Original: Fish Division
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Institute for Fisheries Research
Wayne Tody - O. H. Clark
C. T. Yoder
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INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

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ANN ARBOR, MICHIGAN

March 23, 1951

Report No. 1282

A SURVEY OF THE RIFLE RIVER SYSTEM, ARENAC AND OGEMAW COUNTIES, MICHIGAN

By

Fred E. Locke

ABSTRACT AND PREFACE

A biological survey of the Rifle River and its tributary streams, in Ogemaw and Arenac counties, was made during the summer of 1941. Observations were made on fish fauna, bottom fauna, aquatic vegetation, temperatures, flow, soil types, stream dimensions, etc., at about 160 separate stations. The present report is a detailed record of these observations, plus separate management recommendations made for each section of the river or each tributary.

During the interval between the time of preparation of the first draft of this report (in 1941-1942) and final typing (in 1951), much has happened in the form of fisheries work in the watershed. The Rifle River Area was acquired by the State partly to serve as a fisheries research area, and much creel census data have been obtained. Many special studies of fish populations in streams, and a summer biological survey of the lakes on the Area have been made. Much stream and lake improvement work on the watershed has been done,

in part as a result of management recommendations now incorporated in the present report. Finally the Rifle River Watershed Improvement Project has been initiated by the Lake and Stream Improvement Section of the Fish Division.

The present report contains only the data obtained by the 1941 survey. It is believed that the various records which are available for the Rifle Area and also the watershed as a whole, in this report and in other reports and record files, will be of considerable value in the watershed development project now underway.

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By

Fred E. Locke [1]

A biological, chemical, and physical survey of the Rifle River and its tributaries was conducted during the summer of 1941, from June 13 to August 18. Investigations were under the direction of Dr. A. S. Hazzard, Dr. C. J. D. Brown and Dr. James Moffett. The personnel of the survey party was composed of Fred E. Locke, party leader; Burton P. Hunt, Fisheries Technician A; Boyd W. Walker, Fisheries Technician A; and Ray Buller, Fisheries Technician C.

The party wishes to express their sincere appreciation and acknowledgement for the many contributions of others which facilitated a more comprehensive survey of the river system. We are indebted to Conservation Officers--J. W. Baird and Gus Templin, and to Mr. L. F. Oeming, Mr. Robert Foresman, Mr. H. M. Jewett, Mr. H. M. Alexander and Mr. Bryan Graber for the innumerable services rendered in the field. The diary of one local fisherman proved to be of considerable value in indicating certain biological changes that occurred on the river during the seven years prior to the survey. Certain of

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[1] The report has been edited extensively by G. P. Cooper and C. M. Taube.

these catch records are incorporated into this report. Publications of the Michigan Stream Control Commission, and the Land Economic Survey of Michigan, as well as the United States Geological Survey and other federal divisions, have been consulted to secure information relative to the Rifle River watershed.

Location of Rifle River System

The Rifle River system is one of the smaller river systems in Michigan; it has the 26th largest primary drainage area in the state. Its origin lies in the northern part of Ogemaw County, where it flows almost due south to the northern part of Arenac County, thence in a southeasterly direction to its mouth on the north shore of Saginaw Bay about six miles southeast of the village of Omer. The headwaters of the river arise at approximately 44.30 N. latitude, while the mouth lies near the 44.00 latitudinal line. A large percentage of the Rifle River proper runs parallel to and slightly to the west of the 84 longitudinal line, but crosses to the east in Arenac County before entering Saginaw Bay. The mouth of the river lies in Section 10, T. 18 N., R. 5 E., while the origin of the northernmost tributary lies in Section 18, T. 24 N., R. 3 E. Approximately 25 tributaries of the system are considered worthy of intensive fisheries investigations.

The United States Geological Survey reports the area of the Rifle watershed to be 385 square miles. Other reports have stated the area as being 390 square miles. We obtained a figure of 386 square miles, by measuring the area on a small topographic map marked in 100 foot contours. Only approximate elevations of the area can be given as the

only available contour map of the area cited above is difficult to read and applies to small areas The upper tributaries of the river system arise at an elevation between 1,000 and 1,100 feet above sea level, but fall to less than 900 feet before reaching the main stream. The Rifle has a more or less uniform fall from slightly less than 900 feet at its origin in Devoe Lake to 581 feet (mean elevation) at its mouth at Saginaw Bay. In general, the upper half of the river has a greater degree of slope than the lower half. Variations in fall from approximately 2 feet per mile to 8 feet per mile occur in the main stream. An average fall of 4.8 feet per mile was computed for the entire river.

Due to the irregular course of the streams and to lack of accurate land surveys of the drainage area, it is impossible to give the exact number of linear miles of water within the system. It has been estimated that the river itself is about 65 miles long, while the system including all tributaries has about 260 linear miles.

Geology of the drainage area

The following data for the Rifle watershed have been taken from McNamee's (1930) report on the water resources of Michigan:

Lakes and swamps	--4.5 percent of the area
Clayey till	--37.5 percent of the area
Sandy till	--14.9 percent of the area
Sand	--38.3 percent of the area
Gravelly loam	-- 4.8 percent of the area

The surface conditions of the drainage area within Ogemaw County are described in the Land Economic Survey report (Mich. Land Econ. Surv., 1923) for Ogemaw County: The county occupies an area which extends from the Saginaw Basin Plain across and bordering till plains and moraines of the Saginaw-Huron ice lobe, and on to the high-lying,

interior outwash plains. The surface geology of the area gives rise to a number of important physiographic land forms. There is a high plain in the northwest townships which is fronted by a hilly belt to the southeast. There are rolling uplands in the central and eastern parts of the county, smooth rolling uplands in the southeastern townships, and a low central plain in the south central part of the county with extensions to the north and northwest.

From a glacial map of the southern peninsula of Michigan, the watershed can be separated into a number of divisions. An area covered by moraines lies to the west and northwest of West Branch. Ground moraine of till plain lies to the south and southeast of the morainic deposit. Sandy drift, not definitely moranic, lies to the southeast of the ground moraine and adjacent to the river proper. Sand and gravel plains lie to the east of the river in both Arenac and Ogemaw counties. Three clay areas which lie in the north central, central, and southeastern part of Arenac County are transected by the course of the Rifle.

The soil associations of Ogemaw and Arenac counties are given in the Year Book of Agriculture, 1938, to be:

Arenac County---Toledo-Vergennes association.

Ogemaw County---Ontonagon-Trenary association.

Three bedrock surface formations of the Carboniferous Period lie within the watershed. The Saginaw Formation underlies a large portion of the drainage area to the south. Parma Sandstone and the Grand Rapids group lie to the north of the Saginaw Formation. The Marshall Formation are found under the extremities of the northern tributaries of the watershed.

The early history and development of the area composing the watershed is well described in the Land Economic Survey report for Ogemaw County. The history of Ogemaw County has been one of rapid agricultural settlement, linked with the lumbering industry. From 1870 to 1890 the lumbering industry reached its height. From 1894 to 1900 there was a decided decline in the lumbering business and between 1900 and 1910 the lumberjack farmer was cutting cedar and hardwood in winter and cultivating his farm in the summer. Since 1910 the farmers have been unable to depend on work in the woods to contribute to their support, and so only four of the townships most highly developed agriculturally maintained an increase in population between 1910 and 1920.

McNamee (1930) lists the principal crops and area of developed farm lands for Arenac and Ogemaw counties as follows:

	Principal crops	Improved farm land (square miles)
Arenac County	Corn, oats, rye	42
Ogemaw County	Oats, potatoes, rye	59

It has been estimated that approximately 5 percent of the watershed is enbraced within operating drainage projects, of which the greater portion lies near the mouth.

Climatic Conditions

The only station of the United States Weather Bureau, within the watershed, is at West Branch. Table 1 (from McNamee, 1930:117) includes data from this station and from two nearby stations outside the watershed, which cover periods of 28 to 36 years.

Table 1

Station	Elevation, in feet	Normal annual precipitation, in inches	Normal annual snowfall in inches	Normal annual temperature degrees F.	Years of records
West Branch	973	26.04	51.0	42.9	29
East Tawas	590	27.69	43.7	44.0	36
Mio	1,000	29.14	56.5	42.3	28

Water source, volume and velocity

Most of the water supply of the river system is provided by springs, lake outlets, seepage, and surface runoff. A number of abandoned wells and drainage projects also produce a small volume of water. The water supply, with the exception of surface runoff, appears to be relatively constant; and few, if any streams supporting game fish become intermittent during extreme drouth conditions. From observations in the field it would seem that tributaries in the lower part of the river system are more subject to the effects of surface runoff than those in the upper part. The majority of large springs in the drainage area lie between West Branch and Lupton, and contribute water to about four tributaries in that area. The water temperature of most springs was found to be 47° F. The head waters of Crapo Creek were found to be running about 46° F. As far as could be determined no large springs enter the Rifle River directly, although temperature readings would indicate that an appreciable volume of spring seepage enters the river in the vicinity of the junction with highway M-55. A number of small springs were observed at this point while traversing the stream.

The origin of the Rifle River is at the outlet of Devoe Lake in Ogemaw County, Gamble Creek, a large tributary to Devoe Lake, is an important factor in governing the volume of flow at the outlet. Devoe Lake serves as a stabilizing unit in that it forms a reservoir to compensate for exceptionally low water or flood conditions. The normal flow of the lake outlet in summer is approximately 35 c.f.s. (cubic feet per second), with a velocity between 1.5 and 2.0 f.s. (feet per second). At a point about a half mile below the lake outlet, the volume of the river is nearly doubled by the addition of Houghton Creek. There is a more or less uniform flow from this point to about 5 miles below, where the additional flow of several tributaries increases the volume to about 105 c.f.s. Numerous tributaries, including the West Branch, Silver, Mansfield, and Eddy creeks, add to the volume in the course of an additional 25 miles to the Alger bridge where the flow is approximately 140 c.f.s. The velocity in this area averages about 1.5 f.s. A gaging station at the Sterling bridge, 5 miles below the Alger bridge, has been in operation by the United States Geological Survey since 1937. An average summer flow of between 150 and 190 c.f.s. has been estimated from the gaging station records of June, July, and August. A velocity of 2.1 f.s. was recorded at this station at the time of the survey.

Table 2 shows maximum and minimum volume records and gage heights obtained at the United States Geological Survey gaging station (Sterling

Table 2

Year	Date	Maximum flow, in c.f.s.	Minimum flow in c.f.s.	Maximum gage height, in feet	Minimum gage height, in feet
1937	April 27	2,060	...	7.5	...
1937	August 16,17,30	...	110	...	1.3
1938	March 17	2,760	...	9.1	...
1938	July 30	...	122	...	1.6
1939	March 25,26	1,700	...	8.0	...
1939	July 20, 22	...	123	...	1.4

bridge) from 1937 to 1939. The maximum volume recorded in 1938 and the minimum obtained in 1937 indicate that the stream is subject to a wide range in fluctuation. The normal summer flow was estimated, from U.S.G.S. records to be 170 c.f.s. The maximum recorded flow was thus about 15 times the normal, while the minimum flow recorded for the three year period was about 2/3 normal. This indicates the presence of a rather uniform supply of ground water and a rather heavy surface runoff. No records are available on the volume of the river above the Sterling bridge station during flood stages. However, from observations and reports obtained throughout the course of the survey, it is possible to arrive at several conclusions. It has been reported that the river seldom if ever overflows its banks unless ice jams block certain narrow channels. It is believed that a normal spring runoff will increase the normal summer level about 3 or 4 feet, but ice jams may increase the height to 8 or 10 feet. A rise of 1 to 1 1/2 feet may occur during a normal summer season.

The data in Table 3 were collected at a station on the Rifle River at a point approximately a quarter mile above its mouth. It is believed that

Table 3

Date	Average width, in feet	Average depth, in inches	Velocity, in f.s.	Volume in c.f.s.
June 15, 1941	100	23	2.8	510
August 13, 1941	93	13	2.0	192

the reading on June 15 represents the largest volume carried by the river during the course of the survey, while that recorded on August 13 is about a normal summer flow. Although no attempt was made during 1941 to secure volume records during minimal flow, it is believed that drought conditions which prevailed in the early part of the summer would have resulted in a very low figure if a record had been made during the latter part of July.

Methods of survey investigations

General

State Highway and Conservation Department maps of Arenac and Ogemaw counties were used as a guide for field investigations. In many instances the maps were in error in regard to stream locations, and necessary corrections were made by the field parties. It is believed that the maps of the Rifle System, which accompany this report, are fairly accurate. On the corrected maps the New York System was used in assigning each tributary a number. In the present report the tributaries are referred to by number and by name (for those which are named).

The plan of the survey was to make detailed examinations of small and representative areas of the river and its tributaries, and general observations over the entire river and all of its principal tributaries. Thus in the present report the discussions and tables dealing with food conditions, cover, bottom types, vegetation etc., will represent average conditions as well as detailed information on relatively small areas.

Initial survey work was started at the mouth of the river, and subsequent investigations were continued toward the source. A truck and boat trailer permitted all operations to be conducted from two base camps, one in the lower half of the drainage system, and one near Devoe Lake. The entire length of the river was traversed by making short floats of 3 to 7 miles in a small rowboat. With the exception of a few small streams, all tributaries were traversed throughout most of their length. The extent of investigation on tributaries was usually determined by their size, accessibility, and to some extent local reputation as fishing streams. Field data on tributaries were obtained in a manner comparable to that for the river, except that they were traversed by wading or walking along the banks. It was found that, by starting at the origin of the tributaries and working downstream, more significant maximum temperatures were obtained on the lower portions since they were obtained at a later hour of the day.

Fish collecting

Equipment and methods used in fish collections included:

Equipment:
3 - 3 x 10' common sense seines
2 - 3 x 6 ' common sense seines
1 - 5' x 14', 1/2" tied seine
1 - 5' x 25', 1/4" tied bag seine
1 - 5' x 100' bag seine
1 - 25' trammel net
1 - 100' experimental gill net
1 - 4' fyke net
1 - stream trap net

Seining with a 10-foot common sense seine and a 25-foot bag seine proved to be the most effective methods of collecting forage and small game fish. Larger seines and trap nets could not be used efficiently due to the high velocity of the stream. In addition to collections made with nets and seines fish were taken by set lines, spearing with a jack light, dynamite, live-bait fishing, fly casting, plug casting, and hand fishing. Set lines, angling, and blasting proved most affective in taking larger game fish.

Bottom samples and vegetation

Bottom samples were collected at individual stations by one or more of three methods. The stream bottom sampler was used quite extensively in most of the gravel areas. A Peterson dredge was used at the beginning of the survey, but later abandoned because of excessive weight involved in its transportation. It was found that most areas of stream could be sampled by the stream bottom sampler or by a fine-mesh sorting screen. In addition to the regular bottom sample collections many areas were examined by making observations on rubble and other larger objects found in the stream. In general, a large series of bottom samples was collected and examined to determine the relative abundance of the different types of

organisms present at each sampling area. The conventional methods of making detailed counts and volumetric measurements were dispensed with, in order to examine a larger series of samples and thus cover a greater area. Faunal counts were made where the abundance of submerged aquatic vegetation was considered a contributing factor in the food supply.

The following classification has been used to designate the abundance of the different bottom organisms: 1, very abundant; 2, abundant; 3, numerous; 4, common; 5, few; 6, rare.

Representative samples of all species of aquatic plants observed in the river were preserved, and verifications of identifications were made at a later date in the laboratory. In the inventory of aquatic plants, particular emphasis was placed on recording the extent of the bottom covered with vegetation, the density of plant beds, and the role of weed beds as cover for fish and fish-food organisms. Changes in the flora of the river system from mouth to source were noted.

Chemical conditions

The proper management of any body of water relative to the production of game or commercial fish requires an investigation dealing with a number of chemical constituents. Although it is not always possible to alter the chemical content of water, the lack of information regarding this particular phase of fisheries research often leads to improper management and losses through undesirable planting. In general, chemical investigations of water from a fisheries point of view have been reduced to a minimum to obtain the most pertinent information in the least amount of time. All natural waters have dissolved in them certain gases and minerals which may be either harmful or beneficial to aquatic animal life. Fish usually tolerate a fairly wide range of chemical conditions. However, excessive

concentrations or lack of a certain element or compound may result in death or poor condition, while the presence of minute quantities of a toxic material may cause mortality. The optimum concentrations of dissolved substances in water for most species of fish are known only in a general way.

Water in lakes and streams is derived from three major sources; rain water, ground water, and surface runoff. Rain water is relatively uniform in composition and lacks certain minerals which normally occur in most ground water. The dissolved matter in ground water and surface runoff depends to a large extent upon the chemical composition of the soil or rock formations from which it comes.

In a general survey the fisheries biologist is interested in obtaining information on the amount of oxygen, carbonates, hydrogen-ion concentration, and the presence or absence of carbon dioxide in water.

Waters of certain large springs lacking oxygen will not support fish life until they have been aerated in some natural or artificial way. Thus the absence of one chemical element may make the water untenable for fish life. Although the depletion of oxygen in unpolluted stream water is quite rare, it often occurs in the lower portions of certain stratified lakes. The minimum oxygen concentration ordinarily tolerated by trout is approximately 3 to 4 parts per million. Large concentrations of this element which would be lethal to fish life do not occur in nature. Small amounts of carbon dioxide are essential for aquatic animal life while an excessive accumulation will result in death. Large concentrations of this gas are never found in unpolluted aerated streams. The acidity of water is expressed as a pH value, and is determined by the free acid present in the water. A pH reading of 7.0 is considered as neutral, while figures

above this are alkaline and those below are acid. The range of pH tolerance of most fresh-water fish is at least from 4.5 to 9.5. The amount of certain bound carbonates (the union of carbon dioxide and calcium or magnesium) determines the hardness of water. The methyl orange test measures the concentrations of these compounds, and figures of the methyl orange reading expressed in parts per million are thus used to designate the hardness of water. Waters having a low methyl orange reading (0 to 50) are said to be soft while those having a relatively high reading (150 to 250) are classified as hard. Calcium and magnesium are necessary for plant growth which in turn determines to some extent the well being of aquatic animal life. In general, soft and exceptionally hard waters are said to be less productive than those having a methyl orange reading of between 50 and 200 ppm. As a rule, streams are more subject to rapid chemical changes than lakes, due to the extreme fluctuations in the volume of the different water sources. When normal stream levels are increased by rain water or snow water, certain chemical changes such as the lowering of the methyl orange reading may be expected. Results of the chemical analyses of the waters of the Rifle River system are represented numerically in tables or by limited discussion.

Stream flow and temperature

Volume and velocity measurements were made by the timed-float method in most instances. In certain areas where conditions would not permit accurate measurements, the flow was estimated.

The extent of the watershed made it impossible to examine all the questionable trout water at critical periods during warm weather. A number of maximum and minimum temperature readings were made on different portions of the river. Water and air temperatures were recorded at various times of

the day in areas or portions of the stream investigated. Three sections of the river were examined over an eight-hour period to determine daily fluctuations in water temperature.

Pool classification

Pools of the various portions of the river and of its tributaries are evaluated according to the classification outlined by Drs. Hazzard and Brown (See literature cited) in the Institute for Fisheries Research "Outline of Survey Methods." Certain physical characteristics of streams are not clearly expressed by this pool classification. Thus, brief descriptions of the physical features of stream sections are given in addition to the pool classifications. The system of pool classification is as follows:

Size:

1. Pools having an average width or length much greater than the width of the stream.
2. Pools having a width or length equal to the width of the stream.
3. Pools much narrower or shorter than the stream width.

Type:

1. Deep (2 feet or more), exposed pools containing a great luxuriance of aquatic plants harboring a rich fauna; or deep pools with abundant shelter (overhanging banks, logs, roots, boulders) much drift or detritus, shaded by forest cover or shrubs.
2. Pools intermediate in depth, shelter, plant abundance, etc.
3. Shallow exposed pools without shelter and without plants; scouring basins.

Frequency:

1. More or less continuous pools--about 75 percent to 25 percent relation of pools and riffle areas.
2. Rather close succession of pools and rapids--approximately 50-50 relation.
3. Pools infrequent with long stretches of swift, shallow water between--pools making up 25 percent or less of the total stream area.

If we let S refer to size, T to type, and F to frequency, then it is evident that a combination of $S_1 - T_1 - F_1$ would be the highest rating and $S_3 - T_3 - F_3$, the lowest. Likewise various other combinations may be roughly recorded as intermediate, although they are not necessarily of equal value. However, a more detailed evaluation would be too complicated to undertake, in view of the purpose for which the outline is intended.

In case of heavily fished streams which are worked intensively, it is a good practice to make an actual count of the pools per mile of stream, classifying them as to size and type. Such a count may explain the high or low productivity of the stream and indicate definitely the amount of stream improvement needed.

Divisions of stream system

To facilitate the interpretation of biological, chemical and physical data it seemed advisable to separate the watershed into a number of parts. Thus each of the major tributaries is considered as a unit separate from the Rifle River, and is subdivided into a number of sections. The river has been divided into three sections, of which the dividing lines are somewhat arbitrary but tend to define natural divisions based on physical characteristics. Starting at the mouth the first section of the river has

been designated as I, the second as Section II, and the third as Section III. The three sections of the river are each further subdivided into three portions. A map showing the three sections and their respective portions accompanies this report.

Survey data and discussion

Rifle River

Section I

Section I includes about 30 miles of stream and extends from the mouth of the river to the Alger bridge. The lower portion of Section I extends from the mouth to Townline Creek. The central portion extends from Townline Creek to the Sterling bridge (Highway M-70). The upper portion is from Sterling bridge to the Alger bridge.

Volume and velocity data

The volume and velocity of Section I have been discussed in some detail in the preceding general discussion of the watershed. The volume of flow through this section is increased about 25 percent as indicated by two flow measurements. A reading of 141 c.f.s. obtained in the upper portion was increased to 192 c.f.s. in the lower portion. Velocities from 1.5 to 2.8 f.s. were recorded, and it is believed that the normal summer velocity for this section would be about 1.7 f.s.

Widths and depths

Widths in the lower portion of Section I range between 80 and 100 feet with depths varying from 6 inches to 3 feet. The central portion averages about 70 feet in width, ranging from 60 to 80 feet, and the depths vary from 8 inches to 2 1/2 feet, the average being about 18 inches. The upper

portion is from 70 to slightly over 100 feet in width, and between 6 inches and 4 feet in depth.

