches and the width about 20 feet. There are few pools but fair cover of willows on the banks. The food is fair but the temperature very low — maximum around 48°F.

Only a small stretch near the mouth was examined.

Remarks. Too cold for Cutthroat; possibly Brook trout should be tried.

McPhail and Carnarvon Creeks. McPhail creek is a little over five miles long and its tributary, Carnarvon creek, is about four miles long. McPhail enters the Highwood approximately eight miles below Storm and Mist. McPhail descends at 350 feet per mile and Carnarvon about 200 feet per mile. Both streams are very cold, the daily temperature range is from 42 - 48°F.

Both streams were examined almost in their entirety.

McPhail is 15 - 20 feet wide, mostly shallow and swift. The velocity is 2.5 miles per hour. The lower parts have some excellent deep pools with mossy undercut banks and overhanging willows. Here also the stream is broken into three channels, one of which has been dammed by beavers.

The food supply of the lower part is very good — 1.4 cc per square foot. The sample contained:—

Mayflies		Caddis larvae	6
Baetis	55	Midge larvae	5
Rithrogena	83		
Ephemerella	15	Stoneflies	
Siphlonurus	1	**Acroneuria**	27

The upper stretches of McPhail are shallow and exposed with no pools or cover. No fish were seen in this part. A few Dolly Varden were taken in the lower part.

Carnarvon Creek is about 15 feet wide and a little swifter than McPhail. In some places it is only two feet wide and very deep and swift. The lower part has some good pools with undercut banks and heavy willow growth. There is very little quiet water, even in the pools. The upper parts are more exposed.

The food supply is rich.

No fish were seen.

There is a sawmill functioning on upper Carnarvon (the men at the mill call it McPhail) and an abandoned mill on upper McPhail.

Remarks. Both streams seem too cold for Cutthroat but look like good Eastern Brook streams. Planting could be easily accomplished by using the sawmill roads.

Cat Creek. This stream, which enters the Highwood about two miles below McPhail creek, was only briefly examined at its mouth. It is approximately twenty feet wide, of uniform shallow depth with no pools or cover. The flow is 1.6 miles per hour. The temperature at 4:00 p.m. (maximum) was 51°F. The food supply is moderate.

Remarks. Appears to offer no habitat for trout.

Etherington Creek. This creek enters the Highwood some 14 miles below Storm and Mist. It is about seven miles long and falls at an average of 140 feet per mile. It was ascended from the mouth about two miles to Baril creek.

The section examined was 15 - 45 feet wide with a current of three miles per hour in the swifter, narrower section. The bottom is of gravel and rubble with an encrusting brown growth. Pools are not frequent; those present are very deep and separated by two 300-yard stretches of rapids running through sheer rock walls. The water is crystal clear and reaches a maximum of 51°F.

The food supply is very rich for this district and amounts to 1.7 cc per square foot.

The following were found:—

Mayflies		Stoneflies	
Baetis	54	**Perlinella**	1
Rithrogena	29	**Acroneuria**	9
Ephemerella	13	Midge larvae	5
		Caddis larvae	13

No fish were seen.

Etherington is evidently subject to floods; evidence of water six feet above normal level was found.

Remarks. A beautiful appearing stream with good food supply and moderately good pools and cover. We recommend a trial with Eastern Brook trout.

Cataract Creek. Cataract creek joins the Highwood approximately 17 miles below Storm and Mist. It is about 12 miles long and descends at an average of 80 feet per mile.

The survey party examined the lower three miles, by walking up the stream from the Highwood.

Just above its mouth the creek is 100 feet wide; very shallow and gravelly. Upstream it is narrower and consists of a long series of rapids and falls. The rapids are 50 - 300 yards long with little falls of 2 - 4 feet. Between the stretches of rapids are large, deep pools; some of these are 70 feet long by 50 feet wide and eight feet deep.

About a mile up from the mouth is a narrow gorge, ten feet wide, leading to a twelve-foot fall — an impassable barrier to fish.

Of the three miles examined there was altogether only about 100 yards of quiet water. The rest is all rapid and falls.

The temperature ranges from 46 - 55°F.

The food supply is rich. Several samples were taken which ran about 1.0 cc per square foot.

We saw no fish.

We were informed that the upper Cataract and its tributary, Wilkinson creek, were much quieter and contained fish. No fish were there previous to a planting made many years ago.

Remarks. Cataract creek is a very beautiful stream. However, it is rather cold and has very little quiet water in the lower reaches. Brook trout might be tried; the planting would have to be made with fry as there is no way of getting a fingerling tank across the Highwood at this point. The planting should be made above the falls.

Trap (Flat) Creek. Trap creek enters the Highwood 28.5 water miles below Storm and Mist and about nine miles outside the Forest Reserve boundary. The creek is 17 miles long and descends at an aver-

age of approximately 90 feet per mile. The survey party examined a section at the mouth and a section about two miles upstream.

The stream is about 30 feet wide with nice pools every 50 to 100 yards and rapids between. The pools are open and exposed with cover provided mainly by large boulders. The stream velocity is three miles per hour. The temperature ranges 55° - 70°F.

The food supply is relatively rich — 1.1 cc per square foot.

The following organisms were found:—

Mayflies		Caddis		Stoneflies	
Baetis	16	**Glossosoma**	1	**Acroneuria** (stonefly)	8
Blasturus	20	**Brachycentrus**	1	Parnid beetle	1
Rithrogena	50	**Hydropsyche**	1	Midge larvae	4
Siphlonurus	8	Unidentified	3	Aphid	1

Cutthroat trout are plentiful in Flat creek, although difficult to catch because of the open nature of the stream. The fish taken were one- and two-year-olds and exceedingly well grown. The two-year-olds were up to eight ounces in weight. Most of the fish were immature.

Remarks. Flat creek appears to be a good Cutthroat stream. The 69,000 Rainbow planted since 1941 have left no trace. Flat creek could be opened for fishing in 1948. A further check should be made at the end of a season's fishing and policy for other years decided on the findings. Occasonal plantings with Cutthroat may prove desirable. No further Rainbow plantings should be made.

Sullivan Creek. Sullivan creek enters the Highwood some 33 miles below Storm and Mist junction. About 10.5 miles long, it descends at an average of 70 feet per mile. This is a much more gentle gradient than the tributaries further up the Highwood.

The survey party examined a large part of Sullivan creek all the way from the headwaters in the Forest Reserve, through the ranch country to the Highwood. For most of its length it is a gentle stream (about 1 mile per hour) from 2 - 6 feet wide with a beautiful succession of deep, quiet, shaded pools and dense vegetation on the banks. In many stretches the banks are undercut, or the willows hang right across the stream so that abundant shade is provided.

The Sullivan creek valley was not burnt in the Highwood fire; there is, therefore, little evidence of flooding and we observed that, unlike the upper Highwood and its tributaries, Sullivan creek remains clear during and after heavy rain storms.

Sullivan creek is warm; we observed a daily temperature range from 58° - 70°F. The food supply is moderate to rich. A typical sample yielded 0.7 cc per square foot. The following forms were found:—

Mayfly		Caddis		Midge larvae	8
Baetis	38	**Rhyacophila**	5	Parnid beetle larvae	5
Callibaetis	20	Unidentified	1	Tipula larva	1
Iron	9			Stonefly	
Siphlonurus	1			**Acroneuria**	7

The lower parts of Sullivan, in the open, ranching country are 10 - 20 feet wide, deeper, slower and slightly warmer. The pools have earth or buried stone bottoms. The water remains clear and cover still excellent.

Sullivan creek suports a large fish fauna. We found common suckers, Cutthroat trout and Dolly Varden. The Cutthroat and Dolly Varden occurred in the ratio 53 Cutthroat to 4 Dolly Varden.

The Cutthroat trout were very numerous; we found fish from one to four years old, but more than half were two-year-olds, and immature. In size they ran from 1.5 to 8.5 ounces, mostly about three ounces. These fish are fairly well grown but possibly would do better if not so crowded.

Remarks. Sullivan creek is a beautiful Cutthroat stream, warm, sheltered and fairly rich in food. We believe the stream would benefit from an open season in 1948. At the close of this open season it should be again examined and future policy based on the findings.

Since 1941, 94,700 Rainbow trout have been planted in Sullivan creek. The population now present is exclusively Cutthroat. No further plantings with Rainbow should be made. The 15,000 Cutthroat planted in 1946 may or may not be the two-year-olds we found. In any case, the population is now very large and further plantings with Cutthroat would merely aggravate the overcrowding.

Ings Creek. Ings creek enters the Highwood about three miles below Sullivan. It was examined only briefly at the bridge over it on the road. It appears to be a warm, gentle stream, 6 - 10 feet wide with good pools and shelter and a moderate food supply.

It would appear to be a Cutthroat stream.

Pekisko Creek. Pekisko creek, about 15 miles long, enters the Highwood some 52 miles from the junction of Storm and Mist. It descends at an average rate of 80 feet per mile, but much of it is more gentle than this.

The survey party examined Pekisko creek in the Forest Reserve and at several points through the ranching country down to the Highwood.

Pekisko is 30 feet wide over much of its length and is, therefore, larger than Sullivan creek. In other respects, however, it is very similar. There is the same abundance of sheltered, quiet pools and warm water (50° - 70°F.). One portion of the stream, a two-mile stretch just outside the Forest Reserve is rather open and shallow, but most parts are well sheltered.

The food supply is the richest we have found anywhere. One sample, taken near the Bar U ranch buildings yielded 8.2 cc per square foot. Elsewhere samples yielded about 1.5 cc per square foot. A wide variety of organisms was found as shown in the following enumeration:—

Brachycentrus	401	**Baetis**	43
Rhyacophila	9	**Epeorus**	55
Unidentified	10	**Siphlonurus**	6
Acroneuria (stonefly)	9	**Ephemerella**	16
Parnid larvae (beetle)	7	**Habrophlebia**	1
Midge larvae	13	**Simulium** (blackfly)	2
Tipulid larvae	2	Planarians	3

A few miles outside the Forest Reserve there is a large fall of about 12 feet. Below this is a large deep pool where a number of big Dolly Varden and many smaller Cutthroat are living. We managed to remove

four of the Dolly Varden which were up to 4 pounds in weight. These falls appear to be impassable for fish.

Pekisko creek has a fine population of Cutthroat trout, a few suckers and a few Dolly Varden. The Cutthroat are from 1 - 3 years old, mostly two-year-olds. About half are immature. They are well grown and weigh up to 7.5 ounces. The average of our sample was 4 ounces.

Remarks. Pekisko creek is a fine Cutthroat stream. An open season could be permitted in 1948, but, like Sullivan, it should be re-examined and future policy based on the findings.

Since 1941, 103,000 Rainbow trout have been planted in Pekisko Creek. There is no trace of these fish.

30,000 Rainbow, planted in July, 1947, were studied by the survey party. Instead of dispersing in the stream, they schooled together in a long, shallow pool, where they made quite a sight, jumping at the surface. We could find no evidence of these fish moving up or downstream each day many died and, probably, none would be left by freeze-up.

A brief examination of Stimson creek, tributary to Pekisko, convinced us it is not suitable for trout.

SUMMARY OF REMARKS

The upper Highwood and tributaries downstream to Cataract creek are very fast, cold streams; we feel they may be suitable for Eastern Brook trout.

The lower Highwood provides good Rainbow water and any Rainbow plants on the Highwood drainage should be restricted to the lower part of the main stream.

The tributaries below Cataract creek are all Cutthroat streams. Recommendations re all tributaries examined are summarized as follows:

1. Storm creek. Not to be planted with any species.
2. Mist creek. A small plant of Eastern Brook trout if surplus is available.
3. Odlum creek. Plant with Eastern Brook trout—fry.
4. Loomis and Bishops creeks. Plant with Eastern Brook fingerling or yearlings.
5. Lineham creek. Plant with Eastern Brook fingerlings or yearlings, but only if surplus is available.
6. McPhail and Carnarvon creeks. Plant with Eastern Brook fingerlings or yearlings.
7. Cat creek. Not to be planted with any species.
8. Etherington creek. Plant with Eastern Brook fry (no road for tank trucks).
9. Cataract creek. Plant with Eastern Brook fry (no road for tank trucks).
10. Flat or Trap creek. Plant no more Rainbow trout. Open season for Cutthroat in 1948 recommended. A re-check in fall of 1948 to determine future policy.
11. Sullivan creek — Same as Flat.
12. Pekisko — Same as Flat and Sullivan creeks.

Tongue and Bull Creeks, Highwood River Tributaries (1948)

Tongue and Bull creeks are tributaries of the lower Highwood, entering the left and right banks, respectively.

Tongue Creek — consists of approximately 28 water miles of gentle stream which rises in the foothills and empties into Highwood north of High River. It has an average gradient of 36 feet per mile; most of the drop occurs in the upper half. The stream was examined July 19, 1948, from four miles below its source, downstream, intermittently, to below the Purity Refinery.

At the first point, four miles below the source, it is about 12 feet wide, shallow, rocky, rocks covered with slime and algae, flow very gentle, becoming muddy after 15 minutes light rain; pH 7.7; bottom food rather poor, of small mayfly nymphs, caddis larvae and blackfly larvae. Large fauna of five-spined sticklebacks. Maximum temperature 66 - 70°F.

A few miles below this point the stream is in open country, and is slower and rather dirty. The bottom has become mud. Temperatures well over 70°F. Bottom fauna mainly blackfly larvae . Many sucker fry.

Below Purity Refinery the stream is heavily polluted with oil. Oil and grease were found clinging to aquatic plants and stones. All animal life was absent. To check on the source of pollution we examined the stream again immediately above the Purity Refinery and found bottom animals and sucker fry present.

In conclusion, we consider Tongue creek too warm, dirty and in lower reaches, too polluted, to be a trout stream.

Bull Creek consists of about 7.5 miles of water entering the Highwood just west of Longview. It is a fairly cool stream (60°F.) 2 - 3 feet wide, with a brisk flow, gradient of 80 feet per mile. It is very shallow, often just a trickle, and too small to be of interest as a trout stream. It contains a few minnows (species not determined) which local people catch for bait.

Conditions in Flat (Trap), Sullivan and Pekisko Creeks (Highwood Drainage) (1948)

As a result of recommendations based on the surveys of 1947, Flat (Trap), Sullivan and Pekisko creeks were open to anglers for the 1948 season. In order to check on the results of this open season, a visit was made to these streams on August 26th. The streams were fished and examined for fry and young fish.

Flat (Trap) Creek. In one hour's fishing on Flat creek we took four trout, only one of which was legal. However, we saw plenty of fish; these were very wary and, as the stream is open, it is hard to approach fish without being detected. We found large numbers of fish-of-the-year along the stream margins.

We conclude that Trap creek has not been affected much by a season's angling. The principal result has been to make the fish wary and harder to catch.

Sullivan Creek. We took eight trout in an hour's fishing, four legal and four under-size. This is no appreciable difference from last year (in the lower reaches). Numerous fry were observed.

We conclude that a season's fishing has not harmed Sullivan creek.

Pekisko Creek. We caught large numbers of small fish, but no large ones. We saw many large ones lying in pools; these would not rise or take bait.

We conclude that Pekisko is still richly supplied with fish, mostly small.

A NOTE ON STREAM TEMPERATURES

During the survey made in 1947 of the Jumping Pound, Sheep and Highwood drainages, it was observed that stream temperatures varied a good deal according to the time of day. To find how great this variation was, we took temperatures (at the same place) as many times during each day as opportunity allowed us. We were rather surprised to find that the daily temperature variation on most streams covered a range of 15 - 17°F.

At 8:00 a.m. the temperature is still at the overnight minimum. The daily maximum is reached at about 4:30 p.m. (times are daylight saving). Temperatures taken at 8 or 9 in the morning are 16°F. below the maximum. Since, in trout investigations, the maximum temperature is the one wanted, readings made before noon or in the evening can give a very misleading picture of a stream.

Accordingly, from the summer's temperature data, we have prepared a graph which enables an approximate correction of temperature taken at any time during the day (7:00 a.m. to 12:00 midnight). To use this graph it is only necessary to have the temperature of the stream and the time the temperature was taken. Select this time on the bottom line of the graph and run a finger along the vertical line until it intersects the curve. Then follow the horizontal line from this intersection to the left margin of the graph and read there the number of °F. which should be added to the temperature reading to give the daily maximum. (See graph on page 42.)

This curve will fit well enough any of the streams examined in summer, but it may not be applicable at times other than July and August.

This brief report is submitted in case it may be of some value to fieldmen in helping them to "size up" streams.

Notes on the Cutthroat Trout from the Jumping Pound, Sheep and Highwood Drainages (1947)

The Cutthroat trout, **Salmo clarkii,** is the only trout native to our east slope streams. Although he is a handsome and gamey little fish, Alberta anglers, perhaps influenced by tales from the West Coast, have never seemed to appreciate him, and the demand has been for Rainbow trout propagation. Obeying popular desire; the provincial Fisheries Branch has specialized in Rainbow trout; since 1941, 777,250 Rainbow, 52,750 Cutthroat and 12,400 Eastern Brook trout have been planted in these three drainages.

These enormous plantings of Rainbow trout, most of which were fingerlings or older fish, should certainly be yielding a good harvest to the angler. Are they? Here is what we found this past summer. Of 617 trout which we examined carefully, 599 were native Cutthroats, 14 were Dolly Vardens and 4 were Rainbows. The four Rainbow seen were small and we have reason to believe they were part of a 1947 planting. The conclusion is surely obvious; the campaign to introduce Rainbow trout has not been a success. Native trout, produced in the streams, have provided nearly all the fishing.

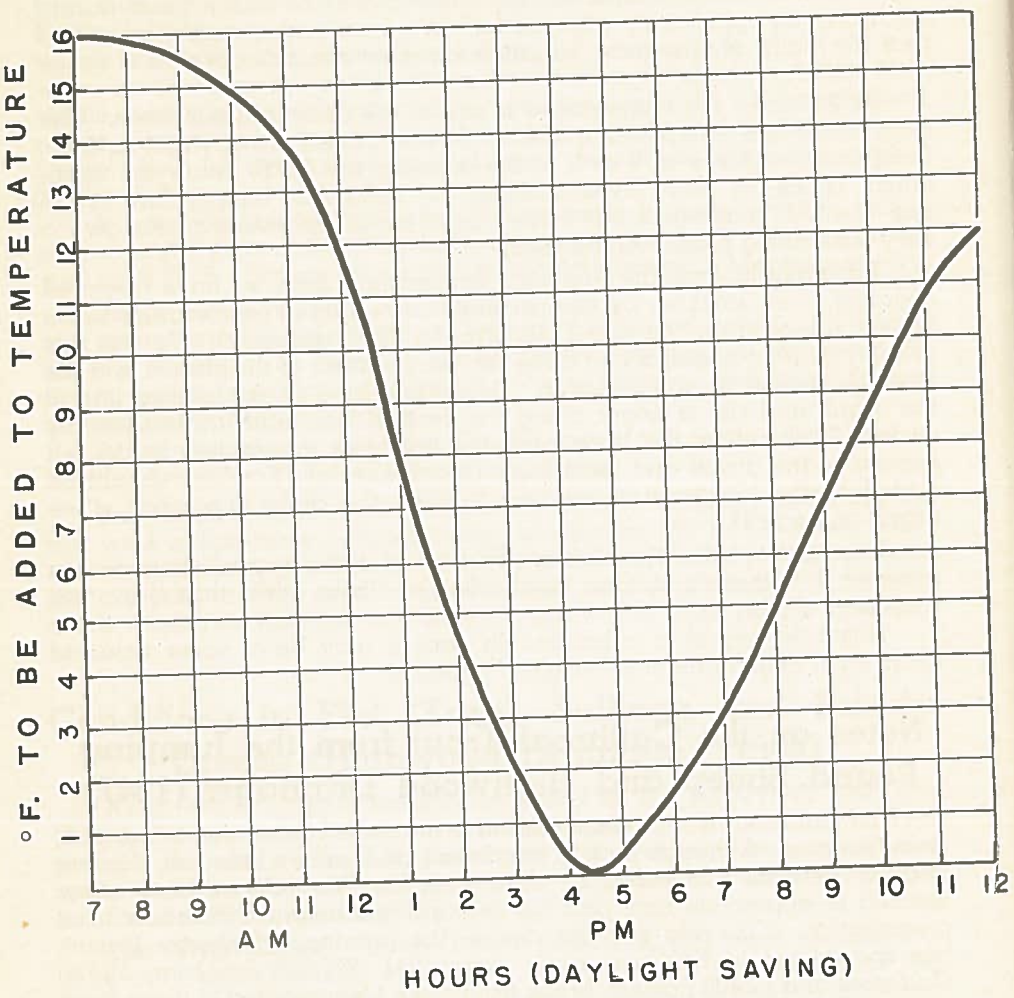

°F. TO BE ADDED TO TEMPERATURE
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
A M
P M
HOURS (DAYLIGHT SAVING)

FIG. 2

Recognition of the Cutthroat

The statements we have made in the preceding section will not go unchallenged. Many anglers have reported good rainbow catches this past season, and reports of Rainbow catches have been frequent in other years as well. During this past summer and also in 1946, our survey crew several times met angling parties on the streams. The sportsmen were always happy to show us their catches. Without exception they told us they had caught Rainbow trout; without exception their catches were actually Cutthroat trout. No doubt many an angler who reads this will be righteously indignant; he will know perfectly well how to distinguish between Cutthroat and Rainbow. And no doubt some anglers do know. But we claim the majority do not distinguish. It is not an easy thing to do. Here are the characters used for this purpose:—

Rainbow:—

No red slash in crease below each side of lower jaw.
No hyoid teeth in throat.
Scales of lateral line number around 135.
Mainly black-spotted, but some red spots present.

Cutthroat:—

Red slash in crease below each side of lower jaw usually present.
Hyoid teeth in throat.
Scales of lateral line number around 150.
Entirely black-spotted — no red spots.

The reader will probably be struck at once by the fact that the favorite feature, the "Rainbow" stripe is not listed. This rosy band, which extends along each side of the body from cheek to tail, is present as often on Cutthroat trout as it is on Rainbow. Other color characters are not reliable either; the red "Cutthroat" slash, while confined to Cutthroat trout, is fairly often absent. For sure identification the fish student is forced to rely on anatomical characters such as hyoid teeth and scale count. This is not surprising when one considers that the two species are so closely related that they interbreed, and produce fertile hybrids, not "mules".

Some of the Cutthroat trout we studied this summer were used in a colour study. Thus of 73 Cutthroat trout studied for colour, 40 had strong "Cutthroat" marks, 13 had only faint marks and 20 fish had no Cutthroat mark at all. That is, nearly half the fish had the typical "cut" mark faint or absent. Even when it is strongly present many would overlook it unless the deep crease where it occurs were pulled open to expose it.

Another group of 62 Cutthroat was examined for rosy band along the side; 33 had this band and 29 lacked it — about fifty-fifty break.

We found a strong association between the rosy band and the "Cutthroat" mark. Thus no fish with the "cut" mark lacking had rosy sides. Conversely, most of the fish with strong cut-marks also had rosy sides. The actual figures found were:—

"Cut" marks strong, rosy band present	28
"Cut" marks strong, rosy band absent	2
"Cut" marks faint, rosy band present	3
"Cut" marks faint, rosy band absent	9
"Cut" marks absent, rosy band present	0
"Cut" marks absent, rosy band absent	20

The fish which look most like Rainbows (pronounced rosy band) on examination under the jaw, also look most like Cutthroat.

Some have advanced the theory that the brightness or faintness of colours is connected in some way with sex. Undoubtedly, at spawning time the male is the more resplendent, but at other times this may not be so. Our study shows no association of colour and sex. The figures are:—

Rosy band present — 22 males and 9 females.

Rosy band absent — 20 males and 11 females.

The ratio of the two sexes is the same for rosy band present and rosy band absent.

"Cut" marks strong — 27 males and 15 females.

"Cut" marks weak or absent — 15 males and 5 females.

Again there is no great difference in the ratio of sexes for strong and weak "cut" marks.

From this brief analysis of the colour situation it is clear that characters such as scale counts must be given greatest weight in deciding to what species a trout belongs.

Growth of Cutthroat Trout in Different Streams.

We measured, weighed and took scale samples from 263 Cutthroat trout during the past summer's survey. Each scale sample was cleaned, mounted on a glass plate and projected on a screen so that the markings on the scales could be studied. From these markings an estimate of the age of each fish has been made. Next the average length and weight of each age group was calculated. Most of the fish used in this growth study came from eight streams. The growth rates of the Cutthroat trout from these eight streams are shown in table 7. The average length for each age is given in inches and the average weight in ounces.

TABLE 7.

Average lengths (inches) and weights (ounces) for Cutthroat trout of each age taken from eight streams.

	Age					
Jumping Pound Drainage—	1	2	3	5	4	
Jumping Pound	--	--------	6.9—2.25	6.6—1.75	8.8—5	--------
Sibbald	--	--------	--------	8.7—4.3	10.1—6.3	10.3—6.5
Sheep Drainage—						
Coal	--	--------	5.9—1.2	7.0—2.5	8.7—4.2	--------
Gorge	--	--------	7.2—2.7	8.1—3.4	9.9—6	--------
North Fork	4.0	6.9—2.2	9.1—5.8	10.7—8.3	12.0—11.5	--------
Highwood Drainage—						
Sullivan	--	5.9—1.5	7.5—3.1	9.2—5.2	11.0—8.5	--------
Pekisko	--	6.8—2.6	7.9—3.8	9.8—7.1	--------	--------
Flat	--	6.2—1.8	9.3—5.7	--------	--------	--------

The trout in these streams were small and young and the sizes of older specimens are unknown. Also rather small samples were studied from the Jumping Pound and our findings for this stream cannot be regarded as fully trustworthy.

A study of Table 7 shows a remarkable variation in the size of fish of the same age from different streams. For example, a two-year-old from the North Fork of the Sheep river weighs nearly six ounces whereas a fish of the same age from Coal creek weighs only slightly over one ounce. A large part of our survey work, reported elsewhere, was a

study of the streams themselves — food, cover, temperature, pools and current. The explanation of the wide variation in growth in different streams must lie in characters of the streams. In Table 8 the eight streams are shown arranged in the order of the growth rate of the Cutthroat; the various characters of each stream are listed.

TABLE 8.

Eight streams arranged in the order of the growth rate of the Cutthroat trout in them, with various stream characters listed.

Stream	Food cc/sq. ft.	Temp. °F.	Pools	Cover	Velocity (m.p.h.)	Size
N. Fork	0.2	51-70	Frequent	Good	2	Large
Flat (Trap)	1.1	55-70	Average	Fair	3	Medium
Pekisko	1.5	50-70	Frequent	Good	1	Medium
Sullivan	0.7	58-70	Frequent	Good	1	Small
Sibbald	Poor-0	48-53	Frequent	Good	0.7	Small
Gorge	0.5	47-66	Frequent	Fair	1.5-2	Small
Coal	0.7	50-52.5	Average	Fair	1.5	Small
Jumping Pd.	0.2	50-60	Rare	Poor	1-2.5	Large

The analysis in Table 8 is weakened by the lack of more accurate measurements of food, temperature, etc. The true temperature range could only be obtained by daily observations all year round. Similarly food supply varies seasonally and from place to place and the figures above are doubtless very crude approximations. However, in spite of these limitations, we may draw some conclusions as to what constitutes a good Cutthroat stream.

Food supply does not appear a limiting factor, although two of the best streams, Flat and Pekisko, had rich food supplies. It will be shown later that Cutthroat depend a great deal on surface food, so bottom food (shown in Table 8) is not so important.

Temperature is of extreme significance. The cooler streams very definitely show the poor growth. Taking all the characters into account we may generalize as follows:—

A good Cutthroat stream is warm, swift and wide with frequent pools and good cover. The amount of bottom food need not be great, but is usually fairly large.

Poor Cutthroat streams (i.e., slow-growing fish) are cold, slow and small (or large with no pools or cover). The amount of food on the bottom is small.

The above discussion fails to take into account the effect of population density. This may or may not be large, but it is believed not to be significant in the streams here studied. The North Fork, for example, was heavily populated, yet showed the best growth. A discussion of population density in two streams is presented in a section further on.

Age and Size at Maturity.

Whenever we could determine the sex of a fish and, by examining the sex organs, reach a good opinion as to its maturity these facts were recorded. Altogether we collected information on maturity from 233 Cutthroat from seven streams. In Table 9 the number of mature and immature fish is recorded; also the weight range in ounces of immature and mature fish and the range of ages during which maturity is reached.

TABLE 9.

The number of mature and immature Cutthroat, their weight ranges and age of maturity.

Stream	No. Mat.	No. Imm.	(Size Ranges Oz.) Mature	Immature	Age of Maturity
N. Fork	16	10	5.5 and up	up to 5-7	2-3
Flat	4	7	6 " "	" " 5	2-3
Pekisko	13	13	3 " "	" " 6	2-3
Sullivan	18	39	4 " "	" " 3.5	2-3
Sibbald	22	4	3.5 " "	" " 4	2-3
Gorge	22	32	2.5 " "	" " 2.8	2-3
Coal	30	3	1 " "	" " 1.1	2

Table 9 brings out a number of interesting points; there is quite a range of sizes at which maturity is reached. In the North Fork immature fish of seven ounces were found; in Coal creek the largest immature fish weighed only 1.1 ounces. The other streams lie between these extremes. In spite of this variety of sizes, the age of maturity is quite constant; many fish mature as two-year-olds, the remainder as three-year-olds in each stream. No differences in the age or size of maturation of males and females were noted.

The angler is more interested in the lengths, in inches, of mature fish. Table 10 shows the largest length, in inches, which would include an appreciable proportion of immature fish.

TABLE 10.

The maximum length, in inches, of Cutthroat trout, which would include an appreciable proportion of immature fish.

Streams	Lengths
North Fork	10.8
Flat	9.3
Pekisko	9.7
Sullivan	9.2
Sibbald	8.7
Gorge	8.1
Coal	7.2

The legal minimum length is now eight inches. Obviously this allows the taking of many immature fish as only one creek, Coal, lies below eight inches. What is needed, for good conservation, is a size limit for each stream. Since this is obviously impossible to administer a compromise is necessary. We suggest a legal minimum of nine inches. Ten inches would be better but this limit would cut down rather heavily on the angler's creel and probably would not be adhered to.

Food of Cutthroat Trout.

The stomach contents of 263 Cutthroat trout were examined and recorded. The findings are summarized in Table 11, which shows the number of stomachs in which each item was found.

TABLE 11.

The frequency of occurrence of various food items in Cutthroat trout stomachs.

	Item.	Number of Stomachs.
Aquatic in origin	Mayflies	61
	Stoneflies	73
	Caddis larvae	81
	Corixids (bugs)	48
	Snails	1
	Cutthroat eggs	1
	1. Miscellaneous	48
Terrestrial in origin	Spruce needles	26
	Beetles	152
	Ants	112
	2. Other insects	61
	Mice	1
	Stones	1

1. Miscellaneous aquatic includes dragonflies, midges, craneflies, blackflies, worms.

2. Other insects includes bees, blowflies, grasshoppers, beeflies, hornets, caterpillars.

The Cutthroat trout is not narrow in its choice of food, apparently it will eat almost anything. Table 11 shows a slight preference for surface-feeding; thus items picked off the surface were found 378 times. Beetles and ants were the most frequently occurring food items. It is clear from this that the amount of food on the bottom of the stream need not be a limiting factor in the growth of trout.

Study of Population Density.

A general survey, such as we were conducting this past summer, gives little opportunity for intensive study of one thing. We did try, however, to get some idea of the numbers of fish living in two streams, Gorge creek, tributary to the main Sheep river, and the North Fork of the Sheep river. The technique used was to catch a number of trout, clip the right pectoral fin off, and release them. Later the same section was fished again; if the number of recaptured fish is y and the total number marked is x, then the population P, in the section studied is given by,—

$$P = \frac{x}{y} \text{ times number caught.}$$

This method is accurate only if large numbers of fish are used — a thing we were unable to do. Our figures are large enough to give a rough approximation of the population.

Gorge Creek. On July 4, 1947, 53 Cutthroat trout were caught in 3/4 miles of Gorge creek, marked by fin-clipping, and liberated.

On July 8, 1947, the same section was fished; 47 fish were caught of which two were marked. The population, therefore, equals $\frac{53 \times 47}{2} = 1{,}245$ fish, or, approximately 1,600 fish per mile.

All fish caught were liberated.

On August 25, 1947, 52 days after the fin-clipping, the same section was again fished; 56 fish were caught of which 5 were marked fish $P = \frac{53}{5} \times 56 = 594$ fish, or approximately 792 fish per mile.

The population per mile in Gorge creek must lie somewhere between 790 and 1,600 fish per mile. Gorge creek is only two to six feet wide, so this is a large population.

This experiment on Gorge creek brought out some interesting secondary facts:

We found no dead fish, and fish which had been fin-clipped were still living 52 days later. These fish were hooked on a fly, taken firmly in one hand and the fin cut off close to the body, rather rough treatment.

During the second visit, in August, we fished very thoroughly above and below the 3/4-mile section where the fish had been marked. No marked fish were found except in the experimental area. This suggests that Cutthroat stick to one part of the stream, at least in summer.

North Fork. On July 5th, 1947, 68 Cutthroat were removed from about 3 miles of the stream, marked by fin-clipping, and liberated. Unfortunately we were forced to continue our experiment the next day—the marked fish had only one night to recover from their rough handling. On July 6, therefore, the same section was again fished; 71 fish were taken of which 4 were marked. The population estimate is:—

$$P = \frac{68}{4} \times 71 = 1{,}207 \text{ in three miles, or 400 per mile.}$$

A denser population appears to exist in Coal creek, but no opportunity to try a marking experiement was available.

Seasonal Movements of Cutthroat

Unfortunately, we have almost no information on this most important topic. Where the trout go during flood or winter is largely a matter of conjecture. We have gathered a little evidence which has a bearing on the subject.

Rate of Growth. The figures in Table 7 giving the rates of growth of Cutthroat in 8 different streams show that the fish in each stream have their characteristic growth rate; each stream is different. This suggests strongly that the population of each stream is permanent, for, if the fish moved in and out of the streams, all should show the same growth rates.

Gorge Creek Experiment. It was explained in the previous section that from July 4 to August 5th the fish in Gorge creek had not moved, as no marked fish were found outside the area in which they had been marked.

The evidence given above suggests that Cutthroat trout stay in the same stream where they are born. If this is true it means that closing tributary streams will not provide a nursery to stock the main stream. Our observations on the Sheep, Highwood and Jumping Pound provided no evidence that trout from the closed streams were moving into the main rivers.