Bottom types

Section I is characterized by shifting sand bottom in about 95 percent of its area. There are a few gravel and rubble riffles, confined mostly to an area immediately below the Alger bridge, where good pool and riffle formations exist. Muck and silt deposits occur along the banks and eddies of river bends, but are few in number and limited in area. Some muck and organic detritus were found under beds of rooted vegetation.

It is believed that the area of bottom covered by rooted vegetation is considerably limited by the smothering or grinding action of shifting sand. This undesirable effect of sand deposition was markedly shown at the lower margin of certain plant beds. Beds of Potamogeton pectinatus, the variable pond weed, 2 feet in width by 2 1/2 feet in length were usually covered to some extent. The sand appeared to be deposited on the downstream side as the force of the current was reduced by the resistance of the plant growth. The rate of accumulation of sand on plant beds was not observed. However, any object of a size sufficient to retard the current had a small mound of sand built up immediately below it. The supposition is that plant beds produce similar results.

Pools

Pools in the lower portion of Section I are few in number and invariably fall in the class S3-T3-F3. Pools in this portion of the section usually occurred at points where the river made sharp turns and the concentrated current prevented the accumulation of sand and silt. These pools were generally small, with a width of less than half the stream.

The middle portion of Section I has a number of pools of the S2-T2-F3 class, which were separated by long stretches of flat water which do not fall within the classification of pool or riffle. These areas are definitely not riffles and yet the veolocity and physical properties of which they are characterized do not conform to that of a pool classification. In general these areas are canal-like stretches of water much longer than the width of the river, with a velocity of 1.0 f.s. or more and a width comparable to the average width of the stream in the particular region. Depths vary from 10 inches to 2 feet and cover is very poor, with the exception of a few plant beds or an occasional boulder. The bottom type is usually sand, but rubble and boulder combinations are sometimes present. Such canal-like bodies of water are known to the angler as "flat water" and are usually passed over in fishing. These areas are at the most only fairly productive, and would certainly be classed as undesirable habitats for larger game fish.

Pools in the upper part of Section I are more numerous and occasionally reach a depth of 6 feet. There is also an increase in the amount of cover, which is formed by exposed roots, deadheads, cut-banks and log-jams. The bottom is mostly of rubble and boulders upstream near the Alger bridge, but is mostly sand in the downstream area above the Sterling bridge. The pools in the boulder and rubble area are shallow and canal-like, but become progressively deeper as the sand replaces the rubble and boulder bottom type. An average classification of the pools in this portion of Section I would be S2-T1 and 2-F3.

Fish spawning grounds

There are very few gravel riffles in the lower portion of Section I, and it is believed, that these few areas contribute very little to the

reproduction of game fish or to the production of fish food. The central portion of Section I has some excellent gravel spawning areas, but here again the percentage of this bottom type is relatively small and it is doubtful if it is sufficient to meet the spawning demands of a good population of smallmouth and rock bass.

The upper portion of Section I has some excellent gravel and rubble riffles, most of which lie in the extreme upper end. The number of small and adult warm-water game fish found within this area would indicate that natural reproduction is adequate for this portion.

Shade and cover

The river banks in the lower portion of the section have been cleared of trees and shrubs to a large extent, thus reducing the shade to a minimum. Cover is also very poor in this area. With the exception of a few plant beds and deadheads, this portion is rather open and exposed.

The middle portion of the section is mostly forested along the river banks and the stream is well shaded. There is a definite improvement in the cover in this portion as compared with that below, although on the whole the quality and quantity would only be considered fair. There is little cultivation adjacent to the stream.

Certain parts of the upper portion have adequate cover while in others it is entirely lacking. Large boulders form the bulk of the cover below the Alger bridge, but farther downstream logs, deadheads, exposed roots, and cut banks are more common. In general, the pools lying within this portion are well supplied with cover.

Color and turbidity

The Rifle River in Section I is colorless during normal flow. Exceptionally high turbidity may accompany a heavy run-off. A Secchi disk

reading of 8 inches was recorded on June 15, 1941 in the lower portion of the section, approximately 24 hours after a heavy rain which appeared to be uniformly spread through the watershed.

Temperature

Daily maximum and minimum water temperatures were recorded at a station just above the Sterling bridge (which separates the middle and upper portions of Section I) from June 20 to August 13, 1941 (see Table 4).

Table 4.

Daily maximum and minimum water temperatures (degrees F.) taken on the Rifle River at the Sterling bridge, (T.19N., R.4E., S. 5) from June 19 to August 13, 1941.

	June		July		August	
Date	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1			78	73	78	70
2			72	70	80	68
3			70	65	80	70
4			72	62	82	72
5			..	..	82	70
6			..	..	76	66
7			72	68	76	64
8			72	66	74	68
9			74	68	76	70
10			74	67	78	72
11			74	68	74	68
12			70	65	74	68
13			72	65	72	60
14			74	64	..	..
15			74	66		
16			74	68		
17			70	62		
18			70	65		
19	..	..	68	62		
20	78	75	67	58		
21	78	74	68	62		
22	74	70	70	64		
23	77	75	76	70		
24	77	75	78	72		
25	79	76	80	74		
26	80	78	80	76		
27	81	78	..	..		
28	79	77	82	76		
29	..	..	82	76		
30	..	..	82	74		
31	..	..	80	74		

A maximum water temperature of 82° F., was recorded on five different days which included one three-day period. Temperatures of 80 and 81° F., were recorded on an additional seven days. The average of the daily maximum temperatures for the period was 75.6° F. Minimum daily water temperatures exceeded 75° F., during two hot spells. Similar high water temperatures probably occur some distance above this station as only a few small tributaries enter the river between this station and the Alger bridge.

From the temperature readings in Section I it is obvious that water temperatures remain above the toleration point of trout for considerable periods of time during normal climatic conditions of the summer months, and therefore this section is not adapted to the maintenance and propagation of any of the three species of trout found in Michigan.

The tributaries which enter the river in this section do not have more than a minor influence on the temperature of the stream because of their small size. Although cold water from spring fed tributaries may have an effect at the point of entrance, making it possible for a limited number of trout to remain in a restricted area, this is believed to be of little importance in Section I of the river. The pool at the mouth of Bear Creek is an example of this limited condition.

Chemical characters

The hydrogen-ion concentration of the water in Section I was found to be consistently alkaline. One reading, pH 8.0, was obtained during a heavy runoff, but later checks indicated that a rather consistent pH of 8.4 prevailed. Tests for free carbon dioxide were negative. Dissolved oxygen ranged between 7.6 and 10.5 which is well above the minimum required by trout. Phenolphthalein alkalinity expressed in parts per million ranged from 3.0 to 7.0, in this section. Methyl orange alkalinity tests gave values of 156 to 174 p.p.m. (see Table 5.).

Table 5

Chemical conditions at three stations on Section I of the Rifle River

Station, date (1941), time, weather	Temperatures Air	Temperatures Water	Dissolved oxygen p.p.m.	Methyl orange p.p.m.	Phenol-phthalein p.p.m.	Carbon dioxide p.p.m.	pH
Bridge 1/2 mile above mouth (T19N, R5E, S.36) June 15, 1:30 p.m., cloudy	62	61	7.6	163.	5.0	0.0	8.0
Bridge 1/2 mile above mouth (T19N, R5E, S.36) August 13, 11:30 a.m., clear	67	68	9.9	156.	7.0	0.0	8.4
Two miles above mouth of Townline Creek (T19N, R4E, S.2) August 13, 2:00 p.m., clear	70	66	10.5	166.	7.0	0.0	8.4
Sterling bridge (T19N, R4E, S.5) June 19, 4:00 p.m., clear	85	73	9.4	174.	3.0	0.0	8.4

Aquatic plants

Submerged aquatic vegetation in Section I is not extensive, and the total area of the river bottom covered with rooted plants is very small. In most cases the plant beds are rather dense but are restricted in size and limited in number. Sago pondweed (Potamogeton pectinatus) was the predominant plant in the section. Waterweed (Anacharis canadensis), clasping-leaf pondweed (Potamogeton Richardsonii), stiff water crowfoot (Ranunculus longirostris), flat-stemmed pondweed (Potamogeton zosteriformis), and large leaf pondweed (Potamogeton amplifolius) follow in order of abundance. A total of 23 species of submerged and emergent aquatic plants were recorded for the section. In most cases submerged aquatic plants were restricted to

areas of quiet, shallow water along the shores. However, P. pectinatus was often found in fast water and in some cases on riffles. The shifting sand bottom predominating in this section most assuredly plays an important role in limiting the distribution and abundance of the submerged aquatics. It would appear that the food and cover produced by the aquatic plants in this section are of limited value to the game fish population.

Fish-food organisms

The abundance of the different fish-food organisms and the total productivity of the section are definitely related to the types of bottom soil. Four bottom types were represented in Section I, namely: shifting sand, gravel and rubble, vegetation and trash, and a more or less stable sand-silt combination. Shifting sand, the predominant bottom type of Section I, is very poor in the production of fish-food. A few midge larvae and an occasional small clam were the only organisms found in this type of bottom. Gravel and rubble were about average in richness, and produced the following organisms in large numbers: Mayflies, midges, caddis flies, and stone flies. The sand-silt bottom type was also average in richness, midge larvae and Mayfly nymphs being the predominant forms. Beds of vegetation and drift piles harbored a good number of snails, and insects such as caddis larvae, and Mayflies.

Crayfish appeared to be well distributed in the rubble and gravel riffles as well as in vegetation beds and drift piles.

Since shifting sand compromises a large percentage of the total bottom area of Section I, this section is poor in the production of fish food organisms.

Fish in Section I

Fish collections in Section I were made by seining and angling. Angling proved the more satisfactory in collecting larger game fish. It was found that, by seining alone, a fair sample of coarse, forage and small game fish could be obtained, but due to the physical properties of the stream larger game fish were seldom taken. Thus it was necessary to supplement seine hauls with another collecting method to get a representative sample of larger game fish. Game fish taken by angling and other fish taken by seining are considered collectively for each station.

Eight collecting stations in Section I were sampled between June 16 and 23. The collecting stations are numbered consecutively upstream, starting with No. 1 near the mouth (see Table 6 and map).

A total of 47 species of fish were collected in this section during the course of the survey. In addition, the smelt was reported, and the carp was observed, making a total of 49 species, as listed in Table 6. Local reports were that smelt are taken around Omer at the time of the spring run. The 36 species of fish collected at Station 1 represent one of the largest collections ever recorded in the state of Michigan, in terms of number of species. The total of 49 species is probably indicative of a transitional area between lake and stream forms as well as between cold- and warm-water forms. Although cold- and warm-water fish were found in this section, the latter predominated, thus showing a definite correlation between fish fauna and high temperatures. The two trout recorded for the section were taken about the middle of June when water temperatures were in the low seventies. Game fish in this section have been listed as to order of abundance in Table 6. The bulk of legal game fish found here appears to be present in the upper portion. Rock

Table 6

Fish species, and their relative abundance, in Section I (from Alger bridge to the mouth) of the Rifle River as determined by collections and observations at eight stations. Stations numbered consecutively from mouth upstream, see map. Of species collected: P = predominant form, A = abundant, VC = very common, C = common, F = few, R = rare, and VR = very rare. Rep. = reported as present. Ob. = observed, but not collected.

Station	1	2	3	4	5	6	7	8	Station records	Relative abundance
Game fish										
Rock bass	P	P	P	P	Ob.	P	P	P	8	1st. in abun.
Smallmouth bass	F	F	-	F	-	C	C	C	6	2nd. in abun.
Perch	C	-	C	C	-	-	-	-	3	Common
Northern pike	-	-	-	F	-	C	F	-	3	Few
Brown trout	-	-	-	-	-	VR	-	-	1	Very rare
Rainbow trout	-	-	-	-	VR	-	-	-	1	Very rare
Pumpkinseed	R	-	F	-	-	-	-	-	2	Rare
Smelt	Rep.		-	-	-	-	-	-	-	Reported
Coarse fish										
Common white sucker	P	P	P	P	-	P	P	P	7	1st. in abun.
Hog sucker	A	VC	-	VC	-	VC	C	-	5	2nd. in abun.
Golden redhorse	C	C	-	C	-	C	C	-	5	3rd. in abun.
Greater redhorse	C	-	-	C	-	-	-	-	2	Few
Northern redhorse	-	-	-	C	-	-	-	-	1	Few
Northern black redhorse	F	-	-	C	-	-	-	C	3	Few
Yellow bullhead	F	-	-	-	-	-	-	-	1	Few
Brown bullhead	F	-	-	-	-	-	-	-	1	Few
Forage fish										
Common shiner	A	P	P	P	-	P	P	P	7	1st. in abun.
Rosyface shiner	P	A	-	A	-	VC	VC	VC	6	2nd. in abun.
Hornyhead chub	VC	F	-	C	-	VC	VC	VC	6	3rd. in abun.
Creek chub	VC	C	F	C	-	VC	VC	VC	5	4th. in abun.
River chub	C	C	-	-	-	VC	A	VC	7	5th. in abun.
Brassy minnow	C	C	-	F	-	F	F	-	5	Few
Brook stickleback	C	F	C	C	-	-	-	-	4	Few
Blacknose shiner	VR	-	-	-	-	F	F	F	4	Few
Barred fantail	C	F	-	C	C	C	C	C	7	Common
Johnny darter	VC	-	C	VC	-	C	VC	C	5	Common
Channel darter	C	F	-	F	F	C	F	C	7	Common
Blackside darter	VC	-	C	C	-	C	C	-	5	Common
Iowa darter	R	-	-	-	-	-	-	-	1	Few
Logperch	C	F	-	F	-	-	-	-	3	Few
Rainbow darter	-	F	-	C	C	C	C	C	6	Common
Blacknose dace	-	-	-	-	-	R	A	F	3	Few
Stoneroller	VR	-	-	F	-	-	R	-	3	Few
Banded killifish	R	-	-	-	-	-	-	-	1	Rare
Lake emerald shiner	C	C	-	F	-	-	-	-	3	Few
Spottail shiner	VC	-	-	-	-	-	-	-	1	Rare
Spotfin shiner	C	-	-	-	-	-	-	-	1	Rare
Mimic shiner	R	F	F	-	-	-	-	-	3	Few
Fathead minnow	R	-	F	-	-	-	-	-	2	Rare
Western mudminnow	C	-	C	C	-	-	-	-	3	Common
Tadpole madtom	R	-	-	-	-	-	-	-	1	Rare
Michigan brook lamprey (ammocoetes)	-	C	-	C	C	C	C	-	5	Common
American brook lamprey (ammocoetes)	-	-	-	-	C	-	C	-	2	Few
Longnose dace	-	-	-	-	-	-	R	-	1	Rare
Bluntnose minnow	C	-	F	C	-	-	-	-	3	Few
Stonecat	R	-	-	F	-	-	F	-	3	Few
Obnoxious fish										
Sea lamprey (ammocoetes)	-	F	-	-	F	-	C	-		Predominant
Carp	-	-	-	-	-	-	Ob.	-		Few
Mud pickerel	-	-	F	-	-	-	-	-		Rare
Total species at each station	36	21	14	28	8	21	26	15		

bass and smallmouth bass are the predominant forms. Great northern pike were collected in a few deep pools and observed in a number of others. Although perch were quite common in Section I, it is not one of the leading game fish of the river. A table representing the growth rates of the game species of this section will be included in a summary of the three major divisions of the river.

Forage fish, including many species, were found to be rather abundant in this section of the river. It is believed that the existing forage crop is of sufficient size to support a larger number of game fish than was present at the time of the survey.

Information on the history of fishing in this section is rather confusing, due to conflicting reports. However, it is believed that some trout fishing has been offered by the upper portion of Section I, as reports on this area seem to be in agreement that large brown and rainbow trout are taken between the Alger and Sterling bridges. For the seven or eight years prior to 1941, a few large rainbow trout were reported caught by live bait anglers in the vicinity of Omer. These may have been spawning-run fish from Lake Huron. The first observed smelt run occurred on the lower Rifle about 1938, and apparently the runs increased considerably up to 1941.

Sucker netting in the lower section of the Rifle has been permitted for a number of years, and serves as a combination sport and food fishery. The fish taken include the common white sucker and several species of redhorse, in spawning runs from Lake Huron. About 25 to 30 dip nets are in operation intermittently between the first of March and the fifteenth of May. In the spring of 1941 the heavy run occurred between April 2 and April 10. No records could be obtained regarding the pounds of fish per

net per season, but there have been reports that a single evenings catch may run as high as several hundred pounds. Although it has been reported that some fish are sold to commercial dealers, most of the catch is utilized as fresh fish or smoked by the local netters.

The AuGres River, lying about 15 miles north of the Rifle, has a fair-sized run of rainbow trout out of Lake Huron. Records for the past year reveal a correlation between the time the suckers run in the Rifle and the rainbow trout run in the AuGres. It might be expected that spawning-run rainbows in the Rifle would be taken occasionally in the sucker nets, yet no evidence of this could be obtained. A few rainbows were reported caught, and returned to the river, by the sucker fisherman using hook and line in the same area.

Rifle River

Section II

Section II includes about 10 miles of stream, extending from the Alger bridge to the Iron Bridge Rapids. Through this section there is a marked change in the physical and biological properties of the river. It is an area in which both warm- and cold-water fish are found, and will be designated as marginal trout water. It is emphasized that no sharp line of demarcation can be drawn between habitats of warm-water and cold-water species, but rather an overlapping may occur.

Physical Properties

Physical factors such as depths, widths, bottom types, and cover show wide variations in this section. Certain areas of the section resemble parts of the river either above or below, while other portions, such as the oxbow (See Fig. 1), are unlike any other part of the river system.

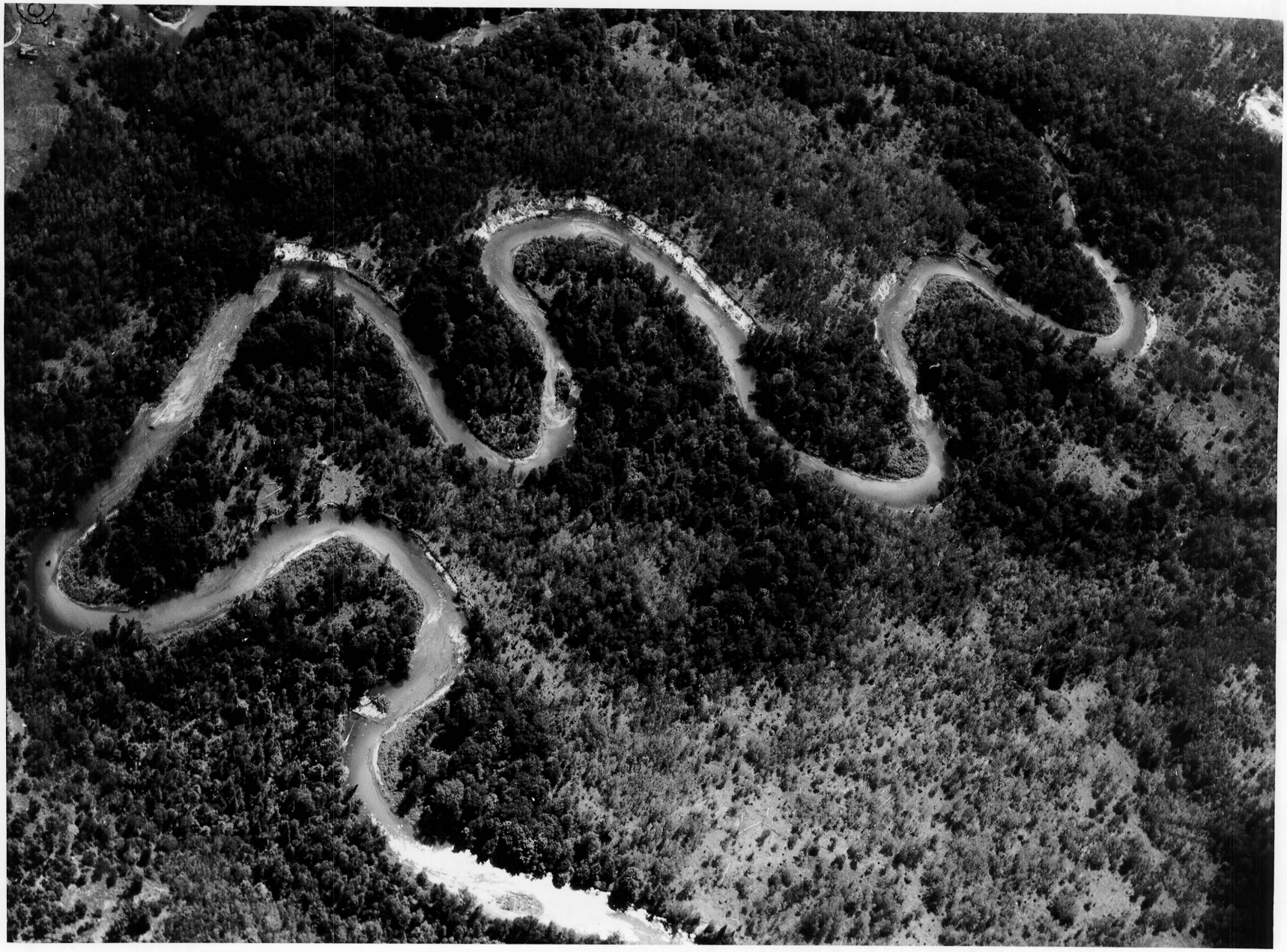

Figure 1. Oxbow of Rifle River above Island Rapids; photo taken from an elevation of 3,000 feet.

Volume and velocity

The volume of the river in this section is similar to that of the upper part of Section I. Within Section II some flow is added by several small tributaries. Velocities within the section ranged from 1/2 f.s. in the oxbow to 2 1/2 f.s. in the rapids. These are approximately the maximum and minimum velocities recorded for the river.

Widths and depths

Widths in the area vary from 50 to 110 feet, the average being about the same as in other sections of the river. The widest portion is in the region above the Alger bridge (See Fig. 2). In the region of the oxbow the river ranges between 50 and 60 feet in width.

Depths range from 6 inches to 8 feet. Maximum depths for the river are found within the oxbow and central portion of the section.

Bottom types

The bottom types of Section II are quite diversified and range from solid bed rock to silt. Gravel, rubble, and boulders predominate in the lower portion, and certain small areas have a sand bottom. It is believed that under certain conditions the gravel and rubble substrata may be covered with sand from time to time, depending upon fluctuations of water, volume and velocity. This fact was revealed by the presence of exposed boulders and rubble in sand areas. It was found that, in many places having these exposed boulders, the rubble and boulder substratum was covered by from 4 to 8 inches of sand.

The middle portion of Section II is predominantly sand and silt. In several large, deep pools, scoured out by the current, there was rubble and gravel.

Figure 2. The wide, rubble and boulder type of stream found in the vicinity of the Alger bridge.

The bottom types of the upper part of Section II are sand, gravel, rubble, and a sand-silt combination. On the whole the predominant bottom types in this portion were of sand and the sand-silt combination. The abundance of gravel and rubble riffles in this portion apparently contributes much to the productivity.

Pool classification

The lower portion of Section II has many canal-like stretches of water, similar to those described for Section I. Fair cover is provided by a large number of exposed boulders. Good pool and riffle formations are to be found for some distance above the Alger bridge, but on the whole the pools of the lower portion would fall in a class of S2 T2 F3.

The middle portion has pool formations quite unlike those found in other parts of the river. It is within this part that the dead water, locally known as the oxbow occurs. In this area the water appears to be impounded by the exposed bed rock of Island Rapids, although several gravel riffles separate the long deep pools. The pools are rather uniform in width and depth with an abundance of cover throughout. Pools in this portion have been classified as S2 T1 F1.

In the upper portion of the section a number of good pools are found interspersed with canal-like stretches. A general pool classification of the upper portion of the section would be S2 T2 F3.

Shade and cover

Shade is rather dense throughout Section II, although certain small areas in the extreme lower end are pastured and somewhat open along the banks. The steep eroding banks found in the central portion of the section apparently do not support a good plant growth adjacent to the stream, but it is believed that they protect the water from the direct rays of the sun throughout the greater part of the day.

Cover in the lower portion is composed mainly of boulders. In some pools other types of cover such as cut-banks, dead-heads, and water-logged brush are to be found. The central portion has an abundance of cover which is well distributed in the long deep pools. Exposed roots, cut-banks, and dead-heads appear to be about equal in abundance. The upper portion has a fair amount of cover in the form of boulders, cut-banks, snags, and dead-heads.

Color and turbidity

Color and turbidity of the water in this section are quite comparable to the conditions described for Section I. Through general observations it is believed that Section I becomes slightly more turbid.

Temperature

A maximum temperature of 81° F., was recorded for this section, in the lower part of the oxbow, during the latter part of June. Daily maximum and minimum water temperatures for the first 2 weeks in July averaged 74° and 67°, respectively.

A series of hourly temperatures was recorded during a 10 hour period on August 6, 1941 at the Alger bridge in the lower end of this section, to determine the daily fluctuations that occur with known air temperatures. These and comparable data for other stations on the Rifle system are given in Table 7, and shown graphically in Figure 3. Although the graphs in Figure 3 do not represent maximum temperatures for the summer, they serve to demonstrate the great fluctuation in water temperature brought about by changes in air temperature. The night of August 5 to 6 was unusually cool, and the following day was a fairly hot one. These two circumstances resulted in considerable fluctuation in water temperature. In addition to the Alger bridge series, the other water temperatures recorded in Table 6 and Figure 3 were obtained from 3 stations on the Rifle River in Section III and one station on Houghton Creek. They show the relationships of air and water temperatures in these parts of the system.

Table 7

Hourly air and water temperatures in degrees Fahrenheit from morning to evening on August 6, 1941 at four stations on the Rifle River and at Houghton Creek at its mouth.

Alger bridge			M-55 bridge			At Jewett Ranch*			Above mouth of Houghton Creek			Houghton Creek		
Time	Air	Water	Time	Air	Water	Time	Air	Water	Time	Air	Water	Time	Air	Water
...	...	...	7:30	59	62	7:25	61	62	7:45	67.5	71	7:50	67.5	57.5
8:00	65.5	64	8:30	71	63	8:25	68	63	8:45	68	72	8:45	68	57.5
9:00	70	65	9:30	75	64	9:30	70	63.5	9:45	70	73.5	9:45	70	58
10:00	76	67	10:30	75	66	10:00	71	64	10:45	75.5	75.5	10:45	75.5	59
11:00	77	69	11:30	77	69	11:00	76	66	11:45	76	77	11:45	76	59.5
12:00	78	71.5	12:30	78	70.5	12:00	78	67	12.45	79.5	78.5	12:45	79.5	61
1:00	79.5	73.5	1:30	79	72	1:00	80.5	68	1:45	81	80	1:45	81	62
2:00	80	75	2:30	80.5	74	2:00	80	69	.. .	...	...	...	...	...
3:00	82	76	3:30	79.5	72**	3:05	79.5	70	3:00	79.5	81	3:00	79.5	63
4:00	81.5	77	4:30	80	73.5	4:00	79.5	70.5	3:55	79.5	81	3:55	79.5	63.5
5:00	80	77	5:30	75	73	5:05	76	71	5:00	76	80.5	5:00	76	64
6:00	79	75.5	6:30	73.5	72.5	6:00	73.5	70.5	5:55	73.5	79.5	5:55	73.5	64
...	...	...	...	...	...	7:15	69.5	69.5	7:00	69.5	79	7:10	69.5	63.5

* Station is approximately 1/4 mile below mouth of Houghton Creek.

** Reading probably in error, one or two degrees.

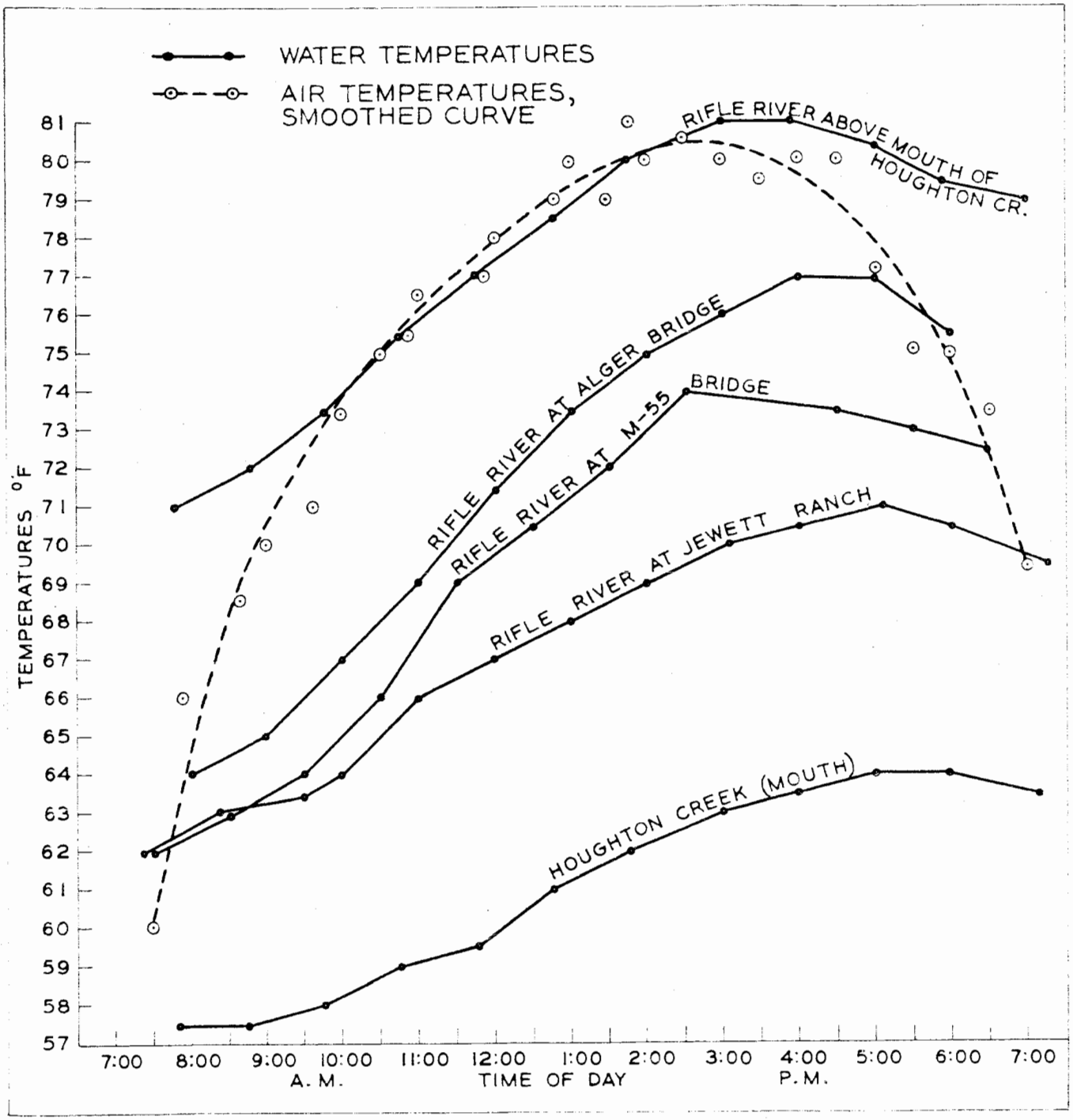

Figure 3. Hourly temperatures of water and air at four stations on the Rifle River and one station on Houghton Creek at its mouth, on August 6, 1941. Data are from Table 7. Air temperatures are averages for the several stations.

At the Alger bridge station the hourly rise in water temperature was almost in direct proportion to that of the air, whereas at the Jewett Ranch station and in Houghton Creek there was a considerable lag in rise of water temperature. Houghton Creek has cold water, and its entry into the Rifle River above the Jewett Ranch accounts for the relatively cool water temperatures at the Jewett Ranch station. Further comments on the data of Table 6 and Figure 3 are given in a following discussion of Section III of the river.

Chemical characteristics

The data obtained from chemical analyses of the water in this section show no undesirable factors to be present. Essential elements and compounds were present in quantities well within the range of the species of fish present in the area.

Table 8

Chemical conditions in various stations in Section II

Location, date (1941), time	Temperatures degrees F.		Dissolved oxygen p.p.m.	Methyl orange p.p.m.	Phenol-phthalein p.p.m.	Carbon dioxide p.p.m.	pH
	Air	Water					
Alger bridge August 13, 4:00 p.m.	72	70	12.0	162	10.0	0.0	8.4
Greenwood bridge August 13, 5:00 p.m.	66	67	10.3	173	8.0	0.0	8.4
Iron bridge June 25, 9:45 a.m.	79	66	8.6	174	10.0	0.0	8.0

Plants

There are relatively few plant beds in this section of the river. The species found here were much the same as those of Section I, except that, sago pondweed (Potamogeton pectinatus) was replaced to some extent by another pondweed (Potamogeton vaginatus) on the gravel and rubble riffles. Waterweed (Anacharis canadensis) and stiff water crowfoot (Ranunculus longirostris) are present in large beds, but are limited to sand and silt areas along shore. Other plant species are rare. It is believed that the few weed beds in this section are of little value as cover for trout.

Fish food organisms

The productivity of Section II is somewhat better than that of Section I. Also, there appears to be some increase in the number and volume of organisms from the lower to the upper part of Section II. This upstream increase in bottom organisms is correlated with the appearance of riffles with gravel and rubble bottom. However, the difference between Sections I and II in food organisms is rather slight. Section II is rated as only poor to fair. Probably the shifting sand bottom partially renders the limited gravel areas of little value in food production.

Among the bottom organisms encountered, crayfish, clams and caddis flies were common to numerous; stoneflies, dragonflies, mayflies and water mites were common; and alder flies, beetles, midges, other Diptera, and snails were few.

Fish

Twenty-nine species of fish were collected in Section II (see Table 9). In addition, the sea lamprey was reported to be present, and the carp

Table 9

Fish species [1], and their relative abundance, in Section II of the Rifle River, as determined by collections and observations at three stations. Stations are: 9--near mouth of Mansfield Creek, 10--near Greenwood bridge, and 11--near Iron bridge. P = predominant form, VC = very common, C = common, F = few, R = rare, Ob = observed but not collected, Rep = reported to be present.

	Stations			Relative abundance
	9	10	11	
Game fish				
Brook trout	--	R	R	Rare
Rainbow trout	R	C	C	Common
Brown trout	R	C	C	Common
Northern pike	R	F	F	Few
Smallmouth bass	C	F	F	Few
Rock bass	P	F	F	Few
Coarse fish				
Common white sucker	P	P	P	Predominant
Hog sucker	C	C	C	Common
Brown bullhead	--	F	--	Rare
Black bullhead	--	F	--	Rare
Greater redhorse	Ob	C	--	Common
Golden redhorse	Ob	C	--	Common
Forage fish				
Common shiner	P	--	P	Predominant
River chub	F	--	C	2nd. in abundance
Hornyhead chub	C	--	--	3rd. in abundance
Blacknose dace	F	--	C	4th. in abundance
Rosyface shiner	C	--	C	5th. in abundance
Creek chub	-	--	C	6th. in abundance
Pearl dace	F	--	R	Few
Brassy minnow	F	--	C	Common
Bluntnose minnow	--	--	F	Few
Stone cat	--	F	--	Few
Brook stickleback	--	--	C	Common
Rainbow darter	C	--	VC	Predominant darter
Channel darter	--	--	C	Common
Blackside darter	--	--	C	Common
Johnny darter	--	--	C	Common
Barred fantail	--	--	R	Rare
Michigan brook lamprey	--	--	F	Few
Obnoxious fish				
Sea lamprey	Rep	Rep	Rep	Adults reported
Carp	Ob	Ob	Ob	Few

[1] For scientific names, see Appendix I.

was observed, making a total of 31 species. The smaller number of species listed for this section is probably due to the small area of the section and the relatively few collecting stations as compared with Sections I and III. It is reasonable to assume that more intensive collecting in this area would increase the species list to a number approaching that for the sections above and below.

Since a survey base camp was located at Camp Greenwood (on Section II), larger game fish were collected intensively by use of larger nets and traps, by night spearing with jack-light, by frequent angling, and by contacting other anglers.

One fisherman reported a black crappie as taken from this section of the Rifle River. We have no other record for this species in the Rifle, and therefore suspect that the fish came from one of the lakes connected with the river system.

Judging from our survey collections, and considering the types of habitat and fishing effort, the order of abundance of game species in Section II is: brown trout, rainbow trout, rock bass, smallmouth bass, northern pike, and brook trout. The most significant result of fish studies in this section is the record of an increase of cold-water forms over the warm-water species, as compared to Section I. Generally, the warm-water species were more abundant in the lower portion of the section, whereas, trout predominated in the upper portion. However, Island Rapids, (see Figure 4) which is some distance below the Greenwood bridge, produced a good number of trout until about July 10. Very few brown or rainbow trout were taken below this point. The northern pike was rather common in the deep water of the oxbow, but was rare in other parts of Section II.

Figure 4. Island Rapids, below Greenwood bridge. Photo from elevation of 800 feet.

Judging from our fish collections and temperature observations, the central portion of Section II of the Rifle, in the vicinity of the Greenwood bridge and the oxbow, is the lower extreme of marginal trout water. Most trout were taken from above the Greenwood bridge, and most warm-water fish were taken below. In this area it was noted that most trout were to be found in fast and deep water or at the mouths of cold inlets, rather than in quiet pools and shallow riffles. This distribution, in itself, is an indication of the marginal character of the water from the standpoint of trout habitat. Trout will tolerate somewhat higher temperatures in rapidly flowing water than in quiet water. This presumably accounts also, for the presence of trout encountered in the Island Rapids which are some distance below the Greenwood bridge and within the non-trout portion of the river.

The explanation for the transitional nature of Section II from a temperature standpoint is indicated by the data in Table 6 and Figure 3. Throughout most of Section I the water is sufficiently cold for trout (see data for the Jewett Ranch and M-55 stations). At the lower end of Section II (see Alger bridge station records) the water is too warm for trout. The temperature data thus delimit the transition zone as somewhere between the M-55 and Alger bridges. From the actual evidence of trout distribution, the transition zone is further delimited to the vicinity of the Greenwood bridge and the oxbow. Presumably the low water temperature of Section III is extended into the upper portion of Section II where it is further cooled to some extent by the added flow of Eddy Creek.

The common sucker is one of the most abundant species of the river system. Undoubtedly it would surpass all other species in terms of pounds per acre.

Forage fish are quite abundant in this section. The common shiner is the most abundant species. The river chub, hornyhead chub, blacknose dace, rosyface shiner and creek chub follow in order of abundance.

History of fishing

Reports of the history of fishing in this section when compared with the survey records indicate that certain changes have taken place in the game fish population of Section II. The reports are that at one time fair trout fishing extended through Section II and some distance down into Section I, including good catches of rainbow trout in the Alger bridge portion of the stream. This is quite in contrast to the data obtained by the survey party.

Records obtained from diary (Table 10) suggest that there has been also some recent change in the species composition of the trout population in Section II and the lower part of Section III. These angling records show some increase in the take of brown trout, accompanied by a marked decrease in the take of rainbows. The influence of stocking on the relative abundance of these two species is not known; however, rainbow trout have predominated in the plantings. Brook trout have rated third in the trout catch, according to these records, and nearly equaled the catch of browns and rainbows in only one of the six years of records. The poor returns of brook trout in this section of the Rifle is certainly due to high temperatures which frequently exceed 75° F. It is doubtful if the brook trout can exist in this section in localities other than those cooled by spring seepage or spring fed tributaries.

The average length of legal trout has remained somewhat uniform over this period of 10 years. Browns averaged 10.9 inches; rainbow trout have an average slightly above 10 inches; and brook trout, a little less than

Table 10

Fishing records from one angler's diary, 1932 to 1937, plus 1941 records of angling by survey personnel in Section II and the lower part of Section III of the Rifle River.

Species	1932		1933		1934		1936		1937		Total		1941 (survey)	
	Number	Average length	Number	Average length	Number	Average length	Number	Average length	Number	Average length	Number	Average length	Number	Average length
Rainbow trout	59	9.6	55	10.0	17	9.9	35	10.8	28	10.1	194	10.0	11	10.2
Brown trout	14	11.0	9	11.2	9	8.9	25	10.9	13	11.7	70	10.9	20	10.9
Brook trout	4	9.0	0	...	5	9.2	23	8.7	7	8.8	39	8.8	3	8.0

9 inches. Large rainbow trout, presumably migrants from Lake Huron, were reported to be rather common in this section until about 1936. None of the large, Lake Huron rainbows were taken by the survey party during 1941, although one five-pound fish was reported as taken from Section I of the river on the opening day of trout season.

Adult sea lampreys were collected on spawning beds in Section II in the spring of 1941 by R. L. Foresman. The first record for this species in the Rifle River was in 1936.

Rifle River

Section III

Section III is designated as that portion of the river extending from the Iron Bridge Rapids to the dam at Devoe Lake. It includes approximately twenty-five miles of stream. Four major tributaries enter the river within the boundaries of this section, three of which play an important part in preventing high water temperatures during June, July, and August. It is also believed that they act as feeder streams, and provide spawning and nursery areas for trout. There are no great biological or physical irregularities within the section other than in the upper one-half mile of stream. The area from the outlet of Devoe Lake to the confluence of Houghton Creek has exceptionally high temperature, and is apparently populated with warm water fish from the lake.

Physical properties

The section is subdivided into three portions to accommodate a more detailed discussion of physical, chemical, and biological properties. The lower portion extends from Iron Bridge Rapids (see Figure 5) to Highway M-55; the central portion, from Highway M-55 to the confluence of Prior Creek; the upper portion, from the junction of Prior Creek to the dam at Devoe Lake.

Figure 5. Rifle River at Iron Bridge Rapids, showing white water in lower part of the rapids. Photo from elevation of 800 feet.

Volume, velocity, width, and depth

The lower portion of the section has a normal summer volume of about 106 c.f.s. in the vicinity of the M-55 bridge. The volume is further increased by the West Branch of the Rifle River some distance below. The volume of flow contributed by the West Branch depends on seasonal fluctuations and on the amount of water used at the power dam of Flowage Lake. Tributaries entering Flowage Lake average about 20 c.f.s. The velocity in this portion varies from about 1.5 f.s. to over 2 f.s. A velocity of 1.9 f.s., recorded at the M-55 bridge is slightly above the average for this portion of the stream. The width of the stream in this portion varies between 40 and 75 feet. The depth varies from 6 inches to 7 feet.

The volume of the central portion of the section, calculated from the volume above and below, would vary from approximately 75 c.f.s. at the upper portion to about 105 in the lower portion during normal summer water levels. The velocity for the most part would be slightly above that in the lower portion and would in most areas approach 2.0 f.s. The width in this portion varies from 30 to 60 feet, and the depth, from 6 inches to 5 feet.

A normal summer flow in the outlet of Devoe Lake would be approximately 40 to 45 c.f.s. With the additional flow of Houghton Creek, this volume is increased to 65 to 80 c.f.s. This upper portion of Section III has an average velocity of about 2.0 f.s., and a maximum velocity of 2.38 was obtained below the mouth of Houghton Creek. The width varies from 30 to 55 feet, and the depth from 6 inches to 5 1/2 feet.

Pools and riffles

The lower portion of Section III has better pool formations than any other part of the river, with relatively few canal-like stretches of water.

The pools are not only deep but have a considerable amount of cover. Pools in this portion would, in general, grade from S1-T1-F1 to S2-T2-F2.

The central portion has relatively few good pools, with the majority classified as S2-T2-F3. A few pools below Selkirk would be S2-T1 (see Figure 6). For the most part, the central portion of the section is composed of canal-like bodies of water having a rubble and boulder bottom with an occasional depression of 2 1/2 to 3 feet around boulders. Some fine catches of brown and rainbow trout have been taken in these areas; however, similar areas having a sand bottom and without the boulder cover are very unproductive.

Pools in the upper part of Section III increase in number and quality from the mouth of Prior Creek to the junction of Houghton Creek. Between the mouth of Prior Creek and the bridge at section line 22-27 (see map) there are a few pools of depths of 4 to 5 feet, but most of the water lying between these two points is relatively shallow and the bottom types are sandy-gravel and rubble. A considerable area has become established in plant beds, but in most instances these are confined to the shallower flat stretches. Upstream from the bridge on section line 22-27, there are exceptionally long pool formations and very few riffles. In most cases the pools are deep and narrow and have good cover of snags, cut banks and vegetation. The pool classification for Section III is S1-T2 and 3-F1.