The question of where trout go, if anywhere, during a flood cannot be answered. We found trout in a beaver dam during a flood on Sibbald creek; none was found in the creek itself. While the same flood was on at least some of the trout in the Jumping Pound took refuge in small temporary spring streams which remained clear during the high-water period. We believe many trout do not move at all, but take cover

under cut banks and in deep pools. The tremendous number of bruises on every trout's body (visible on magnified scales) testify that the trout take quite a beating — probably during floods.

Some people maintain that, during winter, trout drop down to the larger rivers. While this is probably true in many cases—e.g., Rainbow trout — the evidence for Cutthroat does not agree. At the time of spring break-up forest rangers report having seen trout killed by suffocation washing down stream in large numbers. Mr. Jim Cartwright of D. Ranch on Pekisko creek told us that Cutthroat wintered in that creek; on one occasion, about Christmas time, he told us of the water getting so low that stretches dried up and he and his men moved trapped trout to other stretches of the stream.

On the whole, therefore, we tentatively conclude that the Cutthroat trout remain in pretty much the same locality for a good part of their lives. We found no very old fish and it is possible that beyond 5 or 6 years of age the trout do move into larger waters.

Recommendations.

1. The importance of the Cutthroat trout justifies a special study of its movements, growth and feeding habits. This should be conducted somewhere on the east slope on a year-round basis.

2. Since the Cutthroat provides most of the angling the hatchery should relieve the angling pressure by planting more Cutthroat and fewer Rainbow.

3. A staggered system of open tributaries should be worked out. On the basis of present knowledge it would appear that each tributary should be fished one year and closed for the next two. The staggering could be arranged so that some of the tributaries are open each year.

4. Tributaries should not be permanently closed on the theory that they stock the larger rivers.

5. The legal minimum should be increased to at least nine inches (fork length).

6. This report, or the information contained in it, should be made accessible to the anglers who fish on the east slope.

Summary.

The report presents the data on Cutthroat trout which were secured during a survey of Jumping Pound, Sheep and Highwood drainages, in the summer of 1947.

Cutthroat, the native trout, provide almost all the angling in these drainages. An account of their colour characters and how they may be distinguished from Rainbow trout is presented.

The growth rate of the Cutthroat in eight streams is given and an attempt is made to correlate the growth with stream conditions.

Observations on age and size at maturity show that the present legal limit of eight inches allows a large number of immature fish to be taken.

Studies of population density in two streams are outlined.

A discussion of seasonal movements, based partly on evidence and partly on hearsay, is presented.

Six recommendations are made.

On the Success of Plantings of Speckled Trout in the Elbow, Sheep and Highwood (1948)

The 1946 survey of the Elbow river recommended that Eastern Brook trout be planted in some of the tributaries and in the main Elbow, above the falls. The 1947 survey of the Sheep and the Highwood also recommended Eastern Brook trout for some of the upper tributaries of both these streams. All these waters appeared to be too cold to give a good growth of the native Cutthroat, and Rainbow, tried repeatedly, have not made a good showing. As a result of these recommendations Eastern Brook (speckled) trout were planted in the suggested waters in the late summer of 1947.

The Elbow River.

In August, 1947, approximately 10,000 yearling Brook trout were planted in Prairie creek and in the Elbow above Prairie creek. As reported last year, we visited the planted areas a week after the plantings and found that no trout has dropped below the point of release. Instead, we found that the trout had moved upstream a full mile. This was a most encouraging sign. We revisited Prairie creek on July 15, 1948, and made a search for these Eastern Brook trout. We found them distributed over a mile of stream (all that was examined) and present in goodly numbers. They evidently over-wintered satisfactorily.

Highwood River.

On July 30, 1947, 6,700 Eastern Brook trout yearlings were planted in Loomis creek and 6,000 in McPhail creek. On July 18, 1948, we attempted to visit these creeks. We were unable to reach Loomis creek because of a washed-out bridge. We did examine McPhail creek but failed to find any trout except Cutthroat.

Sheep River.

On July 29, 1947, Dyson creek was stocked with 6,500 and Junction creek with 4,700 Eastern Brook trout. Some were also placed in Blue Rock creek.

Mr. Andrekson, who was stationed on the Sheep river all summer, recovered Eastern Brook trout from all these streams during July, 1948. We visited Dyson creek ourselves on August 24, 1948, and secured a few Eastern Brook trout.

Junction Creek. The trout were planted at the Millsite, upstream of 13 log aprons. None was found at the Millsite or upstream from it. The first were found below the third log apron and from here they were plentiful all the way downstream.

Blue Rock Creek. Two specimens were secured 6.4 and 7.6 inches long weighing 1.6 and 2.6 ounces respectively.

Dyson Creek. Nine specimens were secured which ranged from 4.9 inches and less than 1 ounce to 6.75 inches and almost 2 ounces. The average was 5.8 inches and 1.2 ounces.

These fish are all two-year-olds. Their growth is not good, but it is as much as can be expected in these cold streams. It is equivalent to the growth of the Cutthroat in the same and slightly warmer waters.

In conclusion it now seems safe to predict that Eastern Brook trout will become established in these cold streams and provide a certain amount of sport which did not exist before.

Bassano Dam

The government survey party visited Bassano dam on August 9th to 12th, 1947. The dam is located at the horseshoe bend in the Bow river, near the town of Bassano.

The portion of the river affected by the dam extends upstream for several miles; the party studied only that part from the dam to the point where the river valley turns northwest. The area of this portion is about one and one-quarter square miles. Some attention was also given to the Bow river immediately below the dam.

Depths. The accompanying sketch map shows the depth distribution in the reservoir. The deepest water is a few yards above the dam; we were informed that there was sixty feet of water here but the deepest we found was 31 feet. Elsewhere it is much shallower; one-half mile above the dam it is only 14 feet; as the dam itself is much deeper than this it must be concluded that the reservoir is more than half filled with silt.

Temperature, Oxygen and pH. The reservoir warms up from top to bottom. On August 10th, the bottom at 31 feet was 17.4°c. (64.2°F.), and the surface 18.5°c. (65.3°F.). These temperatures are the same as the Bow river downstream. The reservoir has plenty of dissolved oxygen (4.9 cc/1 at 30 feet); the pH is quite alkaline — 7.7 — similar to the Bow river water elsewhere.

Transparency. Due to the heavy silt load in the water the transparency is low — only 5 feet on a clear, quiet day.

Plankton. On August 10th a plankton haul was made with a standard silk net from 30 feet to the surface. The volume of plankton obtained was too small to be measurable, but a considerable quantity of silt was found. Although the reservoir has been in existence for many years the plankton has not become of the lake type, but has remained scanty and more like river plankton. The forms found were:—

Protozoa
- **Ceratium**

Crustacea
- **Bosmina**
- **Cyclops biscuspidatus**
- **Daphnia**

Algae
- **Fragilaria**
- **Stephanodiscus**

A few filamentous greens.

Bottom Fauna. Three dredgings were taken at 7, 14 and 31 feet. The bottom at all depths consisted of fine, smothering silt. The animals found are listed in tabular form.

Dredgings in Bassano Dam.

Depth.	Worms.	Midges.	Clams.	Leech	Total vol./sq. ft.
7	114	42	4	0	14
14	68	17	270	2	8.4
31	88	30	223	1	9.2

The worms are oligochaetes.

The clams are minute sphaeriidae.

The midges are larvae and pupae of chironomids.

This fauna is moderately rich; of interest is the unusual abundance of oligochaetes which are able to withstand silting with its consequent

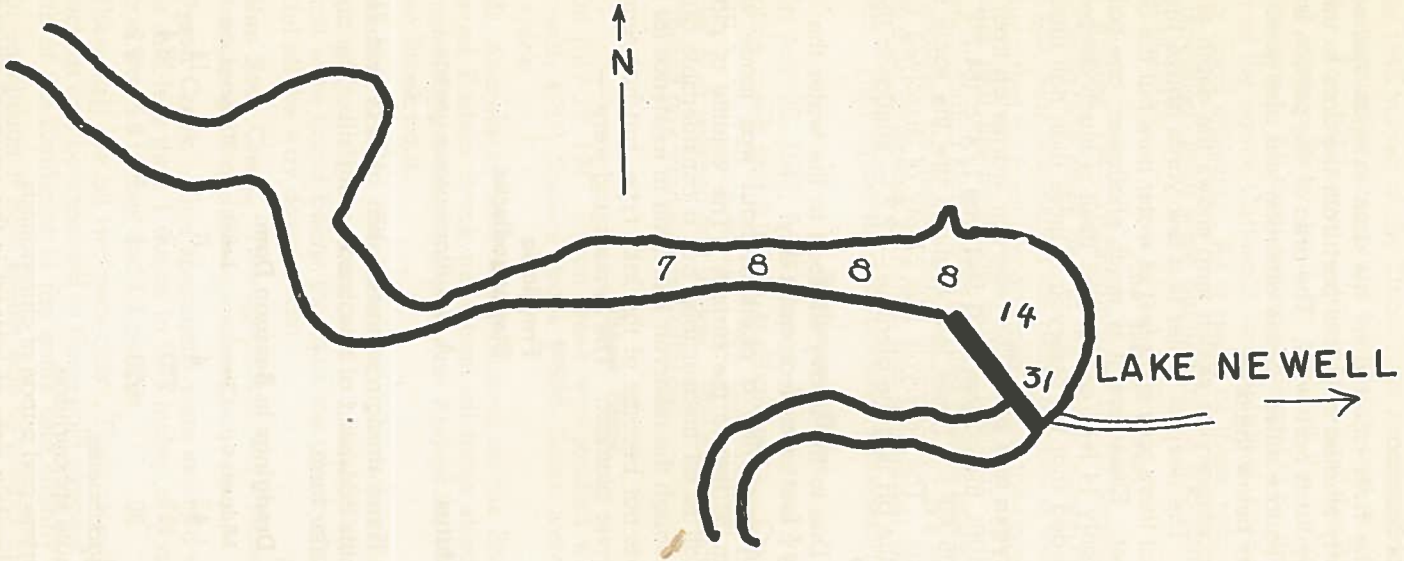


FIG. 3

BASSANO DAM

1 INCH = 1 MILE

smothering. The midge larvae are also resistant to silting. Animals such as fresh-water shrimps, characteristic of shallow lakes, are absent, possibly because of the silting.

Fish. A setting of 500 yards of gill net ranging from 1½-inch mesh was made across the reservoir about 200 yards above the dam. The lift next morning yielded only 4 common suckers and one pike.

Conclusions. The reservoir created by Bassano dam is apparently too silty to attract fish. It is very poor in food for young fish, and possesses bottom food available chiefly only to such fish as suckers. If fish (such as pickerel or trout) were planted here they would undoubtedly move out.

Fish fauna below Bassano Dam.

Quite a few fishermen fish in the river below the dam; on a Sunday some hundred or so people collect. Most of them have fair luck. Their catches are chiefly pickerel, but a trout, which they call steelhead, and goldeyes are also caught.

We examined several of these trout and they proved to be the same as those taken further up the Bow river at Carseland and in Calgary. Although called steelhead these fish have many Cutthroat characters and it seems probable that they are actually hybrids between Cutthroat and Rainbow. Their characters are distributed as follows:—

Cutthroat

often with red slash below the jaw.	all spotting black hyoid teeth often present

Rainbow

scale count of 135, "rainbow stripe" sometimes well marked.	hyoid teeth weak in many, red slash under jaw missing on many.

It has been reported that these hybrids are fertile.

We made two settings in the current below the dam on August 10th. On August 11th these nets yielded as follows:—

3½-inch mesh

12 pickerel	2 whitefish
4 common suckers	1 Rocky Mountain whitefish
2 red horse	4 goldeyes
2 northern suckers	

4½-inch mesh

17 pickerel	9 whitefish
13 goldeyes	8 common suckers

This is a rich and varied fish fauna. In addition the river here is swarming with minnow, **Notropis hudsonius.**

Scale samples were taken from the pickerel and the goldeye. The goldeye **(Amphiodon alosoides)** appear to be a slow growing fish. The growth, as determined from the scales is as follows:—

Age	6	7	8	9	10
Av. total length (mm.)	341	370	391	396	*415
Av. weight (oz.)	20	20	29	30	*39

* One fish only.

The pickerel ran from 2 to 5 lbs. and were from 4 to 6 years old. This is a very fine growth.

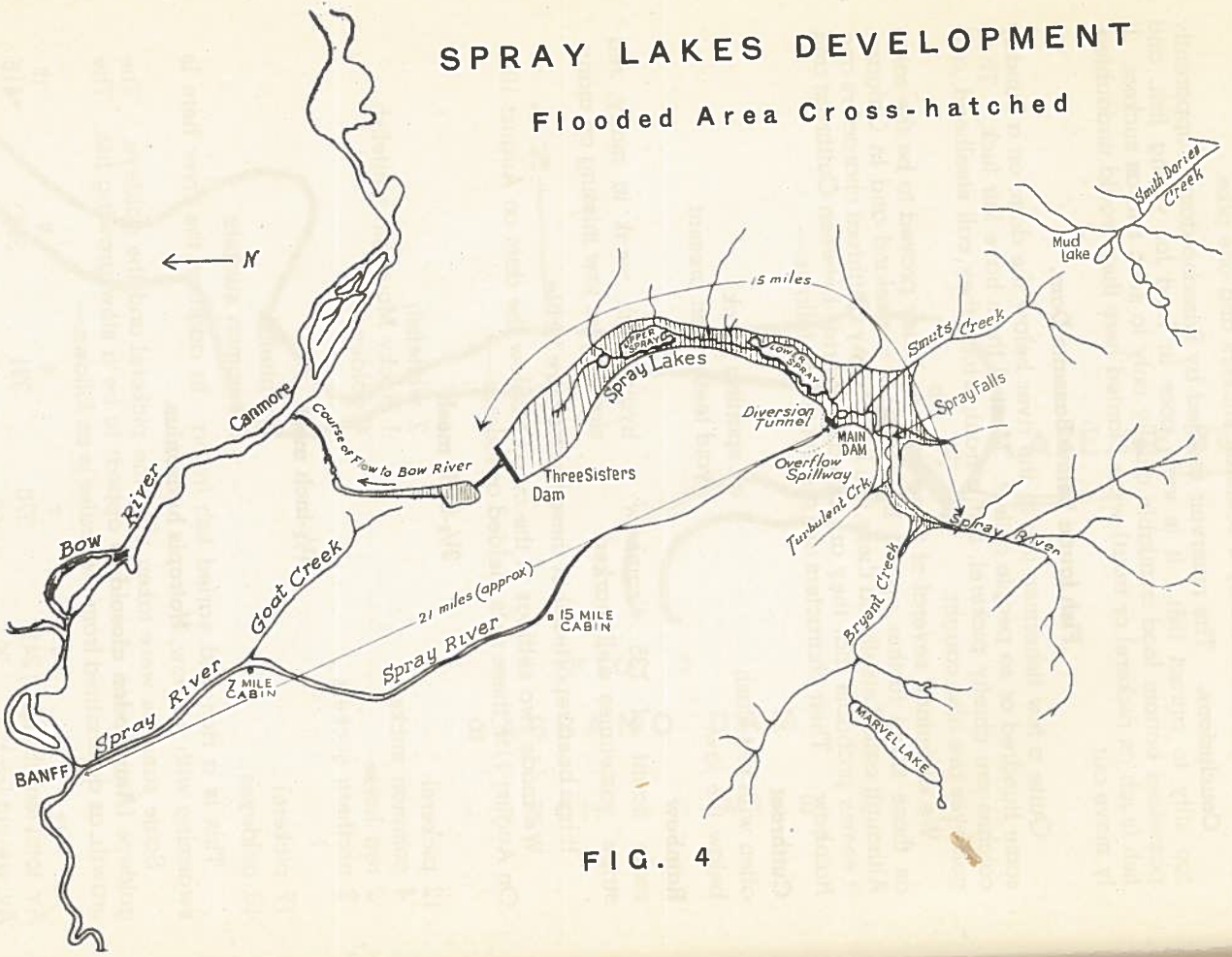

SPRAY LAKES DEVELOPMENT
Flooded Area Cross-hatched
N
Canmore
Bow River
Course of Flow to Bow River
ThreeSisters Dam
Spray Lakes
Upper Spray
Lower Spray
15 miles
Smuts Creek
Smith Dorien Creek
Mud Lake
Spray Falls
Diversion Tunnel
MAIN DAM
Overflow Spillway
Turbulent Crk
Spray River
Bryant Creek
MARVEL LAKE
Goat Creek
21 miles (approx)
15 MILE CABIN
Spray River
7 MILE CABIN
Spray River
BANFF

FIG. 4

The Effect of the Spray Lakes Development on the Sport Fishery

The Spray lakes and the Spray river below the lakes have long been famous for Cutthroat fishing. In 1948 anglers caught 1,059 Cutthroat trout up to 23 inches long from the river alone. For over thirty years, the spawning run of these trout on the lakes has been used for fish cultural purposes. The development of the lakes into a water reservoir for power purposes, now begun, will alter the whole area considerably and it is the purpose of this report to point out what changes may be expected in the Cutthroat populations. This report covers the Spray lakes and the Spray river below the lakes. The latter area, in Banff Park, was visited through the courtesy and co-operation of Banff Park officials.

The investigation ran from May 25th to June 13th, 1949. The lakes were examined in some detail and also the Spray river from the dam site downstream to the Bow river. The upper Spray was examined as far up as Bryant creek. Of the tributaries, Smuts creek and an unnamed creek south of Smuts creek were examined in full, while a more cursory examination was made of Goat, Turbulent and Bryant creeks.

Consultation with officials of the Calgary Power Company was made in Calgary and at the dam site. The Calgary Power Company was most co-operative in supplying information.

We shall first describe the Spray system as it now is. Then we shall present an account of the Cutthroat populations present in the Spray system, and finally the power development and its probable effects on these populations.

The Spray System as It Now Is.

The Spray system as a whole is laid out on the accompanying map. The lakes lie in a long, narrow valley, roughly north-south in direction and drain to the south into the Spray river, some twenty-two water miles above its mouth, and just below the Spray Falls. There are two lakes, the upper and the lower.

The Upper Lake. Upper Spray lake is roughly 1 mile long and 113 acres in area. It is barely more than a pond. The maximum depth is only 12 feet and two-thirds of the lake runs from 5 to 9 feet in depth. The whole upper third is about 3 feet deep. It receives its water from a muskeg area populated by beavers and northern suckers. Trout do not frequent this portion of the system.

The large area of shallow water provides a fairly rich food supply consisting of fresh-water shrimps (Gammarus), small snails, clams and midge larvae.

TABLE 12.

Bottom food in Upper Spray Lake.

Depth	Quantities of animals per dredging.				Volume /sq. ft.
	Shrimps	Snails	Clams	Midges	(cc.)
4	24	55	6	44	4.5
8	--	36	7	5	3.0
10	--	1	--	11	0.8

Plankton hauls revealed a very meagre microscopic fauna and flora. This is discussed more fully in the account of the lower lake.

On May 26th the water was still cold; the surface temperature was 53°F. and the bottom 52°F. By June 10th the surface temperature had reached 64°F. The lake is alkaline in reaction.

The upper lake drains by Buller creek into the lower lake. Buller creek, about three water miles in length, meanders through a long meadow. It has a gentle flow and, from time to time, has been dammed by beavers. Its upper stretches are gravelly and provide spawning beds for trout.

The Lower Lake is approximately two miles long with an area of 313 acres. A series of forty soundings showed it to have a very irregular bottom contour. There is very little shallow water; depths fall to 60 feet a few yards from shore. The deepest water found was 96 feet and most of the lake is 70 feet deep and over. In spite of this great depth there is no reduction of oxygen; we found the water at 81 feet was saturated. The lake is cold ranging from 47°F. at the surface (May 27th) to 42°F. at 80 feet.

The bottom fauna is rather poor due, probably, to the depth and low temperatures.

TABLE 13.

Bottom food in Lower Spray Lake.

Depth.	Quantities of animals per dredging. Clams.	Snails.	Midge larvae.	Volume /sq. ft.
5	6	--	3	0.5
34	17	4	13	0.8
60	3	--	26	0.8
89	52	--	30	1.0

Plankton hauls were made on the Lower Lake with a No. 20 silk bolting cloth net. The fauna and flora were very sparse, possibly due to the earliness of the season and the cold water. The zooplankton has been studied by Mr. J. E. Moore, of the Zoology Department, who reports as follows:—

Crustacea—

Diaptomus sp., a very large, red form for which no description could be found;

Diaptomus sicilis;

Cyclops biscuspidatus.

This sparse fauna is remarkable for the absence of Cladocera, normally present in lake waters.

The Lower Lake drains by Woods creek some three-quarters of a mile into the Spray river, about a mile and a half below the falls and just above the beginning of the Spray gorge. Woods creek provides gravelly bars for spawning areas.

The Spray River and Tributaries. The Spray river is divided by a natural falls into upper and lower parts. The fish do not move from the lakes or the lower Spray river up the falls into the upper river. The upper river consists of roughly twenty water miles of main stream and tributaries. The Lower Spray river consists of twenty-two water miles with two tributaries of importance, Smuts creek and Goat creek. All these waters are very cold (40° - 50°F.) and surprisingly rich in bottom food.

The lakes and the lower river contain Cutthroat trout, Dolly Varden, northern suckers and, in the lower river only, some Rainbow trout and Rocky Mountain whitefish. In the upper river the Cutthroat and Dolly Varden were found. The principal game fish, however, is the Cutthroat trout; the others are of minor importance and only the Cutthroat was studied.

The Cutthroat Populations of the Spray System.

From some of our other studies on the Cutthroat trout of the east slopes we have learned that this fish tends to be local and non-migratory. In spite of this foreknowledge, we were somewhat surprised at the number of local populations of Cutthroat trout which we found in the Spray system. In general, it may be said that each tributary has its separate and distinct population, nor is the population of the main river all one. Not only did we find a different population above the Spray falls, which was, of course, to be expected, but we also found convincing evidence of two populations below the falls and a third inhabiting the lakes. Omitting mention of the tributaries for the present, we believe the Spray system Cutthroat populations to be as follows: 1. The Upper Spray population (above the falls); 2. The Spray Lakes population; 3. The Spray river population from the Spray falls downstream to within 15 miles of Banff and including some residence in the lower lakes; 4. The Lower Spray population inhabiting the lower 15 miles of the Spray river. These populations will now be considered in turn.

1. **The Upper Spray Population.** We found these fish in the Upper Spray, above the falls. They spawn in gravel bars at the mouth of Bryant creek. Spawning was in full swing on June 11th. The fish are a golden colour, with rather larger spots than the other Cutthroats. The eggs **are a pale, lemon yellow.**

2. **The Spray Lakes Population.** We were able to examine large numbers of these fish. Fish traps were operated at each end of Buller creek (between the two lakes) and in Woods creek (below the Lower lake). The spawning areas used by these fish are the gravel beds in Buller and Woods creeks, and, perhaps to some extent, the gravel bars in the Spray river below the falls.

This year, spawning was underway in Buller creek as early as April 8th (observation by Mr. L. M. Schram, 24 - 14th Street N.W., Calgary). It was over by the end of May. Eyed eggs were found in the spawning beds on June 6th and empty egg shells and living fry on June 10th. Traps located in Buller creek showed that the fish were moving in the creek until about the end of May. The trap below the lower lake (in Woods creek) took no fish until June 5th or 6th when a movement out of the lakes into the river was noted. Most of these fish were spent and it does not appear this was a spawning migration. However, some of the population of the lower lakes may spawn below the Spray falls and live in the river around the falls and downstream a few miles during part of the year.

The lake fish have **deep orange eggs** and **red flesh.** They are silvery in colour with small, sparse spotting, mainly above the lateral line.

3. **The Spray river population from Spray Falls, downstream to within 15 miles of Banff.** This population spawns in the gravel beds immediately below the falls. Spawning is in full swing by June 11th and eggs were recovered from the gravel on that date. These fish are coloured like the lake fish and have red flesh and orange eggs. They undoubtedly spend some time in the lower lake and move out in June to spawn. Later in the summer they drop down the Spray river, and, in August, anglers fishing the Spray river 15 miles above Banff often catch them. We observed them in the Spray Gorge in the first week in June. They had not yet gone downstream as far as 15-mile cabin. In May they had not reached the Spray river in quantities and were, presumably, mostly in the lower lake.

4. **The lower Spray River population.** These fish inhabit the Spray river from the Bow, at Banff, upstream about 15 miles. They are **pale-fleshed** and have **pale, yellow eggs.** We searched the river carefully for their spawning areas but found none in the river itself. Eggs were recovered from gravel bars near the mouth of Goat creek so we conclude this is the principal spawning area. Local belief is that these fish winter in the Bow river. It is not usual for Cutthroat trout to winter downstream but we have no evidence to disprove the theory.

In distinguishing these populations and those of the tributaries, mention has been made of flesh and egg colour; i.e., river fish are pale-fleshed and have yellow eggs, whereas lake fish have pink to red flesh and deep orange eggs. This colour evidence, however, is only part of the proof of the existence of the populations. We have in support the evidence from a study of the rates of growth of 81 Cutthroat trout.

This evidence is summarized in Table 14.

TABLE 14.

Growth rates of Cutthroat trout from the Spray System.

Length in inches, weight in ounces.

Locality.		Age in years. 1	2	3	4	5	6	7
Buller creek and Upper Lake	L.	6.5	8.6	11.3	13.2	14.5	15.9	---
	W.	1.9	4.0	8.7	14.1	18.3	21.5	---
Spray river below falls and new dam	L.	--	9.2	12.2	13.7	16.5	---	---
	W.	--	5.1	14.0	16.0	27.4	---	---
Spray river above falls	L.	--	--	---	12.0	---	---	16.3
	W.	--	--	---	10.7	---	---	30.0
Lower Spray River	L.	--	--	---	12.1	---	---	---
	W.	--	--	---	9.5	---	---	---
Smuts Creek	L.	--	--	8.1	---	---	---	---
	W.	--	--	3.5	---	---	---	---
Goat Creek	L.	--	7.1	---	9.1	9.6	---	---
	W.	--	2.5	---	5.0	6.0	---	---

The data in Table 14 show that the fish from Smuts creek and Goat creek grow much more slowly than those of the Spray river and lakes. These tributary fish attain a weight of only five ounces in four years of growth while the Spray lake fish reach fourteen ounces to a full pound in the same time. The table also shows that the fish from the lakes and from the river near the lakes (fish which spend time in the lakes) are much heavier than those from the Lower or Upper river. Thus the coloured flesh and egg difference is supported by the evidence on growth rate. It was noted that all the Spray system Cutthroat spawned for the first time as four-year-olds, irrespective of rates of growth.

We have given a brief survey of the situation as it now is in the Spray System. We wish to discuss next the changes which the Calgary Power Company's development will bring to the Spray System.

The Reservoir Development and Operation.

The location of the main dams and the flooded areas resulting are shown on the accompanying map. The main dam is being built across the upper end of the Spray Gorge about two miles below the falls and immediately below the outlet of Woods creek from the Lower Spray lake. This dam will flood 4,800 acres of the valley occupied by the lakes and create a lake some 15 miles long. The lake will be contained by a second dam, the Three Sisters' dam, where the take-off of water for power purposes will be controlled. At full level the lake surface will be 5,580 feet above sea level.

Up to the present time, construction has not altered the normal course of events. The dam across the gorge is well under way but the whole flow of the river is taken care of through a tunnel in the bank around the dam. We observed fish using this tunnel. At no time has the river been obstructed to fish movement so far. However, when the main dam is completed and the tunnel closed, the following changes will occur:—

1. The Upper and Lower lakes will merge and be enlarged to make one large lake about 40 feet deep at its upper end and over 200 feet deep at its lower end (over the present Lower lake).

2. Buller and Woods creeks, present spawning areas for the lake fish, will disappear.

3. Spray falls will disappear. There will be no barrier to movement from the reservoir to the headwaters of the Spray river.

4. The extensive spawning areas immediately below Spray falls will disappear.

5. The Spray river below the main dam will be greatly reduced in size. The agreement calls for the maintenance of a flow of 200 cubic feet per second at Banff during June, July and August. This flow will be maintained by a pipe through the dam. Enough water will be allowed to flow through this pipe to bolster the flow **at Banff** to 200 cubic feet per second **during June, July and August.** In a normal year most of this will be supplied by the watershed (100 square miles) below the dam. It seems very probable that five or ten miles of the Spray river immediately below the dam will be dry or nearly dry for a large part of each year. The flow in the Spray below this near-dry portion will be continuous but much reduced. Thus in November, 1947, the combined flow of Goat creek and the Lower Spray, exclusive of water originating above the dam-site, was 76 cubic feet per second. In December of the same year this flow was 65 cubic feet per second. From one-quarter to one-third of this flow comes from Goat creek alone. It is obvious, therefore, that the Spray will be reduced to a small stream; its maximum flow will be 200 cubic feet per second in June, July and August; at other times it will be much less and, in dry years, may fall as low as 40 cubic feet per second.

6. Spawning areas in the Upper Spray at the mouth of Bryant creek will be eliminated.

The reservoir will be operated in the same way as Lake Minnewanka, i.e., water will be stored during the spring run-off to a maximum of 170,000 acre feet. Any additional water (which will be only in rare, very wet springs) will be discharged through an overflow around the dam and into the Spray river below the gorge. Of the water stored, 150,000 acre feet will be available for power. If all of this is used during late summer and fall for power development, the reservoir level will drop approximately 35 feet and 1,400 acres of land will be exposed. The draw down at Three Sisters' dam will be a sub-surface one.

The Probable Effects of the Reservoir on the Cutthroat Fishery

From our information on the distribution of the Cutthroat populations, given in an earlier section, it is possible to make some forecast of the changes that the reservoir will probably produce.

1. It seems likely that the fast growing, highly-coloured lake population will disappear. Their spawning areas are eliminated. To find new ones they will be forced to migrate up to Spray river for five or more miles. Here they will merge with the upper river population and disappear as a separate entity. The new, deep lake, with fluctuating water levels, will not produce much food for Cutthroat trout.

2. It follows that the fish now caught in the Spray river below the falls and above 15-mile cabin will also disappear since, (a) the river will be dry or nearly dry and, (b) the dam will prevent them getting down river from the lakes (from where they now come).

3. The Cutthroat now living in the Lower Spray will be confined to a much smaller river. Their growth rate will suffer accordingly and they will degenerate to the small, slow-growing population, typical of small streams, such as the fish now found in Goat creek or Smuts creek (see Table 14).

Suggestions for Future Fishery Policy in the Spray System.

It is obvious that the reservoir and dam will create profound changes in the Spray lakes and the Spray river below the dam. Unfortunately, there is no provision in the agreement for fishery protection, and, indeed, if the reservoir is to be operated effectively for power purposes, it is difficult to see how provision could have been made for fishery protection. Under these circumstances it is difficult to make any very helpful suggestions. A few rather obvious points may be mentioned:—

1. The new reservoir should be suitable for lake trout. We would suggest a delay until a year after the reservoir is full (1951) before planting as it seems probable that the 4,400 acres of flooded fresh pine stumps will release toxic substances into the water for a time. The draw down in late summer and fall will be poor for lake trout but they seem to be surviving this situation in Lake Minnewanka. Recent reports suggest they are spawning in very deep water where the draw down does not reach the eggs. It may be necessary to introduce Rocky Mountain whitefish to provide a food supply for the lake trout and additional angling.

2. In the Lower Spray river, after the dam is in operation and the new river level is established, it would be advisable to make a survey of spawning areas. A little labor with a bull dozer might accomplish much in fashioning new spawning bars at the proper depths (6-12 inches), or in maintaining access to present spawning beds in Goat creek.

3. It is our understanding that the agreement between the Dominion Government and the Calgary Power Company calls for the holding of 20,000-acre feet of water in the reservoir for the use of Banff Park. We do not know how the park proposed to use this water, but the possibility of using it to maintain a small, but constant flow in the Spray below the dam should be explored.

Preliminary Fishery Survey of the Athabaska Watershed (1948)

1. The McLeod river drainage, Obed lake and creek, Lobstick river.

CONTENTS

INTRODUCTION

It is now an established policy of the Provincial Fishery Branch to carry out biological surveys of Alberta's lakes and streams. Government officials and sportsmen, alike, now realize that sound fishery management must be based on a knowledge of biological conditions in the fish world. These surveys must be, at first, of a preliminary nature, as shortage of trained personnel and expensive equipment mean that to cover the whole province within a reasonable time, only short periods can be spent on each project.

Rainbow trout fishing in the McLeod has never been very satisfactory. One purpose of the survey was to discover, if possible, the reasons why the Rainbow do not do well, and to suggest what other species, if any, might be tried.

WATERS SURVEYED

This report contains information on the following waters:

I. The McLeod river from the Peers ferry upstream to Mountain Park and primary tributaries of the McLeod as follow:—

- A. Carrot creek.
- B. Muskeg (Edson river) with tributaries:
  - (1) North Branch creek.
  - (2) Mile 35 creek.
  - (3) Strychnine creek.
  - (4) Mile 20 creek.
- C. Wolf creek.
- D. Sundance creek and tributary:—
  - (1) Little Sundance or Hornbeck.

E. Embarras river and tributaries:—
   (1) Erith river.
   (2) Lambert creek.
   (3) Mitchell creek.
   (4) Twenty-fourth creek (McNeill & Prest creeks).
   (5) Bryan creek.
   (6) Jackson creek.
   (7) Chance creek.
   (8) Dummy creek.
   (9) Coalspur creek.

F. Tributaries of West Loop: Roy, Mill, Twin, McPherson. and White creeks.

G. The Gregg river and tributaries:—
   (1) Grizzly creek.
   (2) Warden creek (hearsay only).

H. Mary Gregg lake and creek.

I. Mercoal creek.

J. Beaverdam creek.

K. MacKenzie creek.

L. Watson (17) creek.

M. Luscar creek.

N. Whitehorse creek.

O. Tie creek.

P. Sulphur creek.

Q. Coal Company dam on upper McLeod.

II. Obed lake and creek, tributary to Athabaska.

III. Lobstick river, tributary to the Pembina, and tributaries:
   (1) Coldwater creek.
   (2) Little Brule creek.
   (3) Brule creek.

A map showing these waters is attached to this report. The information presented here on these waters was gathered largely by the authors from June 1 - 22, 1948. Data gathered in previous surveys have also been included, namely:—

Miller and Watkins, May, 1947.
Miller and Watkins, Sept., 1946.
Miller and Watkins, April, 1945.
H. V. Dempsey, August, 1945.
A. G. Whitehead, August, 1943.