Riffles in the lower part of Section III are of rubble, gravel and shelving rock. The latter forms the substratum of a few riffles above the Iron Bridge Rapids. Gravel and rubble replace shelving rock above this point. About a third of the area is composed of good gravel and rubble riffles, many of which are somewhat deeper than the average for the river.

Figure 6. Rifle River below Selkirk. Four pools and one deep run are present in area shown in photo.

In the central portion of Section III, riffles of gravel and rubble predominate over the pool areas.

In the upper part of the section riffles are quite numerous in the area below the road on section line 22-27. In some instances the riffles have spread out over considerable area, are from one to three hundred feet long, and have an average depth of a few inches. Above section line 22-27 bridge there is very little riffle area as compared to that in pool formations. Here riffles are reduced in width and length, with an increase in depth and velocity. Rubble and gravel form the bulk of the riffle substrata.

Shade and cover

The lower portion of Section III is well shaded, with the exception of a small area devoted to pasture. Trees and shrubs line the banks and in many instances overhang the stream. Log jams and cut banks provide additional shade. The volume and quality of cover found in this portion of the stream is far above that found in most other parts of the river. Deep pools having an abundance of cover in the form of vegetation, cut banks, exposed roots, and deadheads are quite numerous.

Shade in the middle portion of the section is moderate. The development around the Selkirk area has reduced the shade to some extent (see Figure 6), while other parts are well protected. Cover in the middle portion of Section III varies considerably. Large boulders form the bulk of the cover, although beds of water weed (Anacharis canadensis) and a few cut banks serve this purpose in restricted areas. There are relatively few deadheads and snags. The conformation of the stream bed does not permit the accumulation of deadheads, snags, and other forms of cover, which are normally found in areas having sharp turns and cut

banks. In general, the river bed has a gradual slope shoreward; however, in places where there are sharp turns such as below Selkirk, the cover is materially increased by cut banks and accumulation of brush and snags.

The upper portion of Section III may be divided into two distinct areas relative to the amount of shade and cover. Below the bridge on section line 22-27 shade is relatively poor, since much of the river bank is cultivated and pastured. The lack of cover is even more apparent than that above the Selkirk area in the middle portion of Section III. The relatively straight course of the stream associated with the gradual bottom slope has resulted in the formation of scouring basins. The bottom is sand and fine gravel. Plant beds are found along the margins of some pools, but have little value in providing cover. Above the bridge on section line 22-27, shade is excellent, and only a smallamount of cleared land lies adjacent to the river. Considerable cover lines the steep banks and margins of pools. Dense beds of submerged aquatic plants, cut banks, deadheads, exposed roots, and log jams constitute most of the cover. The entire area is practically devoid of large boulders and rubble. Sand and silt are the predominant bottom types.

Bottom types

Bottom types have been discussed to some extent under the subject of pool and riffle formations, but a brief summary of the different types found in the section is included here. It is typical that the bottom soil of pools differs from that of adjoining riffles.

Above Iron Bridge Rapids in the lower portion of Section III, there is a stretch where the riffles have bedrock and the pools have sand bottom. Above this, the riffles are gravel and small rubble, and the pools are of sand and silt. Next upstream, the riffles have rubble, boulders and some gravel, and the pools have sand, silt, and gravel.

In the Central portion, rubble and boulders predominate with an occasional gravel riffle; sand bottom pools predominating.

The upper portion has mostly sand or sand-silt bottom on long stretches of flat water. There are some gravel and rubble riffles below the section line 22-27 bridge, but few above this bridge.

Color and turbidity

The water in Section III is colorless. Turbidity readings with a Secchi disc were not taken in this section, but observations on the turbidity of the tributaries revealed the principal sources of turbidity to the river. The West Branch of the Rifle River, entering the lower portion of Section III, has many tributaries flowing through cleared land, and as a result carries a considerable volume of silt during a heavy run-off. It was observed that a slightly cloudy condition existed for a considerable period of time after the West Branch had receded to a normal water level, but this may have been due to the organic material suspended in the sewage effluent from West Branch. Houghton Creek probably carries the largest amount of silt of all the tributaries entering Section III. The high turbidity accompanying a heavy run-off is largely due to the erosion of cultivated fields and dirt roads.

Klacking and Prior Creeks had little turbidity even during heavy run-offs. The outlet of Devoe Lake is usually clear. The small amount of silt carried by Gamble Creek presumably is precipitated on reaching Devoe Lake.

Temperature

Devoe Lake is the source of the Rifle River. One-half mile below the lake, Houghton Creek enters the river. Devoe Lake contributes about 55 percent of the volume, and Houghton Creek about 45 percent. The Devoe Lake water is surface water and therefore warm (Table 11) during the

Table 11

Water and air temperatures on the Rifle River at the outlet of Devoe Lake, August 8, 1941.

Time	Air temperature degrees F.	Water temperature degrees F.
7:45 a.m.	67	73.5
9:45 a.m.	81	75
11:00 a.m.	83	75
12:30 p.m.	87	76.5
2:00 p.m.	81	76.5
4:00 p.m.	73	75

summer, while Houghton Creek is spring-fed and cold. Thus the Rifle River water is cooled considerably by the addition of Houghton Creek, the extent of which is shown by hourly temperatures taken on August 6, 1941 (Table 7 and Figure 3) and by temperature readings of July 24 (Table 12).

Table 12

Temperature for the upper portion of Section III, July 24, 1941

Place	Time	Air temperature degrees F.	Water temperature degrees F.
Devoe Lake Outlet	10:45 a.m.	85	76
Houghton Creek	10:45 a.m.	85	63
One-fourth mile below junction of Houghton Creek	11:00 a.m.	85	68.5
Two miles below junction of Houghton Creek	3:00 p.m.	90.5	73.5
Section line 22-27 bridge	4:45 p.m.	89	74.5

From Devoe Lake to Houghton Creek mid-day summer water temperatures are usually above 70 degrees F. and may exceed 80 degrees F. (see Table 7). Thus this short section of the river is too warm for trout. Below the mouth of Houghton Creek, recorded water temperatures ranged from the low seventies on afternoons of hot days. It was 73.5 degrees F. (air 90.5 degrees F.) two miles below Houghton Creek on July 24, 74.5 degrees F. (air 89 degrees F.)

at Section 22-27 bridge on July 24, 79 degrees F. one mile above Prior Creek on July 25, and 80 degrees F. above the mouth of Klacking Creek on July 28. Throughout the upper portion of Section III the water is thus too warm for brook trout. The trout population is mostly browns and rainbows.

The wide shallow river bed extending several miles below the Section 22-27 bridge apparently subjects the water to the heating action of sun and air. The water temperature of 79 degrees F., recorded one mile above Prior Creek on July 25, probably represents the maximum that may be expected for the upper portion of Section III as it occurred in the latter part of a period of exceptionally warm weather when maximum daily air temperature ranged between 90 degrees and 97 degrees. The maximum temperature of 80 degrees, above the mouth of Klacking Creek on July 28, probably represents the maximum for the central portion of Section III, as a number of spring-fed tributaries enter the river below this point. A maximum temperature of Prior Creek was 75 degrees, obtained at its mouth on July 28. Judging from this, it is believed that the Prior Creek has little effect in reducing the water temperature of the river during critical warm weather periods. A maximum temperature of 72 degrees was obtained on Klacking Creek at its mouth; this was 8 degrees below the river temperature at this point, indicating that the Klacking has some cooling effect on the river. Several small tributaries entering the river between the mouth of Klacking Creek and the M-55 road bridge are also considered as important factors in reducing the water temperature of the river in this portion of Section III. A number of springs and small cold tributaries enter the river below the M-55 bridge, but are of minor importance as compared with those above.

The West Branch of the Rifle River, entering the lower portion of Section III, has little influence in reducing water temperatures of the river. A temperature of 78 degrees F., obtained at the mouth was two degrees F., above that of the river at 4:00 p.m. on June 27. The power dams on the West Branch and its tributaries undoubtedly are responsible for the extremely warm temperatures obtained in the lower portion of this tributary.

Hourly water temperatures on the main river taken at the M-55 bridge are shown in Table 7 and Figure 3, and will not be discussed here.

A summary of critical water temperatures of Section III may be stated as follows: The entire volume of the river above the mouth of Houghton Creek is supplied by the outlet of Devoe Lake and reaches a temperature of 84 degrees or more. Houghton Creek remains in the low seventies, even in extremely warm weather. Immediately below the confluence of the Houghton, the river may reach a maximum of approximately 75 degrees F.; however, such conditions are of short duration as the temperature of Houghton Creek drops very rapidly after 5:00 p.m. The shade and other physical properties of the river from the mouth of the Houghton to the Section 22-27 bridge apparently have considerable influence in preventing a temperature rise of the water. Between the Section 22-27 bridge and the mouth of Prior Creek, the river is shallow and wide and has little shade. Here the heating action of sun and air may increase the temperature to about 80 degrees F. The tributaries and cold springs entering the river below this point are apparently effective in lowering the water temperature to some extent.

Chemical characters

(See Table 13)

The acidity of the water in Section III expressed in pH remains more or less constant at 8.4. One reading of 8.3 was obtained between Prior and Klacking creeks. A positive phenolphthalein reading was obtained at each station, (range from 5.0 to 10.0 p.p.m.) thus eliminating the possibility of any appreciable amount of carbon dioxide being present.

Table 13

Chemical conditions at various stations on the Rifle River in Section III and at one station on Houghton Creek

Station, date (1941), time weather	Temperature Air	Temperature Water	Dissolved oxygen p.p.m.	Methyl orange p.p.m.	Phenol-phthalein p.p.m.	Carbon dioxide p.p.m.	pH
One mile below M-55 bridge, June 29, 4:00 p.m. clear	86	72	8.8	178.	7.0	0.	8.4
At M-55 bridge, August 13, 5:30 p.m. clear	66	65	9.3	165.	10.0	0.	8.4
Two miles above Selkirk, July 22, 11:45 a.m., clear	82	65	9.0	163.	7.5	0.	8.3
Devoe Lake Outlet August 16, 5:00 p.m. clear	77	69	8.2	174.	7.0	0.	8.4
Houghton Creek, at its mouth, July 26, 11:00 a.m. cloudy	85	62.5	10.1	175.	5.0	0.	8.4

Methyl orange alkalinity ranged from 163 to 178 p.p.m., indicating that the waters in this section are moderately hard. At each station dissolved oxygen was near saturation for prevailing water temperatures, and sufficient to meet the demands of cold-water fishes. Oxygen expressed

in parts per million ranged from 8.2 to 10.1, being highest in the cold water of Houghton Creek, and lowest in the warm water of the Devoe Lake outlet.

Plants in Section III

Shelving rock in the extreme lower portion of Section III is practically devoid of vascular aquatic plants. Immediately above the bed rock formation, rather extensive beds of water weed (Anacharis canadensis) and stiff water crowfoot (Ranunculus longirostris) were found along the margins of pools, and beds of pond weed (Potamogeton vaginatus), covered large areas in some riffles. Occurring less frequently and in smaller beds were sago pond weed (Potamogeton pectinatus), clasping-leaf pond weed (Potamogeton Richardsonii), musk grass (Chara sp.), water star grass (Heteranthera dubia), pond weed (Potamogeton Friesii), mare's tail (Hippuris vulgaris) and water milfoil (Myriophyllum sp.).

The central portion of Section III has a moderate supply of submerged aquatic plants. Stiff water crowfoot (Ranunculus longirostris), water weed (Anacharis canadensis), and sago pond weed (Potamogeton pectinatus) were very common. Clasping-leaf pond weed (Potamogeton Richardsonii) was more prevalent in shallow rubble areas. This portion of Section III has few deep pools, and consequently the majority of plants are confined to relatively shallow water. It is doubtful if the plant beds are used extensively as cover by fish, although the productiveness of the area should be considerably enhanced by the insect fauna they harbor.

In the upper portion of Section III, that area lying between the mouth of Prior Creek and the Section 22-27 bridge has mostly flat sand bottom apparently unsuitable for plant growth. There are a few riffles in which sago pond weed (Potamogeton vaginatus), has become established. Above

the Section 22-27 bridge, excellent beds of water weed (Anacharis canadensis), stiff water crowfoot (Ranunculus longirostris), musk grass (Chara sp.) and water milfoil (Myriophyllum sp.) line the shores and in many instances extend into deep water.

Fish food organisms

The volume and number of fish food organisms found in the lower portion of Section III ranges from poor to excellent. The shelving rock above Iron Bridge Rapids is not productive, but from the end of this rock formation to the M-55 bridge the large amounts of rubble and vegetation apparently are responsible for the presence of an exceptionally large number and volume of organisms, which places the area in a class of average to exceptional richness.

The central portion of Section III also produces a good number of fish food organisms. Certain sand stretches in this area are very poor in quality, but there is a preponderance of rubble over sand bottom. The productivity of the area is classed as good.

The upper portion of Section III ranges from fair to good. The flat stretches of sand bottom from Prior Creek to the Section 22-27 bridge are poor in food, but certain extensive fine gravel riffles and associated beds of Potamogeton vaginatus are fair producers. The area above the Section 22-27 bridge has much submerged vegetation well populated with aquatic fauna. Although much of the bottom type is sand or sand-silt, it appears to be in a more stable condition than that found below and produces more fish food organisms. The portion of the river between the mouth of Houghton Creek and Devoe Lake is low in productivity. Shifting sand and marl are believed to be responsible for the low productivity of this area.

Table 14

Fish food organisms in Section III, showing relative abundance as found in random collections, June 27 to July 24.

Type of organism	Stations						
	Lower portion		Central portion		Upper portion		
	Iron bridge to State Police cabin	State Police cabin to M-55	M-55 to Selkirk	Selkirk to Prior Creek	Prior Creek to Section 22-27 bridge	Section 22-27 bridge to Houghton Creek	Houghton Creek to Devoe Lake
Hirudinea	...	...	Few	...	Few	...	...
Gastropoda	Few	Few	Few	Few	Few	Few	Few
Pelecypoda	Few	Few	Few	Few	Few	Few	Few
Amphipoda	...	Rare	Rare	Rare	Few	Few	Few
Hydracarina	Few	Few	...	...	Common	Common	Common
Ephemeroptera	Few	Abundant	Numerous	Numerous	Common	Common	Common
Odonata	Common	Common	Common	Common	Few	Common	Few
Neuroptera	...	Common	Few	Few	Few	Few	...
Trichoptera	Numerous	Very abundant	Abundant	Common	Numerous	Numerous	Few
Coleoptera	Few	Few	Few	Few	Common	Common	Few
Chironomidae	Few	Common	Common	Common	Common	Common	Few
Other Diptera	Few	Common	Few	Few	Common	Common	Few
Plecoptera	Common	Common	Common	Common	Few	...	Few
Crayfish	Numerous	Abundant	Numerous	Numerous	Common	Common	Few
Average richness (summary)	poor to medium	fair to excellent	fair to good	fair to good	poor to fair	poor to fair	poor

The most productive part of the entire river, in terms of bottom organisms is that part of Section III between Iron Bridge Rapids and the mouth of Prior Creek. The exceptional richness of this area seems to be correlated with the large amounts of rubble and vegetation that are present. There are relatively few, small areas of sand bottom.

Fish in Section III

Thirty-nine species of fish were recorded for Section III. Their relative abundance at the six collection stations is stated in Table 15. The game species included the brook, brown and rainbow trout, northern pike, perch, smallmouth bass and rock bass. Trout were far more abundant than the warm-water forms.

There was a very noticeable difference in the relative numbers of rainbow and brown trout in Section III as compared to Section II. Brown and rainbow trout were present in about equal numbers in Section II while Section III had twice as many rainbows as browns.

Most brook trout collected were from the mouth of Dedrich Creek. At the time of investigation this tributary was practically dry with the exception of a few isolated pools. Brook trout were found in a few of these pools as well as in the Rifle at the mouth of the brook. It is believed that a fair volume of cold sub-surface water was flowing through the gravel stream bed and isolated pools. Probably the brook trout taken at the mouth of Dedrich had dropped downstream from the creek and were concentrated in the vicinity of the cold water seepage, rather than being migrants from other parts of the river. One brook trout was taken in the Selkirk area and four were taken in the upper portion of Section III, the coldest part of the river.

Table 15

Fish species, and their relative abundance, in Section III (from Iron Bridge Rapids to Devoe Lake) of the Rifle River, from collections and observations at six stations. Stations are numbered consecutively upstream. P = predominant form, A = abundant, VC = very common, C = common, F = few, R = rare, VR = very rare, Rep = reported to be present.

Species	Stations 12	13	14	15	16	17	Number of stations where found	Relative abundance
Game fish								
Brook trout	-	-	-	F	-	F	2	Rare
Brown trout	C	C	C	C	C	C	6	2nd in abundance
Rainbow trout	P	C	C	C	C	C	6	1st in abundance
Northern pike	VR	R	-	-	Rep	-	3	Rare
Perch	VR	VR	-	-	C	F	4	Few
Smallmouth bass	R	VR	-	-	-	-	2	Rare
Rock bass	C	C	-	-	F	F	4	Few
Longear sunfish	-	-	-	-	F	-	1	Rare
Coarse fish								
Common white sucker	P	P	P	-	P	P	5	Predominant
Hog sucker	C	C	C	-	C	C	5	Common
Forage fish								
Common shiner	P	P	P	-	P	VC	5	1st in abundance
Blacknose dace	VC	A	A	F	A	VC	6	2nd in abundance
River chub	VC	VC	A	-	A	C	5	3rd in abundance
Creek chub	VC	VC	VC	-	VC	C	5	4th in abundance
Fathead minnow	C	F	F	-	-	F	4	Few
Johnny darter	VC	VC	C	F	A	VC	6	5th in abundance
Rainbow darter	C	VC	F	-	C	C	5	Common
Channel darter	F	-	-	-	-	-	1	Few
Brook stickleback	C	VC	F	C	C	C	6	Common
Michigan brook lamprey	-	C	C	-	C	F	4	Common
Pearl dace	-	C	F	-	VC	VC	4	6th in abundance
Rosyface shiner	-	VC	-	-	C	P	3	Common
Barred fantail	-	C	-	-	C	F	3	Few
Blackside darter	-	VC	F	-	C	F	4	Common
Least darter	-	R	-	-	-	-	1	Rare
Hornyhead chub	-	VC	-	-	VC	C	3	Common
Stonecat	-	F	-	-	F	-	2	Few
Western mudminnow	-	-	-	F	-	F	2	Few
Northern muddler	-	-	-	-	F	C	2	Few
Logperch	-	-	-	-	F	F	2	Few
Minnow hybrid (N. rubellus x N. cornutus)	-	F	-	-	F	-	2	Few
American brook lamprey	-	-	-	-	-	F	1	Few
Blacknose shiner	-	-	-	-	-	VC	1	Few
Brassy minnow	-	-	-	-	-	F	1	Few
Noxious fish								
Sea lamprey	-	-	C	-	-	-	1	Few
Total species	17	25	16	7	25	27		

Forage fish were rather abundant in this section. The six most abundant species were the common shiner, blacknose dace, river chub, creek chub, Johnny darter and pearl dace. The rosyface shiner was very abundant in the upper part of the section. The ammocoetes of three species of lampreys were recorded for this section, the sea lamprey (Petromyzon marinus) being the only parasitic form. The sea lamprey is confined to the Great Lakes during the harmful adult period.

The slimy muddler, (Cottus cognatus) was not taken in any section of the river, although a concentrated effort was made to obtain this species during each collection.

In addition to the regular fish collection, an attempt was made to determine the total fish populations of typical pools in Section III of the river. It was impossible to do this by conventional methods, and therefore dynamite was used. This operation was confined to two pools, picked at random, one (No. 1) about a quarter mile below the mouth of Houghton Creek and the other (No. 2) about two miles below. Dynamite was discharged in the two pools on August 1, and a repeat was made in pool Number 1 on August 14. Although a complete kill of an entire pool may not have been obtained in each case, it is believed that all the trout within the prescribed areas were collected. The fish recovered from the two pools are listed in Table 16.

The results of dynamiting gave a higher proportion of brown trout as compared to rainbows than was obtained by the general seining over the entire section. During seining, the majority of rainbow trout were taken in relatively fast water while most browns were taken in well shaded pools. This habitat difference would seem to account for the preponderance of browns in the dynamited pools. Since a large percentage of Section III is relatively fast water, the rainbow probably outnumbered the browns in the stream as a whole.

Table 16

Fish obtained from two typical pools of Section III of the Rifle River, by use of dynamite. Pool Number 1, located about one quarter mile below, and pool Number 2, located about two miles below the mouth of Houghton Creek.

Species	Pool Number 1 August 1, 1941		Pool Number 1 August 14, 1941		Pool Number 2 August 1, 1941	
	Number	Weight (ounces)	Number	Weight (ounces)	Number	Weight (ounces)
Brown trout	6	84	1	2.5	10	10.6
Rainbow trout	...	...	...	...	4	4.4
Perch	54	16	56	16	...	...
Rock bass	1	0.7	...	...	...	...
Common white sucker	55	235	21	70	9	282
Hog sucker	3	42	...	...	5	?
Creek chub	23	9	7	0.9	21	5.5
River chub	...	...	2	0.8	7	?
Hornyhead chub	25	10	18	6.7	3	2.0
Blacknose dace	5	0.6	...	...	6	?
Pearl dace	10	2.3	1	0.1	15	?
Finescale dace	...	...	...	...	1	?
Common shiner	201	37.5	158	20	33	4.8
Rosyface shiner	10	0.7	9	0.8	11	?
Logperch	3	0.9	1	0.4	1	?
Brook stickleback	...	...	...	...	1	?
Total	396	27 1/4 (pounds)	274	7 1/2 (pounds)	127	19 1/4 + (pounds)

The area of pool Number 1 was measured to be roughly 1/9 acre, and that of pool Number 2 to be 1/10 acre. From the data of Table 16, the weights of fish per acre in these two pools as of August 1, were calculated as follows:

Pool Number 1--Brown trout, 47 pounds per acre.

Pool Number 1--All fish, 245 pounds per acre.

Pool Number 2--Brown trout, 6 1/2 pounds per acre.

Pool Number 2--Rainbow trout, 2 1/2 pounds per acre.

Pool Number 2--All fish, 192 pounds per acre.

The average weight per acre of brown and rainbow trout was about 25 pounds for the two pools. The large size of the browns in pool Number 1 accounts for the relatively high figure (47 pounds) per acre. The large number of perch secured in pool Number 1 probably represents an accumulation from the outlet of Devoe Lake.