GENERAL REMARKS

The lower McLeod country is heavily forested and liberally sprinkled with muskeg. The streams are practically inaccessible except after a prolonged dry spell; and to be caught by rain on one of the stream trails with an automobile is indeed a bitter fate. While we were working on the Edson river system, the Sundance and the streams entering the great west loop of the McLeod, we spent half our time extricating our truck ("Gertrude") from the holes, muskegs, washouts and creek beds, or in building bridges around and over such obstacles. This type of terrain produces slow-flowing, mud bottom, "brown" water tributaries

characteristic of northern forest and muskeg country. Clearly belonging to this category are the Embarras and its lower tributaries: Sundance, Wolf and Carrot creeks, the Edson river, tributaries of the west loop of the McLeod and the Lobstick river.

The upper McLeod is in much higher, rocky, less heavily forested country. Here travel is still difficult as it must be mainly on foot over very rugged terrain. In some places (e.g., Mary Gregg Lake, Gregg river) we had to carry our equipment down (and up) slopes of 4,000 feet in a mile. The streams in this country are of the clear, cold, mountain type. Such are a few of the upper Embarras tributaries, the Gregg River System and all the upper McLeod tributaries.

The lower waters, the ones we have called "brown" water streams, offer any angler who cares to struggle through a few miles of muskeg, the thrills of catching genuine Arctic Grayling. Many of these streams are fine grayling streams, unmatched anywhere except possibly in the District of MacKenzie, N.W.T. The Rainbow trout do not grow very well in grayling waters and merely serve to eat food and occupy space which would be better utilized by the grayling.

The upper waters, fast and clear, are also cold and barren. Rainbow trout are present in incredible numbers in every little creek and beaver-dam, in the larger tributaries and in the main McLeod. The low temperature and poor food supply have converted these Rainbow into a dwarf race of absolutely no sporting value; though they mature and spawn, only a few long-lived specimens manage to achieve legal size—a noble 8 inches.

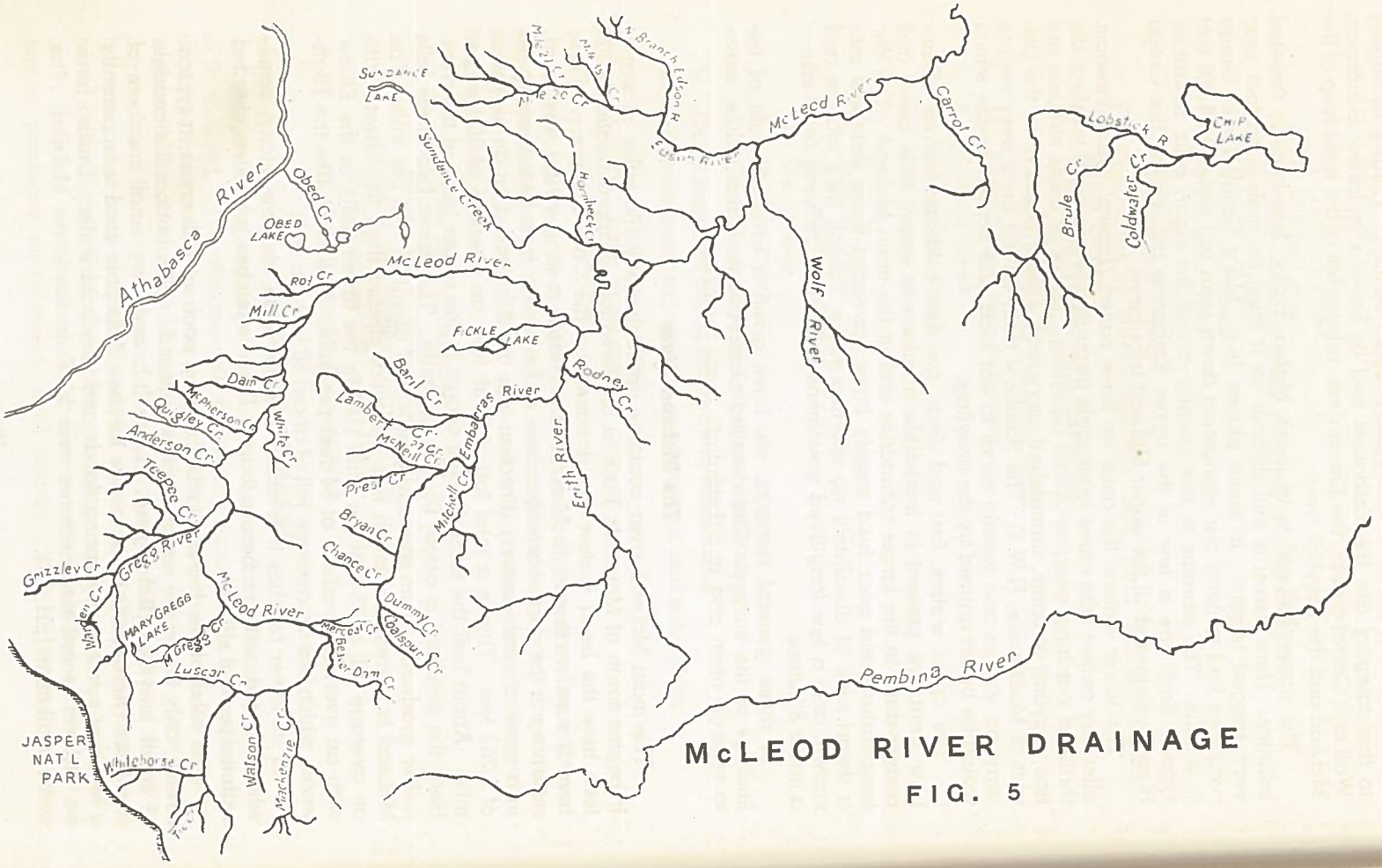
In these general remarks, we have given a brief abstract of the findings of the survey. The detailed observations, which follow, serve to enlarge upon and to substantiate these remarks.

The McLeod River

The main McLeod river contains approximately 160 miles of water. It begins south of Mountain Park at an elevation of approximately 8,000 feet; here the head waters are dammed by the Coal Company. From here it runs north-east to Mercoal, then takes a long swing westward, returning to the north-easterly course at Embarras; from here it continues in a general north-easterly direction into the Athabaska, at an elevation of 2,262 feet. This is a total fall of 5,738 feet, an average of 36 feet per mile. About half the total descent occurs in the upper third of the river. Here the gradient is about 65 feet per mile. The lower two-thirds falls rather gradually at an average gradient of about 14 feet per mile. The McLeod is therefore a much less torrential stream than the Sheep, with an average fall of 75 feet per mile (167 in the upper half), or the Elbow with an average gradient of 54 feet per mile. It is more like the Highwood, which has an average fall of about 30 feet per mile.

In its lower reaches it is about 200 feet wide, shallow, stony, somewhat braided, with numerous bars. These stretches are often clouded with suspended silt.

The food of the lower reaches is very poor; at Mill creek, a typical stretch, only 0.1 cc per square foot was found. The bottom life consists of small mayflies **(Rithrogena,** 21/sq. ft.), and very small numbers of stoneflies **(Acroneuria)** and midge larvae. This poor food is apparently a result of scouring by spring floods and very cold water. During June, we did not record temperatures over 50°F. in the lower McLeod. The water is alkaline (pH, 7.7).


Athabasca River
Obed Cr
OBED LAKE
Sundance Lake
Sundance Creek
Pine Cr
Muskeg Cr
N. Branch Edson R.
Edson River
McLeod River
Carrol Cr
Lobstick R
CHIP LAKE
Brule Cr
Coldwater Cr
Wolf River
Hamshaw Cr
Roj Cr
Mill Cr
McLeod River
FICKLE LAKE
Rodney Cr
Barrl Cr
Lambert Cr
McNeill Cr
Embarrass River
Erith River
Mitchell Cr
Dam Cr
McPherson Cr
Quigley Cr
Anderson Cr
Wilde Cr
Teepee Cr
Priest Cr
Bryan Cr
Chance Cr
Dummy Cr
Coalspur Cr
Gregg River
Grizzley Cr
Warden Cr
MARY GREGG LAKE
M. Gregg Cr
McLeod River
McBeath Cr
Beaver Dam Cr
Luscar Cr
Watson Cr
Mackenzie Cr
JASPER NAT'L PARK
Whitehorse Cr
Pembina River
McLEOD RIVER DRAINAGE
FIG. 5

The upper McLeod is very similar; at Mercoal it is essentially unchanged. No appreciable difference may be noted until one gets above MacKenzie creek where the water is slightly warmer and the stream much narrower. Further up, above Whitehorse creek, the McLeod is only about 30 feet wide and about seven degrees warmer. Here the stones on the bottom are slimy and the bottom life almost absent. Only about a half dozen mayflies and a few stoneflies and midges were found per square foot of bottom.

The braids of the McLeod in the vicinity of MacKenzie creek and the town of Cadomin have been dammed by beavers and there are many lovely, clear beaver ponds. The water in these is deep, clear and two or three degrees warmer than in the open river.

Fish. The McLeod contains Arctic grayling, northern and common suckers, Rocky Mountain whitefish, Dolly Varden, and Rainbow trout. The Cutthroat, characteristic trout of the Saskatchewan drainage, is absent.

The Arctic grayling are confined to the lower reaches and are not common here, being much more plentiful in the tributaries.

The Rocky Mountain whitefish ascend the river, at least as far as Mercoal, in the late summer, and provide fair angling.

The Rainbow trout are the dominant fish of the river. They are present in large numbers, particularly in the beaver dams. The poor food supply and cool water combine to make them slow-growing and small. A complete account will be found in the section on Rainbow trout.

Conclusions. The McLeod is poor in food and temperatures are too low for it ever to produce good fishing. Furthermore, it is too big for any remedial measures to be practical. As we shall see later, many of the tributaries offer much more hope and fish-cultural activities should be confined to them, at least in the beginning.

LOWER McLEOD TRIBUTARIES (BROWN WATER STREAMS)

A. Carrot Creek.

This stream, about 11 miles of water, was not examined during the present survey. Previous examinations have revealed a brown, slow-flowing stream, with mud bottom and wooded banks. Considerable beaver activity. Bottom food almost entirely lacking. A winter examination showed that this stream (and probably other lower McLeod streams) forms anchor ice.

Summer temperatures probably reach over 60°F.

B. The Edson River

This river is also called Muskeg river, a name which is very suitable as the area drained by it is largely muskeg. The river's principal tributaries are the North Fork, Thirty-Five creek and Twenty creek, which together amount to some 60 miles of water. All the creeks are difficult to get at, due to primitive trails, impassable when wet. We were unable to visit Twenty creek and have only hearsay knowledge of it.

Except in its inaccessible upper parts, the main Edson river is a deep (8 feet and over), slow, brown stream, twenty to thirty feet wide, with very few riffles, and a mud bottom with scattered large stones. The banks are well grown, providing good cover. The water warms to a maximum of 57°F. in June and probably into the sixties and seventies in late summer. The pH is 7.7.

Fish present are Arctic grayling, Rainbow trout, Dolly Varden, pike, suckers and Rocky Mountain whitefish. Fishing in the main Edson river is not too good. This is probably because of the almost complete absence of bottom food and the ten-foot floods which rage every spring.

Thirty-five Creek has the same brown water with the same pH; it is several degrees cooler, and the flow is somewhat faster, over a rocky bottom, and riffles with bottom food are fairly abundant. Beavers are active on this creek and a number of good ponds have been constructed. Bank cover is abundant. Grayling and Rainbow are numerous, both in the stream and the beaver dams, and fishing is excellent. Grayling are more abundant and of better size than the Rainbow. Mainly young fish, 2 - 4 years old, were caught.

We were informed that **Twenty Creek** is about the same as Thirty-five creek, but that it contains enormous numbers of small Rainbow.

Strychnine Creek, entering the Edson at the south-west corner of section 34, flows out of a muskeg. It is only two or three feet wide, but has a gravel bottom and is an important spawning area for Rainbow.

The North Branch of the Edson river is the finest of the tributaries. It has the same temperature and pH as the main Edson, and the same brown water. But it is much faster, with fine deep pools, overhanging willows and a large number of beaver dams. The bottom is rocky with numerous stony riffles. The bottom food, while not good, is better than the other tributaries.

The fishing in the North Branch is very good. Grayling, Rainbow and pike are present, the grayling by far the most abundant. The grayling are larger than in the rest of the system and the occasional Rainbow of about one pound is caught. Unfortunately, the North Branch is not accessible by road; about a two-mile walk through muskeg is necessary.

General Conclusions on the Edson River System. This system is Arctic grayling water, and as such, should probably be left alone. There is a large grayling population, mostly young fish. Winter mortality is high, probably due to flooding and deep freezing; the food is poor for the same reasons. A consistent yield of large fish cannot be expected under these conditions. For further discussion of the fish, refer to the sections on grayling and Rainbow.

C. Wolf Creek

This stream is of considerable size — about 37 water miles. It has never received a thorough examination and only the parts near the Jasper Highway are well known. Here it is about 35 feet wide with deep, quiet pools and a slow flow. The water is brown and the bottom silted and mainly of mud. The banks are heavily grown. Bottom food is almost lacking. Summer temperatures lie in the middle fifties. It contains Rainbow trout and grayling. Late spring examinations show that it forms anchor ice.

D. Sundance and Little Sundance or Hornbeck

Sundance Creek (about 24 water miles). We examined Sundance creek at its source, Sundance lake, and downstream for about two miles, and also in the vicinity of the Jasper Highway and its junction with the McLeod.

Sundance lake is shallow with weedy margins, brownish water, pH of 7.7, temperatures of 66°F. maximum for early June. It contains pike and Arctic grayling. No boat or raft was available for further studies.

Upper Sundance creek is a slow (less than one mile per hour), meandering stream, 4 - 6 feet wide, with numerous deep pools and beaver dams. The banks are partly open and partly willow covered. The bottom is largely mud with a few riffles of gravel and stones. Here live huge numbers of blackfly larvae and a small fauna of caddis larvae and mayfly nymphs. The food supply aggregates about 1 cc per square foot — much richer than the Edson.

The upper Sundance supports a splendid Arctic grayling population. These fish are much larger than in the Edson, probably because of the better food and higher temperatures, (the water gets warm in the lake). Also, the grayling here feed in the lake to a large extent, as their stomach contents proved.

A few Rainbow trout live here as well. They are larger than those in the Edson river, undoubtedly for the same reasons that the grayling are larger.

The lower Sundance is much larger and some seven degrees cooler than the upper. It is a lovely looking stream with a flow of about one mile per hour, numerous deep pools and abundant bank cover. Riffles are fairly abundant but are of mud and large stones, and yield a poor food supply. One square foot of riffle produced 14 small caddis larvae, 143 mayfly nymphs, 1 beetle larva and 2 midge larvae, a total of only 0.4 cc.

Arctic grayling are abundant, but due to the easy accessibility from Edson, very hard to catch. Numerous anglers have made them shy.

Hornbeck or Little Sundance Creek (about 18 water miles), which joins Sundance near the McLeod, is very similar to the Sundance. It is smaller, has a slower flow and slightly cooler water (52 - 53°F.). The upper Hornbeck is a poor stream, 4 - 6 feet wide, heavily flooded, smothered with mud and hidden under a tangle of willows. The lower parts are larger, but very slow, brown and devoid of food producing riffles. Some nice beaver dams are present. The stream winds and twists through a large willow flat near the Jasper Highway. This part is heavily fished. Arctic grayling are present but difficult to catch.

Conclusions. Sundance and Hornbeck are grayling streams. While the food is better than in the Edson, it is still not in rich supply. Sundance is unique in its warmth, produced by the warming of the waters in its source, Sundance lake. This warmth gives quite good growth of Arctic grayling.

These streams are likely best left as grayling streams.

Further data on the fish may be found in the section on grayling and Rainbow trout.

E. The Embarras River and Tributaries

The Main Embarras River. This is a fair-sized stream of about 40 water miles; it varies from 30 to 50 feet wide. The water is brownish, but clear, and has a pH of 7.6 - 7.7. The flow is slow, about one mile per hour in the lower reaches, slightly faster in the upper reaches. The average gradient is roughly 15 feet per mile. The bottom of the lower half is mostly of silt, borne down by 8 - 12-foot floods each spring. The food is very poor, less than 0.05 cc per square foot; a large stone will yield only 1 to 2 mayflies and a stonefly, 4 or 5 of each per square foot. The upper stretches, around Robb, yield better food. Here there is less silt and the clean rocks support about 0.7 cc of food per square foot (6 large and 17 small mayfly nymphs, 2 midge larvae.)

The Embarras is a cold stream; during June, temperatures remained below 50°F.

The fish fauna is very poor; intensive fishing over miles of stream on different days caught only one stunted Arctic grayling. Numerous sucker fry were seen and we were told that Dolly Varden are occasionally caught. The poor fishing is to be expected in a cold stream, very low in food.

The Embarras tributaries. These, with the exception of the Erith river, are all small creeks from six to nine miles long. The Erith will be treated first, then the smaller tributaries, very briefly.

The Erith River comprises some 38 water miles; we were able to examine only the lower 8 or 9 miles. It is a large stream, 120 feet wide near its mouth. Here it is shallow, rocky and exposed. The rocks are slimy and silted by great 12-foot floods. A food sample contained 24 small mayfly nymphs, 1 stonefly nymph, 3 blackfly larvae and 2 midges, a total volume of less than 0.05 cc per square foot. The rate of flow was about 1.5 miles per hour at the time of our visit — (June 11.)

Maximum temperature was 54°F.

pH was 7.9, more alkaline than the Embarras.

We were able to find no fish.

We examined two tributaries on the left bank of the Embarras. One was small, 2 - 3 feet wide, with shallow pools containing chub. (Couesius plumbeus). The only food present was blackfly larvae.

The second tributary, about 8 miles up, was larger; it was three degrees cooler than the other tributary and the Erith itself. This tributary has the most attractive water of the Embarras drainage. It is light brown, perfectly clear and clean. Beautiful pools, 20 - 30 feet wide and 10 feet deep with sandy bottoms, were frequent. The bottom food, however, was very poor (6 mayfly nymphs, 1 caddis larva and a midge per square foot). Several small Arctic grayling were seen in this stream.

The Erith river holds no promise for sport fish; its tributaries may be better. The one good one seen looks like a nice trout stream, it is accessible by lumber road. The numerous tributaries of the upper Erith perhaps should be examined.

Smaller Embarras Tributaries

Lambert Creek — 9 water miles; maximum temperature in June about 55°F.; pH 7.7; sand bottom with fast, rocky riffles and fine deep pools; rocks silted. Food about 0.1 cc per square foot (20 small mayfly nymphs, 1 stonefly nymph, 1 caddis larva). Few or no fish.

Mitchell Creek. — 9 water miles; maximum temperature in June about 50°F. pH 7.5; 15 feet wide; lovely clear brownish water; sand bottom pools and gravel riffles; not much cover. Food practically absent; few or no fish.

Twenty-fourth Creek. (McNeill & Prest) — Altogether about 15 water miles. Examined from union of McNeill and Prest to Embarras river. Lovely clear water, slightly brown, gentle flow, no riffles, deep pools (6 - 10 feet) with pure sand bottoms. Banks open and eroded; much trash from destructive lumbering. Maximum temperature in June about 50°F., pH 7.6, flow about 2 m.p.h. No bottom food, except last half mile. Few or no fish. (Hearsay evidence of Dolly Varden in Prest creek.)

Bryan Creek. — 6½ water miles. Lower half-mile only examined. A small creek, 2 - 3 feet wide, exceedingly tortuous, dense willow cover,

pools fairly frequent, 4 - 6 feet deep. Water clear, slightly brownish. Bottom of sand and silt and washings from mine slag heaps, past which the creek runs. Food very poor — 5 rocks yielded 1 caddis larva and 1 mayfly nymph. Very cold; maximum June temperature, 47°F. Stunted 1-ounce rainbow trout very abundant. Stream used for rainbow spawning area.

Jackson Creek. — 2½ water miles. A mere trickle, too small for serious consideration.

Chance Creek. — 7 water miles. A small stream, 6 - 10 feet wide. Differs from other Embarras streams in being colourless, not brown, and in having rocky rather than sandy bottom. Very shallow, almost all riffle, few pools. Food of 6 - 10 mayfly nymphs per stone, better than most Embarras streams. Maximum June temperature about 55°F. A few small Rainbow trout present. May be a speckled trout stream. Fished by Coalspur anglers.

Dummy Creek. — 4½ water miles; 6 feet wide, slow, brown and dirty; rocky bottom, covered by silt. Cover of 2-foot bushes in scattered clumps. Very winding, pools shallow, food in riffles poor, about 2 mayfly nymphs per stone. Maximum June temperature about 55°F. Fished by Coalspur people. Small Rainbow present, but failed to secure samples.

Coalspur Creek. — 12½ water miles. Really the upper Embarras. Remarks as for Dummy creek and upper Embarras.

Conclusions. This is mainly a brown water drainage. The cold water, silting and predominantly muddy or sandy bottoms make for low productivity. In general, fishing is poor and it seems likely it always will be. Rainbow trout do not do well and the grayling are scarce.

Eastern Brook trout might do well in Chance creek and possibly in Mitchell and Twenty-fourth creeks. The drainage seems too cold for brown trout.

TRIBUTARIES OF THE WEST LOOP OF THE McLEOD

A considerable number of streams flow into this part of the McLeod river. Those for which some data are available are: Roy, Mill, Twin, White and McPherson. Streams not examined are Quigley, Anderson, McCardell, Neal, Antler, Wampus, Deerlick and Eunice creeks.

Roy Creek is of about 7 water miles. It is small and brown and muddy. It was given no special examination. People on the Anderson farm told us they catch small Rainbow trout in it.

Mill Creek consists of about 9 water miles. This creek is only slightly brownish and marks the transition from brown to clear water streams working up the McLeod. The channel is from 8 to 20 feet wide with several beaver dams and a brisk flow. There are no natural pools; except for the beaver dams, the water is from 2 - 4 feet deep with a boulder bottom. Food in the riffles is good, relative to the McLeod as whole, amounting to 0.4 cc per square foot. (1 large stonefly nymph, 42 small mayfly nymphs per square foot).

The water is cold — June maximum about 50°F. pH is 7.8.

The only fish found were small Rainbow trout; these were quite abundant.

Twin Creek.—Reported by Dempsey to have a bottom fauna of 2.1 cc per square foot and beaver ponds teeming with small Rainbow.

McPherson Creek.—Reported by Dempsey to have a poorer food supply than Twin due to silting of the bottom during floods.

White Creek.—Examined briefly in the late summer of 1948. Disclosed good bottom, pools and cover, and gave every appearance of a fine fish stream.

Conclusions on Tributaries of West Loop.—These streams are on the border of brown and clear water areas. As a result, the Arctic grayling is scarce or absent, and the Rainbow are very abundant. The growth of these Rainbow is poor, perhaps due largely to the cold water. The bottom food of these streams is apparently better than in the streams of the lower, more settled reaches of the McLeod. An effort should be made to examine all these streams carefully. Good speckled trout waters may be found.

UPPER McLEOD TRIBUTARIES (CLEAR WATER STREAMS)

G. The Gregg River and Tributaries.

The Gregg River was examined from its upper reaches downstream to the mouth of Grizzly Creek, a distance of about 8 miles. The river contains a total of some 24 water miles. The water is crystal clear, no trace of brown, running over a clean, rocky bottom. It is very fast, (nearly four miles per hour; average gradient, 83 feet per mile), and only 8 - 10 inches deep in most places. The average width of the upper part is 25 to 30 feet. The descent is rapid with few pools and mainly rapids. At the turns, the current has dug deep holes, but these are filled with rushing water. The pH is 7.8. The water is very cold, remaining under 50°F.

The bottom food is very poor; only one or two mayflies and a few caddis larvae were found on each stone of 8 x 12-inch size.

During heavy rains, the Gregg river is said to become black due to numerous coal seams in the district.

There are two very large beaver dams on the upper Gregg and several smaller ones. The largest was over 100 feet long.

About two miles above the mouth of the Grizzly river (labelled Drinnan on most maps) is a waterfall about 6 feet high. We found no fish above this fall, even in the beaver dams. Below the falls we found Dolly Varden and enormous numbers of badly stunted Rainbow trout. These trout require six years to attain a weight of 2 ounces, and spawn at 1 ounce and less than 6 inches in length.

Grizzly and Warden Creeks were not examined but we were told of them by Mr. Tommy Seaton of Luscar. He informed us that Grizzly creek was clear but very cold, except in its upper waters where warm springs occur. Warden creek is less clear and warmer.

Conclusions on Gregg River. Too cold and barren for Rainbow. Eastern Brook might do well; planting them would involve packing on horses from Luscar so that fry would have to be used.

H. Mary Gregg Lake and Creek

Mary Gregg lake is a scenically lovely little lake about one quarter mile long and 100 yards wide. It lies in a deep valley about 800 feet below the ridge separating it from the Gregg river drainage. It drains by the Mary Gregg river into the West Loop of the McLeod river.

Soundings. Within 20 yards of shore, the depth falls to 30 feet and continues from 30 - 35 feet for the whole length of the lake.

Temperature. The temperature falls from 55°F. at the surface to 41°F. at 30 feet. There is a fairly sharp thermocline at 15 feet, the temperature here being 45°F.

Oxygen. Below the themocline, only 0.3 cc per litre of oxygen were found.

Bottom life. As might be expected from the very low oxygen, the bottom, of a fine black muck, is almost without life. A dredging yielded only four small midge larvae. The mud smells of stagnation.

pH. 7.7 at the surface and 6.7 at 30 feet. The bottom stagnation is shown in the acid nature of the water at 30 feet.

Transparency. Eight feet.

Fish. In the shallow water there is an enormous population of five-spined sticklebacks. Also present are a few stunted Rainbow trout. We were told that "Pennsylvania" Brook trout had been planted there and had reached a good size, but that none was caught now.

Conclusions. A cold mountain lake, low in productivity and subject to severe stagnation because of the protection from wind action by surrounding hills. Much too cold for Rainbow trout, and unlikely to support any great growth of fish. Probably should be planted with Eastern Brook fry — by pack from Luscar.

Mary Gregg Creek. The uppermost mile of this creek was examined. It is a small creek, two or three feet wide, with mud bottom and banks, a tangle of overhanging shrubbery, and no food. It harbors a few small Rainbow trout.

I. Mercoal Creek

A small, clear stream of about 8½ water miles. Few pools and poor food. Not examined carefully.

J. Beaverdam Creek

A large stream of 16 water miles and 40 feet wide at the mouth. Very rapid flow of over three miles per hour. The bottom food is very poor. Examined only at the mouth.

K. MacKenzie Creek

A beautiful stream of 14½ water miles and a width of 50 - 75 feet. The water is perfectly clear, (reminiscent of Cataract creek, Highwood river). The flow is very fast over a rocky bottom; often large boulders project through the surface and the banks are of sheer rock walls in many places. There are numerous deep rock pools full of swift, rushing water.

The food is fair, consisting of about two large mayfly nymphs and several caddis larvae per square foot. pH 7.5.

The stream is subject to seven- or eight-foot floods.

Maximum June temperature about 54°F.

Conclusions. This stream looks like good Brook trout water. It should be planted with fry by pack train from Cadomin.

L. Watson (Seventeen) Creek

This is a small creek of 6 water miles, about 8 feet wide with numerous beaverdams. The water is clear and slightly brownish. pH 7.4. The flow is very gentle with many pools and a rocky bottom. Cover is good. The food is rather poor — 0.2 cc per square foot (6 small stonefly nymphs, 87 small mayfly nymphs and 5 planarians). Maximum June temperature is about 56°F., beaverdams same temperature.

This stream is heavily fished by railroaders. It is full of small Rainbow, even more stunted than those found in the Gregg river.

M. Luscar Creek

A very poor stream, about 6.5 miles long and 12 - 15 feet wide. The water is shallow, flowing gently over rocky bottom with no pools. The rocks are covered with slime and silt and there is little cover. Few or no fish occur in Luscar creek.

N. Whitehorse Creek

A fine, clear, fast stream about 8½ miles long. It is larger than the McLeod at its point of entry (about 30 feet wide). It is rocky with fine, deep rock pools, but not many of them. About one mile up are falls, possibly impassable. Above these falls are Dolly Varden and small Rainbow.

The bottom food is the best of the upper McLeod streams — 0.8 cc per square foot (9 midge larvae, 4 planarians, 4 stonefly nymphs, 152 mayfly nymphs, 7 caddis larvae in one sample).

The maximum temperature for June is about 50°F. pH 7.5.

Conclusions on Whitehorse Creek. Looks like a fine Eastern Brook trout stream. Plantings should be made at an old bridge, above the falls, a point easily accessible by truck.

O. Tie Creek

A small creek about three miles long; it was too dirty to examine at the time of our visit. Appears to be deficient in food, pools and cover. It is cold (50°F.) and too small to be of importance as a trout stream.

P. Sulphur Creek

A tiny stream, below Mountain Park, which has been dammed to make a large, deep pond. The pond contains Rainbow trout, which were spawning in the upper, shallow end on June 18th. There is little food available and growth is very poor. The water has a maximum temperature of about 57°F. in June.

Q. Coal Company Dam

At Mountain Park the McLeod is dammed to form a large water supply pool. This and the stream above it are poor in food and very cold—(42°F.). The fish in the pond appear to be Rainbow-Cutthroat hybrids and make better growth than the Rainbow throughout the rest of the drainage. The specimen examined was 9.3 inches long and weighed 7 ounces — much heavier than fish of comparable size from other parts of the McLeod. The fish was a sterile female four years old.

Conclusions on Upper McLeod tributaries. The streams of the Upper McLeod are clear, cold and poor in food. The Rainbow trout is very numerous but does not attain satisfactory size. These streams are more suited to Eastern Brook trout than Rainbow trout.

OBED LAKE AND CREEK

Obed lake was examined by H. V. Dempsey in August, 1945, and we did not repeat his work. We did wish to examine the fish population; we made two gill net settings, each of 200 yards 1½- to 3½-inch nets.

Set 1 was in 10 feet of water across the outlet stream (Obed creek). It yielded: 12 common suckers, 4 Colorado Cutthroat trout.

Set 2 was in 35 feet of water in the open lake. The catch was as follows: 4 Rainbow trout, 17 Colorado Cutthroat trout, 93 common suckers.

The Cutthroat trout weighed from 15 to 28 ounces and were in fine condition. All were the same age and are survivors from a planting made in 1946. None of the fish was mature but they were evidently approaching maturity and would reach spawning condition in the spring of 1949. Four of the fish were marked; one had the right pectoral removed and three had had both pectorals removed. All had been feeding on sticklebacks.

The Rainbow trout had achieved very much better growth than Rainbow in the McLeod drainage. Obed trout weighed from five to seven times as much as Rainbow of the same age from the McLeod drainage.

As well as the fish taken in the gill nets, samples of smaller fish were obtained in seine hauls. An enormous population of small fish was found. Present were:

Sticklebacks **(Eucalia inconstans).**
Northern Pearl Dace **(Margariscus margarita nachtriebi).**
Fathead minnows **(Pimephales promelas).**

The last named was breeding under rocks: the males were observed guarding egg clusters stuck to the under side of stones and water-logged wood. The males not only guard, but also aerate the eggs by sweeping with their fins and bodies in such a way as to create a continual water current over the eggs. For stocking brood ponds with fatheads, a load of egg-laden stones could easily be obtained at Obed lake.

The minnows are not confined to the shore area, but were observed well out in the lake.

Obed Creek was examined between Obed and Summit lakes and also below Summit lake. The former portion is a slow-running, brown-water stream, with mud banks and bottom, and many beaver dams. There is a large insect fauna in the dams and also numerous small dace. The temperature reaches 70°F. A single Rainbow from this stretch was 13.3 inches long and weighed 17 ounces. It was four years old and was maturing. This is better growth than in Obed lake.

Obed creek below Summit lake is a slow, brown stream, 6 to 10 feet wide with shallow pools, gravelly or muddy banks and bottom, and numerous low, overhanging scrub. There is little bottom food but plenty of dace. The water is warm, reaching 70°F. Rainbow trout from three to five years old are numerous and grow at about the same rate as in Obed lake. Of the ten fish examined, four had minnows in their stomachs. They were easily caught on hooks baited with minnows. Females were still spawning on June 21st.

Conclusions on Obed Lake and Creek. The warmer water and rich minnow supply provide good growth of trout and a startling contrast to the McLeod drainage. Anglers seem unable to catch the Colorado Cutthroat; yet they were introduced because of the same complaint about Rainbow. The Rainbow were caught by trolling, however, and they seem, therefore, to be preferable.

LOBSTICK RIVER AND TRIBUTARIES

The main Lobstick river, which flows into Chip lake, then into the Pembina river, was not examined during the survey. From previous brief examinations, it is known to be a slow, brown stream, 20 - 30 feet wide, rocky in places, mud-bottomed in others, with fine pools and cover. The food supply is poor, probably due to anchor ice formation in winter and low summer temperatures (maximum under 60°F.). It contains stunted Rainbow and Arctic grayling.

On the present survey, three small tributaries of the Lobstick river were examined.

Coldwater Creek. This is a small, spring-fed stream, 10 - 20 feet wide, with many pools, very dense cover, brown water of pH 7.4. Some of the pools are six to eight feet deep. Stony riffles are present and yield a fair food supply — 1.3 cc per square foot (13 blackfly larvae, 1 large and 6 small stonefly nymphs, 85 small mayfly nymphs, 5 caddis larvae, small clams, beetles, and midge larvae in one sample).

The springs are cold and keep the stream at 50 - 51°F.

Arctic grayling and pike are present. The former spawn in the creek on gravel beds, in the current, about eight inches deep. We collected "eyed" grayling eggs from several redds.

Little Brule Creek. Similar to Coldwater creek but only two to four feet wide and two small to be of much importance. Contains Arctic grayling.

Brule Creek. Identical in nature to Coldwater creek and about the same size. In redds on this stream, we recovered "eyed" grayling eggs and newly hatched fry (June 2nd).

Conclusions on Coldwater and Brule Creeks. These are Arctic grayling streams and we would not advise planting any other species.

The Arctic Grayling in the McLeod Drainage

Arctic grayling were captured from seven streams; lengths, weights, scale samples and stomach contents were obtained for all specimens.

Growth. The average lengths and weights of each age of grayling are shown in Table 15.

TABLE 15.

Growth of Arctic grayling from seven streams.

(Lengths in inches. Weights in ounces.)

Stream	Ages 2 L.	2 W.	3 L.	3 W.	4 L.	4 W.
Coldwater	7.4	2.7	9.3	4.7	---	--
Thirty-five	7.9	2.6	9.1	4.3	10.1	6
North Branch Edson	--	--	9.0	4.6	11.8	10
Edson	--	--	8.1	6	10.1	6
Sundance	--	--	8.8	4.7	10.8	8
Hornbeck	7.5	2.5	--	--	---	--
Embarras	--	--	7.6	2.5	---	--

On the whole, there is little significant difference between growths in the various streams. The specimen from Embarras river, is perhaps, significantly smaller than the others, and the specimens from Coldwater creek significantly larger. In Table 16, some of the stream characters are summarized.

TABLE 16.

The pH, the temperature (June) and food supply of seven Arctic Grayling streams.

Stream.	pH	Temperature °F.	Food.
Coldwater	7.4	50	1.3 cc/sq. ft. (good)
Thirty-five	7.7	54	poor
North Branch	7.7	57	fair
Edson	7.7	57	very poor
Sundance	7.7	66	1 cc/sq. ft.
Hornbeck	7.7	53	poor
Embarras	7.7	50	0.05 cc/sq. ft. (very poor)

It is interesting to note the poorest growth was associated with the poorest food supply and the best growth with the best food supply. Since the best and worst growth took place in streams of 50°F. — the coldest streams — temperature does not seem the most important factor. The more acid water of Coldwater creek may be beneficial.

The average growth for all streams is:

Age.	2	3	4	5
Length (inches)	7.9	8.9	10.8	10.9
Weight (ounces)	2.6	4.3	7.7	8
No. fish	14	24	8	1

This growth is about the same as Arctic grayling make in Great Bear lake. Obviously, in our warmer latitude they should do better. The explanation probably lies in the poor bottom food due to flooding in spring, with silting of the bottom, and low water, with anchor-ice formation over the winter.

Food. The stomachs of all grayling captured were examined. The following was found:

49 stomachs contained surface items such as ants (13 stomachs), beetles (30 stomachs), debris such as spruce needles and seeds (6 stomachs).

28 stomachs contained bottom items such as midge larvae and caddis larvae (14 stomachs).

3 stomachs contained Arctic grayling eggs and one contained remains of a small Arctic grayling.

Maturity. 43 grayling were examined for degree of sexual maturity. Of these, 21 were males. Seven two-year-old males were immature. Ten three-year-old males, three four-year-olds and one five-year-old were all mature.

The 22 females consisted of: seven immature two-year-olds, three of which appeared to be ready to mature next year; eleven three-year-olds of which six were mature and five were maturing (spawners next season). The four-year-olds were all mature.

Thus maturity in both sexes is usually reached at the end of the third year of life.

Spawning. Redds were found in Coldwater and Brule creeks on June 1st and 2nd. These redds contained eyed eggs and newly hatched fry. The redds were of pea-size to half-inch gravel in 4 - 8 inches of water where the current was fairly strong. Spawning was subsequently found to commence the first week in May, 1949, in this area.

Distribution. We found grayling in all the lower McLeod tributaries and in the Lobstick tributaries. None was found in the upper McLeod or its tributaries. The most noticeable difference between upper and lower streams is the colour of the water. Grayling were not found in the upper, clear streams, but were found in the lower, brown-water streams. Some characteristic of lower, muskeg drainage appears to suit them. Possibly it is the less violent flooding of the lower tributaries.

Remarks. With the exception of Sundance creek, the Lower McLeod tributaries appear too cold for any true trout (Brown, Rainbow, Cutthroat). Possibly char would do all right (Eastern Brook). But any established trout population will compete with the grayling, and since these are grayling streams, we would not recommend any further attempts to introduce another species.

THE RAINBOW TROUT
IN THE McLEOD DRAINAGE AND OBED SYSTEM

We were able to catch and examine 58 Rainbow trout from the McLeod tributaries and from Obed lake and creek. These were weighed and measured and examined for sexual state and stomach contents; scales were taken from each for growth study.

Growth. The average lengths and weights of the Rainbow trout taken in various streams are shown in Table 17.

TABLE 17.

Average lengths (fork length in inches) and weights (ounces) of Rainbow trout from McLeod Streams and Obed Lake and Creek.

Waters.	Age. 3		4		5		6		7	
	L.	W.	L.	W.	L.	W.	L.	W.	L.	W.
Thirty-five	--	--	7.1	2.5	7.6	3.0	--	--	--	--
Sundance	7.0	3.0	7.5	2.5	10.9	8.0	--	--	--	--
Mill	--	--	6.1	1.3	7.7	2.2	--	--	--	--
Bryan	--	--	---	---	---	---	7.2	2.3	--	--
Gregg	5.1	0.7	5.7	1.3	6.4	1.7	7.1	2.2	--	--
McLeod dams	--	--	5.1	1.0	5.8	1.0				
Seventeen	4.4	0.5	5.3	1.3	5.8	1.5	6.5	2.0	7.2	2.0
Obed Lake	--	--	9.7	7.5	14.8	27.5	--	--	--	--
Upper Obed Creek	--	--	13.3	17.0	---	---	--	--	--	--
Lower Obed Creek	8.0	4.0	9.1	5.7	10.2	7.0	--	--	--	--

The best growth was found in trout from Obed lake and the upper part of Obed creek. Here the fish attain weights of half a pound to a full pound, and lengths of ten to thirteen inches in four years. In the lower part of Obed creek (below Summit lake), growth is much slower, but still two to three times better (by weight) than in the McLeod drainage.

Growth in the McLeod streams is fantastically poor. In the lower tributaries, e.g., upper Sundance creek, the best growth is found. Here Rainbows achieve lengths of 7.5 inches and weights of 2½ ounces in four years' growth. Fish in Mile 35 creek and in Mill creek grow at slightly slower rates.

The poorest growth is found in the upper McLeod tributaries and the upper McLeod itself. Here **four-year-old fish weigh less than two ounces** and are **just over five inches long.! !** One seven-year-old fish from Seventeen creek **weighed exactly two ounces!** In these waters, one encounters the astounding phenomenon of **spawning five-inch fish, weighing less than two ounces!** These fish are actually smaller than yearling Rainbow which have had one summer in the Westmount ponds at Calgary.

The reasons for this very poor growth seem fairly clear. The best growth was found in Obed lake and creek; here temperatures in June reach 70°F.; large numbers of minnows, which the trout eat, are present. In Sundance creek, where the next best growth occurs, June temperatures reach 66°F. and bottom food is the best of the McLeod streams. In the upper McLeod and its tributaries, where the growth is the poorest, temperatures do not reach 60°F. and the bottom food is present in negligible quantities. The conclusion is obvious — the poor growth must be attributed to low temperatures and lack of food.

Maturity. The sex organs of 56 Rainbow trout were examined. Of these, 32 were males and 24 females. Of the 32 males, 25 were from the McLeod system. These McLeod males consisted of:

One three-year-old—immature.
Eleven four-year-olds—7 mature, 4 immature.
Thirteen over four years—all mature.

Of the 24 females, 16 were from the McLeod system and consisted of:

Six three-year-olds—all immature.
Four four-year-olds—all immature.
Four five-year-olds—all mature.
Two six-year-olds—all mature.

Thus the males begin maturing as four-year-olds, the females as five-year-olds.

Fifteen of the fish were from the Obed system. Seven males consisted of:

One two-year-old—immature.
Two three-year-olds—1 immature and 1 mature.
Three four-year-olds—1 immature and 2 mature.
One five-year-old—mature.

The males appear to mature in the third and fourth years.

Eight Obed female Rainbow trout consisted of:

Three three-year-olds—all immature.
Three four-year-olds—immature, but maturing.
Two five-year-olds—1 mature, 1 maturing.

The females mature in their fourth and fifth year, a year after the males.

Spawning. The spawning season for Rainbows of the McLeod drainage and the Obed system is in June, later than the Arctic grayling. From June 4th to June 21st, partly spent females, and males, ripe and spent, were found in several streams as follows:

Mill creek, June 4th. Two partly spent females.
Sundance creek, June 5th. One spent male.
Gregg river, June 16th. Three ripe males and two spent males; two partly spent and one fully spent females.
Seventeen creek, June 17th. Five ripe and one spent males.
Obed system, June 20th - 21st. One spent male and one partly spent female.

Food. All stomach contents were noted. Food items were divided among materials picked from the surface (surface items found 48 times), materials from the bottom (bottom items found 32 times), and fish, which were found in seven Obed system stomachs.

Surface items were found as follows:

Beetles, 24 times; ants, 17 times; caterpillars, water striders, spruce needles, each twice; deerfly, once.

Bottom items were found as follows:

Stonefly nymphs, 8 times; midge larvae, 4 times; caddis larvae, 4 times; water boatmen (in beaverdam), 6 times; trout eggs, twice; nematode worm, once.

Seven stomachs from Obed Rainbows contained minnows.

Conclusions. The Rainbow trout has flourished amazingly in the McLeod river system; it has spread to all the tributaries and increased to enormous numbers. However, the poor food and cold water of the

McLeod System have combined to produce a very slow growth rate. The Rainbow reach maturity and reproduce without attaining legal size; consequently, they are almost worthless. It is strongly recommended:

(1) That no more Rainbow be planted in the McLeod system.

(2) That the restrictions on legal length be removed for McLeod Rainbows.

(3) That is may also be desirable to remove creel limits on McLeod Rainbow.

It is to be hoped that a much larger take would reduce numbers somewhat and perhaps lead to better growth. It is unlikely that any amount of fishing could eliminate the Rainbow from this drainage.

The Obed system is another story. We would recommend annual or semi-annual plants of Rainbow yearling, or even fingerlings, in Obed lake. The enormous minnow supply provides adequate food. The almost certain partial annual winter-kill in this shallow lake should prevent overcrowding. We believe that no more Cutthroat should be planted in Obed lake, at least until anglers have proven whether or not they are catchable.

Obed creek does not seem to require planting.

SUMMARY AND RECOMMENDATIONS

(1) A brief survey was made during June, 1948, of the McLeod river and its tributaries between Mountain Park and Peers. Some of the streams were given only very brief study; a few entering the west loop of the McLeod were not seen. We feel, however, that we have gained sufficient information to enable us to evaluate the drainage as a whole.

In addition, a visit was made to Obed lake and creek and a few tributaries of the Lobstick river.

(2) In general, the McLeod streams fall into two categories: upper, clear streams, with fairly swift currents and rocky beds, and lower, brown streams, with slow flow and mainly mud banks and bottoms. The tributaries of the West Loop (Mill, McPherson, White) are somewhat intermediate between these two extremes. The Lobstick river and Obed creek belong in the slow, brown category.

(3) The lower streams are Arctic grayling streams and support good breeding populations of this species. The grayling, however, do not grow very rapidly, due to low food supply. The poor food is probably due to flooding which causes silting and leads to low water over winter, with anchor-ice formation. The Rainbow do poorly and aggravate the low food condition by competing with the Arctic grayling.

(4) In the clear, upper streams the Rainbow has flourished and spread, but fails to achieve appreciable growth. Specimens of legal length are seven years or more old and weigh only a few ounces. This is due to the very cold water, with very poor food supply.

Three broad recommendations are made:

(1) Plant Eastern Brook trout in the clear upper streams.

(2) Plant no fish of any kind in the lower streams. A preliminary survey, by Miller and Watkins, recommended attempting to establish brown trout in the lower streams. The present information leads us to believe that these waters are too cold and too low in food for brown trout. If Brook trout do well in the upper streams, two good kinds of fishing should be available — Arctic grayling and Brook trout.

(3) Remove legal restrictions on length of Rainbow trout to be retained by anglers. The restrictions should be left in force from Sundance creek and downstream.

Recommendations for each stream are summarized as follows:

Main McLeod. From Mercoal upstream, plant Eastern Brook trout. No planting downstream.

Carrot Creek. Further information needed.

Edson River. Leave for Arctic grayling.

Wolf Creek. Further information needed.

Sundance Creek. A grayling stream. The only stream that offers any Rainbow possibilities. If the supply in the upper part decreases, further Rainbow plants might be made in Sundance lake.

Hornbeck Creek. Grayling only.

Embarras River. No plants suggested for main Embarras river. Of the tributaries, Eastern Brook trout might be tried in some of the Erith tributaries, Mitchell, Twenty-fourth and Chance creeks. No plants suggested for other Embarras streams.

Tributaries of the West Loop. These streams are rather inaccessible at the present time and probably should be left alone. In the event that some plantings are required, a further survey would be desirable. Present information suggest Eastern Brook trout as the most likely to do well.

Gregg River. Plant with Eastern Brook fry by pack trail from Luscar.

Mary Gregg Lake. Eastern Brook fry by pack train from Luscar.

Mercoal Creek. Does not appear worthy of planting. Further information needed.

Beaverdam Creek. Further study desirable.

MacKenzie Creek. Eastern Brook trout; may be planted by pack train from Cadomin.

Watson Creek. Rainbow so numerous it is dubious if another species could be established. Temperatures suggest Eastern Brook trout.

Luscar Creek. Too poor to plant.

Whitehorse Creek. A good Eastern Brook trout stream, easy to plant with yearlings (plant above falls).

Tie Creek. Of no importance.

Sulphur Creek rearing pond. Leave for a few years to see if Rainbow will provide fishing. If they do not, would try Eastern Brook.

Coal Company Dam on McLeod. As for Sulphur creek pond.

Obed Lake. Plant annually or semi-annually with Rainbow trout; plant no more Cutthroat.

Obed Creek. Requires no further plants at the present time.

Lobstick River. On the main river a survey is desirable. At present, appears best left as an Arctic grayling stream. Lobstick tributaries, Coldwater and Brule creeks, are Arctic grayling streams, and no introductions should be made.

Oldman River Drainage
Preliminary Examination of Parts of the Willow Creek Drainage (1948)

Willow creek begins at the junction of its north and south forks west of Stavely in Township 14, Range 1, West of the 5th Meridian. From here it flows south-eastward for about 68 water miles to enter the Oldman river just east of McLeod. The average stream gradient is 15 feet per mile, but a much steeper gradient exists in its uppermost third; it is, however, a rather slow stream. We spent the period, August 11 - 17, on the Willow creek drainage. During this time there were frequent rains and Willow creek was too dirty to examine extensively. Consequently we devoted our time to the North and South Forks of Willow creek and to one of its most important tributaries, Trout creek, and its tributary, Lyndon creek.

Willow Creek itself was examined briefly at one point about a mile above the mouth of Trout creek. Here the stream was 60 feet wide, very muddy (transparency only 3 inches), and the flow was slow, less than one mile per hour. The temperature was 68°F. at 5:15 p.m. Food was fairly abundant.

North Fork Willow Creek. Only a small portion of the North Fork was seen, the part immediately above the junction with the South Fork and upstream through the A7 ranch to Jim creek. Near its junction with the south fork the stream is 30 feet wide, slow flowing, good alternation of deep pools and riffles. The water was slightly murky. The bottom is covered with silt and large rocks.

At 11:45 a.m., air temperature was 65°F.; water T., 60°F.

At 2:00 p.m., air temperature was 70°F.; water T., 66°F.

The North Fork is therefore a fairly warm stream, which lags only 4 - 5° behind air temperatures.

The pH was 7.9, highly alkaline.

Above the region of its junction with the South Fork the stream becomes more gravelly, with fewer pools and more riffles.

Fishing in the North Fork is excellent. We were able to take three trout in a few minutes. These resemble, perhaps are, rainbow trout. They ranged from 6 ounces to 2 pounds. Further data on fish are in a separate section of this report.

The North Fork has only a fair bottom fauna. One square foot of riffle yielded:

18 caddis larvae.
5 midge larvae.
25 mayfly nymphs.
11 stonefly nymphs.

The total volume of the sample was 0.75 cc.

South Fork and Tributaries, Westrup & Chaffen Creeks

The South Fork of Willow Creek consists of about 15 miles of water. We saw only the portion below Westrup creek. It is a little smaller than the North Fork and a little swifter with fewer pools, but otherwise very similar. At the time of our visit it was very dirty, too dirty to observe fish or bottom characters.

Chaffen Creek. This creek comprises about ten miles of water which flows into the South Fork. We examined the lower half of it. It is from 8 to 12 feet wide, with a brisk flow of clear water. The banks are heavily overgrown with willows. Beaver ponds are frequent, although many were partially washed out in the spring floods of 1948. The stream has a gravelly bottom with nice pools and riffles.

The bottom fauna is fair, 0.9 cc per square foot. The sample yielded:

6 stonefly nymphs.	24 mayfly nymphs.
46 blackfly larvae.	15 midge larvae.

Chaffen is a cold creek; temperatures ranged from overnight low of 47.5°F. to a high of 56°F. pH is 7.5.

Fishing was fair in Chaffen creek. Cutthroat trout and what appear to be Rainbow X Cutthroat hybrids were taken. Details may be found in the section on fish.

Westrup Creek. This creek comprises about 12 water miles, flowing into the South Fork. Only the lower half mile was seen. The water was muddy because of rains. It is larger than Chaffen, about 30 feet wide, and somewhat more open, but still plenty of willow cover. The flow is brisk, about 2 miles per hour. A bottom sample yielded 0.5 cc per square foot. The animals found were:—

9 stonefly nymphs.	27 midge larvae.
42 mayfly nymphs.	1 midge pupa.
2 caddis larvae.	2 beetles.
2 blackfly larvae.	1 cranefly larva.

The water temperature was 60°F. at 12:10 p.m. — warmer than Chaffen creek. pH, 7.7.

Owing to the dirty water, no fish were seen and only one was taken, a small Cutthroat.

Trout Creek and Tributaries.

Trout Creek contains about 32 water miles; it is about 18 miles to the junction of its tributary, Lyndon creek. We examined the stream from near its source above the East Porcupine Ranger Station downstream as far as Cripple creek and again just above its junction with Willow creek.

Within the Forest Reserve the stream is 8 or 10 feet wide with a gentle flow of a little over one mile per hour. The banks are well grown with vegetation. The riffles are of mud and clay, with scattered stones. Pools are frequent. The water is very cold — the daily range is from 43.5°F. - 53°F. at the ranger station, a little warmer a few miles upstream where the maximum is about 56°F. The pH was 7.5. Beavers are numerous in this upper part of the stream.

The bottom is exceptionally rich. One sample yielded 4.0 cc per square foot, a most unusually large amount. The sample contained:—

4 large caddis larvae.	24 stonefly nymphs.
24 large mayfly nymphs.	10 midge larvae.
204 small mayfly nymphs.	

Outside the Forest Reserve the stream is more open and the bottom becomes rather heavily silted, more heavily the further downstream. The bottom food accordingly gets progressively less. The first few miles below the Forest Reserve the food is still exceptional, over 1 cc per square foot. As far down as Burke creek, the food has become poor and continues rather poor the rest of the way down to Willow creek. The stream

is also warmer, reaching temperatures over 60°F. Beaverdams in this lower stretch are washed out, but the beaver are still present.

Fishing was good inside the Forest Reserve. The trout taken were Cutthroat. Few fish were seen outside the Reserve. One was taken in Burke creek, a small tributary. For full information refer to the section on fish.

Suckers are abundant in Trout creek in the portions outside the Forest Reserve.

Discussion of Trout Creek. This is a beautiful trout stream flowing through rich land and, therefore, highly productive. There is evidence, however, of sheet erosion in the heavy silting below the Forest Reserve. This silting is not due entirely to spring run offs, but takes place during the whole open season. We observed that the stream, even within the Forest Reserve, became very dirty within ten minutes of the beginning of a rain. It is our belief that cattle in the Forest Reserve contribute to this erosion by breaking down banks and killing vegetation along the stream. Much of this damage could be avoided by salting the cattle away from the stream. The present salt licks above Twister Coulee have created large bare mud flats along the stream side. Continued silting will ruin all of Trout Creek for fish, as it has already done the lower portions.

Minor Tributaries. Quail creek, Burke creek, Cripple creek and several unnamed tributaries enter Trout creek outside the Forest Reserve. These are small; Cripple creek and the unnamed tributaries go dry in most summers. Quail creek used to contain trout, but is now too small. Burke creek is 3 to 4 feet wide, provided with dense cover and quite clear and cool (53°F. at 11:00 a.m.). One trout, apparently a Rainbow X Cutthroat hybrid, was taken.

Lyndon. This is the major tributary of Trout creek. It consists of about 16.5 miles of water. At its mouth it is fifteen feet wide, much clearer than Trout creek and somewhat slower. It has a dense cover of willows along most of its length. In the Forest Reserve the willow cover is exceptionally dense and the stream is a long succession of fine beaver ponds. These beaver ponds are very well stocked with trout. At the Reserve boundary gravel beds provide spawning grounds. Here fish-of-the-year were observed.

Two miles below the reserve the beaver are gone and the flow is brisker, over a stony bottom. From 44 Ranch downstream the stream is more open, less like a "tunnel in the willows" as it is from T. R. Ranch up to the Forest Reserve.

The temperature range is from a minimum overnight of 48°F. to a maximum in the lower waters of 62°F. at 4:30 p.m. The pH is 7.7.

Inside the Forest Reserve and downstream through T. R. Ranch, the bottom food is exceptionally good. The sample yielded 4.6 cc per square foot — one of the richest ever encountered. The animals found were:

57 Planaria.	3 large mayfly nymphs.
4 large caddis larvae.	6 small mayfly nymphs.
1 large cranefly larva.	6 midge larvae.

Below T. R. Ranch the bottom food is less, but still around 1 cc per square foot. At the mouth it has fallen to 0.5 cc per square foot. Much the same animals were found, but very much smaller specimens, e.g.:—

143 mayfly nymphs (small).	6 blackfly larvae.
7 small caddis larvae.	54 midge larvae and pupae.

The fishing in Lyndon creek is excellent, not only in the Forest Reserve, but down through the ranching country as far as the willow cover

and good food prevail. Fish taken were Cutthroat and Rainbow-like fish (Rainbow X Cutthroat hybrids?). (See section on fish.)

It is interesting that during heavy rains Lyndon creek remains clear. There are two reasons, we believe. First, the cattle have not broken down the banks or trodden stretches along the river into mud flats. Second, there are more beaver ponds than in Trout creek. We found, as a result, no silting of the bottom, and, therefore, more food and better fish in Lyndon than in Trout. It is also worth noting that both Trout and Lyndon creeks, within the Forest Reserve, would go dry in late summer were it not for the storage of run-off in the beaver ponds.

Spring on Riddle's Ranch. There is a spring on Riddle's Ranch which runs into Lyndon creek. It delivers 50 or 60 gallons per minute all year around. The water is very cold — 40°F! A pond has been created for trout. The water in this pond is 43°F. It supports abundant algae but the trout make barely perceptible growth — the water is very much too cold.

Willow Creek Trout

We have studied growth, stomach contents and sexual condition of 30 trout from the parts of the Willow creek drainage that we examined. Sixteen of these fish we believe to be hybrids; the others are Cutthroat.

The "hybrids" showed a blend of Rainbow and Cutthroat characteristics, i.e., some had no "cut" marks, others had pale yellow "cut" marks; some had very weak hyoid teeth, others fairly strong hyoid teeth; many showed "cut" marks plus a rainbow stripe. The scales of the "hybrids" were larger and more like Rainbow scales.

Growth. The average lengths and weights of the two groups are shown in the following table:—

Average Fork Length (inches) and weight (ounces) of 30 trout from the Willow creek drainage.

	Hybrids — Age							
	1		2		3		4	
Creek.	L.	W.	L.	W.	L.	W.	L.	W.
Burke	--	--	7.3	2.5	---	---	---	---
Lyndon	--	--	9.6	6.2	10.7	8.8	---	---
Chaffen	6.9	2.2	8.0	4.0	---	---	---	---
North Fork	--	--	10.9	9.2	---	---	16.8	32.0

	Cutthroat — Age.					
	1		2		3	
Creek.	L.	W.	L.	W.	L.	W.
Trout	--	--	10.9	10	11.6	12
Lyndon	--	--	10.5	8.6	11.4	10.5
Chaffen	6.2	1.8	---	---	---	---
Westrup	--	--	8.7	4.5	---	---

From the data in the table there appears to be no significant difference between the growth of the "hybrids" and the Cutthroat trout. The growth as a whole is excellent. The best growth found in the Bow river drainage was in North Fork of the Sheep river. Here a two-year-old cutthroat trout was 9.1 inches long and weighed 5.8 ounces. Two-year-olds from Trout and Lyndon creeks are over an inch longer and weigh almost twice as much. Comparing North Fork Sheep and Willow creek waters we find no significant differences in temperature, pools or cover. There is, however, a large difference is food. Trout and Lyndon creeks are many times more productive of bottom foods. This must explain the better growth of the trout.

Maturity. In the following table our data on maturity are presented:

Age.	Cutthroat Mature.	Cutthroat Immature.	"Hybrids" Mature.	"Hybrids" Immature.
1	0	2 males 1 female	0	1 male 2 females
2	4 males 3 females	2 females	3 males	6 females
3	2 males	----------	1 male	2 females
4	----------	----------	----------	1 female

The Cutthroat of both sexes begin maturing as two-year-olds. The same is apparently true of the "hybrid" males. But no "hybrid" females which had reached maturity were found; not excepting one female which weighed two pounds. It is possible these "hybrids" are largely sterile.

Food. The thirty stomaches examined contained a mixture of surface and submerged food items. The items, and the number of stomachs in which each occurred, are listed as follows:—

Surface Items		Submerged Items	
Ants	7	Water boatmen	17
Beetles	8	Water beetles	15
Grasshoppers	4	Caddis larvae	10
Wasps	4	Stonefly nymph	1
Spruce Needles	3	Suckers	2

Conclusions and Recommendations

The parts of the Willow creek drainage which we examined (N. Fork, S. Fork, Chaffen, Westrup, Trout and Lyndon creeks) flow through fairly level country, with a thick, rich topsoil. These streams form a sharp contrast to the Bow river streams which flow through mountainous country with very little topsoil. The Willow creek streams are, as a result, much richer in food supply, and grow many more trout, much more rapidly. These beautiful trout streams are, however, subject to sheet erosion whenever and wherever the topsoil is denuded of vegetation. This leads to rapid silt deposition and eradication of bottom life. We strongly recommend that a careful watch be kept on such things as cattle-salting localities, over-grazing and stream side trails. It would be a shame to spoil some of our very best streams in the way that the lower parts of Trout creek have already suffered. Trout appear abundant; we suggest no stocking for a year or two at least, in order to find out — (1) if the fishing will remain good, and, (2) if the "hybrids" will disappear or maintain themselves.

FURTHER SURVEYS OF THE OLDMAN DRAINAGE (1949)

During June, July and August, 1949, the authors examined the following waters of the Oldman drainage:

Livingstone River and tributaries **White and Ridge** creeks.

Northwest Branch of the Oldman and tributary **Hidden** creek.

Dutch Creek.

Racehorse Creek and tributaries **Daisy** and **Vicary** creeks.

Main **Oldman River** from the Gap to Waldron Bridge.

Callum Creek and tributaries **Sharples, Damon** and **Playle** creeks.

Crowsnest River and tributaries **Glacier, Allison** (and **Deadman**), **Gold, Todd** and **Cow** creeks.

Brief observations were also made on **Pincher Creek.**

Because of the large areas involved, and the need for covering most streams on foot, the surveys made are necessarily preliminary in nature. We do not pretend that our findings represent the last word on any of these waters.

The streams are listed above in the order from upstream downwards. In the descriptions which follow the same order will be maintained. The various characteristics of each stream are discussed first. Data on the trout found in them are presented for all the streams together in a concluding section of the report.

The Livingstone River

The Livingstone river runs southward in a wide mountain valley to enter the Oldman river not far above the Gap. The headwaters are close to the headwaters of Pekisko and Cataract creeks of the Highwood drainage. The 26 water miles lie mainly in a rather deep, rocky gorge, but the tops of the gorge are broad and level and have a thick covering of soil with good grass and tree cover. Several hundred head of cattle are grazed here.

The stream gradient is fairly gentle. In the lower parts, particularly, where the gorge is deeper, deep holes are numerous, alternating with fine, clean riffles. The river varies from 30 or 40 to over 100 feet in width.

Character of water. The water is very clear and clean. It is also cold. In June the temperature varied from a night and early morning minimum of 37°F. to a minimum of 53°F. at approximately 3:30 p.m. This is the usual range of temperature variation in the area.

Food. The food supply is very good. In the upper waters about 1.3 cc per square foot were found, but close to the Oldman, a sample of 3.5 cc per square foot was obtained. This is a very rich food supply. The organisms found on a square foot of riffle bottom in upper and lower reaches are shown in the following tabulation.

	Upper	Lower
Mayfly nymphs (large)	10	120
Mayfly nymphs (small)	60	
Stonefly nymphs (large)	0	2
Stonefly nymphs (small)	24	3
Cranefly larvae	1	2
Midge larvae	± 11	3
Caddis larvae	15	1
Blackfly larvae	0	4

Fish present were Cutthroat trout and Dolly Varden.

Conclusion. The Livingstone river is a beautiful trout stream which should support around one thousand catchable fish per mile of stream.

Livingstone Tributaries

These are mainly small creeks which, from their bottom life, appeared to be temporary in character. **White Creek** was the only non-temporary tributary which we examined. This is a rocky, gentle stream, about twenty feet wide, with excellent pools and cover. It has about seven water miles. The water is clear and about 1° warmer than the Livingstone. The food supply is poor, amounting to only 0.25 cc per square foot. A sample contained:

1 large mayfly nymph.	4 stonefly nymphs.
61 small mayfly nymphs.	19 midge larvae.

This is meagre compared to the Livingstone.

The trout in White creek are of poor growth (see concluding section on trout).

Another tributary of the Livingstone, **Ridge Creek,** looks as if it might be of a permanent character. However, no mayfly or stonefly nymphs were found; only blackfly and midge larvae, which do occur in temporary waters. A single 2-ounce Cutthroat trout proved to be a ripe male, 4 years old. Growth is, thus, very poor. Stunted Cutthroats were seen in others of the numerous tiny creeks which enter the Livingstone from the west.

Northwest Branch of the Oldman

The Northwest Branch is about the same size stream as the Livingstone. It is approximately 23 water miles in length. The lower 15 miles only were examined. This stretch has a fairly swift current and the pools are less frequent than on the Livingstone. There is no bank cover, but numerous large boulders in the water provide a good deal of shelter. Water erosion along the banks is evident in places and the stream becomes murky after rains, remaining so for 24 - 36 hours.

Character of water. Except after rains the water is clear. It is warmer than the Livingstone ranging from a low of 50°F. to a high of 61°F. A series on July 15 was:

10:30 a.m.	50°F.	4:50 p.m.	60°F.
12:30 p.m.	56°F.	6:30 p.m.	59.5°F.
3:30 p.m.	61°F.	9:40 p.m.	57°F.

Food. Samples were taken at the ford near the mouth and at the mouth of Hidden creek. As might be expected, due to erosion silt, the food supply is much poorer than in the Livingstone. The lower sample yielded 0.8 cc and the upper 0.5 cc per square foot. The organisms found were:

	Lower	Upper
Stonefly nymphs (large)	2	0
Stonefly nymphs (small)	4	2
Mayfly nymphs	66	± 85
Caddis larvae	0	1
Midge larvae	16	± 3
Planarians	14	0

Cutthroat trout and Dolly Varden were numerous, particularly the former. For a discussion of these, see the concluding chapter.

Tributary of the Northwest Branch

Only one tributary, Hidden creek, was visited. This stream is about six miles long; the lower 3.5 miles were examined.

It is a very nice looking stream, from 15 - 25 feet wide, with abundant bank cover, rapid current and numerous fine pools. It is very cold, about 4° below the Northwest Branch.

The bottom food is moderate, somewhat the same as the Northwest Branch. One sample yielded 0.7 cc per square foot; it contained:

21 small mayfly nymphs.
4 small stonefly nymphs.
3 large caddis larvae.
3 small caddis larvae.

In certain areas a much greater number of caddis larvae was found.

Cutthroat trout were plentiful. Their growth was fair.

Dutch Creek

Dutch creek is smaller than the Northwest Branch and the Livingstone. It has a length of approximately 16 water miles. The stream gradient is quite gentle with an average descent of 56 feet per mile. The width is only about thirty feet in most places. Pools are very frequent, almost as numerous as riffles. The banks are quite open and low but the many twists and turns provide considerable bank shade.

The water is clear and cold. A temperature series on July 16 and 17 was as follows:

8:10 a.m.	47°F.	3:30 p.m.	55°F.
11:25 a.m.	49°F.	5:10 p.m.	55°F.
12:10 p.m.	50°F.	6:45 p.m.	54°F.
		9:15 p.m.	50°F.

The food supply is relatively poor. A sample from the lower parts yielded only 0.3 cc per square foot. The bottom was examined at many places and the amount of food increases upstream, but never equals the Livingstone. One sample contained:

13 medium to large mayfly nymphs.
23 small mayfly nymphs.
1 small stonefly nymph.
6 midge larvae.

Cutthroat trout are very abundant, though mainly young, small fish. The larger fish are apparently caught out early in the season. One party of four anglers removed over 400 in 7 days.

Racehorse Creek.

This stream is the same length as Dutch creek (16 miles), but contains more water; the channel is 40 - 60 feet wide. The gradient is steeper and in the lower reaches considerable channel-changing and braiding has occurred. Higher up the channel is stable but pools are not frequent and riffle predominates. Shelter is provided mainly by large boulders in the stream. There is practically no bank cover. The portion above Wintering creek was not studied.

The water is clear and cool. Temperatures range from 45 - 53°F.

Food. Samples were taken in the lower reaches and also some five miles upstream. In the braided lower parts the bottom fauna is poor, only 0.3 cc per square foot. Above the braiding, however, food supply is rich, reaching 2.5 cc per square foot. The following organisms were found.

	Lower	5 miles up
Large mayfly nymphs	7	14
Small mayfly nymphs	94	160
Stonefly nymphs	21	16
Caddis larvae	0	2
Midge larvae	6	19
Planarians	2	0

Numerous fish were seen but only a few taken. The exposed banks and heavy fishing make successful angling very difficult on this stream. Cutthroat trout, hybrids and Dolly Varden are present. The growth is excellent.

Tributaries of Racehorse Creek

Two tributaries, Vicary and Daisy creeks were examined in their lower reaches.

Vicary Creek. This stream is approximately 12 water miles in length, with a 75-foot-per-mile descent. Although fairly swift, the descent is in steps with stretches of quiet water between small falls. Pools are very abundant, deep and relatively still. Bank cover is thick and abundant. This is a lovely stream.

Water temperatures are the same as the Racehorse.

The food supply is rather variable. The sample preserved for study contained only 0.3 cc of organisms. Other areas were more richly supplied. In the sample retained the following were found:

3 large mayfly nymphs
32 small mayfly nymphs
17 small stonefly nymphs
1 caddis larva
4 midge larvae
1 Planarian

Cutthroat trout and Dolly Varden were abundant. Large Cutthroat were seen in several pools but none was caught. Small ones were easily obtained.

Daisy Creek. This stream, about 9 miles long and 10 - 20 feet wide, is very similar to Vicary. The gradient is steeper (110 feet per mile), but, like Vicary, the drop is in a series of small falls with pools between. Bank cover is abundant. Generally, it is a fine trout stream.