It would seem from these pool counts that only a small percentage of the total weight of fish in this part of the Rifle River is made up of trout. The two pools in question lie within private property and are fished very lightly. The proportion of trout in heavily fished pools might well be even less.

When pool Number 1 was re-blasted on August 14, it was found to contain a number and variety of fish nearly equal to that encountered two weeks previously. Trout were the important exception, for on the second occasion only one small brown was obtained. Perch, common shiners, horny-headed chubs, and common white suckers were the most prevalent of the re-invaders, presumably indicating marked population pressure among these species.

Rifle River summary and recommendations

From survey records it is obvious that the Rifle River may be logically divided into three sections, from the standpoint of temperature and the game fish fauna. This report thus far has been outlined on the basis of these three sections.

The upper section (III) supports brown and rainbow trout throughout extreme summer conditions, but reaches temperatures in excess of those considered as optimum for trout water. The maximum summer temperatures of this section are too warm for brook trout and eliminate the possibility of establishing this species, with the exception of the area immediately below the mouth of Houghton Creek. Water suitable for browns and rainbows extends for some distance into Section II. The central portion of Section II is marginal trout water, because of high temperatures. At the time of the survey it was judged that this zone of marginal trout water extended downstream about to Island Rapids (or Greenwood Rapids). Below this point, the stream is predominantly populated with warm-water fish, and although supporting trout at the mouths of cold tributaries, it is much better adapted to carry smallmouth and rock bass. Since trout are preferred by the majority of stream anglers, the following improvement suggestions are primarily in the interest of trout habitat and an extension of suitable trout water downstream through Section II.

1. It has been found that the outlet of Devoe Lake contributes a considerable volumeof warm water to the headwaters of the river, while the water flowing into Devoe Lake through Gamble Creek remains at a moderately low temperature throughout the summer. The distance from the mouth of Gamble Creek to the outlet of Devoe Lake is about 1,900 feet (see Figure 7).

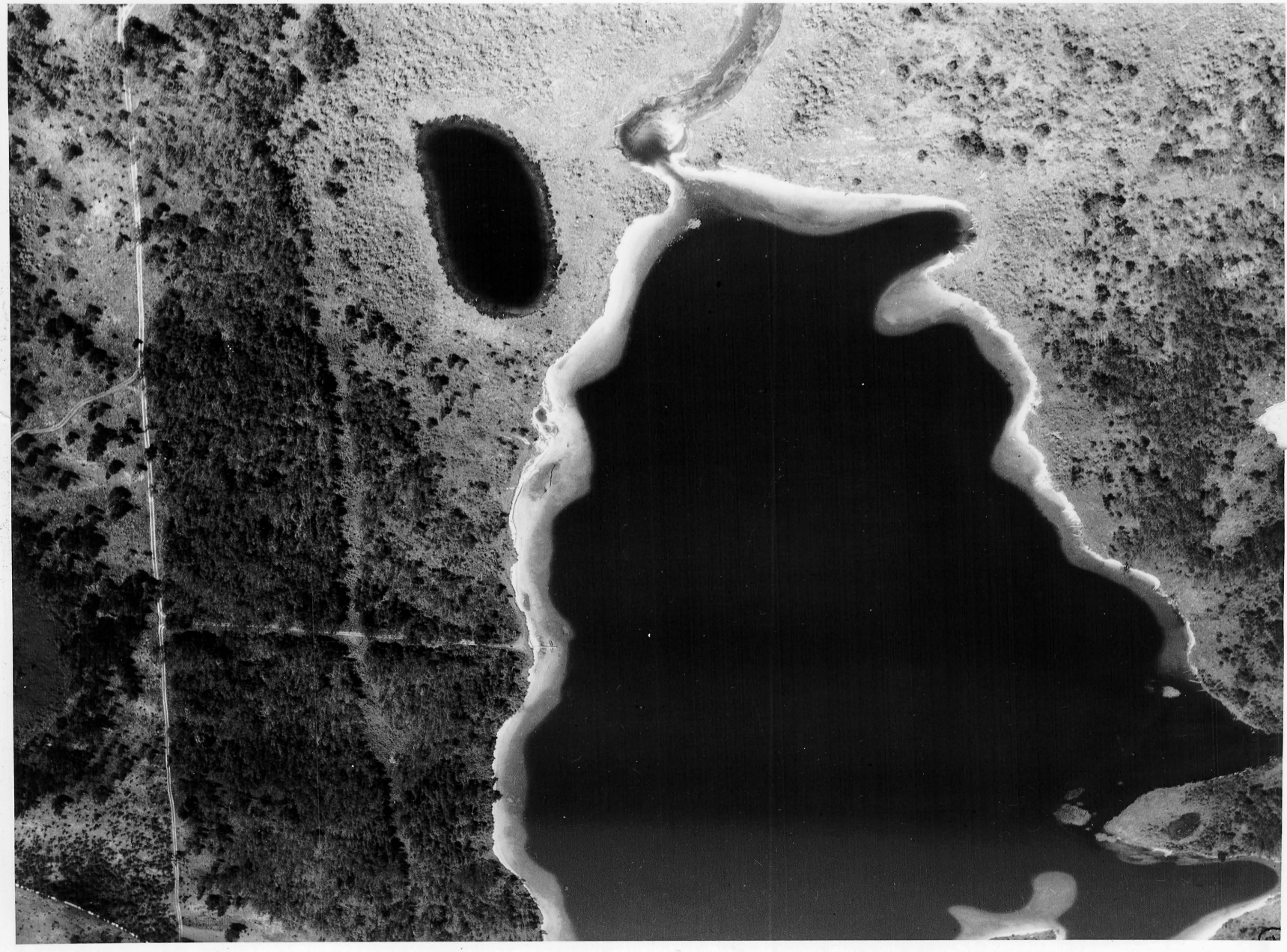

Figure 7. The outlet end of Devoe Lake, with the mouth of Gamble Creek in the upper left corner. Photo from 3,000 feet.

A diversion of Gamble Creek around the lake to the river below the dam would reduce temperatures of the Rifle, below its confluence with the Houghton, probably to the extent of about five to six degrees. The actual mileage of stream which would be affected in reduced temperature by this diversion is not known, but certain predicitions can be made through an interpretation of the temperature data given in Figure 3 and Table 7. It is believed that water reduced five degrees in temperature at the junction of Houghton Creek in extremely warm weather would directly affect water temperatures for some distance downstream. A gradual increase in temperature below Houghton Creek would still occur, but the maximum might possibly remain several degrees below 80 degrees F., down to Iron Bridge Rapids and into Section II. Therefore, it might be possible to convert some of the marginal portion of Section II into year-round trout water, especially if other stream improvement methods were also employed along sections III and II.

Another possibility of lowering the water temperature of the Rifle River below Devoe Lake would be by the use of a siphon or outlet pipe installed so as to draw cold sub-surface water from the lake. This type of installation has not been used to any appreciable extent in trout stream improvement, but the desired results have been observed in instances where power companies draw lower strata of water from impoundments. The cost involved in constructing a conduit from the bottom of the lake to the outlet is not known, but the suggestion is offered as an alternative to the diversion canal. Possibly a relocation of the Devoe Lake dam, at such time in the future when the dam requires rebuilding, would make the installation of the conduit more feasible. Some of the advantages and

disadvantages of the siphon would be:

a. Better water level regulation in the lake, perhaps possible.

b. Permit a continuance of the natural run of spawning brown trout from Devoe Lake to Gamble Creek.

c. Might open the lake to the larger rainbow trout of the Rifle River.

d. A constant drain of the cold water from near the bottom of the lake might extend the depth of the warm surface water, to the detriment of trout in the lake.

e. The siphon might involve considerable cost in upkeep.

2. It is obvious that the river with the exception of a few areas, is much in need of pool improvement. In many portions the river has spread over a wide area, thus exposing a large surface of the water to the heating action of sun and air. The area just below the Section 22-27 bridge (in T. 23 N., R. 3 E.) should be narrowed down in many places by deflectors and other devices. Records show that the water in this area is subject to a very rapid temperature rise on warm, bright days. This area should receive first attention. Improvements should be continued downstream at various intervals through Selkirk to the M-55 bridge. The area from M-55 bridge to the State Police Cabin has a moderate number of pools, but is in need of improvements to reduce the width of the stream. The area from the State Police Cabin to the Iron Bridge has adequate cover and a good proportion of pools and riffles. Improvements in this area should be confined to erosion control. The area from Iron Bridge to Greenwood bridge has a number of badly eroded banks (see Figure 8) which should be corrected. Any improvement devices which will tend to stabilize the substrata and produce permanent pools should be used in this area.

Should improvement devices extend the area of trout water, by reduced water temperature, downstream beyond the Greenwood bridge, additional improvements should be installed to cover the area affected. It would be difficult to install permanent improvement devices below the mouth of Bear Creek as the river from here down is subject to heavy floods.

Figure 8. Erosion in Section II.

3. Stocking. At the time of the survey a large part of the river from the Iron bridge to the mouth of Houghton Creek was well populated with yearling rainbow trout which ranged in size from 3.8 to 8.0 inches. About 25 percent of these fish were of legal size during the latter part of the summer, and the remainder should have obtained legal length by the spring of 1942. It is believed that the small rainbows were present in sufficient numbers to meet the maximum carrying capacity of the stream.

The origin of the large number of small rainbows along the Rifle during 1941 could not be determined definitely. A total of 65,625 four-months-old hatchery rainbows were planted during 1940. Most rainbows collected on the river during 1941 were yearling (same year-class as those in the planting); no young of 1941 were collected from the river, and only 14 rainbows older than the 1940 year-class were taken. Rainbows taken by angling during the first few days of the 1941 fishing season were mostly fish older than yearlings. After about June 18, anglers reported taking the smaller rainbows (yearlings) in such numbers as to be a nuisance, especially in the Selkirk area. The fact that there was an abundance of yearling rainbows in the Rifle during 1941 following heavy plantings in 1940 could be explainable either as good survival of hatchery fish or a coincidence between planting and abundant natural reproduction. The hatchery fish were not marked and thus could not be positively identified. In numerous experiments where hatchery fingerling trout have been marked, the rate of return to anglers has been low (Shetter, 1940; Westerman and Hazzard, 1945). Judging from these experimental results it is considered unlikely that the yearling rainbows in the Rifle were mostly of hatchery origin. Their uniform distribution along the river would also indicate as unlikely a hatchery origin.

During 1942, 1943 and 1944 the Rifle River was stocked with hatchery fingerling rainbows. Starting with 1945 the plantings have been of legal-sized rainbows and browns. The change in the Department's policy to legal-sized fish was made because of poor returns in experimental plantings of marked fingerlings.

4. There were inquiries as to the feasibility of installing a dam in Section I in the vicinity of Omer. It is true that the stream in this area is in need of more pools, but a reservoir formed by a dam probably would soon be made non-functional by filling because in this section the river carries an exceptionally heavy load of sand and silt, (See Figure 9). Moreover, an effective dam doubtless would stop upstream migrations of fish unless fish ways were provided. Since there was a lake-run of rainbow trout at one time, and with evidence that some adult rainbows still run up the Rifle River, it seems advisable that this migration be encouraged as much as possible. Sucker netting, although limited to a few fishermen, is also worthy of consideration in this connection.

The tributaries

Tributaries definitely have physical, chemical, and biological influences on streams. Such vital factors as temperature, pollution, fish food supply, and reproduction are often affected by tributaries; besides, these smaller streams may themselves have fishery resources of considerable importance. Hence, when setting up a management program for a river, it is highly desirable to know conditions in the tributaries as well as in the main stream.

The stream identification system used in this report follows one formulated by the New York Conservation Department. By this system each tributary is given a number in addition to the name or names it possesses.

Figure 9. Delta built up at the mouth of the Rifle River. Note large sand deposits. Photo from elevation of 800 feet.

The first tributary above the mouth of the main stream is designated Number 1, the second, Number 2, etc. Divisions of tributaries are handled similarly. For instance, Barber Creek enters Bixby Creek, which in turn is the third tributary to Houghton Creek, the twenty second tributary of the Rifle River up from the mouth. Thus the number of Barber Creek will be 1-3-22, while Bixby Creek will be numbered 3-22. Where tributaries flow into a lake or reservoir these are numbered in clockwise order starting to the left of the outlet. Hence the first tributary to the left of the outlet would be 1 and the next 2. Gamble Creek feeds Devoe Lake whose outlet forms the Rifle River; thus Gamble Creek is designated tributary Number 1 of Devoe Lake.

A numbering system such as that outlined above tends to prevent confusion in locating streams that either have several names or no name at all.

Tributary Number 1
(Saverine Creek)

Saverine Creek joins the Rifle River between Omer and Saginaw Bay. Its origin is about 1 1/2 miles northeast of Sterling from where it flows approximately 8 1/2 miles due east to its confluence with the Rifle River two miles below the village of Omer. The stream lies entirely within the old Saginaw Basin and has very little fall from source to mouth. About two miles of the lower portion of the stream was dredged in 1915 for drainage purposes. It has a normal summer flow of less than one c.f.s., but is subject to a heavy run-off after rains, as a large portion of the land within the drainage area is cultivated. Although this creek was reported as having contained brook trout at one time, high temperatures obtained at the time of the survey indicate that marked physical and biological changes have taken place. At 4:00 p.m. on June 30, 1941 an air temperature of 89 degrees F., and a water temperature of 82 degrees F., were recorded on this stream about two miles below its source.

Management suggestions

The temperature of this stream shows that it is not suited for trout. Due to its small size, the stream is of no value for warm-water game fish. Its classification should permit the collection of minnows.

Tributary No. 2
(Townline Creek)

Townline Creek lies in T. 19 N., R. 4 E., S. 1. There are about six linear miles of stream including the tributaries. Springs and surface drainage form the water supply. The volume of the stream on June 30, 1941 at a point a quarter mile above the mouth was 1.3 c.f.s., with a velocity of 0.7 f.s. With the exception of a small area of open water in the lower section, the stream is heavily brushed. The bottom type is predominately sand with a few gravel riffles. Cover is rather good throughout the length of the stream.

The stream supports a good volume and number of fish food organisms. Amphipods (scuds) were the predominant organism and constituted the bulk of the food. A few snails, mayflies, dragon flies, midges and alder flies were also found.

Table 17

Water and air temperatures taken near the upper ends of Townline Creek tributaries, June 30, 1941.

Time 12:45 p.m. to 1:30 p.m.			
Tributary	1-2	2	2-2
Air temperature	80°	80°	80°
Water temperature	69°	68°	69°

Table 18

Fish collected at two stations in Townline Creek.

Species	At mouth, June 17, 1941 Number	One-half mile above mouth, June 30, 1941 Number
Rainbow trout	1	1
Common sucker	1	...
Creek chub	...	17
Blacknose dace	4	17
Fathead minnow	...	1
Brassy minnow	...	7
Common shiner	1	...
Rosyface shiner	4	...
Johnny darter	3	...
Blackside darter	2	...
Brook stickleback	...	6
Brook lamprey (ammocoete)	1	...

Intensive seining produced only three small rainbow trout, although temperatures prevailing at the time were within the range of trout. Observations along the lower part of the stream were made to determine the presence of larger trout, but no fish over 7 inches were seen. From the number of forage fish present in the fish collections, it would seem that the stream may be marginal for trout.

Townline Creek produced some good trout fishing up until about five years ago, but since then it has produced only a few fish each spring. Brook trout were formerly taken, but in recent years they have been replaced by brown and rainbow trout. No explanation has been offered for the apparent decline of trout. Although the limited temperature records lie within the range of trout it is possible that critical temperatures sometimes occur. The apparent disappearance of brook trout from Townline Creek would indicate that certain environmental changes have occurred over the last six or seven years. The continued stocking with rainbow trout (15,000 5- and 6-month rainbow trout between 1937 and 1940) might also have produced a competetive factor to bring about this condition. It is questionable if the repeated stocking of rainbow trout has produced results that merit the

continuation of the past stocking policy. It is believed that Townline Creek is too small to produce good rainbow trout fishing. It is thought that this stream should be designated as marginal trout water and further stocking discontinued. Little can be done regarding the control of temperature as the stream is well shaded throughout most of its length.

Tributary No. 3

This stream has a flow of less than 0.5 c.f.s. and therefore has little significance. The brook is located in T. 19 N., R. 4 E., S. 2 and is about two miles long. It is from one to three feet wide and its depth ranges from two inches to one foot over substrata of rubble and gravel. Temperatures at 4:30 p.m. on June 19, 1941 were air, 85 degrees and water, 63 degrees.

Tributary No. 4

(Parmalee Creek)

Parmalee Creek, (T. 19 N., R. 4 E., S. 6) is about one mile in length and carries a very small volume of water. No investigations were made due to the small volume of flow. It has been reported that this stream contains a number of small brook trout.

Tributary No. 5

(Bear Creek)

The origin of Bear Creek lies to the east of M-76, in Section 34. It flows in an easterly direction for about three miles to its junction with the Rifle River in T. 20 N., R. 3 E., S. 25. The Upper portion of this stream drains a large swamp and has been dredged to facilitate more rapid run-off. A number of springs add to the volume about midway along the course of the stream. The following volume and velocity measurements were secured at the mouth:

	June 20	July 2
Volume	3.4 c.f.s.	2.8 c.f.s.
Velocity	2.8 f.s.	2.1 f.s.

The upper portion of this stream is about 6 to 8 feet wide and from 6 inches to 2 feet in depth. There is little flow in the upper section and the water appears to be stagnant. At a point midway between the mouth and the origin the velocity and volume are decidedly changed by a break in the topography and the addition of spring water. The lower part of the stream flows through a heavy growth of cedar which provides an abundance of cover and shade.

Table 19

Chemistry and temperature data from two stations on Bear Creek

	At mouth	Upper portion
Date	July 2, 1941	July 2, 1941
Time	Noon	9:30 a.m.
pH	8.0	7.6
Dissolved oxygen	9.8	2.1
Phenolphthalein	4.0	0.0
Methyl orange	98.0	92.0
Air temperature	86°	64°
Water temperature	57°	65°

The above data show some marked variations in the chemistry and temperature of the water from source to mouth of Bear Creek. The low oxygen content of water in the upper section is below that required by trout. The temperature of the upper part may reach the critical point during extreme warm weather, but the cold springs feeding the stream below that section reduce the temperature to a point well below the maximum limits of brook trout.

The volume and number of fish food organisms in the lower section was found to be good. Amphipods and caddis larvae were numerous while other forms such as mayflies, stone flies, beetles, midges, black flies and snails were present in lesser quantities. These forms were also present in the upper portion, but the total volume of organisms here was considerably increased by dragon fly nymphs.

Brook and brown trout were the only species of game fish in Bear Creek. Brook trout were more abundant than browns, the ratio being about 4 to 1. No forage fish were taken in the lower part of the stream, but a number of minnows and other forage fish were found in the dredged portion.

Table 20
Growth rate of brook and brown trout collected from Bear Creek, 1941.

	Age group		
	I	II	III
Brook trout			
Number	4	3	2
Size range	4.0-4.9	5.1-7.6	8.3-9.1
Brown trout			
Number	2	1	0
Size range	4.3-5.0	8.1	

There are no records of fish being planted in Bear Creek for six years prior to the survey. Bear Creek has apparently remained fairly productive over a considerable period of time. Trails along the lower portion of the stream indicate that this section is fished moderately heavy. The chemical and temperature data show that only the lower portion of this stream is suitable for trout. Conditions at present appear favorable for natural reproduction and therefore no need for management is indicated.

Tributary No. 6

(Wells Creek)

The origin of Wells Creek lies to the west of M-76 in T. 20 N., R. 3 E., S. 32. It flows northeast, crossing M-76 about three-quarters of a mile below the village of Alger to Section 14, thence in a southeasterly direction

to the mouth in T. 20 N., R. 3 E., S. 19, a total distance of about 9 1/2 miles. Springs and runoff constitute the water supply. A beaver dam in Section 29 previously impounded a large volume of water and undoubtedly altered the physical and chemical conditions of the water below. The dam was found broken out prior to the arrival of the survey party on July 3. The water level of the pond had receded forming pockets of stagnant water in which dead northern pike, pumpkinseed sunfish and suckers were found. It is believed that the dam was torn out about two days previous to our discovery. The volume of flow at the outlet was found to be 0.6 c.f.s. This may be in excess of the normal flow at this point of the stream as the pond still seemed to be receding. In Section 15, about midway along the course of the stream, the volume was 1.3 c.f.s. and the velocity 1.5 f.s.; the stream increases little in volume from this point to the mouth. The average velocity probably would be nearer 1 f.s. rather than the 1.5 f.s. recorded for Section 15.

The pools in the lower portion of the creek are 12 to 14 feet wide and 4 to 18 inches deep. The bottom types are gravel and rubble, with some sand. The shade is very good and cover about average. The central section has pools 5 to 12 feet wide and 8 inches to 3 1/2 feet in depth. The bottom types are sand and silt to muck in pools and gravel to rubble in riffles. The cover is very good, but the stream becomes more open in Sections 14 to 15 and above. The upper portion has pools 3 to 5 feet wide and 6 to 18 inches deep. Much of this portion of the stream is brushed over with good cover. Sand and silt predominate.

A few submerged plants were found in the stream. Water cress, (Nasturtium officinale) stiff water crowfoot (Ranunculus longirostris) and leafy pondweed (Potamogeton epihydrus) were confined to small beds in the

central to upper section of the stream. The beaver pond was filled with decomposing flat-stemmed pondweed (P. zosteriformis) and floating pondweed (P. natans).

The stream produces a small number and volume of fish food organisms. There were a few snails, clams, mayflies, dragon flies, neuroptera and stone flies. Large caddis larvae were the most abundant form found. The riffles in the lower portion of the stream were about average in richness but the stream as a whole would be classed as poor.

Table 21
Chemistry and temperature data from three stations on Wells Creek

	At mouth	In middle section	At beaver dam outlet
Date	June 23, 1941	July 3, 1941	July 3, 1941
Time	10:00 a.m.	11:00 a.m.	4:30 p.m.
pH	8.0	7.9	7.4
Dissolved oxygen	8.6	8.3	6.5
Phenolphthalein	3.0	0.0	0.0
Methyl orange	153.0	197.0	184.0
Air temperature	77°	68°	86°
Water temperature	69°	59.5°	74°

Wells Creek has a sufficient quantity of oxygen for game fish throughout its length. The quantity appears to be increased through the central and lower sections of the stream. Carbon dioxide was present in the upper to central section on July 3 but absent at the mouth on June 23. The presence of carbon dioxide may have been due to the decomposition of organic matter in the beaver pond in Section 29. Methyl orange alkalinity ranged from 153 to 197. The 153 p.p.m. obtained on June 23 was lower than later records and is thought to have been due to the influence of surface water. Although this stream was not observed during extremely warm weather, it is believed that maximum daily temperature would raise the water to the high 70's. Water temperatures will be discussed further under management suggestions.