Water temperatures are the same as the Racehorse. The food supply is much the same as Vicary, i.e., only moderate and not as rich as the Racehorse.

Cutthroat trout and Dolly Varden were abundant. The fish are well-grown and in good condition.

Oldman from Gap to Waldron Bridge

This portion of the Oldman is the main trout producing area. It was not all carefully examined but numerous stretches of the 22 miles from the mouth of Livingstone river to the mouth of Callum creek were studied. The river in this area is over 100 feet wide, with a moderate current and a gradient of about 40 feet per mile. There are many sand bars, boulders and rock outcroppings which create numerous fine deep pools. The banks are open and exposed. The water is often faintly murky and quite warm. The afternoon temperature commonly reaches 60°F. and over in July.

The food supply is rich and ranges from 1.0 to 3.0 cc per square foot. The number and variety of organisms is considerable; for example, a sample 5 miles below the Gap yielded:

1 large stonefly **(Neoperla)**
8 **Arthroplea** (Mayfly)
10 **Epeorus** and **Iron** (Mayfly)
73 **Baetis** (Mayfly)
1 **Ephemerella** (Mayfly)
4 other Mayflies
3 **Brachycentrus** (caddis)
1 cranefly larve
6 snail egg masses
1 minnow fry
18 midge larvae

Trout are abundant. Cutthroat and rainbows (or hybrids) are about equally numerous. These fish are exceptionally large for their age.

Callum Creek and Tributaries

Callum Creek flows south for 17 miles through the broad Happy Valley between the Porcupine Hills and the Livingstone Range. It has a very slow flow over a mud bottom and is turbid and dirty at most

times. The banks are also of mud and there is no bank shade. The water follows the air temperature rather closely and reaches temperatures over 70°F. It is too warm and dirty for trout. It is also very small, only 8 - 10 feet wide. A large number of suckers lives in Callum creek.

The west bank receives only short, temporary, spring run-off creeks from the east slopes of the nearby Livingstone Range. The east bank receives several permanent creeks from the Porcupine Hills. These creeks lie in heavy timber and remain cool and suitable for trout. The largest is Sharples creek.

Sharples Creek has about 5 miles of water. The creek is only 2 or 3 feet wide, but has been extensively dammed by beavers to create a long series of fine, large ponds. These are deep and clear with abundant willow cover. The creek and ponds are exceptionally cold, the maximum summer temperature is about 47°F. Out in the open valley, close to Callum creek, the stream becomes warm and muddy and is populated with dace and suckers.

A bottom sample from the forested region of the creek revealed a very rich bottom life of 2.7 cc per square foot. Organisms found were:

87 mayfly nymphs
20 stonefly nymphs
2 large cranefly larvae
4 midge larvae

Small Cutthroat trout were very abundant in the beaver dams and also in stretches of creek between the dams.

Several other small creeks which enter above Sharples were also examined. These are mostly too small to be of importance, being only a few inches to a foot or two wide. One of these small streams, believed to be called Playle creek, has been developed by beavers and a series of excellent ponds are present. These contain large numbers of small Cutthroat trout.

Damon Creek, the same nature as Playle, would also support trout if dammed by beavers. (Possibly beavers are already present high up in the hills, where the stream was not examined.)

CROWSNEST RIVER

The Crowsnest river from its source at Crowsnest lake, runs approximately 33 water miles to its junction with the Oldman. In the present survey, examinations were made at Lundbreck, Burmis, Frank, Coleman and between Coleman and the lake.

Above Coleman, the river is 20 - 30 feet wide, fairly swift, with numerous twists and many fine, quiet pools. These are abundantly provided with bank cover. The water is clear and the bottom clean and free of coal particles. Temperatures are higher than in the Gap area. A series from the upper Crowsnest ran as follows:

8:45 a.m.—50°F.
2:00 p.m.—59°F.
4:20 p.m.—64°F.
5:30 p.m.—63°F.

With these higher temperatures one would expect rapid growth in trout, but, as we shall show later, trout growth is rather slow compared with other parts of the Oldman drainage. This is due to a poor food supply. Thus, the upper Crowsnest yielded only 0.3 cc of bottom food per square foot.

As one moves downstream, the river widens and slows. Below the falls it is over 100 feet wide. Pools are fewer and temperatures reach over 70°F. The bottom is covered with coal particles and the whole stream runs black following rain.

Bottom studies were made at Coleman, Frank and Lundbreck. The food is generally poor except below the falls where 1.2 cc per square foot were found. A summary of the food samples is as follows:

	Upper	Coleman	Frank	Falls
Large stonefly nymphs	0	0	0	3
Small stonefly nymphs	1	7	10	11
Large mayfly nymphs	0	6	2	0
Small mayfly nymphs	34	57	94	96
Caddis larvae	19	2	0	3
Midge larvae	7	4	8	2
Cranefly larvae	0	0	0	1
Beetles	0	1	0	0
Volume	0.3	0.3	0.1	1.2

On the whole, the Crowsnest is a potentially fine trout stream. It is sadly limited by low food supply which may very well be due to extensive coal pollution. In this connection it is perhaps significant that the richest sample was taken far below the source of coal pollution.

CROWSNEST TRIBUTARIES

Of the Crowsnest tributaries, Glacier, Gold and Allison creeks were examined in some detail. Todd and Cow creeks were only briefly examined where the Gap trail from Lundbreck crosses them.

Glacier Creek. This stream is a little over six miles long. It rises in Ptolemy Pass and flows down in Crowsnest lake. On the way it is joined by Ptolemy creek (which we did not examine).

The main body of this creek is 15 - 20 feet wide, swift, shallow and without pools. It offers very little living-space for trout. The food is only fair — 0.5 cc per square foot. The sample contained:

62 small mayfly nymphs
5 stonefly nymphs (small)
16 midge larvae
1 caddis larva
1 blackfly larva
1 Planarian

The water is clear and very cold. The maximum on a hot day was 47°F.

The upper parts of Glacier creek have been populated by beavers. We saw no signs of active beavers — all the dams appeared dead. The dams are old and heavily silted. The upper series of extensive beaver ponds (where fish were planted in 1949) is only 1 - 2 feet deep, and the water is not flowing. Temperatures soar to over 70°F. The food supply is rich. Trout growth in the dams is excellent, but there is grave danger of severe winter killing. The beavers should be re-established.

In the stream the cold and low food give poor growth; trout are abundant both in the stream and in the ponds.

Allison Creek. This creek is slightly over seven miles long. It is 4 - 12 feet wide, rapid, stony and clear. Pools are few and shallow, filled with rushing water. Bank cover is abundant. The temperature range in warm weather is 42 - 54°F.

8:30 a.m.—42°F.
10:40 a.m.—46°F.
12 noon—48°F.
2:30 p.m.—52°F.
5:40 p.m.—54°F.
9:40 p.m.—45°F.

Food supply is rather poor. Samples yielded 0.3 cc per square foot. Many organisms were present but these were all small. The following were found:

181 small mayfly nymphs
32 small stonefly nymphs
8 midge larvae
4 caddis larvae and pupae
6 blackfly larvae
2 Planarians.

Fish were fairly abundant, both Cutthroat and Rainbow. The Cutthroat were very dark with large, round, not-too-numerous spots. The "cut" mark was very bright. Growth is poor.

Dam on Deadman Creek. Mr. Andrew Dow conducted us to a large pond on Deadman creek, a tributary of Allison creek. The dam forming the pond was originally constructed by beavers; it has been enlarged by the Coleman Fish & Game Association and hatchery yearlings have been introduced. These small trout were very much in evidence. The pond is full of Chara and Potamagetons which support a rich food supply. The maximum water temperature is approximately 61°F. A number of fish were taken; these show good growth.

Gold Creek. This stream has a length of a little over ten miles, and a stream gradient of some 240 feet per mile. Much of the drop is in the form of small falls with one series, about 20 feet high, near the mouth. The stream is approximately 12 feet wide with a stony bottom; among the stones much coal may be found. The stones are covered with a golden-coloured algal growth (origin of name) where the water is fast. The growth is absent in the pools. The pools are not frequent.

Bank cover is good. The water is clear and very cold — only 42°F. at 10:40 a.m. on a warm day. The pH was 7.3, more acid than other streams in the area which run from 7.5 - 7.8.

The food is rich. A sample from a riffle yielded 1.5 cc per square foot. The following were found:

4 stonefly nymphs (2 large)
34 mayfly nymphs
25 caddis larvae and pupae
7 midge larvae

Only one fish was seen, an 8-ounce hybrid, ripe, male. This fish was very well grown.

Gold Creek looks like a promising Eastern Brook trout stream.

Todd and Cow Creeks are two mud bank and bottom streams lying out in the open tree-less valley between Lundbreck and the Gap. They are 4 - 8 feet wide, with muddy water, heavily silted bottoms and heavy willow and poplar cover. The food supply is rich. Temperatures reached 68°F. between 1:00 and 2:00 p.m. These streams probably get too warm and dirty to retain many trout.

PINCHER CREEK

This stream was examined briefly at only one point, about 11 miles west of the town. Here it is 10 -20 feet wide, shallow, mainly in riffles with a few shallow pools. Temperature was high, 59°F. at 6:30 p.m. on a rainy day (air temperature was 53°F.). The stream supports an enormous population of blackfly larvae. Over seven hundred were picked from one square foot of bottom. Otherwise food was not abundant. The volume of the sample was 0.6 cc.

Two small Cutthroat trout were obtained. These were rather poor in growth.

TABLE 18.

Growth of Oldman Drainage Trout.

Locality	No.	1		2		3		4		5	
		L.	W.	L.	W.	L.	W.	L.	W.	L.	W.
Oldman	--	C 9.1	5.2	10.0	6.3	---	---	---	---	---	---
N.W. Oldman	8	R 7.7	3.5	10.4	7.0	---	---	---	---	---	---
Hidden	11	5.7	1.0	8.7	5	---	---	---	---	---	---
Livingstone	3	--	--	---	---	10.9	9	---	---	---	---
White	20	--	--	9.7	6.3	11.4	10.6	12.6	11.5	---	---
Ridge	1	--	--	---	---	---	---	8.9	4.0	---	---
Dutch	1	--	--	---	---	---	---	6.5	2.0	---	---
Racehorse	9	5.7	1.0	8.9	5.2						
Vicary	5	5.9	1.0	9.9	7.2	---	---	R 13.0	15	12.4	14.5
Daisy	1	6.5	1.5	---	---	---	---	---	---	---	---
Sharples	3	5.5	1.2	---	---	14.5	17	---	---	---	---
Crowsnest	14	5.2	1.0	7.2	2.5	8.7	4.1	---	---	---	---
Gold	3	--	--	R 7.3	2.7	---	---	---	---	---	---
Allison	1	--	--	R 10.7	8	---	---	---	---	---	---
Deadman	5	--	--	C 6.9	2.5	10.5	8.1	---	---	---	---
Glacier	--	--	--	R 7.3	2.5	---	---	---	---	---	---
Pincher	4 R	7.4	2.5	9.4	6.5	13.3	17	---	---	---	---
	--	--	--	C 11.3	10.0						
	7	--	--	9.0	4.3	10.5	7	14.2	18.2	---	---
	2	5.2	1.2	---	---						
	98										

Length in inches, weight in ounces; C—Cutthroat, R—Rainbow or hybrid; when not specified means Cutthroat.

TROUT OF THE OLDMAN DRAINAGE

As most of the waters surveyed this season were open to public angling, we found it difficult to spend sufficient time on a stream to catch an adequate sample of trout. For a few streams we obtained only one specimen. Altogether, 98 trout were measured and their ages determined. The lengths, weights, ages and sources of these fish are shown in the table on opposite page.

TABLE 19.

Various Oldman Streams Arranged in Order of the Growth Rate of Their Trout, Fastest First, Together with Certain Stream Characters.

Stream	Max. T.	Food	Pools	Cover	Size
Oldman	60 +	2.0 (av.)	numerous	fair	large
Gold	52 ?	1.5	fair	good	small
Livingstone	53	2.4 (av.)	numerous	fair	large
Vicary	53	0.3 +	numerous	good	small
Racehorse	53	1.4 (av.)	fair	poor	medium
Dutch	55	0.3	numerous	fair	medium
N.W. Oldman	61	0.65 (av.)	fair	fair	large
Daisy	53	poor	numerous	good	small
Hidden	57	0.7	numerous	good	small
Allison	54	0.3	poor	good	small
Crowsnest	64	0.5	numerous	good	large
Sharples	47	2.7	numerous	good	very small
White	54	0.25	numerous	good	small
Ridge	?	nearly 0	fair	good	very small

Table 18 shows a considerable range of growth rate. It may be noted that there seems to be no significant difference in growth rate between introduced Rainbow or hybrids and the native Cutthroat where they occur in the same stream. Differences in growth from stream to stream may be correlated with characters of the streams. In Table 19 the streams are listed in the order of the growth rates of their fish, fastest first. Also shown in the table are the various stream characters noted during the survey. Glacier and Deadman are omitted as the fish were taken from beaver dams, not streams. Pincher is omitted as insufficient data are available.

There is a fairly good correlation between food supply and rate of growth. Sharples creek forms an exception to this; though it has a good food supply, growth is slow. This is possibly due to Sharples being so very small. Very small waters seem generally to contain small fish. A few other irregularities occur; thus Vicary appears to have a poorer food supply than Racehorse but slightly better growth. This may perhaps be due to the much finer pools in Vicary creek.

Temperature does not appear to be particularly important.

The general growth picture may be clarified by comparing the Oldman and the Bow drainage trout. In the Bow river tributaries Cutthroat trout reach on the average only 7 or 8 inches and 2 - 4 ounces in their third summer of life; in the Oldman waters fish of the same age are 2 or 3 inches longer and weigh 2 - 4 ounces more. This large difference is not due to temperature. Bow river waters are a little warmer than Oldman waters. The difference is clearly due to food supply. Bow river streams range from 0.2 to 1.5 cc per square foot of food; most of them are toward the lower end of the range from 0.2 - 0.7. The larger Oldman streams run from 0.3 to 2.4 with most of them toward the higher end of the range.

CONCLUSIONS

1. The Oldman drainage contains the best trout waters yet seen in the course of these surveys. It is rich in food and trout make good growth. Reproductive conditions are good and natural propogation is large.

2. These waters are heavily fished and large fish are not abundant; those present are difficult to catch. There is no evidence that the brood stock is depleted to the point where re-population with fry each year is not occurring. All waters contained large numbers of small trout.

3. There is no evidence that introduced Rainbow trout do better in the drainage than the native Cutthroat.

4. Beavers are of inestimable value, particularly in the short, precipitous streams draining into the Crowsnest. Good growth of trout from beaver ponds is clear in Table 1 (Deadman, Glacier).

5. Closing of small tributaries such as White, Ridge, Daisy, Vicary, Hidden creeks is not sound practice. The fish in such streams are not young fish which later drop down to the bigger streams. The fish in these streams stay in them and die in them unless caught. The trout in the larger streams spawn in the stream they live in, not in the small feeder streams.

6. A system of staggered open seasons would provide more fishing for bigger trout than hatchery plantings.

RECOMMENDATIONS

1. A system of staggered open seasons, based on growth rate of trout, should be drawn up for the whole east slope drainage. For example, a stream like the Livingstone, where legal size is reached in the second year of life, could be opened every other year. It would be unwise to close such a stream more than one year, as natural mortality is high and too many fish would be wasted. A stream like Sharples, and many Bow river streams, where legal size is reached in the third year, should be closed for two and open for one year. Large streams, like the Main Oldman, should never require closing.

2. Some revision of regulations re legal minimum length and creel limits may be desirable. The revision should be based on growth studies of all east slope streams.

3. Hatchery planting is most useful in special places, such as the Deadman dam development in the Crowsnest Pass. There is no evidence that hatchery planting will help in ordinary unmodified streams. It seems particularly useless to plant the larger rivers.

4. Eastern Brook trout do not appear necessary in the Oldman system. If an experimental introduction is desired, we would suggest Gold creek in the Crowsnest Pass.

5. If planting in streams is continued we urge that the native Cutthroat, only, be used.

6. Every effort should be made to protect existing beaver colonies and to establish new ones.

MISCELLANEOUS STREAMS

Graburn and Battle Creeks (1947)

Graburn and Battle creeks rise in the Cypress Hills area of Alberta and flow in an easterly direction. About a quarter mile from the Saskatchewan border, Graburn creek flows into Battle; the latter name is retained for the single stream which flows into Saskatchewan and then south to join the Milk river in Montana. Parts of both streams were examined by our survey party on August 20 and 21, 1947.

GRABURN CREEK

This little stream, about 7.5 miles long, was examined from the highway crossing (Graburn campsite), downstream to Battle creek and upstream for about 1 mile.

At the time of our visit the volume of flow was reduced to a mere trickle, and, in one stretch, the stream had disappeared below ground level. Numerous beaver dams provide pools and were it not for these it is doubtful if all-year-round flow would continue.

The stream bottom is heavily silted and poor in food supply. Caddis larvae living on top of the stones are the principle bottom insect; the usual fauna of mayflies and stoneflies under the rocks was poorly represented. This is probably due to the gentle flow and the silt deposit.

There are numerous small feeder springs of fine, cold water, but their flow is slight and they fail to produce a large flow in the main channel.

The water is cool — 56°F.

Seine hauls were made and a number of longnose dace, **Rhinichthys cataractae,** were captured. These little fish (up to three inches) were the only fish life found. A careful search failed to disclose any trout, either adult or fry.

Conclusions. Graburn creek is too small to consider seriously as a trout stream. Quite probably a few trout move into the creek during the spring high water, but it is unlikely they would remain for the summer because of low and poor food supply.

BATTLE CREEK

Battle creek is a larger stream with approximately 10.5 miles of water in Alberta. Our party examined the portion from a few hundred yards above the bridge on the main road, downstream to the entrance of Graburn creek, and from there downstream to about three miles east of the Saskatchewan border.

The stream supports an extraordinarily large number of beavers. In places the beaver dams are less than 100 yards apart and the ponds, lying one below the other, give the effect of a long, gentle stairway. Some of the ponds are over fifty feet wide and have considerable depth; the flow of water through them is thereby reduced to a slow speed. This gentle current has led to the deposition of a heavy load of silt so that the ponds have a mud bottom. The mud, plus the gentle flow, have permitted the growth of rooted aquatic plants which flourish in dense tangles in some of the ponds — a condition wholly foreign to our native trout streams.

Despite the slow current the ponds are not too warm — the highest temperature we recorded was 61°F. This is warm enough, however, to stimulate the growth of a rich supply of water bugs, snails and midge larvae, which live on the weeds and in the bottom mud.

Seining operations were carried on and a rich and varied fauna of small fishes was found. Our party had not previously encountered such a variety of fishes in one stream. Pending further study, these fishes are tentatively identified as follows:—

Pimephales promelas—fathead minnow.
Rhinichthys cataractae—longnose dace.
Chrosomus eos—northern redbelly dace.
Couesius plumbeus—creek chub.
Catostomus commersonnii—common sucker.
Poecilichthys exilis—Iowa darter.
Eucalia inconstans—brook stickleback.

All of these fishes remain small throughout their lives except, of course, the common sucker.

We found no trout fry and were unsuccessful in angling for adult trout. We know, however, that trout are taken in Battle creek.

Recommendations. Brown or Loch Leven trout should be planted annually in the beaver dams. Because of the long haul fry would probably be easier to handle and their chances of surviving in the sheltered beaver dams should be good. Annual plantings are suggested because the stream is poor in facilities for natural spawning and our failure to find fry suggests that little natural reproduction takes place. In streams where natural propogation occurs we have usually been able to find the young.

The heavily silted water, with very gentle flow, provides a poor habitat for Rainbow trout and no further plantings with this species are recommended.

Re-examination of Battle and Graburn Creeks (1948)

CYPRESS HILLS

On July 30 and 31, 1948, we revisited Battle and Graburn creeks. The second day Mr. Harry Bateman and Mr. W. C. Reesor, of Medicine Hat, were with us. Our purpose was to obtain specimens of the Rainbow trout which we failed to secure the previous summer. We were successful in obtaining trout from both creeks. We also examined a stretch of Battle creek near its headwaters which we did not see before.

Both creeks are thickly settled by beavers and their dams form a continuous chain of ponds. These are deep, brown and fairly still. They contain common suckers as well as Rainbow trout. Temperatures are fairly low, 60 - 66°F., maximum.

We secured measurements of ten Rainbow trout, two from Graburn and eight from Battle creek.

The ages, lengths and weights of these fish are as follows:

Age 0 (in first summer) 3.5 inches, less than 1 ounce, immature.
Age 1 (in second summer) 8 specimens, average length 5.6 inches, (range 4.3 - 6.4), average weight 1.6 ounces, (range 1 - 2 ounces); all immature.

Age 3 (in fourth summer) 14.2 inches, 17½ ounces, female mature.

This is quite good growth; it compares favourably with growth in Obed lake and creek.

The range of ages indicates that the population is spawning, and that there is successful natural reproduction.

The largest Rainbow had eaten a shrew and several minnows. The stomachs of the others contained a mixture of terrestrial insects (grasshoppers and beetles), caddis larvae and mayfly nymphs.

Conclusions. While these streams are supporting a Rainbow population, the slow, quiet, brown water suggests that brown trout would do better.

DOG POUND CREEK (1948)

Dog Pound creek was examined July 19, 20 and 21, 1948. It consists of about 65 miles of water, beginning north of Cochrane and running north into the Little Red Deer river. The upper half, ending at Beaverdam creek, was the only portion examined. Of this half, the uppermost 15 miles are the most important. This portion of the stream has a moderate flow, gradient about 37 feet per mile, and numerous deep beaver ponds. The stream and ponds are densely overhung with scrub; so much so that casting a fly is a difficult and tricky business. The channel is 10 - 20 feet wide, composed of mud mainly, with stones on the bottom of the occasional riffles.

In this upper part the water is clean, but distinctly brownish; the pH is 7.7; the beaver ponds are often murky with a transparency of only two or three feet. Maximum water temperatures of this region are about 60 - 65°F.

The bottom food in the riffles consists of very large numbers of small animals; one sample of a square foot of riffle yielded:—

123 blackfly larvae
127 mayfly nymphs
23 stonefly nymphs
13 Caddis larvae
5 midge larvae
1 midge pupa
1 nematode
1 water mite

Although large numbers of bottom animals are present, they are small forms, and the total volume per square foot was only 0.8 cc. In the beaver dams a rich fauna of water bugs and diving beetles exists.

This portion of the stream supports a good population of Eastern Brook and Brown trout. They are heavily fished and very shy; it takes an expert angler to fill his creel. It is possible to fish all day, as we did, and catch nothing. However, careful observation reveals numerous trout in the bearver dams and, in the evenings, they may be seen jumping. We caught one Brown trout, 9.4 inches long, weighing 5 ounces. This fish was an immature male, two or three years old —fairly good growth.

Further down, at the bridge east of Cochrane, the stream is about fifty feet wide, shallow, rocky and open. Temperatures here are some 10 degrees higher, possibly beyond the normal range for trout. Many dace and suckers are present here.

Conclusions

The upper Dog Pound is a warm, moderately rich stream, with plentiful deep, quiet beaver ponds, ideal for Brown trout. The lower Dog Pound is probably too warm for trout.

WOLF CREEK, TRIBUTARY TO NORTH SASKATCHEWAN (1948)

Wolf creek was examined on July 26 and 27, principally in the vicinity of Alder Flats, but also upstream a few miles. A visit was also made to Horseshoe creek, a small tributary.

Wolf creek rises in Township 6, Range 42, west of the 5th Meridian, and flows about 36 miles northward to enter the North Saskatchewan in Township 8, Range 47, west of the 5th Meridian. It is a slow, very brown stream (tea-coloured); beaver dams are numerous, resulting in deep, almost stagnant, very dark ponds. The pH is 7.1.

During our visit it was cold and rainy so water temperatures recorded were abnormally low. For example:—

July 26, 8:45 p.m., air T., 60°F.; water T., 66°F.

July 27, 12:0 p.m., air T., 62°F.; water T., 64°F.

The overnight minimum was 64 and the maximum for July 27 was 68°F. Thus water was running several degrees over air temperature and in normal warm summer weather this stream undoubtedly warms to well over 70°F.

We set gill nets in a big beaver pond near Alder Flats, but got no fish. Pike are reported by Mr. John Anderson, who kindly showed us around while we were there. We were able to find no trace of planted trout.

Food supply is good; in a riffle we collected from one square foot:—

121 Caddis larvae
49 mayfly nymphs
41 beetle larvae
6 midge larvae
1 stonefly nymph

This collection had a volume of 1.4 cc. It is a rich sample but predominantly warm-water animals.

In conclusion, it appears that whereas Wolf creek looks like ideal Brown trout water, it probably becomes too warm for trout. We suggest further efforts to find evidence of survival of previously planted trout before making any further plants.

Horseshoe Creek. — A very small, very brown creek, 4 - 6 feet wide, pH 7.3, covered with brush and full of dead fall. Current, slow; bottom of mud. Numerous chub **(Couesius plumbeus).** Cooler than Wolf creek. Seems too small for serious consideration.

SCHATTLE DAM (BULLSHEAD CREEK RESERVOIR) (1948)

A visit to Schattle dam was made on August 2nd, 1948. It lies in rolling prairie country, 25 miles south and a trifle east of the city of Medicine Hat, on the Eagle Butte Road.

Schattle dam is a storage reservoir formed by building a dam across the mouth of a coulee. There was no inlet to the coulee and the reservoir is filled by surface drainage from the surrounding hills, principally in spring. The spillway leads to Bullshead creek which drains north to the South Saskatchewan river. The spillway is used only when this creek is low and water is needed for stock. Consequently there is no regular variation of water level; in a dry season the reservoir would likely be left very low over winter.

The area of water in the reservoir is 152 acres at full level; at the time of our visit the reservoir was two feet below full level. We took

30 soundings; the deepest water found was 17 feet; half the reservoir is 10 feet or less deep; the rest runs from 11 to 14 feet with a few small deeper holes.

The reservoir warms from top to bottom. The surface temperature was 66.4°F.; temperature at 12 feet, 63.5°F. The air temperature was 76.1°F.

The pH was 7.9 at surface and bottom.

The oxygen content at 15 feet was 3.3 cc/litre.

The bottom consists of fine, rich, black soil. A dredging yielded:—

33 Oligochaetes
5 leeches
2 clams
2 Pisidium
19 Corethra larvae
1 Caddis larva
1 backswimmer

This fauna shows the effects of the reduced oxygen at the bottom; the oligochaetes are typical of semi-stagnant water. The total quantity of 8.0 cc per square foot is fair.

A plankton haul revealed an enormous plankton supply. Although the haul was only 15 feet long, 17.5 cc of plankton were collected. Of this quantity 14.5 cc were **Daphnia** and **Diaptomus** (mostly the former). This is a phenomenally rich plankton. The surface drainage has evidently enriched the water to a great degree — a fact indicated also by the high alkalinity (pH 7.9). The remaining 3 cc of plankton consisted almost entirely of green filamentous algae; these were abundant enough to colour the water an obvious green.

Seine hauls took no fish and none was seen.

Conclusions and Recommendations. Schattle dam is a very rich body of water. If it is not left too low (less than 10 feet) over winter it should support perch and pike and provide very rapid growth. We recommend that perch be introduced first and, after a year to get them established, pike could be added. The pike would then live on the perch. It may develop that perch do so well that fishermen would prefer to reserve the reservoir for perch alone.

POLLUTION OF SOUTH SASKATCHEWAN RIVER BY THE CITY OF MEDICINE HAT (1948)

Some of the sportsmen of Medicine Hat are concerned about the possible ill effects of the raw sewage which the city discharges into the South Saskatchewan River. Accordingly, we made a preliminary investigation on August 3rd, 1948. We are much indebted to Mr. W. J. Harper who accompanied us as guide.

At the time of our visit the river was higher than normal, due to heavy rains, and conditions were not ideal for detecting pollution.

Point I. Immediately above main sewer on south bank.

Water temperature, 70°F.

Oxygen content, 6.7 cc/l—above saturation.

pH, 7.7.

Bottom fauna, caddis larvae and midge larvae in small numbers.

Bottom silt and stones, quite clean.

These observations establish conditions where pollution is very slight.

Point II. At point of discharge of main sewer.
Water temperature, 70°F.
Oxygen content, 5.3 cc/1.
pH, 8.2.
Bottom fauna, no changes noted.
Bottom now slimy.

Reduced oxygen and increased alkalinity reflect effect of sewage, but lowered oxygen not severe enough to bother fish or bottom living insects. However, the large amounts of faeces and other debris present a most unhappy sight.

From Point II downstream for ¼ mile (as far as Seven Persons creek) an eddy keeps the sewage along the south bank.

Point III. 300 yards below main sewer.
Temperature, 70°F.
Oxygen content, 5.3 cc/1.
pH, 8.0.
Other features also similar to Point II.

Point IV. Mouth Seven Persons creek.
Oxygen, 5.3 cc/1.
No further change in any condition.

Point V. 4 - 5 miles below sewer.
Water temperature, 70°F.
Oxygen, 6.3 cc/1.
Bottom very slimy.
Brown, odorless froth on banks.
Appears to be some recovery of Oxygen here.

Point VI. Six miles below sewer.
Oxygen, 5.5 cc/1.
Bottom fauna as above sewer.
Rocks still slimy.

Point VII. We also examined the much smaller (about 16-inch) sewer which enters, above the large sewer, on the north bank. Its effluent is too small to be significant.

In conclusion, we found evidence of pollution in reduced oxygen and increased sliminess below the sewer, and these polluted conditions extend at least six miles downstream. However, at the time of our visit, the reduction in oxygen was not great enough to seriously affect fish or bottom dwelling fish food organisms. It should be emphasized that a full analysis of the pollution would take at least ten days and probably longer. It is possible that the full effects of the sewage do not show up until it has been carried further downstream. (This does not seem probable.)

In November, Mr. Harper collected two water samples in sterilized bottles provided for the purpose by the Provincial laboratory at the University. This laboratory made a bacteriological examination of the samples. They report that the water shows "marked evidence of unfavourable bacterial contamination." It is unfit, even dangerous, to drink. However, fish caught in the water should be safe to eat if they are thoroughly cooked.

LAKES

REPORT ON SKELETON LAKE (1947)

The fisheries survey party spent July 29, 30 and 31 in a study of Skeleton lake and in conversation with local people interested in the management of the lake.

Skeleton lake lies about three miles northeast of the village of Boyle. It is a small lake about three and a half miles long and two miles wide at the widest point. The principal inlet, from Hope lake to the northeast, is not running, nor is the outlet to Amisk lake in the southeast. The lake consists of two basins connected by a half mile of very shallow narrows (only six inches deep in places). The north basin is small and deep with steeply sloping contours. The maximum depth here is 55 feet. The larger south basin has a more gentle contour and is much shallower—the maximum found was 28 feet. The contour map which accompanies this report was constructed from a series of fifty soundings.

Physical and Chemical Conditions. Table 20 shows our findings in the north basin.

TABLE 20.

Physical and Chemical observations in the north basin of Skeleton lake.

Depth feet	Temp. °C.	Oxygen cc/l	pH
0	21	5.0	8.1
10	20.8	--	--
15	20.5	--	--
20	16.2	1.6	--
30	11.0	0.5	--
45	---	0.4	7.1
55	9.8	--	--

At the present time the north basin is unsuitable for fish. From 15 - 20 feet on down to the bottom there is not enough oxygen to support fish life. Also there is an accumulation of decomposition gases which give the water a sulphur taste and odour and a more acid reaction. This condition may be due to an unusually late spring and absence of strong spring winds and, therefore, may not occur every summer. However, the failure of the water to warm up below 15 feet indicates that the north basin is not stirred much by winds and stagnation of the deep water may be expected to occur rather often.

TABLE 21.

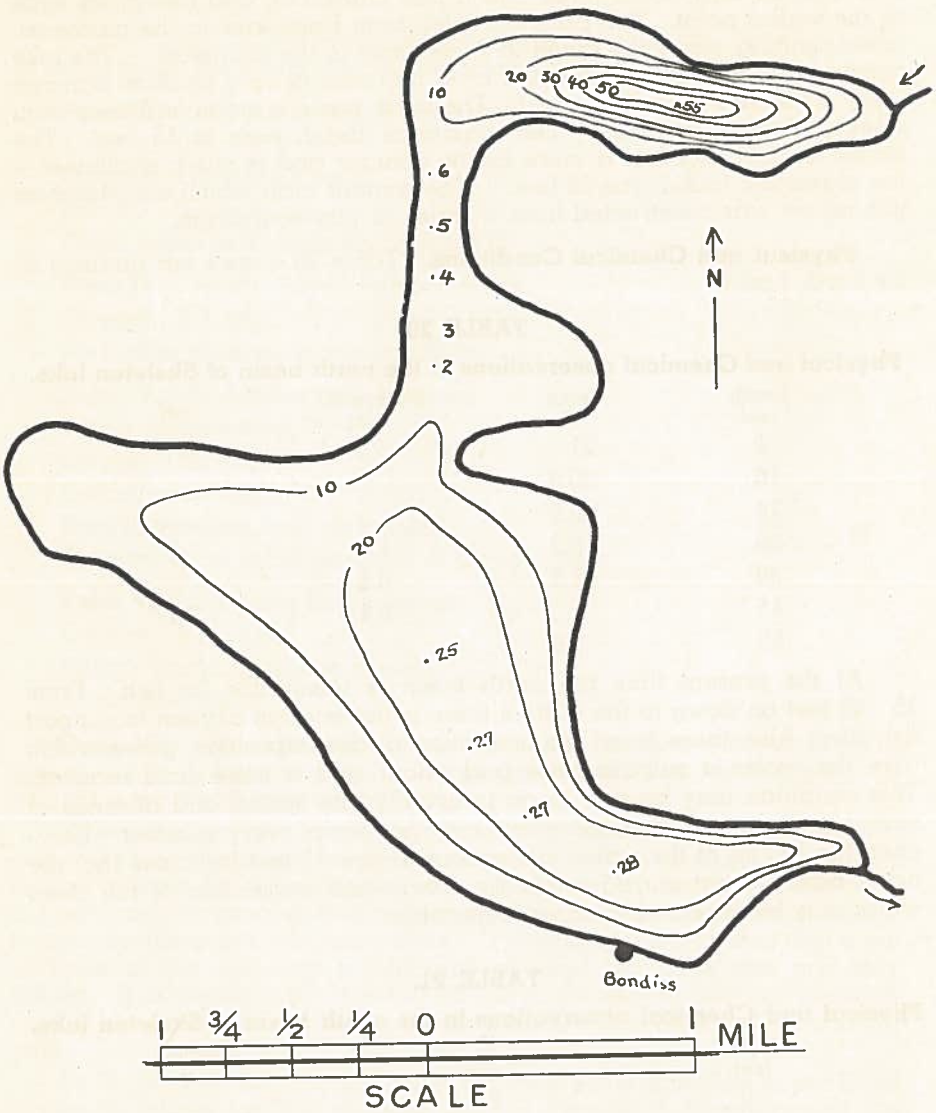
Physical and Chemical observations in the south basin of Skeleton lake.

Depth feet	°C. Temp.	Oxygen cc/l
0	21	--
10	21	--
15	20.7	--
23	18.5	4.5

The shallow south basin warms to the bottom indicating thorough stirring by winds. Consequently it has an adequate oxygen supply.

SKELETON LAKE

FIG. 6



Plankton and Bottom Fauna. A plankton haul in the south basin showed an abundance of microscopic food animals and plants. The commoner types are as follows:—

Animals	Plants
Cladocera	Blue-green algae
Daphnia longispina	**Rivularia**
Bosmina	**Anabaena**
Copepoda	**Clathrocystis**
Diaptomus	Green algae
Cyclops bicuspidatus	**Staurastrum**
Protozoa	**Pediastrum**
Ceratium hirundinella	Diatoms
	Fragilaria
	Tabellaria
	Stephanodiscus

A mild water bloom was in progress, much less severe than in other lakes such as Lac la Biche.

Four dredgings in the south basin showed the bottom to be sandy with a moderate food supply. The food is distributed as follows:

5 feet — 15.4 pounds per acre.
10 feet — 19.2 pounds per acre.
15 feet — 34.5 pounds per acre.
20 feet — 3.8 pounds per acre.

The shallower water is richer in food than the deeper water.

Fish. The fish were sampled by setting a test net consisting of fifty yards of 1½ inch and 100 yards each of 2¾, 3½, 4½ and 5½-inch nets. This was supplemented by seine hauls around the shores.

The species found were:—

Leucichthys sp.—tullibee.
Coregonus clupeaformis—whitefish.
Perca flavescens—perch.
Stizostedion vitreum—pickerel.
Esox lucius—pike.
Lota lota maculosa—burbot (ling)—not taken in the nets.
Notropis hudsonius—spot tail minnow—not taken in the nets.

Notable is the absence of suckers. A fisherman informed us that in many years of fishing he had seen only two.

The growth of the fish, determined from measurements and scale samples is shown in Table 22.

TABLE 22.

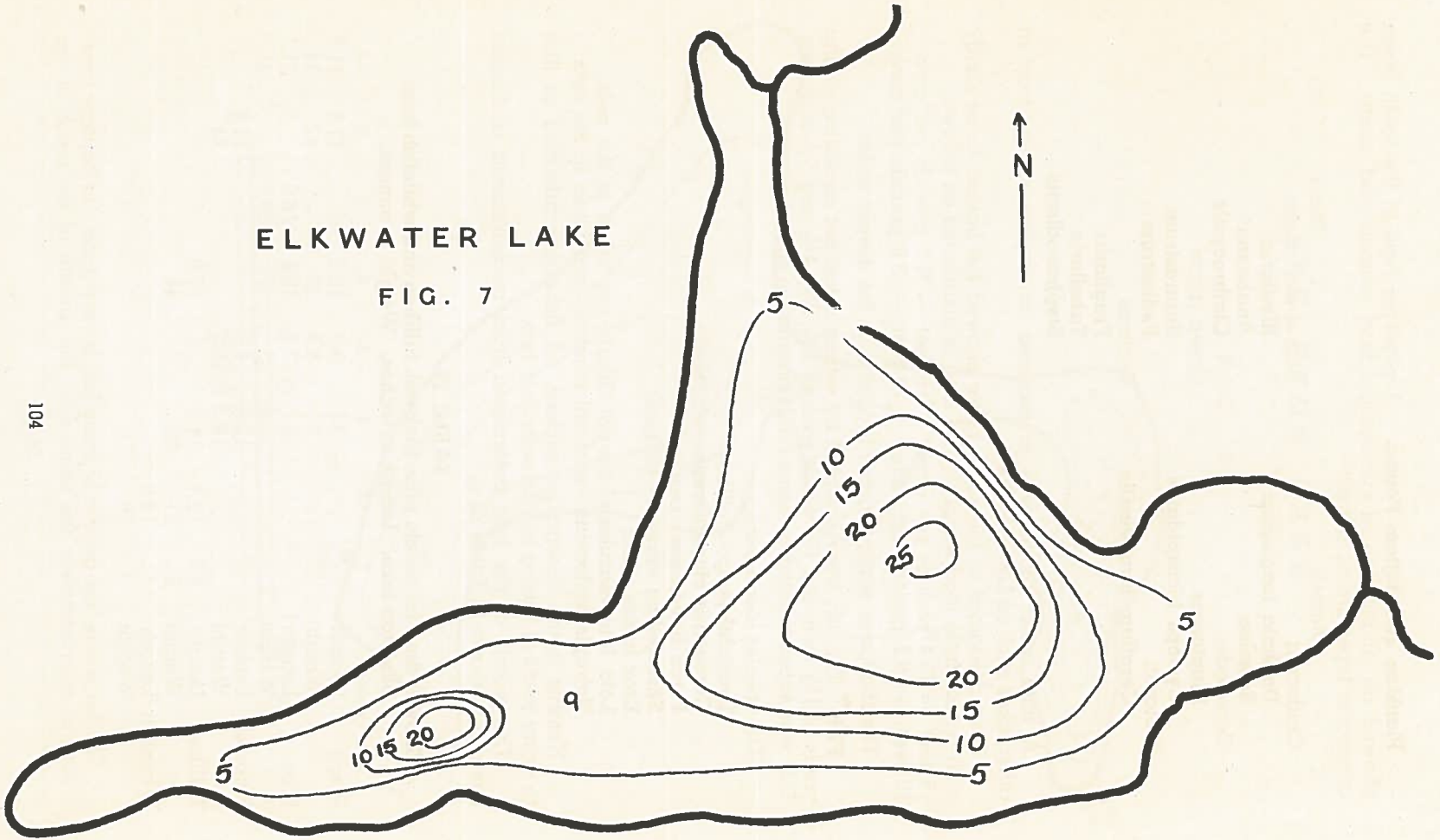
Growth data for perch, pike, pickerel, tullibee and whitefish from Skeleton lake. Length in inches. Weight in ounces.

Age (years)		1	3	4	5	6	7	8	9
Perch	Length	--	---	9.1	9.7	10.3	---	11.6	11.6
	Weight	--	---	7	8.5	10	---	12	14
Pike	Length	--	---	16.7	17.6	18.6	18.9	---	21.1
	Weight	--	---	20.8	25	37	33.5	---	45
Pickerel	Length	--	---	12.6	14.0	---	---	21.8	---
	Weight	--	---	14	15.2	---	---	64	---
Tullibee	Length	6.3	13.4	14.3	---	17.9	---	---	---
	Weight	2	21	29	---	44	---	---	---
Whitefish	Length	--	14.8	---	---	---	---	---	---
	Weight	--	28	---	---	---	---	---	---

On the whole, the growth of these fish is very good. In Baptiste lake, a lake of approximately the same size, the growth of the perch is the

ELKWATER LAKE

FIG. 7



same, the growth of the pike slightly faster and of the pickerel somewhat slower. The Skeleton lake tullibee start about the same as the Baptiste tullibee but soon get much larger; they grow much faster than in most other Alberta lakes. All the whitefish in our sample were three-year-olds; they are large for their age and indicate that good growth occurs.

The whitefish and tullibee are both badly infested with **Triaenophorus.**

Net Selection. The catch in the test net was as follows:—

1½ inch—2 yearling tullibee.
2¾ inch—160 perch, 20 pickerel, 31 pike, 1 tullibee.
3½ inch—9 perch, 4 pike, 3 whitefish, 4 tullibee.
4½ inch—1 pike, 3 whitefish, 5 tullibee.
5½ inch—1 pickerel, 5 tullibee, 2 whitefish.

Conclusions. Skeleton lake is a small lake, rich in food for fish such as tullibee and moderately rich in food for other species. Its north basin is unreliable as a fish producer; this leaves a very small producing lake to be considered. Its maximum sustained yield of whitefish and tullibee could not attain 100,000 pounds per year.

REPORT ON ELKWATER LAKE (1947)

Elkwater lake lies at the foot of the Cypress Hills, in Township 3, Range 8, west of the 4th Meridian, about forty miles from the city of Medicine Hat. It is a popular holiday spot for Medicine Hat people and the only watering-place in the district.

The lake has a surface area of 450 acres and an irregular three-angled shape. The streams serving the lake have not flowed for some years past but, in spite of this, a fair depth of water remains. The deepest water found was 25 feet in a small area near the lake centre. Another small area of 24-foot water was found in the west arm. Over half of the lake is less than ten feet deep. A record of our depth findings is shown on the accompanying contour map.

The water of the lake is very alkaline (pH is 8.1); possibly this alkalinity is partly responsible for some of the features of the lake, e.g., a tendency to form marl and an excessive growth of weeds.

The growth of pond weeds is indeed excessive. All the water up to a depth of seven feet is thickly grown and, in some places, the weeds extend to depths of 15 feet. No definite deleterious effects of this growth can be stated except that, in seasons of low water, its decomposition under ice in the winter uses oxygen and increases the danger of winter-kill of fishes from asphyxiation. There is also the unpleasantness of weeds for bathers. Possibly the use of some of the recently developed pond weed control chemicals should be investigatedd.

Temperature and Oxygen. On August 19th the water of Elkwater lake was at 17°C. (62.6°F.) from top to bottom at all depths. Thus there is no thermal stratification (no layer of deep cold water). Such lakes, which warm thoroughly during the summer, usually get too warm for trout to live in, and are suitable only for warm-water fishes.

The oxygen content of the water was high — close to saturation at all depths; no summer stagnation takes place.

Plankton. The assemblance of microscopic plants and animals which drift about in the water is called the plankton. The plankton forms the food supply of the young of most fishes. It was measured in

Elkwater lake by drawing a fine silk net through the water from the bottom to the surface. The volume thus taken was only 1.1 cc — a rather small amount. The following animals and plants were found:—

Plants (Phytoplankton)		Animals (Zooplankton)	
Fragilaria **Stephanodiscus**	Diatoms	**Cyclops bicuspidatus** **Diaptomus** **Bosmina**	Crustaceans
Pediastrum	Green alga	**Anurea**	Rotifer

This plankton is unusual in several respects; one is the small number of different kinds — usually there are many more species, especially of the plants; another is the surprisingly small total volume of plants — in most of our prairie lakes during August there is a tremendous growth of algae which forms a "water-bloom" and turns the lakes green. The crustacean, **Bosmina,** while very widespread, is not usually so abundant as in Elkwater lake; here it made up the greater part of the volume of our sample.

Bottom Fauna. The assemblage of animals which live in and on the mud of the lake bottom is the bottom fauna. We sampled it by taking a series of dredgings at 3, 8, 16 and 21 feet. Each dredging was washed through a fine screen and the animals picked out, counted and weighed. Since this fauna is an important source of fish food, the amount of it is a useful indication of the productivity of the lake. Our findings are set out below:—

Animals	Number per dredging			
	at 3 feet	at 8 feet	at 16 feet	at 21 feet
Fresh water shrimp **(Gammarus)**	122	61	4	7
Midge larvae **(Chironomidae)**	68	8	90	37
Phantom larvae **(Chaoborus)**	0	0	0	1
Small clams **(Sphaeriidae)**	4	0	8	2
Caddis larvae **(Trichoptera)**	0	2	0	0
Leeches	0	1	0	0

From this table it is clear that the fresh water shrimp, **Gammarus,** is the principal bottom animal and, further, that the shallow water is considerably more productive than the deep water.

The total quantities in grams per square foot have been calculated as follows:—

3 feet — 6.4 grams. 16 feet — 2.8 grams.
8 feet — 5.2 grams. 21 feet — 1.2 grams.

These amounts can only be considered fair productivity; the preponderance of the shrimps is a good point as these animals are considered excellent fish food.

In examining the dredgings we were struck by the large accumulation of dead clam shells on the bottom at depths over three feet. This marl formation, as it called, is regarded as a poor sign for the fish production of the lake. In time it leads to the decrease of the bottom fauna and, hence, a lower fish yield. Observations over several successive years would be needed to show if this is occurring in Elkwater lake.

Fish. The fish were sampled by setting 150 yards of gill net of 2¾ and 3½-inch mesh. The location of the set is shown on the map. The catch consisted of 27 perch **(Perca flavescens)** and 40 pike or jackfish **(Esox lucius).** One of the pike was unusually large (16 lbs.), and the

perch were mainly around 20 ounces — very large for perch. The size of this catch indicates quite an abundant supply of fish. Measurements and scale samples were taken from twenty fish. A study of these has brought out the following facts:—

PERCH

Age	Elkwater Lake Average L.	Elkwater Lake Average Wt.	Baptiste Lake Average L.	Baptiste Lake Average Wt.	Skeleton Lake Average L.	Skeleton Lake Average Wt.
4	---	---	---	---	9.1	7
5	9.6	9.5	9.8	---	9.7	8.5
6	11.5	17	10.5	---	10.3	10
7	11.7	19	11.7	---	---	---

(age determined from markings on the scales)

The perch of Elkwater lake grow in length at the same rate as in other Alberta lakes. In weight they grow much faster. They are very fine perch and the choicest for eating that we have found.

PIKE

Age	Elkwater Lake Average L.	Elkwater Lake Average Wt.	Lesser Slave Lake Average L.
3	12.5	10 oz.	15.8
4	16.9	20	16.5
5	20	36	17.5
6	23.8	53	20.7
10	36.8	256 (16 lbs.)	27 (approx.)

(age determined from markings on the scales)

The pike of Elkwater lake grow much faster than those of Lesser Slave lake, and, therefore, faster than the average for Alberta.

No other kinds of fish were found and it appears there are no minnows of any kind in the lake. The absence of forage fish (minnows) must certainly limit the productivity of the lake and force the pike to live on perch.

Conclusions and Recommendations.

Elkwater lake is a small, warm, shallow, alkaline body of water with excessive weed growth and a tendency to become a marl lake. There are apparently only two species of fish present, pike and perch. The production of these is limited by absence of forage fish, a rather poor plankton and average bottom fauna. The warm water, however, produces excellent growth of both the pike and the perch.

It is recommended:—

(1) That the spot-tailed minnow **(Notropis hudsonius)** be introduced as a forage fish for the pike. (See footnote.)

(2) That when pickerel are available a small planting be made. Because of the present lack of flow through the lake there is not too much chance of pickerel surviving but it is worth a gamble.

Footnote:—Recommendations were made verbally to Mr. H. B. Watkins, Superintendent of Fisheries, before this report was written. A large tank load of spot-tailed minnows has already been planted in Elkwater lake.

NOTE ON ELKWATER LAKE (1948)

We spent August 1st, 1948, making seine hauls around the shore of Elkwater lake. We hoped to find some survivors of the plant of spot-tailed minnows made the previous fall. None was found. We did find very large numbers of perch-of-the-year. Evidently this past spring was a very favorable one for perch spawning.

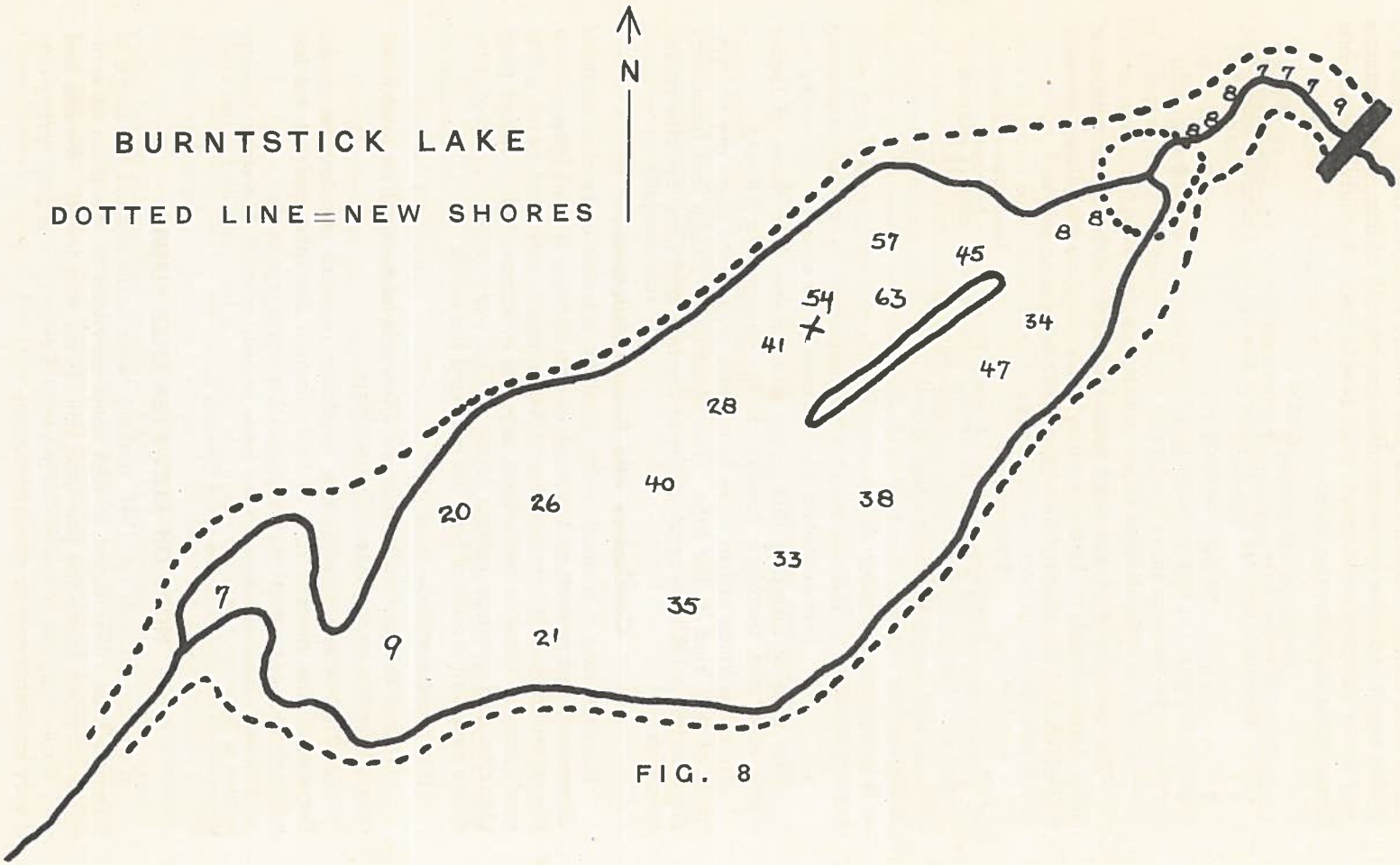

BURNTSTICK LAKE
DOTTED LINE = NEW SHORES
N
57
45
8
8
54
63
34
41
47
28
40
38
20
26
33
7
35
9
21

FIG. 8

REPORT ON BURNTSTICK LAKE (1947)

The survey party visited Burntstick lake from August 13th to 16th, 1947. The weather during this period was cool and clouded with more or less steady rain.

Burntstick lake lies at Range 7, Township 35, Sections 1, 2, 11 and 12, west of the 5th Meridian. It drains by about nine miles of outlet creek into the James river and thence to the Red Deer river. It has an area of approximately one square mile.

A dam has been constructed across the outlet of the lake which has raised the water level from four to six feet. Unfortunately the dense brush which extended to the water's edge was not removed before flooding, and is now submerged. During this, the first summer of the new level, the sunken and partly sunken bushes and trees are beginning to die; it will take many years before all this brush is dead and decayed. In the meantime it is very difficult to approach the lake in the usual way from the east end. A boat may be launched on the river, just above the dam, but the way is not clear from there to the lake. A large patch of muskeg, about two feet thick, has torn loose and floated into the outlet, completely blocking the lake from the river (see dotted outline shown on map). The approximate extent of the flooded area is shown in dotted lines on the accompanying map.

Depth. The outlet varies from seven to nine feet deep. It is now still water and is excessively overgrown with yellow pond lilies, so much so that it is nearly impossible to run an outboard motor.

There is a similar growth fringing the lake shore wherever the depths run from seven to nine feet. There is a large area of this shallow, weedy water near the outlet and another long narrow strip in the center of the eastern end of the lake. The latter is almost an island at some points.

The main lake is quite deep. The deepest sounding was 63 feet; about half the lake is forty or more feet deep. The western half of the lake is shallower than the eastern half.

Physical and Chemical Conditions. Our observations on temperature, oxygen content and pH are shown in the following table.

Temperature, oxygen and pH in Burntstick lake on August 14th, 1947. (at point X on map.)

Depth (feet)	pH	Oxygen	Temperature °C.
0	7.5	5.0	17.5
10	--	--	16.5
20	--	--	16.0
25	--	--	15.1
30	--	1.4	11.4
48	7.0	1.0	---
57	--	--	6.3

The water of Burntstick lake is cool — the surface was only 63.5°F. on August 14th (although it was cool, rainy weather). A distinct thermal stratification occurs; thus the water is fairly warm to 25 feet; from 25 feet down it is much colder. The warm surface layer has prevented aeration of the cooler water below and oxygen depletion has occurred. There is scarcely enough oxygen to support life below 25 feet. The water is slightly tea-coloured; the transparency was seven feet.

Plankton. A plankton haul was made from fifty feet to the surface. The volume was small, only 1.8 cc. The animals and plants present were as follows:—

Plant Plankton

Blue green algae.

Anabaena—abundant.

Diatoms.

Asterionella—common.

Fragilaria—rare.

Crustacea.

Daphnia pulex—rare.

Diaptomus—rare.

Cyclops bicuspidatus—rare.

Animal Plankton

Protozoa

Ceratium—abundant.

Rotifers.

Polyarthra—abundant.

Anurea—abundant.

Nothalca—abundant.

Conochilus—abundant.

A slight waterbloom was in progress, caused by the blue green alga, **Anabaena;** the rest of the plankton was chiefly rotifers. This predominance of rotifers is characteristic of the plankton of bog lakes.

Bottom fauna. A series of five dredgings was taken from seven to sixty-one feet. The findings are shown in the following table:—

Depth	Midges	Worms	Clams	Miscell.	Total volume per sq.ft.
7	2	1	--	7	0.4 cc
23	10	1	17	8	1.2 cc
36	34	frag.	1	0	2.8 cc
49	127	4	0	0	8.0 cc
41	56	0	0	0	2.0 cc

Among the miscellaneous were **Chaoborus** larvae, a leech, three varieties of small snail, 1 amphipod **(Hyalella)** and one deer-fly larva.

This is a rather meagre fauna. The preponderance of midge larvae is to be expected in a lake which undergoes a stagnation. The midges found from thirty-six to sixty-one feet were of the variety known as blood-worms. As they possess haemoglobin they are able to withstand very low oxygen tensions. Similarly the oligochaetes (worms), at 49 feet are able to endure small oxygen values. The small number of clams and snails is characteristic of bog lakes the waters of which are too soft to supply enough lime for shells.

Fish. No minnows were found. One setting of gill net, 500 yards long, of meshes 1½ to 5½ inches, yielded only 3 small pike. These were taken at about 25 feet in the 2¾-inch net.

Conclusions. Burnstick Lake is a deep bog-type lake, subject to severe summer stagnation, and probably winter stagnation as well. It has a poor plankton and a poor to moderate bottom fauna.

The flooded vegetation along the shore is probably releasing toxic substances into the lake as well as rendering it unsightly.

Owing to the stagnation and poor food supply, I would not recommend the introduction of trout in Burntstick lake.

If it is at all possible to open the dam and restore the lake to its former level this should be done so that the brush may be removed.

CONJURING LAKE (1948)

A survey of Conjuring lake was made on July 3rd, 4th and 5th, 1948.

General Features

The lake lies in Township 48, Range 26, west of the 4th Meridian. It has an area of 540 acres. It is a long, narrow lake, 4½ miles long and only a few hundred yards wide, lying in a narrow valley, mainly in an east-west direction. It is well protected from prevailing winds. The inlet, which drains a marsh at the west end, is choked with plants and masses of filamentous algae, and was scarcely flowing at the time of our visit. The outlet, at the east end, is three to four feet wide, with dense reed margins, and a depth of two to three feet. The outlet was flowing gently It drains into the North Saskatchewan river.

The shore line is liberally provided with reed patches, and, at each end, grow dense beds of **Meriophyllum, Potamogetons** and yellow pond lilies.

Depths

A series of 25 soundings was taken from east to west ends. These are shown on the accompanying map. The maximum depth is 37 feet; most of the lake is over 20 feet deep. The shores slope steeply into the deep water.

Physical and Chemical Characters

Observation of dissolved oxygen content, temperature and pH are shown in the following table:

Temperature, dissolved oxygen (cc/liter) and pH in Conjuring lake, July 4th, 1948.

Depth (feet)	Temp. °C.	Oxygen	pH
0	21.0	--	8.1
10	19.2	--	--
15	18.0	6.3	--
20	11.5	1.6	--
25	10.5	--	--
33	---	0.4	--
36	9.3	--	7.0

Due to the long, narrow valley, which protects it from winds, a distinct thermal stratification is set up. The epilimnion (warm, surface layer) extends to 15 feet; the thermocline is around 15 feet; the hypolimnion (deep, cold layer) extends from about 15 feet to the bottom.

The sharp thermal stratification has led to stagnation of the hypolimnion; there is not enough oxygen to support fish life in the hypolimnion. The pH is very high (alkaline) at the surface, but is reduced to neutrality by more acid conditions at the bottom.

The transparency was 4 feet.

Bottom Fauna

The taking of dredgings proved nearly impossible due to the large number of boulders and smaller stones scattered over the bottom, except in the deepest water. One dredging was secured at 30 feet. The following forms were found:

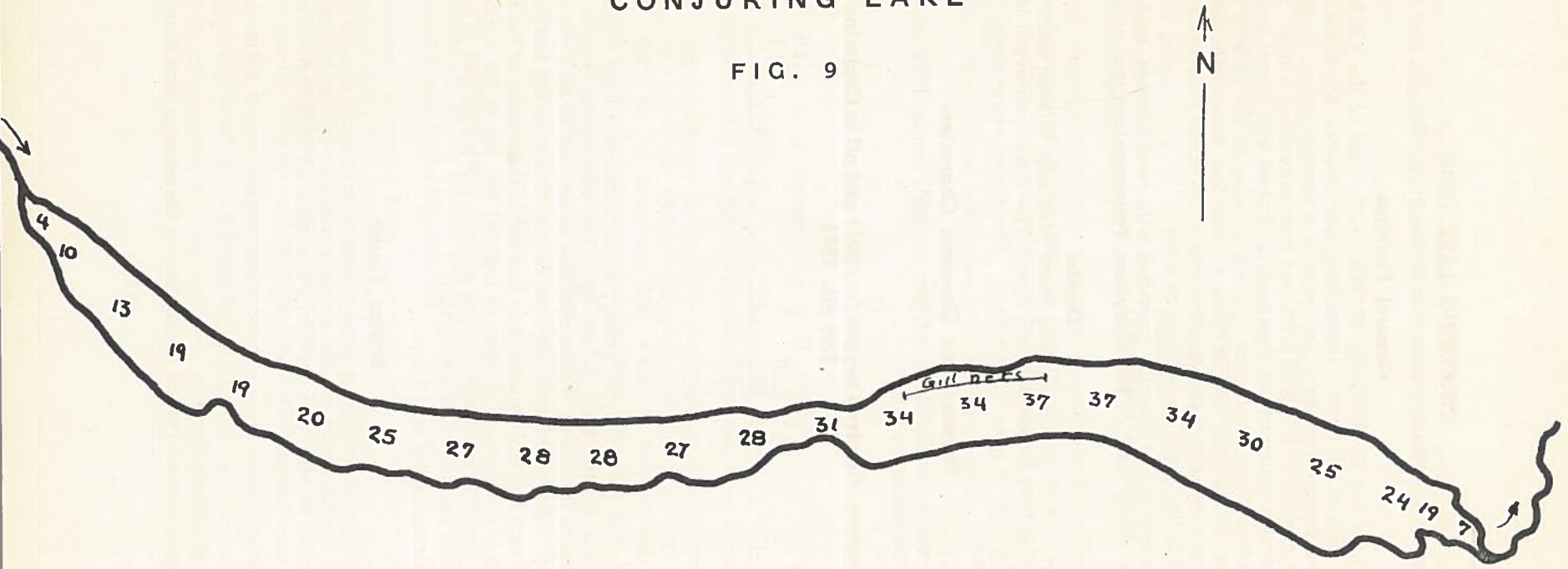
74 midge larvae. 24 Corethra pupae 7 Oligochaetes

The total volume of the sample was 1.9 cc or 7.6 cc per square foot. This is a fair bottom fauna.

Along the shore, a small population of **Gammarus** was found.

CONJURING LAKE

FIG. 9



Plankton

A haul with a silk net was made from 30 feet to the surface. The following forms were found:

Zooplankton	Phytoplankton
Copepoda	Blue-green algae
Cyclops bicuspidatus A	**Anabaena** A.
Diaptomus sp. R.	**Microcystis** C.
Cladocera	**Rivularia** R.
Daphnia R.	Green algae
Leptodora R.	**Pediastrum** C.
Rotifera	Filamentous greens C.
Anurea C.	Desmids
Polyarthra R.	**Staurastrum** R.
Nothalca C.	Diatoms
Protozoa	**Asterionella** R.
Ceratium VA.	**Stephanodiscus** R.

C—common. A—abundant. VA—very abundant. R—rare.

This plankton is rather remarkable for the low blue-green algae and diatom content.

The total quantity — a settled volume of 0.8 cc — is very low for the general run of our lakes.

Fish

We were unable to get a large fish sample as we could not set our nets in shallow water because of the large number of anglers who were trolling along the shore. We made a setting in 25 - 30 feet of water with 250 yards of 1½, 2¾, 3½ and 5-inch nets; (50 yards each). This setting caught:

1½ - 3 perch	4½ - 1 common sucker
2¾ - 0	5 - 0
3½ - 1 pike	

We also seized one 3-inch Eaton net (25 yards) which contained no fish.

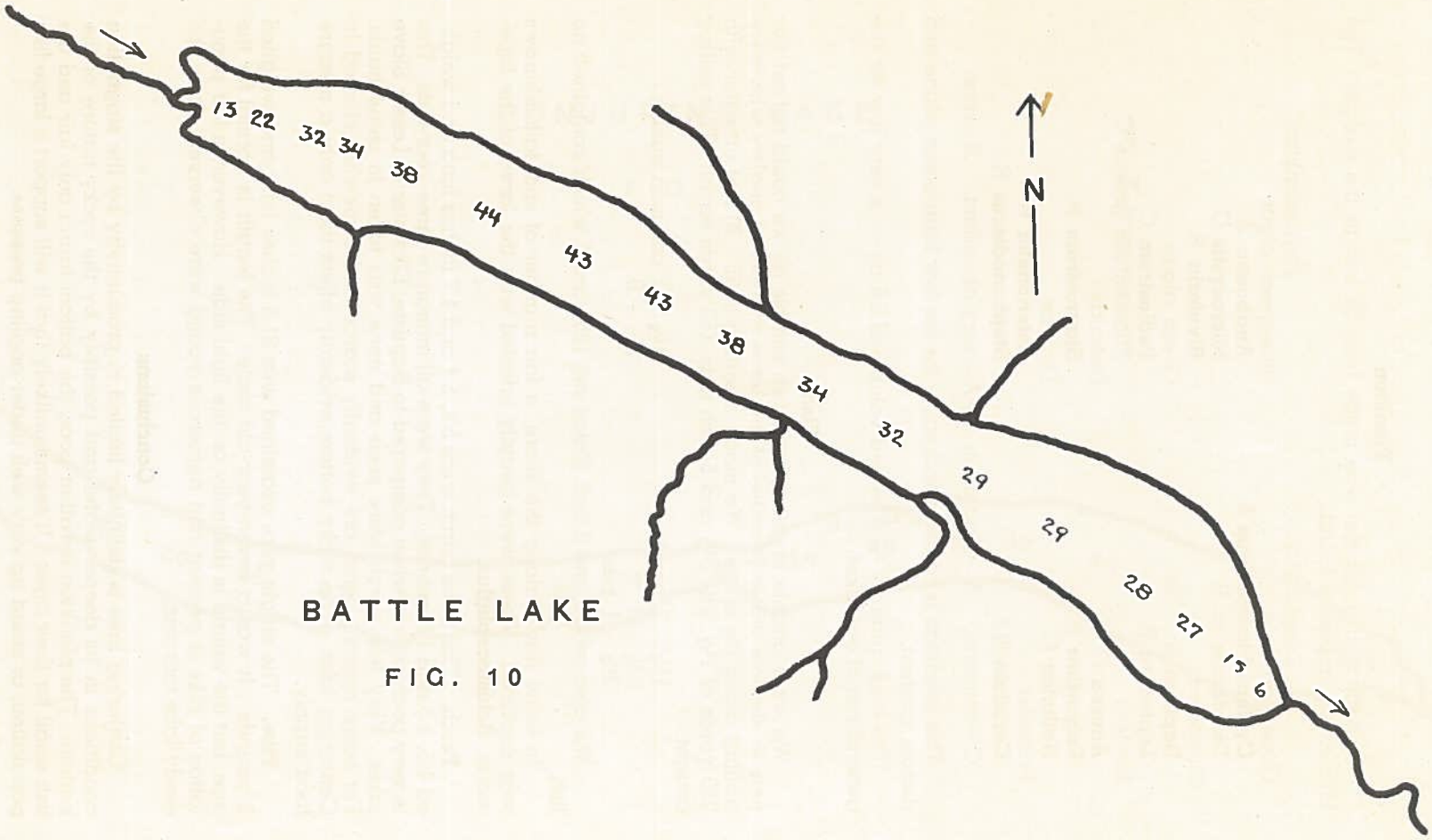
In seine hauls along the shore, a fair number of spot-tail minnows was captured. These were heavily infested with the larva of the tape-worm, **Schistocephalus.**

Perch. The three perch were 5.4, 5.4 and 4.7 inches long and weighed 1.5, 1.0 and 1.0 ounces. They were all immature three-year-olds. This is very poor growth when compared to Baptiste, Elkwater or Lesser Slave lakes. Very few perch were seen and none was taken in seine hauls. For some reason, perch are evidently scarce and somewhat stunted in Conjuring lake. The rocky bottom evidently offers them only a meagre food supply.