Table 22

Fish collected or observed at three stations in Wells Creek, July 3, 1941. Of species collected A = abundant, VC = very common, C = common, F = few, Ob. = observed but not collected.

Species	Lower section	Central section	Upper section (Beaver dam)
Bluegill	...	F	Ob.
Northern pike	F	F	Ob.
Pumpkinseed sunfish	VC	VC	Ob.
Rock bass	F	...	Ob.
Common sucker	VC	...	...
Creek chub	VC	...	...
Hornyhead chub	C	...	...
Blacknose dace	VC	...	...
Pearl dace	F	F	...
Common shiner	A	...	...
Golden shiner	F	...	...
Mudminnow	C	VC	Ob.
Johnny darter	A	...	...
Barred fantail	C	...	...
Rainbow darter	VC	...	...
Blackside darter	VC	...	...
Black chin shiner	...	F	...
Muddler	...	F	...
Brook stickleback	...	C	...
Black bullhead	...	A	Ob.

Game fish in this stream were entirely warm water forms. Northern pike, pumpkinseed sunfish, bluegills, and rock bass were taken, and smallmouth bass have been reported. The pumpkinseed sunfish is the predominant game fish and the common shiner the most abundant forage fish. The large number of minnows and the presence of warm-water game fish are significant in showing the warm-water characteristics of the stream.

Wells Creek was at one time considered a good brook trout stream, but in the past 10 years trout have apparently been replaced by warm-water forms. In recent years catches of 2-pound smallmouth bass have been recorded. It was reported by residents of Alger that large northern pike were speared in the headwaters many years ago. Unless the stream was considerably larger than it is at present, these fish were probably spawning migrants from the river, as the lowland in the upper section of the stream would provide excellent spawning areas.

This stream has been known to support a relatively large population of beaver. It is possible that the extermination of brook trout may have been brought about by the invasion of these animals. Beaver had been in the lower portion of the creek for the past 7 years and have made numerous dams, 5 of which were removed from the lower 2 miles of stream in the spring of 1941. It is possible that the beaver had been eliminated from this area, as no signs of recent beaver work were observed in traversing a large portion of the stream. If the beaver were indirectly responsible for the extermination of trout by increasing water temperatures, it is possible that the removal of these animals may result in lower water temperatures, which are within the range for trout.

Management suggestions

At the present time the size of the stream does not merit any form of improvement for the species of game fish it contains. Since there is a possibility of a decrease in water temperature due to the removal of beaver dams, it is suggested that temperatures be taken during maximum air temperatures in the summer of 1942. Should water temperatures, obtained during critical periods fall within the range of brown trout, it is suggested that 1,200 fingerlings be planted in the spring of 1943. This number was determined from Embody's stocking table. If fingerlings are planted, later investigations should be made to determine the returns from stocking and whether stocking should be carried on or discontinued.

Tributary Number 7

(Mansfield Creek)

The sources of Mansfield Creek lie in Ogemaw County but the main stream crosses over into Arenac County near the mouth. The east branch

is formed in an intensively cultivated area about two miles south of Prescott; Feeding Ground Lake is the origin of the north branch. The creek has a total length of about 11 miles, including tributaries. The water supply is derived from Feeding Ground Lake, runoff, springs, flow from drillings for oil, and a salt well.

The salt well in Section 4 was contributing about 50 gallons per minute to the east branch, having killed most of the trees and shrubs along the banks, and shade and cover on the main stream have also suffered from the chloride. Sand is the predominant bottom type in the east branch, but gravel and rubble also are present,

The north branch contributes about three-fourths of the total volume of flow in Mansfield Creek. This branch is brushy and flows through a heavily forested area. There are few good pools. The bottom types are sand, gravel, and rubble. Velocity of flow in the two branches is less than 1 f.s., but below their junction about 1.5 f.s. is attained. The normal summer volume of flow at the mouth of the main stream is about 8 c.f.s.

A few aquatic plants were found in the outlet of Feeding Ground Lake and in one tributary. The main stream and east branch were completely devoid of vegetation, although dense beds of filamentous algae were present at the mouth of the creek.

The north branch and its tributaries were found rather productive of fish food organisms. Scuds and caddis larvae were the dominant organisms. Leeches, mayflies, midges, dragon flies, and beetles also were found. The east branch and the main stream are very poor in productivity. Only two forms of diptera larvae were able to withstand the contamination from salt brine, although a collection at the mouth produced a few midges, mayflies, and diptera larvae.

Table 23
Chemistry and temperature data from three stations on Mansfield Creek

	Mouth	East branch	Outlet of Feeding Ground Lake
Date	June 24, 1941	July 7, 1941	July 7, 1941
Time	1:00 p.m.	Noon	10:00 a.m.
pH	8.2	7.7	7.9
Dissolved oxygen	10.3	7.3	8.0
Phenolphthalein	9.0	0.0	0.0
Methly orange	144.0	109.0	171.0
Air temperature	83°	...	75°
Water temperature	70°	...	72°

The chemistry tests run on water from the east branch and the main stream may have been influenced by the salt brine pollution. Tests for chloride content were run by a member of the Michigan Stream Control Commissions technical staff and the results are presented in Table 24. This pollutant and the effect on Mansfield Creek will be discussed more fully in the section "Pollution in the Rifle River and its tributaries."

Table 24
Results of tests for chloride content run on Mansfield Creek by a field man of the Michigan Stream Control Commission

Date	Sampling station at Mills - Richland Twp. line (chlorides in p.p.m. as Cl)	Sampling station in N.W., S.W. Section 4 (chlorides in p.p.m. as Cl)
April 10, 1940	2,700	
May 21, 1940	5,940	
June 18, 1940	673	
June 20, 1940	30,700	
June 24, 1940	13,800	
July 10, 1940	26,700	
July 19, 1940	16,600	
August 6, 1940	22,100	
September 3, 1940	29,000	
September 10, 1940	37,600	
March 14, 1941		17,500
April 9, 1941	1,900	
April 18, 1941		6,000

No fish were found in the main stream or the east branch. Brown trout were collected in a tributary to the north branch which also contained mudminnows, sticklebacks, barred fantails and mud pickerel. Brook trout were also observed in Spring Creek, a tributary to the north branch.

Mansfield Creek was considered one of the better brook trout streams of Ogemaw County at one time, and it appears that the decline of trout was correlated with the development of the Mansfield oil field. This development started about 8 or 9 years ago and was apparently closely followed by a decline of trout.

Management suggestions

Temperatures of the larger part of Mansfield Creek probably remain within the maximum limit for trout. On June 24 the water temperature at the mouth was 70 degrees as compared to 74 degrees for the Rifle River near this point. However, this favorable factor of temperature is considerably offset by the unfavorable factor of pollution, making much of the water unfit for trout or other species, and offering little hope for an early return to conditions that existed previous to oil field development. Nevertheless, it is suggested that immediate action be taken to seal the abandoned salt well in Section 31. Further checks should be made to determine if pollution from oil wells occurs and, if so, control measures should be provided and enforced. Later checks should follow to determine the ratio of re-population by fish food organisms. If stocking is contemplated, it ought not be practiced until the affected portions of the stream carry a number of organisms sufficient for the demands of an average fish population.

Tributary Number 8

(Silver Creek)

Silver Creek begins at the outlet of Long Lake in T. 21 N., R. 4 E., S. 1, but is intermittent until reaching T. 21 N., R. 4 E., S. 11. The stream is about 6 1/2 miles long, excluding the intermittent portion in the headwaters. It flows southwest almost its entire length, crossing M-70 in Section 27 and entering the Rifle River in Section 33, a short distance below Island Rapids. A large swamp southwest of Long Lake in Sections 11 and 12 is drained by the stream and forms the initial water supply in late summer, when the level of the lake recedes below the outlet.

A number of springs in Section 11 increase the water supply to a volume of 0.6 c.f.s. Springs and seepage add to this volume, and on reaching M-70 the stream flows about 4.2 c.f.s. At this point the velocity is about 1.5 feet per second. The volume of flow at the mouth was estimated as about 5.5 c.f.s. The stream below M-70 falls very rapidly, increasing its average velocity.

The lower section of the stream averages 4 to 10 feet in width and 4 inches to 2 1/2 feet in depth. The central section from M-70 to Section 11 averages 4 to 8 feet wide and 3 inches to 2 feet deep. The upper part in Sections 11 and 12 averages from 3 to 10 feet in width and 2 to 18 inches in depth.

A great variety of bottom types is found in this stream. The lower section has sand, gravel, rubble, clay, silt, and shelving rock. The bottom types of the central section consist of sand, gravel, rubble, hard-pan, and silt. The upper section has sand and gravel, with muc and silt deposits along the banks. Although the stream is heavily brushed, it is lacking in cover. Three new beaver dams were found in the central section but very little water was impounded behind any of them at the time of the investigation. There are relatively few holes in the lower and central

sections of the stream, and for the most part the stream is quite flat and shallow here, with depths averaging 4 to 8 inches. Gravel riffles suitable for spawning are confined to the central and upper sections. Although gravel riffles are found below M-70, the gravel is quite shallow and usually lies on a clay substratum. It is doubtful if this gravel is utilized for spawning.

Table 25

Chemistry and temperature data from two stations on Silver Creek

	Lower section mouth	Upper section Sections 11 and 14 road
Date	June 24, 1941	July 11, 1941
Time	11:00 a.m.	3:00 p.m.
pH	8.1	8.0
Dissolved oxygen	10.0	8.9
Phenolphthalein	4.0	0.0
Methyl orange	168.0	184.0
Air temperature	77°	69°
Water temperature	58°	59°

A maximum water temperature of 61 degrees was obtained in the lower section. On June 17, a temperature of 60 degrees was obtained at the mouth at 3:30 p.m., when the air temperature was 83 degrees. It is believed that temperatures in this stream probably never exceed 65 degrees throughout the summer.

A few small beds of stiffwater crowfoot and waterweed found in the upper and central sections of the stream were the only submerged aquatic plants recorded for the entire creek.

The stream produces a good volume and number of fish food organisms in the upper and central sections. The lower section is not as productive due to the large amount of clay bottom. Amphipods were the most abundant of all the organisms. Damsel and dragon fly nymphs, caddis larvae and

stratiomyiidae larvae (soldier flies) were rather numerous. A few immature mayflies, beetles, midges, and stone flies were also found. Crayfish were present, but limited in number.

Silver Creek contains brook, brown, and rainbow trout. All three species are found in the lower half of the stream, but only brook trout are present in the upper half. Fingerling brook trout were rather common in the upper and central sections, but could not be found in the lower section.

Table 26

The growth-rate of trout collected from Silver Creek in 1941

Age Group	0	I	II	III
Brook trout				
Number	6	4	6	2
Size range	2.7 - 3.7	3.5 - 7.6	7.2 - 8.1	8.6 - 9.9
Brown trout				
Number	0	5	0	0
Size range	...	6.1 - 8.1	...	...
Rainbow trout				
Number	0	2	0	1
Size range	...	5.7 - 8.3	...	10.5

Table 27

Stocking records for Silver Creek, 1939-40

Year	Species	Number	Age
1939	Brook trout	525	6-month
1939	Brown trout	1,450	6-month
1940	Brook trout	502	7-month

Forage fish were not common in this stream, and were limited to the upper portions. Creek chubs were the predominant form. Johnny darters and mudminnows were also present but less abundant. Four small northern pike and one common sucker were also taken in the upper section. The

northern pike probably came from Long Lake through the outlet, and two carp that were observed in the central section of the stream probably came from the same source.

This was supposed to have been one of the best fishing streams in the southern part of Ogemaw County many years ago. It was reported that at that time the catch was composed of entirely brook trout, but in recent years brown trout have come in and still more recently rainbow trout. The stream is fished mostly by local residents except in the lower part. A 3 1/4-pound brook trout was taken from the headwaters of this creek in the spring of 1941. This stream was once used for logging and probably carried a greater volume of water at that time than at present. It was said that in the lumbering days a logger made a standing offer of a new suit of clothes to the man who could ride a log from the M-70 bridge to the mouth of the creek.

Management suggestions

Silver Creek supports three species of trout, but it is believed better suited for brook trout since natural reproduction of this species is known to occur and water temperatures probably do not exceed 65 degrees. It is thought that natural reproduction of brook trout in the central and upper sections of the stream is sufficient to meet the carrying capacity, and further stocking should not be necessary. However, stocking of legal size fish in the lower and central sections for early spring fishing might be done.

Further investigations should be made to determine the number of beaver dams in the stream and the effect they have on water temperatures. If there is an appreciable rise in temperature because of the dams, immediate action should be taken to remove some of them.

Stream improvement devices to increase depth and provide cover should be installed in the central and lower sections of the stream.

Tributary Number 9

This tributary lies in T. 21 N., R. 3 E., S. 28 and 29, and is about 1 1/2 miles in length. The stream is very small, flowing approximately 100 gallons per minute. It contains a few small brook trout and an occasional rainbow. A maximum temperature of 67.5 degrees was obtained at noon on July 8, 1941. It is of little value either as a fishing stream or in lowering the water temperature of the Rifle River.

Tributary Number 10

Tributary Number 10 lies about a mile to the north of Tributary Number 9 and has similar physical characteristics. The stream was not investigated due to its small size.

Tributary Number 11

(Harwood Creek)

Harwood Creek flows approximately 80 gallons per minute and is about a mile long. It lies in T. 21 N., R. 3 E., S. 19 and 20. Chemistry and temperature data on this stream are given in Table 28.

Table 28
Chemistry and temperature data from Harwood Creek.

Date	July 8, 1941
Time	5:00 p.m.
pH	7.6
Dissolved oxygen	9.2
Phenolphthalein	0.0
Methyl orange	76.0
Air temperature	75°
Water temperature	49°

A long deep pool of the Rifle River below the mouth of Harwood Creek has a reputation of producing some fine trout. The cold water coming in from this tributary is probably responsible for this condition. A few small brook trout are found in Harwood Creek, but it has virtually no value as a fishing stream.

Tributary Number 12

(Eddy Creek)

Eddy Creek lies in the south central part of Ogemaw County. The short main stream is formed by two branches, North Eddy Creek and South Eddy Creek, about 1 1/4 miles above the mouth. The junction of Eddy Creek with the Rifle River lies in T. 21 N., R. 3 E., S. 21. Eddy Creek and its two branches constitute about 13 miles of stream. The north branch is approximately 5 1/2 miles long and the south branch 6 1/2 miles. Each branch begins about one mile to the east of M-76 and about three to four miles below the city of West Branch.

North Eddy Creek has been reduced in length in the upper section as the result of a diversion at the oil refinery below West Branch. The headwaters of this stream have been diverted to the West Branch of the Rifle River and is now known as the C. K. Eddy Creek. The diversion reduced the original length of the north branch about 6 miles, an intermittent portion existing below the refinery.

At the time of investigation the main stream was flowing approximately 5 1/2 c.f.s. Velocities ranged between 1.5 and 1.7 f.s. South Eddy Creek, at the extreme lower end, flows approximately 2.9 c.f.s., with a velocity of 1.7 f.s. The volume and velocity of the north branch is slightly less than that recorded for the south branch.

The stream is fed largely by springs, but apparently is subject to a considerable quantity of run-off in the headwaters during heavy rains.

It is well shaded, but open enough to permit some fly-casting. Some open water is found in the lower 2 miles of the south branch, but above this point it is brushy. The north branch is heavily brushed throughout.

The bottom types of the main stream consist largely of gravel and rubble. Sand, silt and muck are also present but limited to relatively

small areas. The stream has a large number of good gravel riffles but lacks adequate pools. The usual pool-riffle relationship consists of scouring basins 8 to 12 inches deep, 15 to 30 feet long and 10 to 15 feet wide, separated by shallow gravel riffles. A few cut banks, submerged plants, and brush constitute the bulk of the cover, which in general would be considered poor to average.

The bottom types in the lower section of the south branch are similar to those found in the main stream. Pools average from 5 to 6 feet in width and 8 to 12 inches in depth. Above this area sand, silt, and muck deposits are more abundant. Three beaver dams were present in the central section of the south branch. Beaver did not seem to be inhabiting this area, although approximately five acres of water was impounded by one dam.

The north branch is a typical brush stream flowing through a dense growth of cedar and alder. Sand predominates, but an adequate quantity of gravel is present for spawning. The entire stream has excellent cover. Brush, cut banks and logs are found throughout the length of the stream. Pools from 1 to 3 feet in depth are usually associated with logs and snags. Two beaver dams were found in this branch, one lying in the upper section and the other in the central section. The upper dam was of recent origin and it was reported that beaver were active in the area.

Results of chemical analyses taken at the mouth of Eddy Creek were similar to the results obtained elsewhere on this stream. No analyses were made at the impoundments formed by the beaver dams, but several brook trout were taken from one old beaver pond on the south branch, showing that conditions for fish were favorable there at that time.

Table 29
Chemistry and temperature data from Eddy Creek and its branches.

	Main stream	South Eddy creek below beaver pond	South Eddy 1/4 mile below beaver pond	North Eddy Creek T. 21 N., R. 2 E., S. 2
Date	June 25, 1941	July 9, 1941	July 10, 1941	July 10, 1941
Time	12:00 noon	3:30 p.m.	9:45 a.m.	10:00 a.m.
pH	8.1	7.8	7.9	7.4
Dissolved oxygen	9.0	6.4	7.8	2.9
Phenolphthalein	4.0	0.0	0.0	0.0
Methyl orange	125.0	118.0	112.0	138.0
Air temperature	87°	77°	74°	84°
Water temperature	71°	65°	58°	61°

A series of temperatures were taken on Eddy Creek and its branches and the readings are presented in the following table.

Table 30.
Temperatures of Eddy Creek and its branches, and one reading from the Rifle River.

Location	Date	Time	Air temperature	Water temperature	Weather
Mouth Eddy Creek	July 8, 1941	3:00 p.m.	76°	68°	Clear
Mouth Eddy Creek	June 25, 1941	2:30 p.m.	87°	71°	Clear
Rifle River	June 25, 1941	2:30 p.m.	87°	76.5°	Clear
Lower section South Branch	July 9, 1941	1:00 p.m.	82°	66°	Clear
Lower section North Branch	July 9, 1941	1:00 p.m.	82°	59°	Clear
Central section South Branch just below beaver dam	July 9, 1941	10:00 a.m.	74°	58°	Clear
Central section South Branch 1/4 mile below beaver dam	July 9, 1941	3:00 p.m.	77°	65°	Clear

A maximum temperature of 71 degrees was obtained at the mouth of the main stream at 2:30 p.m. on June 25, with an air temperature of 87 degrees. At the same time the temperature of the Rifle River was 76.5°, about 5 1/2 degrees above that of Eddy Creek. The temperature of the two tributaries

at their junction was: south branch 66 degrees, north branch 59 degrees. It is obvious that the north branch is low in temperature and remains about 7 degrees colder than the south branch during the summer. Although maximum water temperatures for the area were not obtained at critical periods, it is believed that sufficient data were collected to make the following predictions. Water temperatures in the lower portion of the main stream probably reach a maximum 75 degrees to 77 degrees during critical warm periods. South Eddy Creek may reach a maximum of 71 degrees to 73 degrees in the lower portions, while similar areas in the north branch would probably remain under 65 degrees.

Dense beds of submerged plants are found in the lower portions of the main stream. Stiff water crowfoot and waterweed were quite common in this area. The beaver ponds contained water milfoil (Myriophyllum sp.), waterweed, musk grass, and pondweed (Potamogeton tenuifolius), and big duckweed, (Spirodela polyrhiza) covered the lower end of the pond.

The bottom fauna of the main stream is considerably above average in quantity. The south branch is also quite productive of fish food organisms in the rubble areas in the lower section, but reduced in the brushy part of the stream above this section. Insect forms in the north branch are limited in number in the lower portion but are plentiful in the meadow area in the headwaters.

Amphipods, caddis larvae, mayfly larvae and helgramites were found mostly in rubble areas of the main stream and its branches. In sand areas amphipods, midge larvae and other diptera were the most abundant forms. On the whole, the stream is considered above average in richness.

The following table indicates the relative abundance of the fish food organisms.

Table 31

Relative abundance of fish food organisms in Eddy Creek and its branches.

	Main stream	South branch	North Branch
Ephemeroptera	Common	Abundant	Few
Anisoptera	Common	Common	Few
Trichoptera	Very abundant	Very abundant	Few
Chironomidae	Few	Few	Common
Other Diptera	Few	Few	Common
Neuroptera	Common	Common	Few
Plecoptera	Few	Common	...
Amphipoda	Very abundant	Very abundant	Common
Gastropoda	Few	Few	Few
Crayfish	Few	Few	Few

Three species of trout were collected in the main stream. The brook trout was the dominant species, followed by rainbow trout and brown trout in order of abundance. Fingerlings of each species were taken in considerable numbers. Legal rainbow trout were not taken, although sub-legal fish were quite abundant. Legal brown and brook trout were present, but were greatly outnumbered by sub-legal fish. Although the stream supports a relatively large number of fish, they are fingerlings or sub-legal and it would appear that either the fishing pressure is sufficient to keep the legal fish reduced in number or, as they reach larger size move into the Rifle River. It is conceivable that a combination of the above factors may be responsible, since suitable cover is limited and the stream is fished rather heavily.

The population of game fish in the south branch is quite similar to that found in the main stream except that brook trout are more abundant here. Results of netting in the beaver pond indicated that the impounded water contained only a few legal brook trout. The only game fish found in the north branch were brook trout. Here again the number of sub-legal fish did not seem in proper proportion to the number of legal fish. Cover seems adequate, so over-fishing may explain the small number of adult fish.

There is some evidence of slower growth rate in the brook trout of the north branch as compared with those in the main stream and the south branch.

Table 32
The growth-rate of trout collected from Eddy Creek in 1941

Age group		0	I	II	III
Eddy Creek and south branch	Brook trout				
	Number	3	16	8	1
	Size range	1.8 - 3.0	4.0 - 7.4	6.7- 8.6	7.2
	Brown trout				
	Number	5	4	2	0
	Size range	1.5 - 2.2	4.8 - 6.1	5.8- 8.3	...
	Rainbow trout				
	Number	0	11	0	0
	Size range	...	4.5 - 6.6	...	...
Eddy Creek, North branch	Brook trout				
	Number	0	10	3	
	Size range	...	4.3 - 5.8	6.0- 7.5	

Ten species of forage fish were recorded for this stream. The creek chub, blacknose dace and pearl dace were the most common forms. Mudminnows, brook sticklebacks, blackside darters, rainbow darters, Johnny darters and muddlers (bairdii) were few in number. Common suckers and ammocoetes brook lampreys were also found. Forage fish were well distributed throughout the main stream and in the lower part of the south branch. A few creek chubs were taken in the headwaters of the north branch but were scarce in the colder water of the lower section.

A total of 6,500, 7-month-old brook trout and 2,250 3-month-old rainbow trout have been planted in the main stream and the south branch in the past six years. Five thousand of the brook trout were planted in 1940. It is possible that some of these fish were collected by the survey party and as legal fish.

Ten to fifteen years ago Eddy Creek and the two branches produced excellent trout fishing. Limit catches of 8- and 9-inch brook trout in the north branch were reported as late as 1935. Beaver ponds in the south branch produced good fishing until about 1935, after which a steady decline occurred. Impoundments near the mouth of the main stream were productive until washed out some years ago. The effects of beaver ponds on the fish population in the main stream and the south branch appears to follow the course that was generally revealed by special investigations of beaver-trout relations. These showed that fishing in the impoundments was good for a number of years after the dams appeared, but later declined to very low productivity.[2]

Management suggestions

The beaver dams in the south branch of Eddy Creek have apparently run their course in productivity and are now virtually sterile basins. Further investigations should be made concerning the activity of beavers in these ponds. If beavers are not present the dams should be removed and the ponds drained. Stream improvement devices to increase depth and provide cover should be installed in the lower section of the south branch, as well as in the main stream. The improvement work in the south branch ought to be undertaken only if the dams are removed, and sludge in the impoundments should be cleaned out by freshets before work on improvement installations is begun.

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[2] Salyer, J. C., Institute Report No. 259, Preliminary Report on the Beaver-trout Investigation. 1934.

Eschmeyer, R. W., Institute Report No. 455, Creel Census for Three Seasons on the Beaver Dams and Lakes in the Gladwin Game Refuge. 1938.

Editorial note: An intensive study of beaver-trout relations is being made by the Department of Conservation at the present time. This investigation is expected to bring important new facts to light regarding the effects of beaver dams on trout and may also serve to alter some conclusions that could be drawn from the earlier studies cited above. For an outline of the current study see Adams, A. K., Institute Report No. 1213, Beaver-trout Investigations in Michigan. 1949.

The new beaver ponds in the north branch should be checked at later dates to determine their productivity. It is possible that natural reproduction of brook trout above these ponds will be adequate to meet their carrying capacity, and therefore it would be advisable to make an investigation to determine the need for stocking before any planting is done.

Further stocking in the main stream and the south branch should be discontinued because trout are present in sufficient number to meet the normal carrying capacity of these areas of the creek.

Tributary Number 13

(Outlet of Norway Lake)

This stream has a volume of approximately 60 gallons per minute. It lies in T. 21 N., R. 3 E., S. 16, and has a total length of approximately one-half mile. Due to its small size, further investigations were not made.

Tributary Number 14

(Prather Creek)

This tributary, which lies in T. 21 N., R. 3 E., S. 9, 10, is about one and one-quarter miles long and has a flow of about 60 gallons per minute. It was not inventoried.

Tributary Number 15

(West Branch of Rifle River)

The West Branch of the Rifle River is known locally as the West Branch. The origin lies in the city of West Branch at the outlet of Weidman's millpond, which impounds the water of Ogemaw Creek in T. 22 N., R. 1 E., S. 24. The stream is fed by five primary tributaries, including

Ogemaw Creek. An irregular easterly course is followed from the city of West Branch to the mouth in T. 21 N., R. 3 E., S. 4. The stream is about 12 miles in length, exclusive of tributaries.

Streams tributary to the West Branch arise from cold springs or lake outlets, and show great diversity in temperature. Two dams on the West Branch and two in the tributaries also alter water temperatures considerably. The volume of flow is regulated to a large extent by the operation of the power dam at Flowage Lake. Tributaries of the stream have a total volume of approximately 21 c.f.s. The volume of flow below Gussman's dam is about 8 or 9 c.f.s., below Flowage Lake about 19 c.f.s., and approximately 22 c.f.s. at the mouth. There are a variety of pool formations in the main stream, ranging from poor to good. Pools above Flowage Lake are from 1 1/2 to 3 1/2 feet in depth and from 10 to 18 feet wide. Pools in the central and lower sections average from 2 to 4 feet deep and from 10 to 25 feet wide.

Rubble and boulders are the chief bottom types in the stream above Flowage Lake, but in many instances these are covered with organic sediment. Sand and fine gravel predominate in the central and lower sections of the stream, with irregular deposits of organic sediment extending about a mile below Flowage Lake. Small areas of muck and silt are also present in the eddies and along the banks.

The stream has an average amount of shade throughout its length with the exception of open areas about the city of West Branch. A large percentage of the land in the central and lower sections is cultivated close to the stream. Cover throughout the course of the stream seems adequate. Cut banks, exposed roots and deadheads are well distributed in all sections.

Table 33

Chemistry and temperature data from the West Branch of the Rifle River.

	Upper M-76	Central 1/4 mile below C. K. Eddy Creek	Central 4 miles below C. K. Eddy Creek	Lower mouth
Date	July 12, 1941	June 26, 1941	June 26, 1941	June 27, 1941
Time	9:30 a.m.	2:00 p.m.	4:30 p.m.	4:00 p.m.
pH	8.0	8.4	8.4	8.1
Dissolved oxygen	9.3	7.8	8.8	8.0
Phenolphthalein	0.0	7.0	7.0	6.0
Methyl orange	170.0	147.0	162.0	162.0
Air temperature	76°	86°	86°	86°
Water temperature	59°	76°	77°	78°

A test for phenol made on water from this stream by a member of the Stream Control Commission's technical staff did not reveal the presence of this poisonous carbon compound, although evidence indicated recent contamination by this substance./ Other chemical factors concerning pollution of the West Branch will be discussed under "Pollution in the Rifle River and its tributaries."

A great variation in temperature is found between the origin and mouth of this stream. The section above Flowage Lake is of a much lower temperature than the section below. Ogemaw Creek, the inlet to Weidman's pond, probably remains in the low sixties throughout the summer, and the resulting overflow of the pond, although somewhat increased in temperature, is still within the tolerance range for trout until reaching Flowage Lake. At the lake the water is held in check for a sufficient length of time to permit the surface water to approach air temperatures. Rifle Creek also flows into Flowage Lake but has a higher temperature than the upper section of the West Branch. Surface water of Flowage Lake is used in the development of hydro-electric power, and therefore it is obvious that water temperatures in the stream below the dam will probably remain high during the summer.

Two tributaries enter the stream below the dam but have little effect on the water temperature. C. K. Eddy Creek has a volume of approximately 300 gallons per minute and is often warmer than existing air temperatures as the water is used by the oil refinery located about 1/2 mile above the mouth. Campbell Creek enters the West Branch in the lower central section, but has little effect on the water temperature as the volume of flow is rather small as compared with that of the West Branch at this point. The following table shows the variations in temperature of the West Branch from source to mouth.

The maximum temperature of 79 degrees obtained at the mouth of the stream on June 27 was two degrees above that of the Rifle River at the same time. Temperatures were not obtained during the critical periods, but it is believed, that sufficient data were obtained to permit the following deductions to be made. Water temperatures above Flowage Lake probably remain sufficiently low for brook, brown, and rainbow trout. During normal summer temperatures the surface water in Flowage Lake is warmed to the extent that it remains above the limits for trout for varying lengths of time. Although the stream immediately below the dam may be slightly below the temperature of surface water of the lake, it still remains relatively high and is further warmed through the remainder of its course to the Rifle River.

The West Branch contains a limited number of submerged aquatic plants. Small beds of leafy pondweed (Potamogeton foliosus), sago pondweed (Potamogeton pectinatus), flat-stemmed pondweed (Potamogeton zosteriformis), waterweed, and floating-leaf pondweed were found in silt and sand areas throughout the greater part of the stream. It is believed that certain organic and inorganic wastes entering the stream may tend to limit plant growth.

Table 34

Temperatures of the West Branch of the Rifle River, 1941.

Upper portion							Lower portion		
	In village of West Branch	At M-76	At M-76	At Flowage Lake (surface)	At Flowage Lake (surface)	Below Flowage Lake	1/4 miles below C. K. Eddy Creek	4 miles below C. K. Eddy Creek	At mouth
Date	July 12	July 19	July 12	July 17	June 24	June 24	June 26	June 26	June 27
Time	9:45 a.m.	10:00 a.m.	9:30 a.m.	11:30 a.m.	noon	noon	2:00 p.m.	6:30 p.m	4:00 p.m.
Air	64°	67°	70°	72°	...	...	86°	86°	86°
Water	58°	60°	59°	72°	77°	74°	76°	77°	79°

Fish food organisms are relatively abundant in the West Branch. The productiveness seemed to be rather uniform throughout the length of the stream, although the volume and number of organisms was increased considerably by the presence of tubificidae in the upper and central section. The following table represents the relative abundance and distribution of the organisms found in the West Branch.

Table 35

Abundance and distribution of smaller organisms of the West Branch of the Rifle River.

	Upper section M-76 bridge S. E. of West Branch	Central section 1/4 mile below Flowage lake	Lower central section T. 22 N., R. 3 E., S. 31
Tubificidae	Exceptional abundance	Very abundant	...
Hirudinea	Common	Few	Few
Gastropoda	Very abundant	Very abundant	Very abundant
Pelecypoda	Few	Very abundant	Very abundant
Amphipoda	Few	...	...
Hydracarina	Few	...	Few
Ephemeroptera	Few	Few	Common
Anisoptera	...	Few	Common
Zygoptera	...	Few	Common
Neuroptera	...	...	Few
Trichoptera	...	...	Few
Plecoptera	...	...	Few
Coleoptera	Numerous	...	Few
Chironomidae	Abundant	Few	Common
Other Diptera	Abundant	Few	Few
Hemiptera	Abundant	...	...
Isopods	Very abundant	...	...
Crayfish	Numerous	Abundant	Very abundant

The large number of tubificidae found below the Flowage Lake dam indicates that some of the organic wastes from West Branch are carried through the reservoir. The lower central section of the stream supports a larger number of species than that part of the stream above, but does not contain tubificids, indicating the absence of strong organic pollution below this point.

Although both cold- and warm-water fish are present in the West Branch, it is believed that very few areas in this stream support a sufficient number of game fish to be of value to the angler. Trout are confined to the portion of the stream above Flowage Lake and the warm-water species below the lake. Brook, brown, and rainbow trout were collected above the lake within the city limits of West Branch; perch, longear sunfish and pumpkinseed sunfish were collected in the central and lower sections of the stream. Smallmouth bass were also observed near the mouth. Several gill nets placed in Flowage Lake produced very few fish. Small perch and one northern pike (4 pounds 8 1/2 ounces) were taken, other forms such as bluegill, pumpkinseed sunfish, largemouth bass, smallmouth bass, rock bass, and longear sunfish have been reported. The relative abundance of forage fish is shown in the following table.

Table 36

Forage fish of the West Branch of the Rifle River.

	Lower central section, T. 22 N., R. 3 E., S. 31	Upper central section, T. 22 N., R. 2 E., S. 33	Upper section T. 22 N., R. 1 E., S. 19
Creek chub	Common	Few	Common
Blacknose dace	Very common	Few	Predominant
Common shiner	Predominant	Predominant	Common
Golden shiner	Few	Common	...
Bluntnose minnow	Few	Few	...
Longnose dace	...	Few	Few
Lake emerald shiner	...	Few	...
Fathead minnow	Rare	...	...
Brook stickleback	Few	...	Few
Blackside darter	Common	...	...
Muddler	...	...	Common

Table 37

Growth-rate of trout collected from the West Branch in 1941.

Age group	0	I	II	III
Brook trout				
Number	0	0	3	3
Size range	...	...	5.8 - 7.2	7.3 - 8.1
Brown trout				
Number	3	0	2	0
Size range	2.5 - 2.8	...	7.3 - 8.6	...
Rainbow trout				
Number	2	0	0	0
Size range	2.0 - 3.1	...	...	...

Table 38

Stocking records for the West Branch from 1937 to 1940

	Brook trout	Brown trout	Rainbow trout
1937	...	...	...
1938	55 adults	15 adults	15 adults
	...	3,625, 6-month	...
1939	200 adults	...	...
	6,000, 7-month	...	...
1940	...	...	...

From results obtained in chemical, physical, and biological examinations it is quite apparent that only the extreme upper portion of the stream is suitable for trout. The sewage introduced by the city of West Branch reduces the value of the stream as a fishing area for some distance below Flowage Lake. The possible loss of fish life due to lack of oxygen resulting from oxidation of organic material in the polluted area above the lake is considered as a potential limiting factor, although such conditions were not observed or reported during the survey. The number of desirable game fish below Flowage Lake is virtually negligible, as only a few smallmouth bass were observed in the lower section.

Previous to drilling for oil in the vicinity of West Branch, Flowage Lake produced good brook and rainbow trout fishing as well as largemouth bass, smallmouth bass, rock bass and northern pike. In 1932 and 1933 pollution from oil wells was thought to have reduced the number of game fish. No trout have been taken in the lake in recent years. The section of stream above Flowage Lake has produced some exceptionally large brown and rainbow trout each season, however. The central and lower sections produced brook and rainbow trout prior to 1933 and 1934, but there is little fishing below Flowage Lake at the present time. It has been reported that large rainbow trout were taken below Flowage Dam in former years.

Management suggestions

Stocking below Flowage Lake should be discontinued because of high water temperatures and pollution. All stocking above the lake in the future should be limited to the section above the sewer inlet, but it is suggested that greater returns may be obtained by improving shade, cover and pools rather than by continuing with heavy stocking. Fingerling brown and rainbow trout were taken in the city of West Branch, which indicates that these species reproduce here and are better adapted to present conditions than brook trout which have predominated in the plantings.

It is thought that the present policy of permitting seining for minnows below Flowage Lake should be continued.

Tributary Number 1-15

(Campbell Creek, Slobtown Creek or Toughmire Creek)

Campbell Creek is the first tributary to the West Branch. It is formed by the outlet of Mud Lake in T. 22 N., R. 2 E., S. 11 and its mouth lies in T. 22 N., R. 3 E., S. 21. It is about 4 1/2 miles in length, excluding

Peach Lake Creek (1-1-15), its only tributary. Springs above M-55 contribute a large part of the volume. The volume and velocity at the M-55 bridge were approximately 1.4 c.f.s. and 0.4 f.s. It was estimated that the stream had a volume of about 2 c.f.s., at the mouth.

Campbell Creek would be classed as a brush stream, although certain areas in the central section are open. Pools are 1 to 2 1/2 feet in depth and have an average amount of cover. Bottom types of sand and gravel predominate, although a few rubble areas are present.

Chemical and temperature conditions were within the range of trout. It is believed that these remain fairly uniform throughout the summer.

Table 39
Chemical and temperature data from Campbell Creek

	M-55 bridge
Date	July 17, 1941
Time	3:00 p.m.
pH	8.2
Dissolved Oxygen	10.6
Phenolphthalein	8.0
Methyl orange	188.0
Air temperature	82°
Water temperature	59°

No submerged aquatic plants were found in Campbell Creek at the points of investigation.

Fish food organisms were quite abundant, especially amphipods. Caddis and diptera larvae were common. The remainder of the bottom organisms were made up of a few leeches, dragongly nymphs, beetles, midge larvae, stonefly nymphs, isopods, and crayfish. As to the volume and number of food organisms available, Campbell Creek would be rated from good to excellent.

A seining station at the M-55 bridge produced only four species of fish. The muddler (cognatus) was found at this station and represents the southern

record of this species in tributary collections from the Rifle River drainage. Cottus bairdii and the mudminnow were the only other species of forage fish found in the stream. C. bardii and C. cognatus were represented in about equal numbers and were abundant, while mudminnows were few in number. The stream apparently maintains a good number of legal sized brook trout, as well as fingerlings. It has produced brook trout for many years. Mr. William Grant of Vassar, Michigan has related experiences on the Campbell which indicate that the stream was well populated with brook trout 25 years ago. At the present time the stream is fished moderately light. It was planted with 2,250, 3-month rainbow trout in 1937.

Table 40

Growth-rate of brook trout collected from Campbell Creek in 1941

Age-group	0	I	II
Brook trout			
Number	2	7	7
Size range	2.8	4.7 - 6.1	6.3 - 7.8

Management suggestions

At the time of investigation Campbell Creek had most of the characteristics that are associated with good brook trout streams. There was sufficient evidence to indicate that natural reproduction was adequate and that food organisms were of ample quantity to support a sizeable population of fingerling and adult brook trout.

Since the stream now contains a good number of legal trout no management suggestions are offered with the possible exception of installation of a small dam in the lower section to increase the fishing area.

Tributary Number 1-1-15

(Peach Lake Creek)

Peach Lake Creek is formed by the outlet of Peach Lake. It carries a very small volume of water and feeds the lower portion of Campbell Creek. It is possible that the stream may become intermittent in the upper portion during dry periods. The stream is about 4 miles in length. The water temperature is too high for trout and the stream has virtually no value to the angler. At the M-55 bridge northern pike and mudminnows were collected and the volume of flow was found to be 20 to 25 gallons per minute. No management suggestions are offered for this tributary.

Tributary Number 2-15

(C. K. Eddy Creek)

C. K. Eddy Creek is the name applied to the upper portion of the north branch of Eddy Creek which has been diverted to the West Branch. It is about 3 miles long. The stream was not investigated other than to obtain temperatures, chemical analyses, and an estimation of volume. The volume of flow was about 300 gallons per minute at the mouth.

Table 41
Chemical and temperature data from C. K. Eddy Creek taken at the mouth

Date	June 26, 1941
Time	2:00 p.m.
pH	7.8
Dissolved oxygen	2.4
Air temperature	86°
Water temperature	92°

A large part of the water in the lower part of the creek is used by the refinery at West Branch is some process of refining oil which produces a water temperature in excess of current air temperatures.

Phenol pollution has been reported, although an investigation on June 26, 1941 by a representative for the Stream Control Commission did not reveal the presence of this compound.

Management suggestions

Past investigations regarding phenol pollution in C. K. Eddy Creek have not been satisfactory due to the rapidity with which this pollutant oxidizes. Until the type and source of pollution can be definitely frozen and subsequent control measures enforced, the West Branch will undoubtedly be subject to irregular pollution of a lethal nature. It is hoped that later investigations by the Stream Control Commission will provide sufficient evidence to formulate control measures.

Tributary Number 3-15

(Rifle Creek)

The origin of this stream is formed by the outlet of Rifle Lake which is in turn fed by Crapo Creek. Rifle Creek flows almost due south, transecting M-55 in Sections 20 and 29. The mouth lies in the upper end of Flowage Lake, about 1/2 mile below M-55. The stream is about 2 3/4 miles in length.

A large portion of the water of Rifle Creek comes through Rifle Lake, Woods Creek joins the stream in Section 20. The water of the stream is impounded by Fisk's Mill dam just north of M-55. The dam forms a 9-foot head and impounds approximately an acre of water. A volume of 8.5 c.f.s. and a velocity of 1 f.s., was obtained above the entrance of Woods Creek. 3 c.f.s.
The volume is increased about/by Woods Creek. The upper section of the stream is approximately 8 to 20 feet wide and from 4 inches to 2 feet in depth. The lower section is from 12 to 20 feet wide and 4 inches to 2 feet deep.

There are few good pools throughout the length of the stream. Pools are usually very shallow, are lacking in cover, and mostly fall in class $S_2T_3F_3$. Much of the land adjacent to the stream is cultivated or in pasture up to the creek banks, and as a result very little shade is found anywhere. Cover is also limited in most parts of the stream. A few boulders, cut-banks or deadheads occur in a few pools, but on the whole, little protection for adult fish is available. Rubble and coarse gravel are the predominant bottom types. Sand deposits are confined to that section of the stream immediately below Rifle Lake.

Table 42

Chemistry and temperature data from Rifle Creek

	Fisk's Mill (surface at dam)	Upper portion Section 21
Date	July 15, 1941	July 12, 1941
Time	10:30 a.m.	10:30 a.m.
pH	8.4	8.4
Dissolved oxygen	10.1	9.8
Phenolphthalein	8.0	8.0
Methyl orange	164.0	164.0
Air temperature	85°	86°
Water temperature	70°	64°

It was reported that in former years the lower portion of this stream was polluted with wastes from oil wells. Investigation of bottom fauna below M-55 indicate that some pollution may still exist. The limited occurrence of bottom organisms could be attributed either to the accumulation of old wastes or to recent pollution. Sediment from the stream bed when agitated produced an oily film on the surface of the water.

Small beds of water milfoil and clasping-leaf pondweed were present immediately below Rifle Lake but vegetation was absent in the central and lower sections of the stream.

The bottom fauna of Rifle Creek was rated poor to fair. The stream above M-55 to Rifle Lake produced a fair number and volume of organisms, but the area below M-55 is poor in productivity. Mayfly and caddis larvae were the predominant forms. Stoneflies, midges, other diptera, isopods, leeches, oligochaetes, crayfish and mollusks were present but few in number.

No trout were taken in Rifle Creek during the course of the survey. One small rock bass was the only game fish taken here. Creek chubs predominated in the class of forage fish. Common shiners, river chubs, blacknose dace, Johnny darters, barred fantails, rainbow darters, common suckers, and hog suckers were also recorded. Little information could be obtained on the history of fishing in Rifle Creek. It has been reported that it produces a few trout in the spring, probably it is fished very little.

Management suggestions

Rifle Creek probably becomes too warm at critical periods for trout. Since the source of the stream is formed by the surface water of Rifle Lake, improvements to lower water temperature would be of little value. Neither the size nor the length of the stream are adequate to encourage introduction of smallmouth bass. It is believed that the only value of Rifle Creek lies in its production of minnows and it should therefore be classed as a minnow stream.