Pike. The single pike examined was 21.5 inches long and weighed 3 pounds. It was a seven-year-old male. The length is normal for the age, but the weight is distinctly on the light side. However, a fair population of pike is present and numerous young were observed along the reedy lake margins.

Conclusions

Conjuring lake is definitely limited in productivity by the stagnation conditions in its deeper water and possibly by the rocky nature of the bottom. The plankton is rather poor, the bottom fauna only fair and the fish small for their ages. It seems unlikely that it will support a large fish population, or stand up very well under angling pressure.



BATTLE LAKE

FIG. 10

If any further attempts to establish black bass are made, Conjuring lake might be considered as a place to try. The rocky nature of the lake is a condition favoured by bass; being a warm-water fish, the bass should not be troubled by the stagnation of the cold water. The spot-tail minnows offer a supply of food. Finally, the outlet is small and easily screened to prevent the escape of introduced fish.

BATTLE LAKE

A survey of Battle lake was made on July 5th and 6th, 1948.

General Features

Battle lake lies in Township 45, Range 2, West of the Sixth Meridian. It has an area of about 1 2/3 square miles. Like Conjuring lake, it lies in a long, narrow valley, about 5 miles long and from 600 to 800 yards wide. The long axis of the lake is roughly northwest-southeast; the high hills offer considerable protection from wind. The principal inlet is at the northwest end; it is a barely flowing creek, 4 to 6 feet deep and 20 feet wide, choked with Potamogetons which extend well into the lake. The outlet, Battle River, is at the southeast end; it is almost concealed by reeds and heavily grown with Potamogetons and thick, floating blankets of filamentous algae. The rooted plants extend 200 yards into the lake. The flow is perceptible but not brisk. The Battle river flows eastward into Saskatchewan, where it joins the North Saskatchewan river at Battleford.

Depths

A map showing the soundings taken is attached to this report. The maximum depth of 44 feet was found in the center of the northwest end. Most of the lake is from 29 to 40 feet deep, with little variation throughout. The shores slope steeply to the water.

Physical and Chemical Characters

Our observations are presented in the following table:—

Temperature, dissolved oxygen (cc/litre) and pH in Battle lake, July 5th, 1948. Air T., 18° C.

Depth (feet)	Temp. °C.	Oxygen	pH
0	18.2	5.9	7.9
10	17.5	--	--
15	17.0	4.4	--
20	14.4	--	--
25	13.5	1.4	--
40	10.75	0.6	7.0

In general the physico-chemical characters closely resemble those of Conjuring lake. There is a thermal stratification set up with a thermocline between 15 and 20 feet, though not so sharply as in Conjuring. The epilimnion tends to be cooler and the hypolimnion warmer than in Conjuring. There is the same severe oxygen depletion and the more acid conditions in the deep water.

The observations recorded above were made in the northwest end. Similar observations were made in the southeast end with the same results, except that the oxygen content was slightly (probably not significantly) higher.

The transparency was 13 feet.

Bottom Fauna

A series of three dredgings was taken. The bottom is sandy to depths of fifteen feet. Beyond fifteen feet it consists of a thick, black muck. There are much fewer rocks on the bottom than in Conjuring lake. Animals found in the dredgings were:—

Dredging 1 at 2 feet—
- 33 Amphipods (Hyalella)
- 3 **Pisidium**
- 3 **Sphaerium**
- 1 Caddis larva
- 1 mayfly nymph
- 1 midge larvae

Volume = 0.5 cc.

Dredging 2 at 15 feet—
- 1 large clam
- 5 snails
- 4 Caddis larvae
- 5 midge larvae
- 1 Amphipods (Hyalella)

Volume = 0.6 cc.
(clam excluded)

Dredging 3 at 26 feet—
- 42 large midge larvae
- 11 small midge larvae
- 2 **Chaoborus** pupae
- 13 **Pisidium**
- 2 Amphipods (Hyalella)

Volume = 3.0 cc.

The shallow water fauna of 2.0 - 2.4 cc/square foot is rather poor. The deep water fauna of 12.0 cc per square foot is moderately rich.

Plankton

A single plankton haul with a 25 cm silk net was made from 25 feet to the surface. The settled volume of the haul was 4.5 cc, considerably more than in Conjuring lake. The commoner forms found were:—

Zooplankton
- Copepoda
  - **Cyclops bicuspidatus** C.
  - **Diaptomus** sp. O.
- Cladocera
  - **Daphnia pulex** C.
- Rotifera
  - **Anurea** C.
  - **Nothalca** C.
- Protozoa
  - **Ceratium** VA.

Phytoplankton
- Blue-green algae
  - **Anabaena** R.
  - **Coelosphaerium** C.
- Green algae
  - Filamentous types C.
- Desmids
  - **Staurastrum** O.
- Diatons
  - **Stephanodiscus** C.
  - **Fragilaria** O.

C—common; O—occasional; R—rare; VA—very abundant.

In general this is a sparse plankton, poor in quantity and number of species, and very similar to the plankton of Conjuring lake.

Fish

The fish were sampled by seine hauls and a setting of 300 yards of gill net of 50 yards each of 1½, 2¾, 3½, 4½, 5½-inch mesh. The nets were set in 18 feet of water.

The catch was as follows:—

5½ - 0; 5 - 4 whitefish; 4½ - 1 whitefish and 1 burbot; 3½ - 2 whitefish; 1 common sucker; 2¾ - 3 whitefish, 1 pike; 1½ - 1 whitefish.

Whitefish:—The ages, lengths and weights of the whitefish were determined to be:—

One year — 7 inches, 3 ounces (1 specimen)
Two years — 11.6 inches, 15 ounces (average of 4 specimens)
Four years — 16.3 inches, 40 ounces (average of 2 specimens)
Five years — 18.0 inches, 58 ounces (average of 3 specimens)

This is about average growth for whitefish.

Pike. The single pike caught was 19.1 inches long, weighed 30 ounces and was four years old. This is a very long fish for its age but certainly a little light for its length.

Young pike were plentiful around the shores and in the weeds at the inlet and outlet. Several of these, taken in seine hauls, were measured; they compare favourably in size with pike-of-the-year of other lakes (including Buck lake).

In seine hauls no minnows or young perch were taken nor were any seen.

Conclusions

Battle lake, like Conjuring, is a victim of its morphometry; its shape prevents the proper wind-action needed to aerate its waters. The resultant stagnation seems to have doomed the lake to rather low productivity. Fish will doubtless always be available here, but not likely in great quantities. No manner of effecting an improvement suggests itself.

BUCK LAKE (1948)

Buck lake was examined on July 6, 7 and 8, 1948. It is an attractive body of water, about 12 square miles in area, lying in rolling, wooded country, Township 46, Range 6, west of the 5th Meridian. It is approximately six miles long and 1.5 miles wide; the long axis is north and south. The inlet is at the south end. It is 30 to 40 feet wide and choked with reeds. There was no visible flow at the time of our visit. The outlet, from a bay in the east shore, drains north to the North Saskatchewan river and is about 20 feet wide and 3 feet deep, with little or no flow and dense growths of Meriophyllum and Potamogetons.

The shore line is mainly muddy but a few sandy beaches occur. There are numerous patches of reeds and tangles of submerged aquatic plants.

Depths

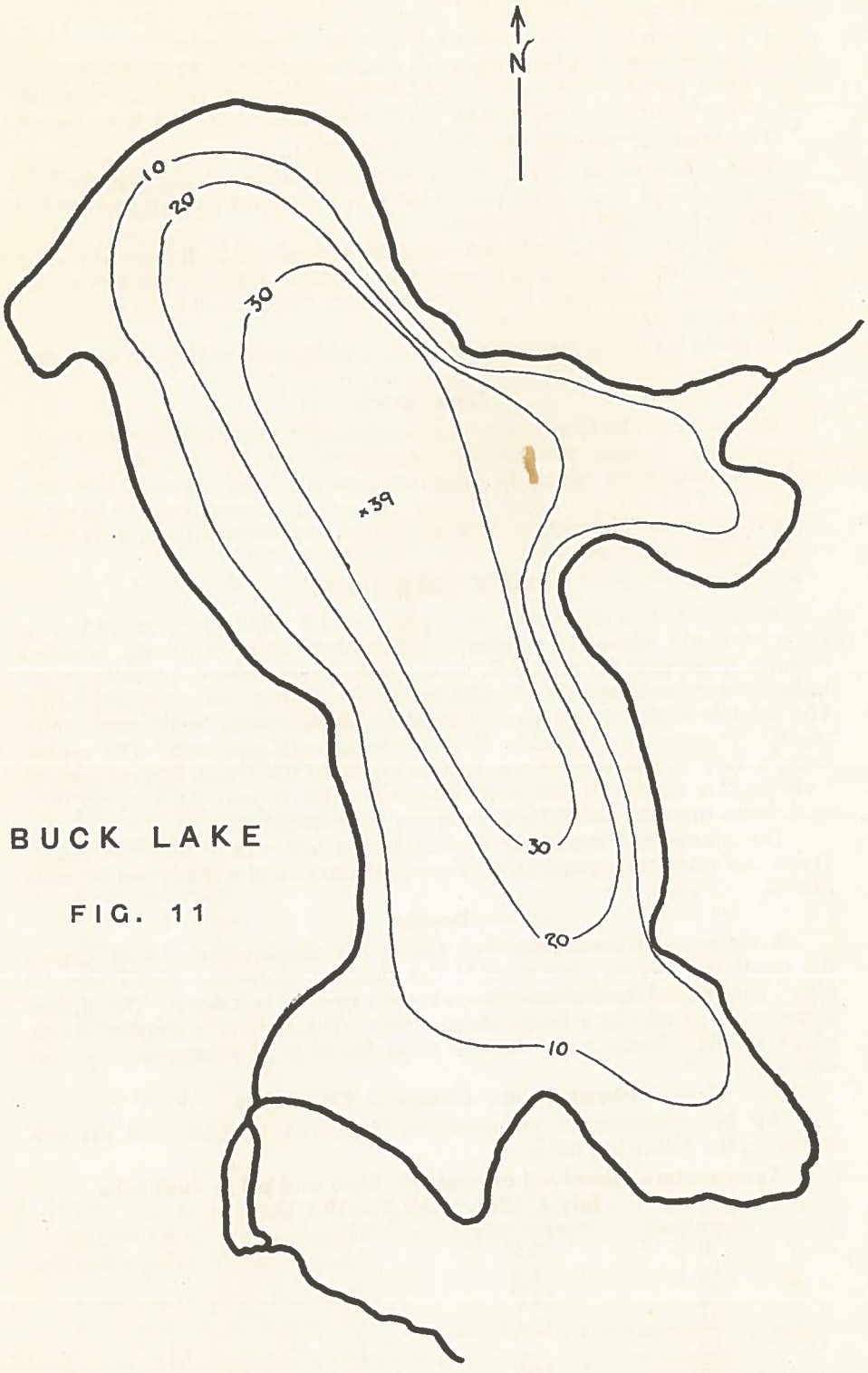
A series of 36 soundings was taken; the accompanying map shows the contours plotted from them. The deepest water we found was 39 feet. The central area of the lake is mostly over 30 feet deep. The shores slope fairly gradually into the deep water. The bottom is largely of rich black muck. Some rocky bottom was found in the bay on the east shore.

Physical and Chemical Characters

The observations of temperature, dissolved oxygen and pH are shown in the following table:—

Temperature, dissolved oxygen (cc/litre) and pH in Buck lake. July 7, 1948. Air T.=19.1°C.

Depth (feet)	Temperature	Oxygen	pH
0	19.2	--	7.7
10	18.3	--	--
20	18.2	5.0	--
25	17.4	--	--
30	---	1.4	7.1
36	15.5	--	--



BUCK LAKE

FIG. 11

Buck lake differs from Conjuring and Battle in that it warms to higher temperatures in its deep waters. There is no thermal stratification as wind action is unimpeded and the water is frequently stirred. Consequently, the severe stagnation encountered in Battle and Conjuring lake does not occur in Buck lake. Oxygen in the deep water is reduced but not to so large an extent, and the oxygen supply is plentiful to a depth of at least twenty feet.

The transparency was reduced to a few inches, due to a heavy bloom of algae.

Bottom Fauna

A series of four dredgings was taken at ten, fifteen, twenty-one and thirty-six feet. The bottom at all depths was a rich, black muck.

The following animals were found:—

	10 ft.	15 ft.	21 ft.	36 ft.
Large midge larvae	62	65	78	41
Small midge larvae	16	--	4	7
Hyalella (Amphipods)	4	1	--	--
Sphaerium	4	--	--	2
Pisidium	3	--	3	3
Oligochaetes	2	--	1	--
Total Volume	4.5 cc	4.0 cc	4.4 cc	2.2 cc

This fauna averages roughly 15 cc per square foot, an enormous amount.

Plankton

A plankton haul was made from 30 feet to the surface. The water was distinctly green in colour and the haul yielded, by settled volume, 30 cc of plankton. This is a tremendous quantity, reminiscent of the reservoirs of the E.I.D. The principal plants and animals in this plankton were:—

Zooplankton

Cladocera
Daphnia longispina A.
Copepoda
Cyclops bicuspidatus A.
Rotifera
Anurea A.
Polyarthra O.
Protozoa
Dinobryon O.
Ceratium A.

Phytoplankton

Blue-green alga
Anabaena A.
Rivularia A.
Aphanocapsa O.
Microcystis C.
Coelosphaerium O.
Green algae
Filamentous—very A.
Desmids
Staurastrum O.
Diatoms
Fragilaria R.
Asterionella A.
Stephanodiscus A.

A—abundant; C—common; O—occasional; R—rare.

The great bulk of the plankton consisted of filamentous green algae and the blue-green algae, principally Rivularia. As the collection was made fairly early in the summer, it is likely that even more would be present by mid-summer. The large quantities of plankton dying and sinking continually, possibly account for the oxygen reduction observed below twenty feet.

Fish

No gill nets were set in Buck lake as the whitefish population is well known from other studies. Seine hauls around the shore revealed an enormous population of perch-of-the-year, yearling perch, burbot, pike-of-the-year and yearling, spot-tailed minnows and five-spined sticklebacks.

Growth of whitefish in Buck lake is remarkably good and the annual production is very large for the size of the lake. This is not surprising when one finds how very rich is the food supply.

Conclusions

Buck lake is a small, shallow eutrophic lake, exceptionally productive in all aspects. The bottom fauna and plankton are unusually rich and fish production, both in quantity and variety, is remarkable.

We suspect that Buck lake is approaching the end of its life as a lake that will produce whitefish. The enormous production is building up its bottom at an accelerated rate. The abundant plant growth is drawing on oxygen reserves in winter. When the lake has become only a little shallower it is likely that winter-kills will be frequent and the fish production will begin to fall off.

NOTE ON SYLVAN LAKE (1948)

Sylvan lake was visited for the period July 7, 8 and 9, 1948. The purpose of the visit was to hunt for trout which may have developed from plantings of eyed eggs. Two gill-net settings were made and numerous seine hauls were taken along the west shore. No trout were found.

Gill Net Returns

Setting 1. 300 yards of 50 yards each of 1½, 2¾, 3½, 4, 5 and 5½-inch nets in 52 feet of water off Third Point.

5½ — 0	4½ — 0	2¾ — 0
5 — 1 burbot	3½ — 2 burbot	1½ — 0

Setting 2. 300 yards of the same meshes, set below Third Point from 12 feet (1½-inch net) to 42 feet (5½-inch net).

5½ — 0
5 — 1 burbot, 1 common pike
3½ — 2 burbot, 4 common suckers
2¾ — 1 pike, 1½ — 0
4½ — 2 burbot, 1 perch

The pike was 20.7 inches long, weighed 45 ounces and was a six-year-old mature female. This is average growth. The stomach contained a small burbot and a mouse! Two pike-of-the-year, collected in seine hauls were very well grown. One contained 2 young burbot.

The perch was 12.5 inches long, weighed 1 pound, and was a six-year-old mature male. This is a long, light perch, reflecting the poor food conditions in Sylvan lake.

Seine hauls captured enormous numbers of ling-of-the-year.

The fish picture in Sylvan lake is apparently the same as it was at the time of the survey in 1942.

Physical and Chemical Characters

In order to provide a comparison with 1942 conditions, observations were made on temperature, dissolved oxygen and pH. These are shown compared to previous observations in the following table:—

Temperature, Oxygen, (cc/l) and pH in Sylvan lake, July 3, 1942; Aug. 14, 1942, and July 9, 1948.

	July 3, 1942		Aug. 14, 1942		July 9, 1948		
Depth	Temp. °F.	Oxygen	Temp. °F.	Oxygen	Temp. °F.	Oxygen	pH
0	65	6.5	66	5.7	63	--	--
5	63	--	--	--	--	--	--
10	61	--	--	--	61.5	--	--
15	58	--	--	--	--	--	--
20	57	--	--	--	60.8	--	--
30	--	--	65	--	60.4	--	--
45	56	4.4	63	4.7	--	--	--
56	--	--	--	--	59	6.0	7.9

There is still no evidence of stagnation or of severe warming of Sylvan lake. Trout should survive and further plantings are recommended. Since Brown and Lake trout have not shown up, possibly Rainbow yearlings should be tried.

NOTES ON SOME SMALL LAKES IN THE EDMONTON AREA

Five lakes in the Edmonton area were examined briefly during June, 1949. These were Cottage lake, Allen Beach, Lake Eden, Hastings lake and Lake Mere. The purpose of the examinations was to determine what, if any, species of fish might be planted to provide angling.

Cottage Lake

This lake lies in R. 2, Tp. 52, west of the 5th Meridian. It has an area of approximately 0.4 square miles. The surrounding country is rolling, partly wooded and sandy in patches.

The lake shore is mostly of mud and the lake bottom is soft. One fine sand beach is present on the east side.

The depths of water are shown on the accompanying map. The greatest depth found was 30 feet. There is a considerable area of water of 20 feet or more in depth. A shallow, sandy bar runs across the southern end and divides the lake into two basins. The area of the northern basin is cut down by a fair-sized island. According to local informants the lake level has been falling for 22 years. There is no outlet and the inlet has not run for a number of years. The same informant told us there had been no fish caught for 4 years. We set no nets but were later told a catch of perch had been made this summer.

Physical and Chemical Characters. The lake warms from top to bottom. On June 17th the surface temperature was 59°F., and the bottom 58°F. Oxygen was plentiful from top to bottom.

Plankton and Bottom Fauna. At the time of our visit the water was clear and only a small plankton was present. A net haul yielded only 1.5 cc. Present were:—

Blue green alga, **Anabaena** (probably blooms later).

Rotifers, **Anurea, Polyarthra.**

Protozoa, **Ceratium.**

Crustacea, **Bosmina, Cyclops, Diaptomus.**

A dredging at 22 feet revealed a rather poor fauna of 2.0 cc per square foot. This was composed of:—

52 **Corethra** larvae. 6 midge pupae. 6 midge larvae.

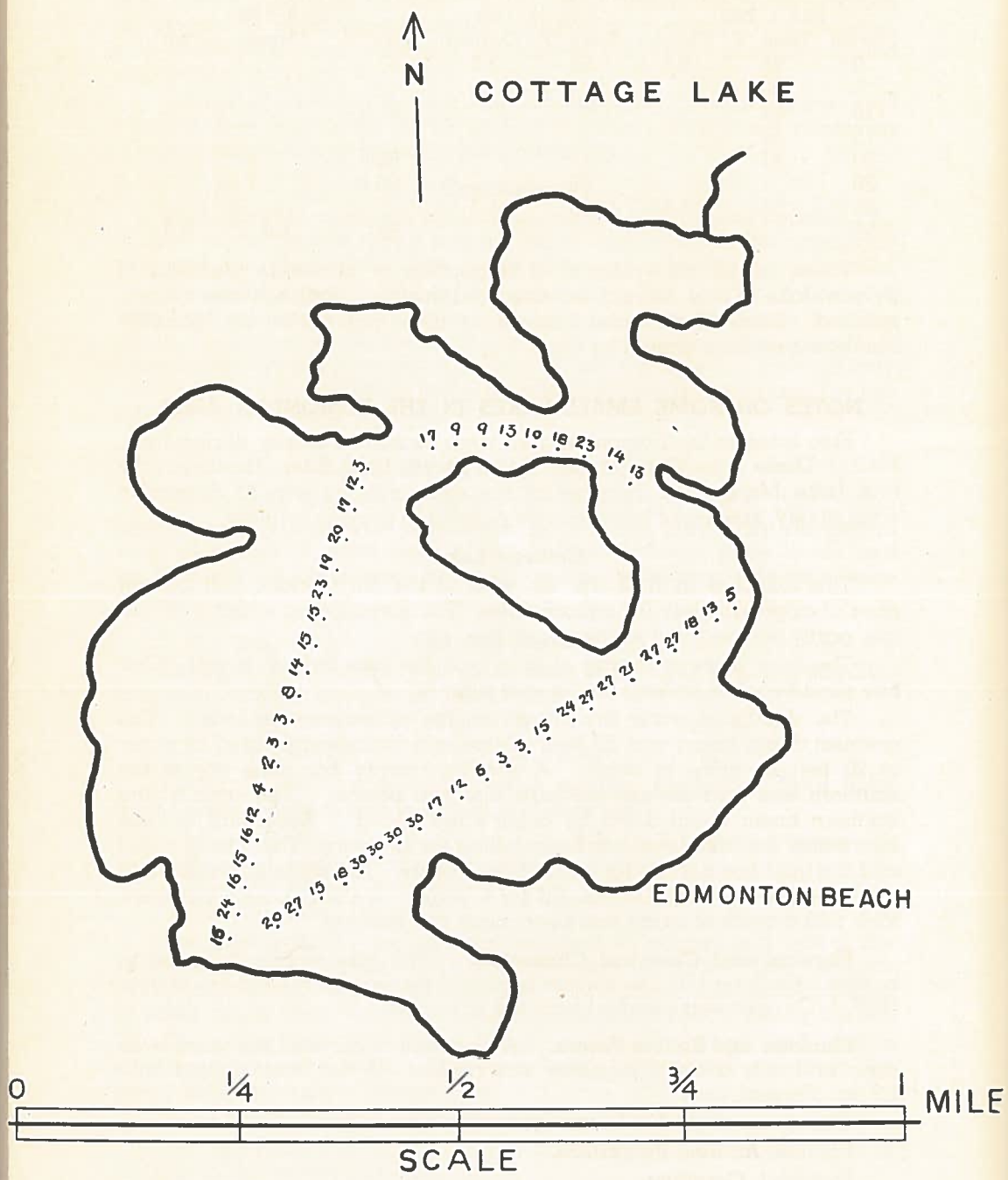

N
COTTAGE LAKE
17 9 9 13 10 18 23 14 13
17 12 3
19 20
15 23
15 14
8 3 3
4 12 3
16 12
15 16
15 24
20 27
15 18 30 30 30 30
17 12 6 3 3 15 24 27 27 21 27 27 18 13 5
EDMONTON BEACH
0
1/4
1/2
3/4
1
MILE
SCALE
1 INCH = 0.15 MILES

FIG. 12

Fish. The 5-spined stickleback, **Eucalia inconstans** was very abundant. All specimens examined were infested with the tapeworm, **Schistocephalus solidus** (adult in birds). No other fish were seen.

Remarks. An unproductive lake, but still deep enough to support a perch population. We recommend stocking with perch and, if these survive, the introduction of pike. The lake is not suitable for pickerel or trout.

Allen Beach

This little lake is about the same distance west of Edmonton as Cottage lake, but lies north of the Jasper highway. No map is available. It is perhaps 3/4 miles long and very narrow, only 100 yards in places. It lies in a narrow valley, its long axis east and west. No inlet or outlet is operating at the present time.

The lake has a remarkable depth contour. There are a series of deep holes, with narrow ridges between them. This is shown by the following series of soundings, from east to west:—

0 feet	27 feet	32 feet
3 "	72 "	32 "
40 "	81 "	43 "
53 "	63 "	42 "
51 "	23 "	45 "
60 "	37 "	18 "
92 "	69 "	9 "
63 "	62 "	11 "
57 "	22 "	21 "
57 "	18 "	10 "
54 "	51 "	20 "
21 "	33 "	11 "

Physical and Chemical Characters. As would be expected in a lake of this type, temperature stratification occurs. A warm surface layer extends to 20 feet. Below this, the temperature falls rapidly. There is the same strafication of oxygen; sufficient for fish is present only in the upper 20 feet of water. There is evidently no circulation in the lake as the pH is also stratified (7.6 at the surface, 7.2 at 70 feet). Considerable dissolved carbon dioxide is present in the deep water. The oxygen and temperature observations are shown in the following table:

Depth	Temp. °C.	O_2 cc/l.
0	15.3	6.5
20	14.5	4.5
25	8.9	---
30	7.0	1.8
40	7.1	1.3
50	---	1.1
60	6.5	0.9
70	6.3	0.9

Plankton and Bottom Fauna. The water was clear, the plankton net being visible for 16 feet. Despite this, a fair plankton (5 cc per haul) was present, mainly of crustacea. The following were found:—

Crustacea—**Daphnia, Bosmina, Cyclops, Diaptomus.**
Rotifers—moderate.
Protozoa—**Ceratium**—moderate.
Only a few algae present.

Dredgings were taken at 81, 45 and 25 feet. The two deeper dredgings contained no life. A thick, gelatinous, evil-smelling muck was found. At 25 feet 4 midge larvae, 1 nematode and a shot-gun pellet (!) were

found. Around the shore a few caddis larvae and a few shrimps **(Hyallela)** were living. The shores slope so steeply that there is little shallow water life. On the whole, the food supply in this lake is very poor.

Fish. One perch and six pike were examined. The pike were all three-year-olds. The average length was 13.5 inches and the average weight 9.7 ounces. This is about average growth for the province. The single perch was 9.2 inches long, weighed 5 ounces and was 8 years old. This is very poor growth. As perch are largely dependent on bottom fauna, this poor growth is not surprising.

Remarks. Allen Beach lake suffers from severe stagnation. It is unsuitable for trout and will not support a fast growing population of any fish.

Lake Eden

This lake lies in the same general area as Allen Beach. It is about the same size and shape, though not quite so narrow for its length. There is a much greater shore development with extensive beds of reeds, pond lilies and Potamogetons.

An east to west series of soundings showed the following depths:

0 feet	45 feet	30 feet
3 "	24 "	23 "
33 "	27 " narrows	41 "
39 "	33 "	33 "
45 "	39 "	9 "

The greatest depth is 45 feet; most of the lake is at least 30 feet deep.

Physical and Chemical Characters. At the time of our visit (June 18th) the surface water was warmer than in the other two lakes (64°F.). Thermal stratification was evident, the temperature dropping sharply from 15 feet. Oxygen depletion was evident below the thermocline. Our findings are summarized in the following table:—

Depth	Temp. °C.	O_2 cc/l.
0	17.6	--
10	16.1	--
15	15.1	--
20	10.0	5.2
30	7.5	--
40	---	0.6
45	6.9	--

Plankton and Bottom Fauna. Plankton was fairly rich at the time of our visit. The transparency of the water was 10 feet. The volume of the plankton haul was 6 cc. Algae were not yet abundant, although **Anabaena** which commonly causes blooming, was present. The crustacean, **Diaptomus,** was abundant and also several rotifers.

A dredging at 43 feet yielded 1.6 cc per square foot, a somewhat meagre amount. It contained:—

81 Corethra larvae. 1 midge larva. 1 midge pupa.

This is poor fauna, very similar to that of Cottage lake.

Fish. No fish were examined. The lake is said to contain stunted perch.

Remarks. This lake is not suitable for trout or pickerel. It should support perch and pike. If the perch are stunted, heavier fishing is the only practical remedy.

Lake Mere

This small lake (approximately 1/8 square mile) was visited on June 20th, 1949. It lies in Tp. 53, R. 1, W. 5th Meridian. It is a marshy lake with reedy shores and a muck bottom supporting pond lilies and masses of filamentous green algae. The outlet creek is dry.

Two series of soundings were made. These are shown on the accompanying map. Maximum depth is 19 feet. Most of the lake is from 6 - 12 feet deep.

Temperature and oxygen determinations are as follows:

Depth	Temp. °C.	O_2 cc/l.
0	17.6	5.1
8	15.8	2.3
15	11.0	0.5

In spite of the shallow water there is considerable drop in temperature with depth and a corresponding reduction in oxygen. The water is neutral — pH 7.0. As the general drainage is alkaline, this indicates incipient acid conditions.

A water bloom was in progress at the time of inspection.

Dredging at 18 feet failed to find life.

Remarks. This lake is unsuitable for trout and probably almost unsuitable for any other type of fish. At best, a few perch and pike might survive.

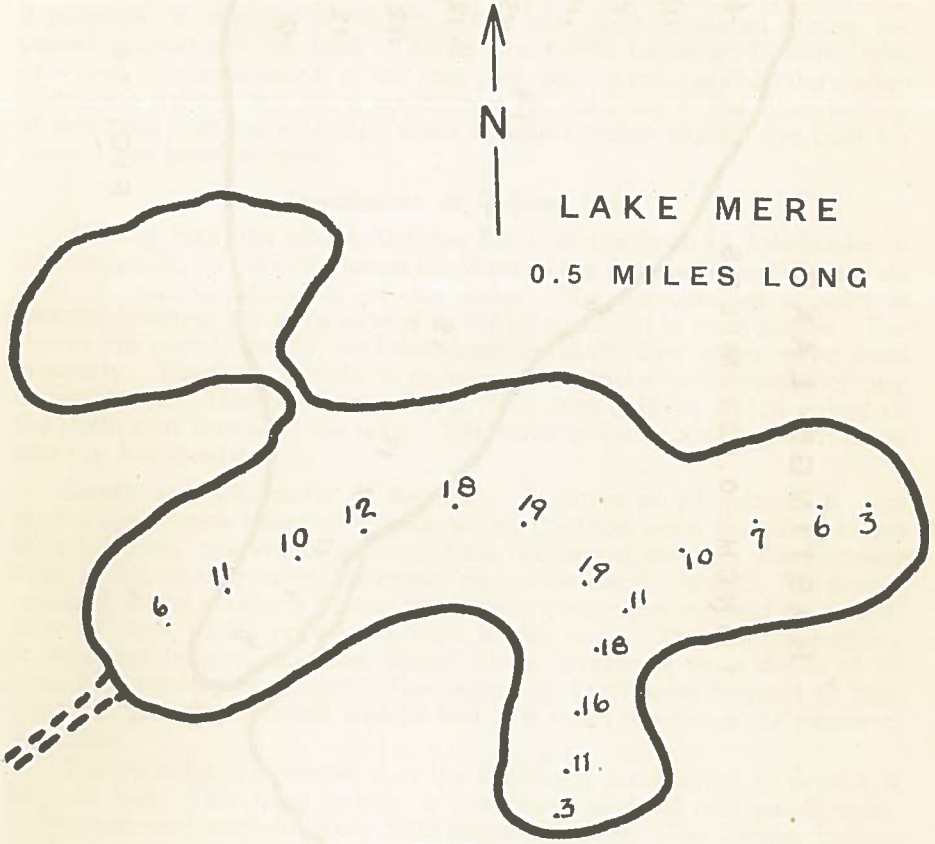


FIG. 13

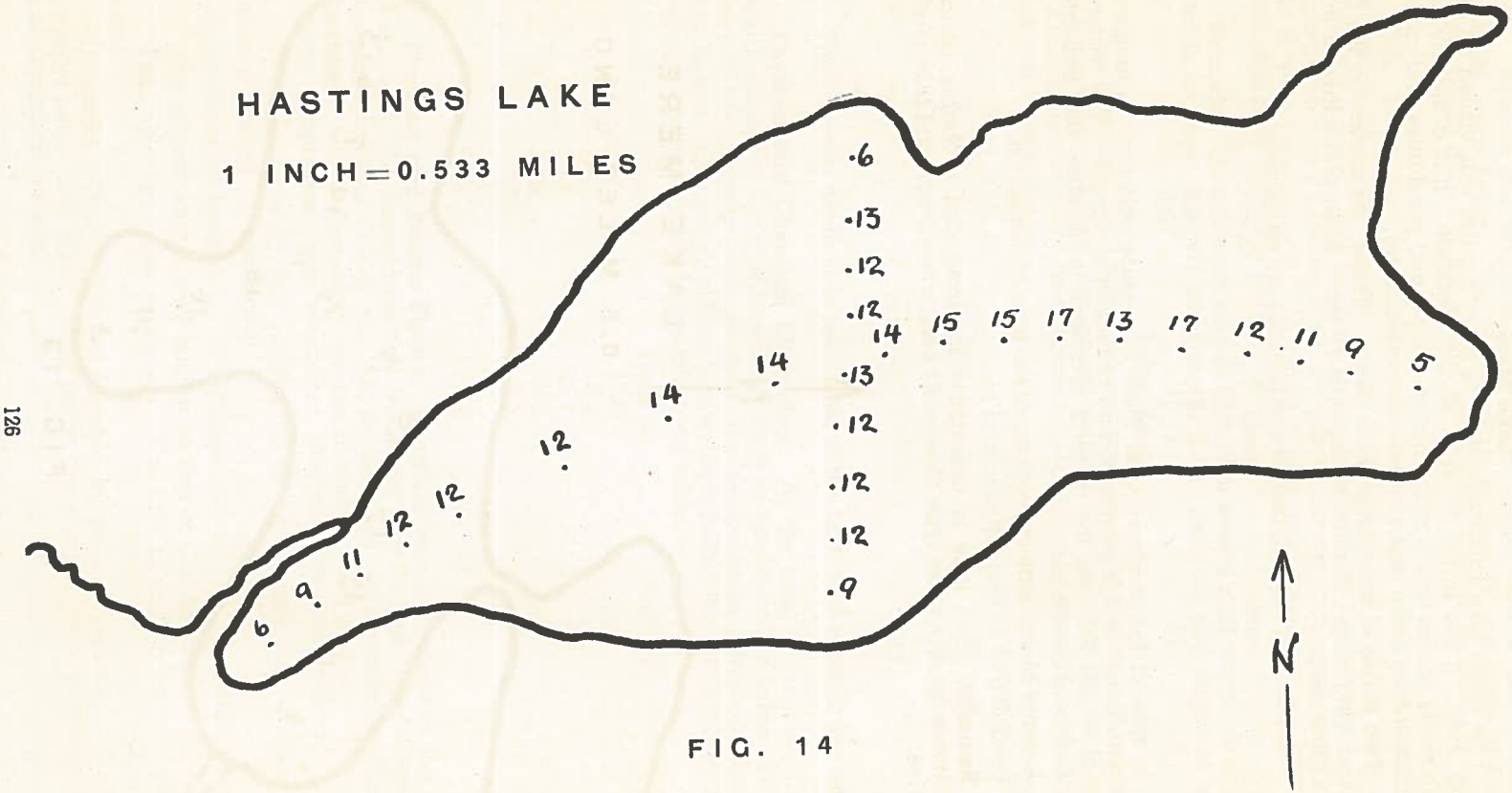

HASTINGS LAKE
1 INCH = 0.533 MILES
6
13
12
12
14
15
15
17
13
17
12
11
9
5
14
13
14
12
12
12
12
12
11
9
6
9
N

FIG. 14

Hastings Lake

This lake lies east of Edmonton in Tp. 51, R. 20, W. 5th Meridian. It has an area of approximately 3½ square miles. It formerly drained into Beaverhill lake and thence to the North Saskatchewan. June 22nd was spent on the lake. The purpose of the visit was to make soundings; winter-kills are said to occur regularly in Hastings lake and we wished to see how shallow it is. Two sounding lines were run as shown on the accompanying map. The maximum depth is 17 feet; much of the lake is 12 - 14 feet deep. It is thus a very shallow lake and winter-kills are to be expected in severe winters. It should not suffer every winter, however, as there appears to be enough water to carry perch through ordinary winters.

The water warms from top to bottom. On June 22nd it was 16.7°C. at the surface and 16.6° at 10 feet. Oxygen was abundant throughout (5.3 cc/l at 10 feet). The pH was 7.6 +.

Remarks. More or less regular plantings with perch seems the only way to provide angling.

REPORT ON CALLING LAKE (1949)

Calling lake has supported a commercial fishery for whitefish for many years. The history of this fishery shows a rather irregular availability of fish; fish have never been catchable in summer and, at various times, the winter fishery has deteriorated badly. The purpose of the present study has been to discover the causes of this recent decline and, if possible, to suggest a remedy. The lake was examined during the period August 12 - 16, 1949. Thanks are due to Inspector L. Silver who provided accommodation at the lake and, also, much helpful information about the fishery and local conditions. In addition to the examination of the lake, various whitefish scale samples, taken during the past six years, have been studied.

Description of Calling Lake

Calling lake lies about 30 miles north of the town of Athabaska in Townships 71, 72 and 73, Range 22, West of the 4th Meridian. It has an area of approximately 52 square miles. The surrounding country is heavily forested; the trees extend to the lake margin in most places. The shores are mainly sandy, and development of shallow water weed beds is scanty. The lake margin is quite regular; there are no bays of any consequence. The principal inlet is Rock Island River which enters at the northwest corner of the lake. The outlet is Calling river which flows into the Athabaska.

Depth and Character of Bottom. A series of 50 soundings was made; these were taken in 4 lines across the lake, each sounding being at a 5-minute interval of running time (outboard motor). The contour map which accompanies this report shows the depths found. The dotted contours in the southern part of the lake are not substantiated by soundings as high winds prevented work in this area. The bottom contour is remarkably regular. The shores slope gradually to a depth of 20 feet, then rapidly to 40 feet. The bottom is fairly level beyond 40 feet; the maximum depth found was 58 feet in a small area near the center of the lake.

The soundings revealed that the bottom is hard down to depths of 30 - 45 feet. This hard bottom is composed of sand and small rocks. It is clean and contains very little organic matter. The deeper bottom is of soft muck in a thick layer over sand.

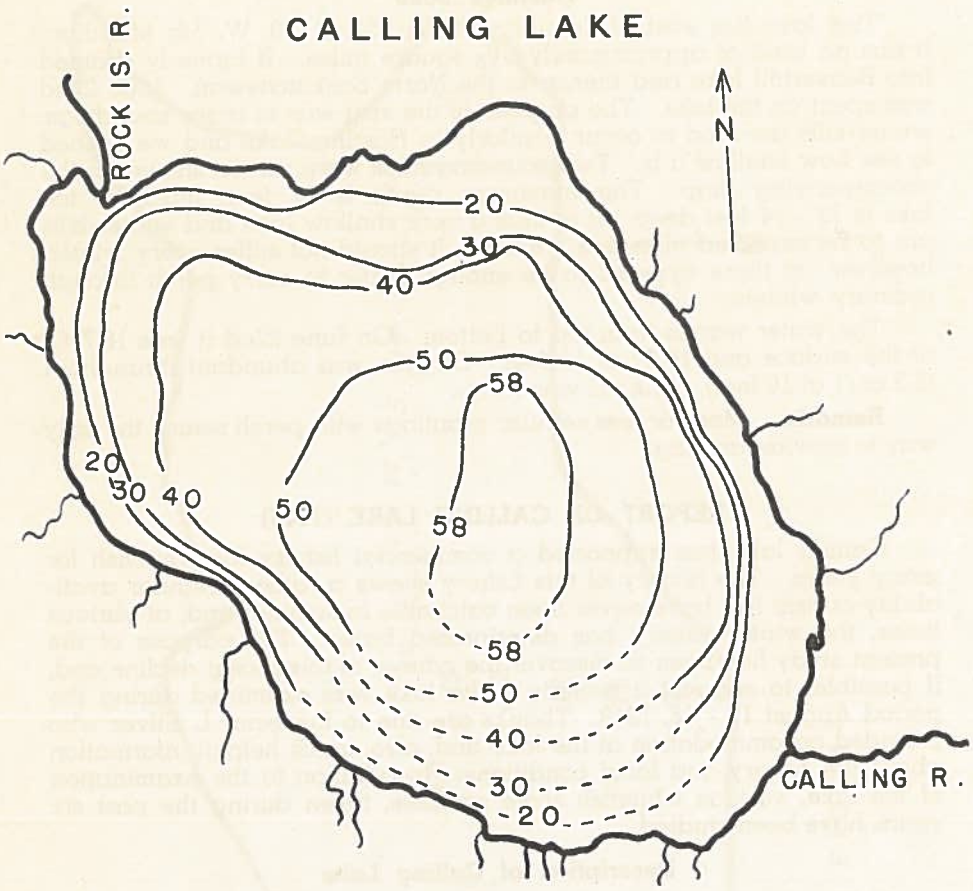


FIG. 15

Temperature and Oxygen. The approximately circular outline of the lake renders it exposed to winds from any direction. Consequently there is no thermal stratification or oxygen depletion in the deeper waters. Conditions on August 15th are shown in Table 23.

TABLE 23.

Temperature, Oxygen and pH in Calling lake, August 15th, 1949.

Depth (feet)	Temp. (°F.)	O_2 (cc/1.)	pH
0	64	--	7.0
30	64	--	--
50	63	5.7	--

A mild water bloom was in progress and the transparency was only 5½ feet.

Plankton and Bottom Fauna. A mild water bloom was present. This was due to a filamentous green alga plus the blue-green, **Rivularia.** The following forms were found.

Phytoplankton	Zooplankton
Blue-green Algae	Cladocera
Rivularia, A.	**Bosmina,** C.
Anabaena, O.	**Daphnia pulex,** O.
Green Algae	Copepods
Filamentous type, A.	**Diaptomus** sp., O.
Staurastrum, R.	**Cyclops bicuspidatus,** O.
Diatoms	Rotifera
Stephanodiscus, A.	**Anurea,** O.
Asterionella, O.	**Polyarthra,** O.
Fragilaria, O.	Protozoa
	Ceratium, A.

A—abundant; O—occasional; C—common; R—rare.

The volume of a single haul was 16.5 cc. This is a moderately rich plankton.

Dredgings were taken at 10, 20, 37 and 54 feet. At the two shallower depths, pure sand was found which contained no animals. At 37 feet some muck was mixed with the sand and a small number of animals was found. At 54 feet only black muck was encountered with a relatively rich supply of animals. The following forms were found:—

At 37′ — 17 Pisidium (clams).
14 midge larvae.
4 nematode worms.
1 snail.
Vol./sq. ft = 0.8 cc.
At 54′ — 35 midge larvae.
5 nematodes.
Vol./sq. ft. = 5.2 cc.
Calling lake has a very poor bottom fauna.

Summary of Lake Description.

Calling lake is moderately deep and, because of its shape, thoroughly warmed and aerated. This has led to a fairly rich plankton growth. In general, however, the lake is unproductive due to its sandy basin and low shore development.

The Calling Lake Fishery

The catches of fish in Calling lake since 1940 are shown in Table 24. The data were supplied by Inspector Silver except for 1942-43 and 1943-44 which were taken from the Dominion Fishery statistics.

TABLE 24.

Catches of Fish from Calling Lake (lbs.)

Season	Whitefish	Pickerel	Pike	Tullibee
1940-1	111,746	52,954	9,000	------
1941-2	108,000	31,600	10,000	few
1942-3	83,021	61,850	7,000	300
1943-4	94,800	68,800	12,050	11,000
1944-5	50,205	85,790	24,325	95,000
1945-6	45,510	106,000	13,760	100,000
1946-7	14,800	46,265	10,680	203,000
1947-8	12,330	8,100	15,830	76,350
1948-9	9,590	1,055	7,260	57,000

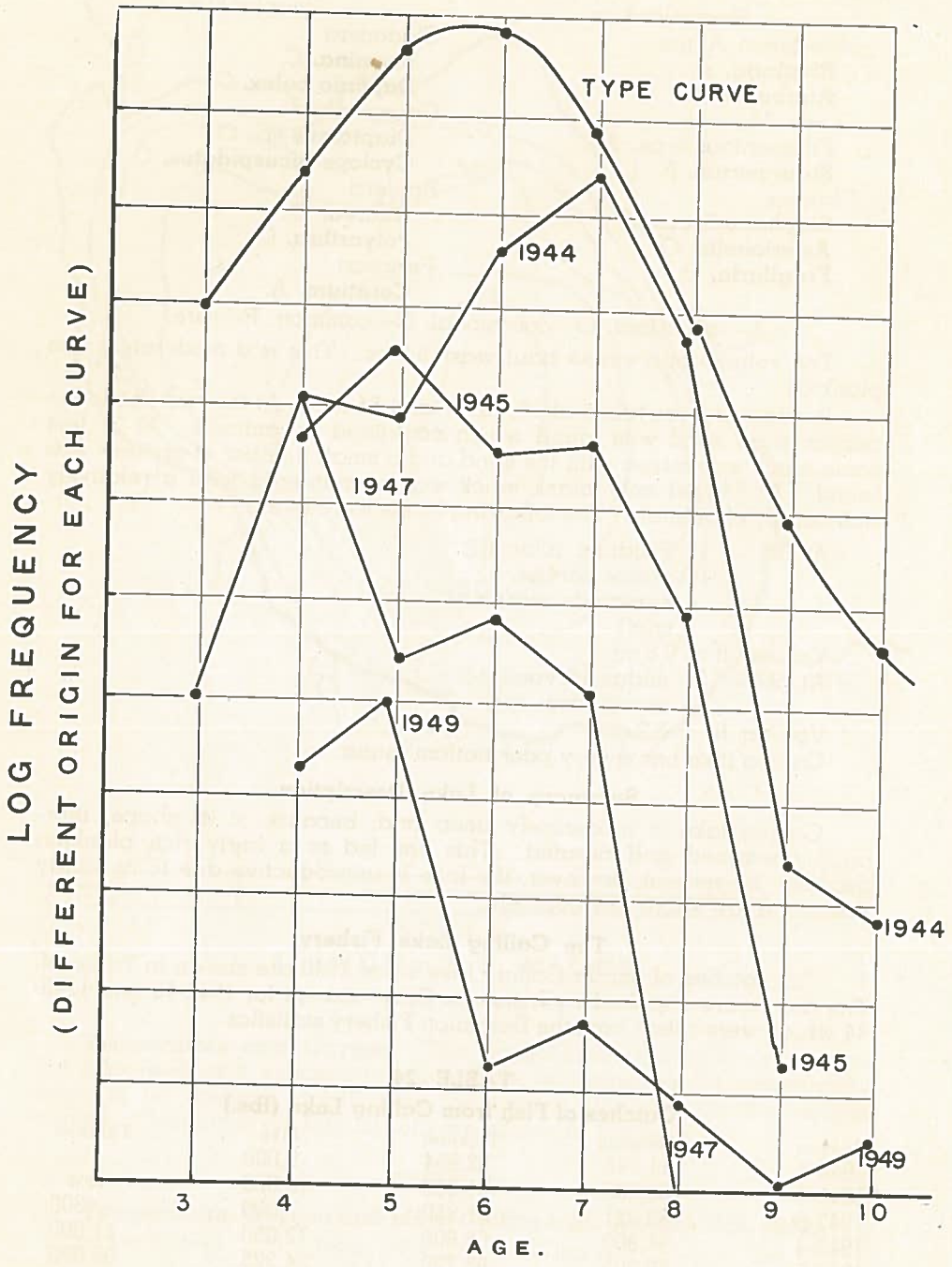

TYPE CURVE
1944
1945
1947
1949
1944
1945
1947
1949
LOG FREQUENCY
(DIFFERENT ORIGIN FOR EACH CURVE)
3
4
5
6
7
8
9
10
AGE.

FIG. 16

Table 24 shows that during the last nine years there has been a pronounced and severe downward trend in whitefish catches. Present catches are less than ten per cent of catches in 1940-42. During the early years of the whitefish decline the pickerel catch increased; a peak was reached in 1945-6, followed by a rapid collapse of the fishery. Pike and tullibee catches are not pertinent to the discussion. The higher tullibee catches are a reflection of the mink industry and are not necessarily related to the whitefish and pickerel fishery. Also, burbot and common suckers have, in the last few years, been extensively taken for mink feed. There is no evidence that this fishing for mink feed has had any part in the collapse of the pickerel and whitefish fisheries.

The question arises, what **has** caused the collapse of this fishery? The figures in Table 24 suggest overfishing. But this is incredible in view of the comparatively small catches. Calling lake is twice as big as Wabamun or Pigeon lake, yet these lakes produce more whitefish on a sustained yield basis than Calling does. The rather low productivity of Calling lake should not make that much difference. However, the question of overfishing requires further exploration. It has been established on Pigeon lake and Lesser Slave lake that overfishing causes an increased growth rate and a lowered average age of the population. Let us examine Calling lake whitefish for evidence of these effects.

Calling Lake Whitefish

Samples of Calling lake whitefish are available for the spring and fall of 1944, fall of 1945, 1947 and 1949. The age composition of these samples is shown in Table 25.

TABLE 25.

Age Composition of Whitefish from Calling Lake.

Date	Size of Sample	% at each age						
		3	4	5	6	7	8	9-11
Jan.-Feb., 44	287	0	20	32	29	12	6	1
Aug.-Oct., 44	227	--	12	11	24	34	17	2
Sept.-Oct., 45	113	--	20	31	19	20	9	1
Oct.-Nov., 47	123	11	46	13	16	11	1	2
Oct., 49	100	0	29	40	7	9	6	9

The data in Table 25 are not of much help to us. The age composition is rather irregular (important point in later discussion!) and, while there is some trend toward a younger age composition, it is not large or consistent. We must examine, then, the growth rates found in these samples. These are shown in Table 26.

TABLE 26.

Average Lengths and Weights of Calling Lake Whitefish, 1944-49.

L.—length in inches. W.—weight in lb.-oz.

Date	Ages: 4		5		6		7		8	
	L.	W.	L.	W.	L.	W.	L.	W.	L.	W.
Jan., 44	16.5	2-5	17.6	2-11	18.1	2.13	18.9	3-6	19.4	3-8
Sept., 44	16.4	1-14	17.4	2-3	18.2	2-8	19.1	3-3	20.0	3-7
Sept., 45	16.6	2-5	17.5	2-14	18.3	3-2	19.0	3-6	19.6	3-10
Oct., 47	16.4	2-7	18.0	2-13	18.2	3-4	18.9	3-7	19.4	3-9
Oct., 49	16.2	2-1	17.4	2-9	18.5	3-9	18.9	3-5	20.2	3-15

If we compare the lengths and weights of each age group over the 1944-49 period, making due allowance for random variation inherent in the samples, we must conclude that there has been no change either in rate of growth in length or rate of growth in weight. It appears evident that ordinary overfishing has not caused the decline in the whitefish catches. Instead, we must assume that over the last ten years or so there have been very few whitefish in Calling lake; so few, in fact, that the population grew at maximum rates for the whole period. This assumption may be tested by comparing the rate of growth of Calling lake fish with those of other lakes. In Table 27 such comparisons are shown using Pigeon, Wabamun and Lesser Slave lakes.

TABLE 27.

A Comparison of the Growth Rates of Whitefish from Calling, Pigeon, Wabamun and Lesser Slave Lakes.

Lakes	Ages 4		5		6		8		7	
	L.	W.	L	W.	L.	W.	L.	W.	L	W.
Calling	16.4	2-6	17.6	2-10	18.3	3-1	19.0	3-5	19.7	3-10
Pigeon[1]	15.9	2-13	16.8	3-2	17.4	3-6	18.1	3-14	---	---
Wabamun[2]	15.7	2-8	16.2	2-4	17.4	2-8	18.4	3-7	19.3	4-0
Lesser Slave[3]	15:3	1-15	16.3	2-4	17.3	2-8	18.3	3-3	18.8	3-7

(Average lengths and weights at capture in the fall — very nearly the same as at time of annulus formation in the spring, i.e., fish have completed age plus one year's growth.)

1—Sample of Dec., 1943, before heavy fishing increased the growth rate.

2—Sample of Oct., 1947.

3—Sample of Oct., 1949.

From Table 27 it is very clear that the growth rate of Calling lake whitefish is unusually fast. Since the bottom fauna of Calling lake is poor, this fast growth can only be explained on the basis that the Calling lake population is small so that food is abundant for each fish.

We have shown, therefore, that Calling lake has an abnormally small population of fast-growing whitefish. The collapse of the fishery, therefore, was due to a natural phenomenon—a naturally small population. The next problem is to determine why the population is small. In this connection we have a clue. It has been observed by Inspector Silver and others that, some years, great windrows of whitefish eggs wash up on the shores of Calling lake in the late fall, following spawning. These eggs are, of course, lost. Furthermore, the eggs remaining in the water have been washed into the shallows where they are liable to destruction by freezing in the late winter. This has probably happened to a greater or lesser extent to all the year classes of the last ten years. The level of the lake has been unusually low for this period, a condition which would contribute to egg destruction. The loss in years when egg windrows were observed must have been greatest. Consequently, the age compositions of samples since 1944 (Table 25) should show some year classes weaker than others. In order to examine this possibility, figure 16 has been prepared. This figure shows the logarithms of the frequencies of each age group plotted against age for each year that data are available. At the top of the figure is a smooth curve which gives the theoretical frequency distribution which might be expected with a constant

fishing rate and each year class being of the same strength. Each of the actual observed curves should be compared with this theoretical one. In this way, the ages which are represented by fewer than normal numbers may be picked out. For example, the curve for 1945 shows a relatively small number of six-year-olds. These fish were hatched in 1939 so we assume a weak year class for 1939. The information which may be extracted from the curves in this way is set in Table 28.

TABLE 28.

Weak Year Classes of Whitefish in Calling Lake as Deduced from Catch Curves (Figure 1).

Year	Weak Age Groups	Weak Year Classes
1944	3, 5, 9	1941, 1939, 1935
1945	6	1939
1947	5, 6	1942, 1941
1949	6, 7	1943, 1942

An examination of Table 28 shows that the year classes of 1939, 1941, 1942 show up as weak on two of the curves; 1943 shows very weak on the 1949 curve. A serious failure of these four-year classes may be assumed. In fact, the very irregularity of the catch curves themselves proves erratic recruitment (thus, variable year class strength).

Summary of Conclusions re Whitefish

The arguments and data presented relative to the Calling lake whitefish seem to warrant the following conclusions:—

1. The whitefish population of Calling lake is small.

2. The decline in the fishery has resulted from fishing (at below normal intensity) in a population not large enough to support any fishing.

3. The small population has arisen through low water conditions which caused loss of eggs and year class failures.

Discussion and Recommendations re Whitefish

In 1947 the administration, appreciating that egg loss was occurring due to low water levels, built a dam across the Calling river which has raised the lake to its normal level. It is too early to determine if this has been effective in preventing egg loss, although windrows of eggs were not observed in the fall of 1948. However, from this summer's observations on the lake, the authors are somewhat dubious about the success of the dam. In 600 yards of small mesh net set variously from 20 yards to one-half mile off shore only 4 young whitefish were taken. This may or may not be significant, but it is certainly not encouraging. Even with the restored lake level the hard, sandy shores of the lake, where the whitefish spawn, slope rather gradually into deep water. In many places there are shelves, apparently formed by ice pushes while the lake level was low. If the fish spawn on top of these the danger of egg loss is still great. If the Calling lake fishery does not improve markedly in the next two years, it may prove desirable to raise the lake level another 2 or 3 feet. In the meantime, the present policy of restricted and carefully watched fishing seems the only course to pursue. It has been suggested that large plantings of "eyed" eggs might help. While this

could certainly do no harm, there is not much likelihood of it helping unless eggs were planted annually in hundreds of millions. The following records of the plantings in Calling lake make this plain:

Year of Plant.	No. Planted (millions).	Calling Lake's Weakest Year Classes.
1938	0	----
1939	0	1939
1940	5	----
1941	5	1941
1942	4	1942
1943	0	1943
1944	4	----

Of the weak year classes two correspond to years of planting and two do not. Obviously, plants of this size are too small to affect the picture (5 million eggs represents spawn from only 2-300 fish).

Calling Lake Pickerel

The data in Table 24 reveal a spectacular collapse in the pickerel fishery in the last four years. This collapse was much more abrupt than in the whitefish. As pickerel are fish-eaters, this is not surprising, since, in general, fish-eating populations are smaller than populations that feed on lower forms of life. We have very few data on pickerel so that a complete analysis may not be attempted. However, six pickerel were obtained during the survey and the lengths of these are shown compared to those from two other lakes in Table 29.

TABLE 29.

Lengths and Weights of Six Calling Lake Pickerel Compared to Pickerel from Lesser Slave and Baptiste Lakes.

Age.	Calling.	Lesser Slave.	Baptiste.
3	11.5" — 9 oz.	---	---
4	—	11.3	---
5	16.0 27	12.3	11.1
6	—	13.3	12.8
7	16.7 33	14.2	15.0
8	—	16.2	15.1
9	20.3 51	17.9	16.2
10	22.8 80	20.4	17.8

The data in Table 29 suggest that Calling lake pickerel are considerably faster growing than those in Lesser Slave or Baptiste lakes. This indicates a similar situation to that found for whitefish, i.e., a small population.

It seems likely that the decline in pickerel is the result of the simple overfishing of an originally small population.

Summary

1. Calling lake has an area of approximately 52 square miles, a maximum depth of 58 feet, a sandy, unproductive basin and a regular,

undeveloped shore line. Plankton is good but bottom fauna is poor. There is no thermal or chemical stratification.

2. The whitefish and pickerel fisheries have collapsed in the last few years.

3. The data show that the collapse has been due to the fishing out of originally small, fast growing populations.

4. The small whitefish population is believed to be due to year class failures caused by egg destruction in the fall.

5. A dam on the Calling river, built in 1948, should help eliminate this egg destruction. No data are yet available to show if the dam is succeeding.

6. It is shown that planting would have to be on a very large scale to be effective.

7. The present policy of reduced catch and careful watching seems the only one to pursue.

REPORT ON GOLDEYE LAKE (NORDEGG DISTRICT) (1949)

Goldeye lake was visited on June 11th, 1949. It is located in Township 40, Range 16, west of the 5th Meridian. It has an area of 100 acres and a maximum depth of 45 feet. Oxygen and temperature were observed as follows:

Depth	Temp.	O_2 (cc/l).
0	59	--
10	57.2	---
20	52.7	6.3
30	46.4	---
40	43.7	3.3

Thermal stratification and oxygen depletion occur. The latter may become severe by midsummer.

Dredgings at 40 feet found only 1 midge larva. At 20 feet midge larvae and snails (Planorbis) were found to the extent of 1.6 cc per square foot.

Chara extended in a dense mat on the bottom from the shore out 20 or 30 feet. The bottom appeared to be soft everywhere.

Plankton was not abundant as the transparency was 15 feet.

An inlet and outlet were present. The latter was flowing, a small stream 2 feet wide and 8 inches deep.

The Northern Pearl Dace **(Margariscus margarita nachtriebi)** and the Brook Stickleback **(Eucalia inconstans)** were present. No other fish were seen but local reports tell of three Dolly Varden having been caught last summer.

A Rainbow planting is recommended.

REPORT ON BEAUVAIS LAKE (1949)

Beauvais lake lies in the S. W. quarter of Section 29, Township 5, Range 1, west of the 5th Meridian. It has an area of about 1/6 square miles. It is about 3/4 miles long and 1/4 wide; the long axis lies N.W.-S.E. The banks are high and steep except at the two ends where the shores are low and marshy. The inlet comes from marshy country to the N.W.; the outlet leaves through similar country to the S.E., draining ultimately

into Pincher Creek. At the time of our visit (July 24th) no flow was visible in either inlet or outlet. A small dam had been erected on the outlet.

Depth. Deepest water found was 29 feet. Soundings, at equal intervals down the center of the length of the lake were: 2, 13, 16, 19, 19, 20, 20, 20, 23, 24, 26, 26, 29, 28, 12 and 5 feet.

Temperature. July 24th was a cool, rainy day. The surface water temperature was 60.8°F. At 10 feet the temperature was the same; at 22 feet it had fallen to 59.5°F. There is, therefore, no thermal stratification and complete circulation probably occurs all summer.

The **pH** was 7.5.

Plankton and bottom fauna were poor. The bottom from shore to depths of 8 feet is carpeted with **Chara** in dense mats. Little life was found here.

Fish. Seine hauls revealed a large population of forage fishes as follows:—

Brook stickleback, **Eucalia inconstans.**
Iowa darter, **Poecilichthys exilis.**
Northern redbelly dace, **Chrosomus eos.**
Young common suckers, **Catostomus commersonnii.**

Trout. On July 24th we measured 2 trout of the Rainbow type caught by an angler on the lake.

On September 30th, 1949, 550 yards of gill nets consisting of 50-yard pieces of 1½, 2½, 3½, 4½ and 5-inch mesh were set. These yielded 5 trout and 3 suckers, a very poor catch. These trout were of the Rainbow type. Average lengths and weights of each age are shown in Table 30.

TABLE 30.

Average Lengths and Weights (inches and ounces) of 7 trout from Beauvais Lake.

	Age 1	Age 2	Age 3
Length	8.2	11.4	14.3
Weight	4	9.2	18.5

The size and weight of the yearlings is not as great as in wild fish in the main Oldman. It is, however, better than average for the Oldman drainage. The sizes of the older fish show very fine growth. These facts are undoubtedly due to poor plankton and bottom fauna, on which yearlings and younger mainly feed, and to a good supply of forage fish on which the older fish feed.

Spawning. The single three-year-old fish was an adult female. It had not spawned but was reabsorbing its eggs, some of which (about 20) were loose in the body cavity. We saw no spawning grounds, and it is possible that no spawning occurs in the lake.

Recommendations. Annual plants of not more than 2,000 yearlings are suggested. This would be an ideal lake on which to run a creel census. It is comparatively easy to check all traffic in and out of the lake (only two roads). The information would be valuable in assessing the number of fish which survive from each planting.

REPORT ON LONG LAKE (1949)

Long lake is in the Hayter-Chauvin district, Township 41, Range 1, west of the 5th Meridian. It was visited on July 9th, 1949. The lake is about 1¼ miles long and from a few yards to ¼ mile in width. It is surrounded on the north and south by hills which are covered with brush.

There is no visible inlet. The lake is spring fed and contains fresh water, whereas other lakes of this region are alkaline and unproductive. The outlet runs from its western end into an alkaline slough known as Killarney lake.

Depths are shown on the accompanying sketch map. It will be noted that the eastern two-thirds is very shallow, mostly from 3 - 6 feet with only a small area 12 feet deep. This part of the lake is overgrown with aquatic plants, mostly pond-lilies. The western third of the lake is free of excessive growth and is much deeper, much of it 18 or 19 feet.

Temperatures. The following temperatures were observed:

0 (surface)	69.1°F.
10 feet	64.8°F.
15 feet	63.9°F.
19 feet	63.9°F.

Chemical features. Dissolved oxygen was present to the extent of 6.0 cc/l at 8 feet and 4.4 cc/l at 16 feet. No severe stagnation appears to occur and the temperatures indicate that circulation is general. The pH was 7.6.

Plankton and Bottom Fauna. A plankton haul yielded a volume of 2.0 cc, a rather meagre amount. A dredging at 18 feet revealed a small fauna of insect larvae, viz.:—

16 midge larvae.
28 Corethra pupae.

The volume of this sample was negligible.

Fish. The Brook Stickleback, **Eucalia inconstans** was abundant.

Discussion. The eastern two-thirds of the lake are not likely to keep fish alive during the winter. The western third is possibly habitable the year around, but this is by no means a certainty. A planting of yearling and older pike and perch was made. Future management may be based on the fate of these fish during the next two winters.

REPORT ON BURMIS LAKE (1949)

Burmis lake is a very small, spring-fed pond located in the Crowsnest Pass just south of the highway and across it from the town of Burmis. It has an area of about one acre. It is roughly circular with high, rocky banks forming the southern shore and a more gentle, open, grassy slope elsewhere. The east shore has some trees and is used as a picnic and bathing spot as well as pasturage and water-hole for cattle. There is no inlet or outlet.

The lake has a maximum depth of 9 feet. Soundings from east to west ran 4, 7, 9, 8, 4, 4 feet and from south to north ran 8, 9, 7, 6, 3 feet.

Temperatures on July 14th were 64.8°F. at the surface and 62°F. at nine feet. Oxygen content at nine feet was 5.8 cc/l.

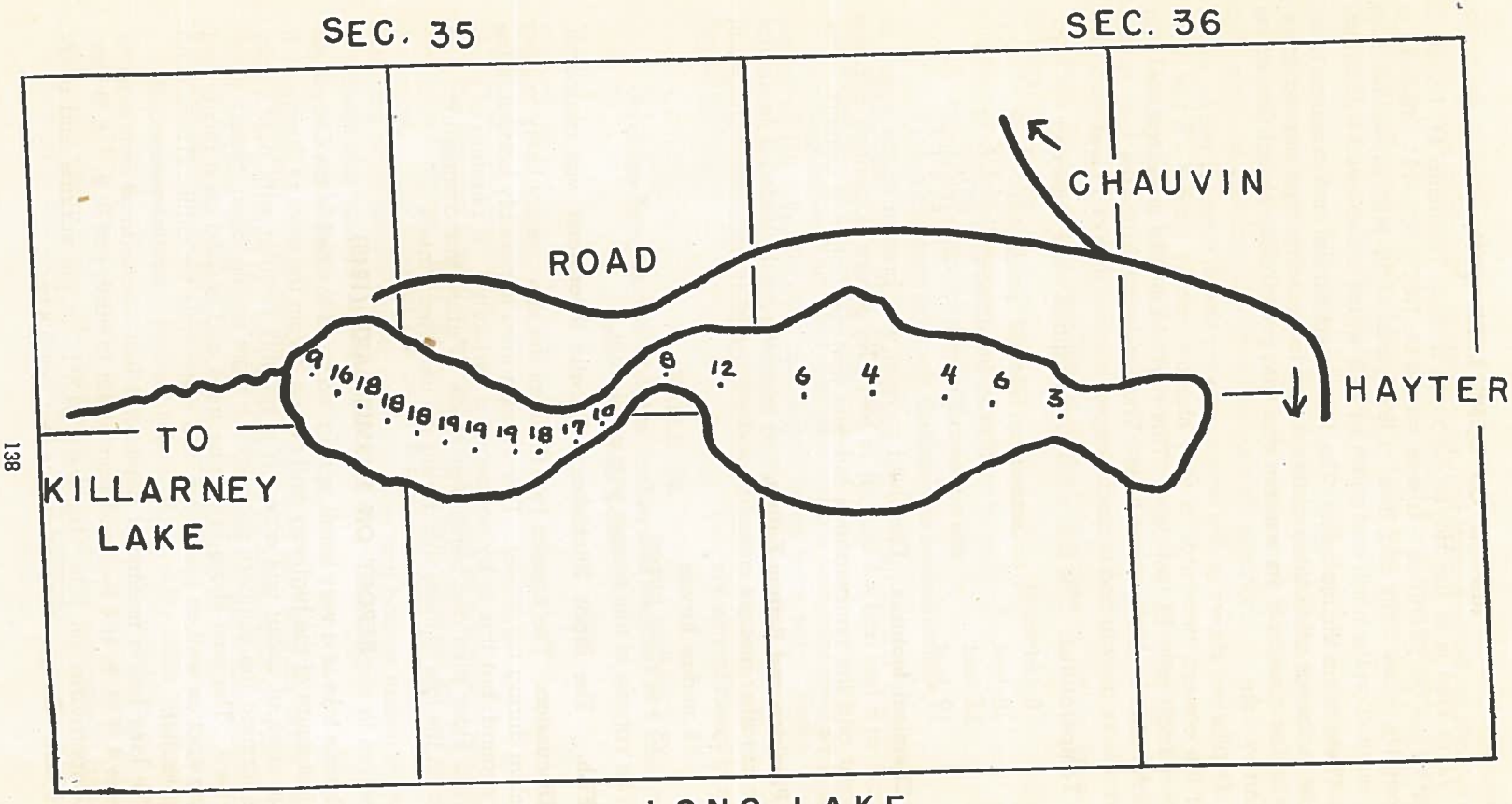

SEC. 35
SEC. 36
CHAUVIN
ROAD
HAYTER
TO
KILLARNEY
LAKE
9 16 18 18 18 19 19 19 18 17 10
8 12 6 4 4 6 3
LONG LAKE

FIG. 17

Plankton was quite rich. The bottom fauna appeared to be poor. The bottom is carpeted with a very dense growth of the alga, Chara. Some Meriophyllum and a small pink water lily, near shore, were also present. Dredgings brought up only masses of Chara in which no bottom animals could be found.

No forage fishes were seen.

Seventeen trout were captured and examined. Of these 16 were year-old fish, planted from rearing-ponds. They appeared to be Rainbow x Cutthroat hybrids. They averaged 9.2 inches long and 5½ ounces weight. This is excellent growth. A single large hybrid (?) 19.4 inches long and weighing 2 lbs. 7 ozs. was taken. This fish appeared to be 5 years old. It was in rather poor condition, i.e., light and thin for its length.

The plan to use Burmis lake as a rearing-pond appears to us to be impractical. We recommend that this lake be opened for fishing and that it be planted annually with 500 - 1000 yearlings (Rainbow). We further recommend that sticklebacks (**Eucalia inconstans**) and, if available, minnows of some species (**Pimephales promelas**) be introduced as forage fishes.

EDMONTON
Printed by A. SHNITKA, King's Printer for Alberta
1950