Tributary Number 1-3-15

(Woods Creek)

Woods Creek is about 4 1/2 miles in length. Its origin lies in T. 21 N., R. 1 E., S. 12, and is formed by the outlet of Heinz Lake. It enters Rifle Creek at Fisk's Mill Pond.

The outlet of Heinz Lake forms only a small portion of the volume of Woods Creek. A large beaver dam about a quarter mile below the lake impounds

2 to 3 acres of water which backs up almost to the lake outlet. Numerous springs entering the stream as it passes through a large cedar swamp below the beaver dam contribute much of the volume of Woods Creek. A volume of 3.1 c.f.s., and a velocity of 1 f.s., represent a normal summer flow at the mouth.

The headwaters are of little value for fishing as the water for some distance below the beaver dam is too warm to support trout. The cedar swamp below is so thick that even "brush fishing" is difficult. Ten pools were found within the swamp, but the area in general shows signs of being filled in by sand and silt. A few gravel riffles and pools were found in this section. The central and lower sections of the stream flow through cultivated and pastured land and are rather open, although alder and willow along the banks offer some shade. Gravel and rubble predominate in the central section, but the lower section is filled with sand. Pools in the upper portion would be classed as $S_3\ T_3\ F_3$ and in the lower two sections as $S_3\ T_2\ F_2$.

A chemical analysis of the water was made in the central section of the stream and temperatures recorded at intervals throughout its length.

Table 43

Chemical and temperature data from Woods Creek, 1941.

	Upper Section		Middle Section		Lower Section	
	Lake outlet	Below beaver dam	Section 17	Section 18	Section 20	Mouth
Date	July 12	July 12	July 12	July 12	July 15	July 12
Time	2:00 p.m.	2:30 p.m.	4:00 p.m.	1:00 p.m.	10:00 a.m.	10:30 a.m.
pH				8.0		
Dissolved oxygen				8.0		
Phenolphthalein				6.0		
Methyl orange				155.0		
Air temperature	80°	80°	76°	75°	81°	71°
Water temperature	78°	74°	59°	66°	61°	58°

From the data presented in Table 43 conditions for trout appeared adequate. The temperatures do not represent maximum summer temperatures, but were believed to be sufficient for marking out suitable areas for trout. Water temperatures below the lake and for some distance below the beaver dam probably become too high for cold-water forms but the spring water added to the stream in the cedar swamp is sufficiently low in temperature to cool the water so that it may be utilized by trout. Although the central and lower sections are rather exposed, it is believed that water temperatures remain suitable for brook trout to within 1/2 mile of the mouth. A sludge deposit similar to that found in Rifle Creek was observed in the lower 1/2 mile of this stream.

Submerged aquatic plants were not present in any portion of Woods Creek. The stream is rated as fair to good in its production of fish food organisms. Amphipods were the predominant form. Caddis larvae and mayfly nymphs were also abundant, these three forms compromising the bulk of the fish food organisms found here. A few snails, leeches, dragonflies, stoneflies, beetles, midges, other diptera, and crayfish were also present.

Woods Creek appears to support a fair number of legal size brook trout and a considerable number of fingerlings. No other species of trout was collected or reported for the stream. Creek chubs were the only species of forage fish collected. A few pumpkinseed sunfish were observed in the beaver pond.

Little could be obtained regarding the history of this stream. At the present time most of the fishing is confined to about 1 1/2 miles of creek in the central section. Although limit catches have been made in recent years, the stream is not heavily fished.

Table 44

Growth-rate of brook trout collected from Woods Creek in 1941

Age group	0	I	II	III
Brook trout				
Number	0	3	10	1
Size range	...	4.1 - 5.6	5.2 - 8.6	6.7

Management suggestions

The most objectionable aspects of Woods Creek for brook trout are an inadequate number of good pools and lack of cover. Conditions of the stream lying within the cedar swamp favor natural reproduction. Natural reproduction is apparently adequate, thus eliminating the need of planting. The thick brush makes over-fishing almost impossible, thus protecting brood stock. The activity of beavers was confined to the headwaters of the creek and is not considered objectionable in a management plan for the stream. Stream improvements that will create pools and provide cover should be placed in Sections 17, 18, and the upper half of Section 20.

Tributary Number 1 of Rifle Lake

(Crapo Creek)

The source of Crapo Creek lies in T. 23 N., R. 2 E., S. 33, and the mouth in T. 22N., R. 2 E., S. 16. This stream is fed by four tributaries near the source and one about midway along its course. The creek and its tributaries have a total length of approximately 4 1/2 miles. It flows thru Crapo Lake in the lower part of its course and subsequently forms an inlet of Rifle Lake. Springs and cold tributaries in the headwaters provide the initial water supply. The lowlands in the central and lower sections undoubtedly increase the volume to some extent under normal conditions and especially after heavy rains.

The central section of the stream was flowing about 4.8 c.f.s. and 2 to 3 1/2 f.s., at the time of investigation, and it is believed that the volume in the lower section probably approaches that of Rifle Creek i.e., approximately 8 c.f.s.

Shade and cover are excellent in the upper half of the stream but are somewhat lacking in the swamp area below. Fine gravel and rubble are the predominant bottom types in the headwaters but are replaced by sand and muck in the central and lower sections. Pools in the headwaters are from 1 to 2 feet in depth and have an abundance of cover. Similar pools are found for some distance below, but a gradual change occurs when the stream reaches the level land about the middle of the central section where canal-like stretches of water 8 to 17 inches in depth with limited cover predominate. These stretches continue throughout the lower section.

The width of the stream varies from 2 to 5 feet in the headwaters to 12 to 15 feet in the lower section. A small portion of the central and lower sections is in open water and suitable for fly casting.

Chemical analyses on Crapo Creek were limited to oxygen and pH determinations. The pH was 8.4 and the oxygen 10.4 p.p.m. Temperatures of the headwaters of Crapo Creek were below those found in any other tributary of the Rifle River. A temperature of 46 degrees was recorded near the origin of the stream and in one tributary. This temperature was 1 degree less than that for most springs of the Rifle River drainage.

Table 45
Temperatures for Crapo Creek from headwater to mouth, July 12, 1941.

					Lower outlet of Crapo Creek
Time	10:00 a.m.	10:00 a.m.	noon	5:00 p.m.	5:00 p.m.
Air temperatures	81°	81°	87°	81°	81°
Water temperatures	46°	48°	52°	62°	69°

Temperatures in the headwaters are rather low for good trout growth, but increased temperature in the central section makes for better conditions. The temperature below Crapo Lake may become too warm for trout during critical periods, although the reading obtained at the time of investigation was well within the tolerance range of trout. Crapo Lake was formerly a fine trout lake, but constant deposition of sand and silt, and an encroaching shore have apparently reduced the area and depth to where it is now little more than a warming basin for lower Crapo Creek. A few trout are found in the lake each spring, but presumably move into upper Crapo Creek as the temperature of the lake rises in summer. The stream is unique in having a temperature variation of 23 degrees from headwaters to mouth in a distance of about 2 1/2 miles. Even greater variation probably occurs during maximum summer air temperatures.

Table 46

Volume and temperature data for the tributaries of Crapo Creek, 1941

		Temperature	
		Air	Water
Tributary 1-1-1-3-15	less than 1/2 c.f.s.	81°	60°
Tributary 1-1-1-1-3-15	no data		
Tributary 2-1-1-3-15	about 300 gallon per minute	81°	70°
Tributary 3-1-1-3-15	about 1 c.f.s.	81°	48°
Tributary 4-1-1-3-15	about 1 c.f.s.	81°	46°
Tributary 5-1-1-3-15	about 1/2 c.f.s.	81°	46°

Few plants were found in Crapo Creek. Submerged and emergent mosses were found in the well shaded areas of the upper half of the stream, and a few marginal sedges occurred in the lower half. The amount of submerged vegetation available for cover was negligible. The sumberged mossesin the upper part of the stream are probably responsible for the greater number of insects found in that area.

Fish food organisms in the brush section were rated good to excellent. Amphipods predominated here, although, large numbers of mayfly and caddis fly larvae were also found, as well as a lesser number of midges, stoneflies beetles, dragonflies, miscellaneous diptera, and crayfish.

The lower section of this stream was not sampled, but the number of fish food organisms there was believed to be fewer than in the above area because of the less favorable substratum and the lack of cover.

Brook trout and brown trout occur in Crapo Creek. Brook trout outnumbered the browns and were the only species found in the extreme headwaters. Seining and observations in the upper and central sections of the stream revealed many sub-legal brook and brown trout, although a decrease in the number of small fish in the area above Crapo Lake was noted. No trout were taken in the section between Crapo and Rifle lakes.

Table 47

Growth-rate of brook trout collected from Crapo Creek in 1941.

Age group	0	I	II	III
Brook trout				
Number	6	5	6	4
Size range	1.8 - 2.1	4.5 - 5.6	5.5 - 6.5	7.0 - 7.8

Crapo Creek has produced good brook trout fishing over a period of years. It was reported that rainbow trout were planted at one time and appeared in the catch a few years later, but apparently did not reproduce. No information could be obtained relative to the time brown trout were introduced, but it probably was before 1937 as fish planting records do not list the stream as having been planted in the past five years. Reports indicate that the stream is fished by a few anglers throughout the summer and invariably produces good catches.

Forage fish were not found in the central and upper sections of the stream. Common shiners were abundant in the lower section.

Management suggestions

The lower central section of Crapo Creek and the part immediately above Crapo Lake, comprising about three-quarters of a mile of stream, should be improved to provide shelters and pools.

Further stocking apparently is unnecessary as natural reproduction in the headwaters seems adequate.

Tributaries 1, 3, and 4 might be considered as possible sites for dams to create trout ponds if it is thoughtmore fishing can be provided by such impoundments than by the creek above Crapo Lake. However, before a project of this kind is undertaken, the potential merits of ponds should be weighed against possible adverse effects which may be produced on the stream.

Tributary Number 4-15

This tributary is about 1 1/4 miles long and is not of sufficient size to merit investigation.

Tributary Number 1-1-15

(Ogemaw Creek)

Ogemaw Creek is approximately 5 1/2 miles long, including a single tributary. The stream begins north of Ogemaw Springs, and most of the water is contributed by flowing wells in the latter area. It flows in a general southeast direction and enters a mill pond in West Branch. The volume in the vicinity of Ogemaw Springs is approximately 2 c.f.s. with a velocity of 2 f.s. Additional water contributed by the tributary springs and seepage increase the volume to approximately 8 1/2 c.f.s. in the lower section. The velocity at this point of examination was 2.4 f.s.

The stream is well shaded, but the extreme lower part is somewhat open and suitable for limited fly casting. Many deadheads and snags, are present throughout the entire length of the stream, but in many instances these have been made useless for cover by heavy deposits of sand and silt. A few stream improvement devices observed in the lower portions were functioning properly while others were clogged with sand, and failed to provide suitable cover. Considering the volume and velocity, and the number of natural deflectors and underpasses available, holes of 2 to 2 1/2 feet in depth should have been common, but only few were found. Frequently sand had completely filled the area under logs forcing the water to flow over the top. This condition was particularly common in the central portion of the stream in Sections 15, 22 and 23. Gravel and rubble riffles in the upper and lower sections were rather common, but scarce in the central section.

Table 48

Chemical and temperature data for the lower section of Ogemaw Creek

	Section 24
Date	July 14, 1941
Time	10:00 a.m.
pH	8.2
Dissolved Oxygen	10.6
Phenolphthalein	8.0
Methyl orange	161.0
Air temperature	70°
Water temperature	51°

A series of temperatures taken in the three sections indicates that the stream maintains a relatively low temperature throughout its entire length.

Table 49

Temperatures taken on three sections of Ogemaw Creek, July 14, 1941

	Lower		Central		Upper		
					Above Ogemaw springs	Below Ogemaw springs	Spring
Time	10:00 a.m.	11:30 a.m.	2:30 p.m.	2:30 p.m.	2:00 p.m.	2:00 p.m.	2:00pm.
Air temperature	70°	77°	81°	81°	80°	80°	80°
Water temperature	51°	54°	53°	55°	52°	51°	47°

In considering the volume of cold spring water entering Ogemaw Creek, and the shade, length and velocity of the stream, it may be assumed that water temperatures, even in the extreme lower section, probably seldom exceed 65 degrees F. The water temperatures of Ogemaw Creek remain too low for good trout growth over the greater part of the year. However, the cold spring water in the tributary and headwaters of the stream is excellent for spawning and for rearing young fish.

Chara was the only submerged aquatic plant found in the stream and was confined to small beds in the upper and central sections.

The stream rates fair to good in production of fish food organisms. The gravel and rubble areas of the upper and lower sections are most productive.

The abundance of sand in the central section reduces the productivity of the stream as a whole. Amphipods were the dominant food organism. Mayflies and caddis flies were also generally abundant. Stoneflies were abundant in the rubble areas and midges in sand and silt areas. A few dragonflies and dobson flies were found in the gravel along the stream margins.

Only three species of fish were obtained from Ogemaw Creek. The abundance of brook trout ranging from about 1 1/2 inches to legal size, was quite noticeable. Brook trout appeared well distributed throughout the

stream. It is believed that Ogemaw Creek contains a larger population of this species than any other tributary of the Rifle River.

Angling returns show that sub-legal fish outnumber legal fish about 3 to 1. It is possible that larger fish move downstream to eventually enter the mill pond, as it has been reported that many large brook trout are taken there each year. The muddler, Cottus cognatus, seemed to be well distributed and undoubtedly are utilized as trout food. Ammocoetes of the non-parasitic lamprey Ichthyomyzon fossor were found in areas of silt and detritus but are believed to be of little value as forage.

Table 50

Growth-rate of brook trout collected from Ogemaw Creek in 1941

Age group	I	II	III	IV
Brook trout				
Number	11	17	5	1
Size range	3.8 - 5.2	5.6 - 7.8	6.4 - 9	8.6

Table 51

Brook trout stocked in Ogemaw Creek from 1937 to 1940

Year	Number planted	Age of fish	Location of planting
1937	2,500	6-month	Sections 23, 24
1938	6,000	6-month	Section 23
1939	200	adult	Section 24
	8,000	8-month	Section 24
1940	10,000	7-month	Section 24

Ogemaw Creek and the mill pond are considered very good for brook trout fishing. Some fine catches have been made in the stream and pond in past years. Brook trout from 12 to 16 inches are often taken in the pond, while the bulk of the legal catch in the stream averages from 7 to 9 inches.

The sand and silt deposits are believed responsible for a decrease in the catch within recent years. The mill pond is fished by a greater number of anglers than the stream. The pond has been open to fishing since the dam was first constructed. A few areas along the stream have been posted in recent years, but fishing privileges are usually granted by the land owners to those asking permission.

Management suggestions

At the time this survey was made the source of erosion causing Ogemaw Creek to be choked with sand was not found, so further investigations should be made to determine the source. If possible, erosion control measures should be established. Then if the stream remains clogged with sand after erosion is stopped in the headwaters, uncovering deadheads and snags in the congested area may be advisable.

Natural reproduction in this stream is excellent and should be adequate to maintain the brook trout population without the addition of hatchery fish. It is possible that a sufficient number of trout move into the mill pond from the stream, which would eliminate the need for stocking the pond. It is suggested that planting be withheld for a few years and subsequent checks made to determine what effect the downstream movement of large brook trout may have in populating the pond. Should this method prove inadequate, later plantings could be made without appreciable loss to the anglers.

Tributary Number 1-5-15

This tributary is about 1 1/4 miles long, 2 to 3 feet wide, and 2 to 8 inches deep. Its volume of flow is slightly less than 1 c.f.s. and has a velocity of from 1 to 2 f.s. It was reported that brook trout move into this brook during spawning periods but are absent during the fishing season, so its chief value appears to be that of serving as a nursery stream.

Tributary Number 16

(Peterson Creek)

Peterson Creek is approximately , 1 1/2 miles long. A single tributary (1-16) of similar length joins the stream just above the mouth, entering the Rifle River about 1/4 mile above the mouth of the West Branch.

This stream is 4 to 8 feet wide, 3 to 18 inches deep, has a volume of 0.5 c.f.s., and a velocity of 1 f.s. The bottom is composed of sand and some gravel. Cover consists mostly of deadheads. The pool classification given this stream was S_2 T_2 F_2. There was an active beaver dam in the headwaters.

Table 52
Chemistry and temperature data for Peterson Creek

Date	June 27, 1941
Time	3:00 p.m.
pH	8.2
Dissolved Oxygen	8.4
Phenolphthalein	4.0
Methyl orange	196.0
Air temperature	89°
Water temperature	69°

In regard to fish food organisms, this stream rated from poor to fair. Amphipods and midges predominated.

Peterson Creek supports a sizeable population of brook trout and it was reported that fairly good fishing has been experienced here for a long time. A member of the survey party in 45 minutes of fishing caught eight trout, four of which were of legal size.

The brook stickleback is the predominant forage species; Johnny darters and blacknose dace were found in fewer number.

No management suggestions are offered for this stream because the present conditions seem satisfactory.

Tributary Number 17

(Dedrich Creek)

This stream is a little over 3 miles long, 2 to 8 feet wide, and was from 1 to 10 inches deep at the time of investigation. The shallow depth was in part due to beaver dams in the headwaters which retained much of the

flow. The volume was only about 30 gallons per minute and the current slow.

The bottom types are sand, gravel, and rubble. The cover is good. On July 11, 1941, a mile above the mouth, air and water temperatures were 75 degrees and 63 degrees, respectively.

A good number of fish food organisms were found in this stream and consisted of mayflies, caddis and stoneflies.

Brook trout occurred in isolated pools. This was the only species seen or reported during the survey. In 1937 a planting of 750 three-month-old rainbow trout was made in the stream.

No management suggestions are offered for this tributary.

Tributary Number 18

(Little Ammond Creek)

This creek is about 2 and 1/2 miles long and enters the Rifle River a short distance below Selkirk. It is 2 to 4 feet wide, 2 to 18 inches deep, has a volume of less than a half cubic foot per second, and the current is slow.

Table 53

Chemistry and temperature data for Little Ammond Creek

Date	July 17, 1941
Time	6:00 p.m.
pH	7.8
Dissolved oxygen	8.1
Phenolphthalein	3.0
Air temperature	75°
Water temperature	54°

The stream produces a few brook trout, but the fishing area is considerably limited. A large brown trout was reported taken from it.

This tributary is too small to merit improvement and no management suggestions are offered.

Tributary Number 19

(Hiltz Creek)

This stream was observed but no investigations were made. It enters the Rifle River between Selkirk and the mouth of Tributary Number 18. It is too small to be of much value for fishing or as a feeder stream. On July 11, 1941, the stream was almost dry at a point about a mile above its mouth T. 22 N., R. 3 E., S. 15.

Tributary Number 20

(Klacking Creek)

The source of Klacking Creek lies in T. 23 N., R. 2 E., S. 34. It flows in an easterly direction, crossing M-33 about 5 1/2 miles south of Rose City, and enters the Rifle River about 1 1/2 miles north of Selkirk. Two tributaries enter the stream in its upper portion in Section 35. Exclusive of tributaries, Klacking Creek is about 6 miles long. Springs and seepage provide the water at the source, and additional springs and the tributaries increase the volume considerably. A beaver dam in the headwaters and an artificial dam (Gleason's Dam) in Section 35 impound some water in the upper section of the stream. The volume below the beaver dam is about 1 to 2 c.f.s., but the volume is increased to about 6 c.f.s., before the stream enters Section 1 of T. 22 N., R. 2 E. The velocity of Klacking Creek is fairly rapid, ranging from 1 to 2 f.s.

Pools and cover in Klacking Creek are above average. In the brushy portion above Gleason's Dam, the pools are quite shallow but have an abundance

of cover. Pools in the area between the dam and central section have greater width and depth with good cover. The bottom types underlying riffles in this portion are gravel and rubble. The upper section in general is well shaded, although somewhat open below the artificial dam. A number of stream improvement devices in the central section were found in working order. About half of this section is well shaded and the other half somewhat open. The pools here have been rated S_1 T_1 and T_2F_2 and F_3. Good pool formations are found in the lower section. Some stream improvement devices here were in working order while others were silted in or washed out. The shade is excellent throughout the lower section and is especially heavy near the mouth of the stream. The pools have been rated S_1 T_1 F_2.

Table 54

Chemistry and temperature data from the lower section of Klacking Creek.

Date	June 27, 1941
Time	1:45 p.m.
pH	8.4
Dissolved oxygen	8.9
Phenolphthalein	10.0
Methyl orange	174.0
Air temperature	90°
Water temperature	62°

Klacking Creek was investigated when exceptionally high air temperatures prevailed, and it is believed that some of the water temperatures obtained probably represent the maximum that may be expected during a normal summer season.

Table 55
Temperatures recorded at various stations on Klacking Creek, 1941

		Date	Time	Temperature	
				Air	Water
Upper section	In Section 34	July 26	2:00 p.m.	89°	76°
	Entrance of Gleason's pond	July 26	3:00 p.m.	89°	62°
	Outlet of Gleason's pond	July 26	3:00 p.m.	89°	75°
	1/4 mile below Gleason's pond	July 26	3:00 p.m.	89°	62°
	Tributary 19-1	July 26	4:00 p.m.	...	59°
Central section	At M-33	July 28	2:00 p.m.	91°	66°
	Section 5	July 28	2:30 p.m.	92°	68°
	Section 5	August 4	2:45 p.m.	80°	70°
Lower section	At mouth	July 28	4:30 p.m.	89°	72°
	Rifle River above entrance of Klacking Creek	July 28	4:30 p.m.	89°	80°

A maximum temperature of 76 degrees was obtained in the headwaters in Section 34. This area contained a large number of brook trout which apparently were not affected by the high water temperature. The tributaries and springs which enter the stream in Section 35 reduce the water temperature considerably. A reading of 62° was obtained in the lower part of Section 35. It appears that there is a gradual rise in water temperature from this point to the mouth.

Klacking Creek has a limited number of submerged aquatic plants. Water cress occurs in the upper section and in the upper half of the central section in relatively small beds. Two other species, musk grass and clasping-leaf pondweed, were also limited in area and confined to the extreme lower section of the stream.

Klacking Creek produces a good volume and number of fish food organisms. Gravel and rubble areas in the upper and central sections are rather extensive and yield a good quantity of aquatic organisms. The lower section was not sampled, but sand and silt areas in the lower central section were rather productive and it is believed that a similar abundance of organisms occurs in the lower part of the stream.

Table 56

Abundance and distribution of smaller organisms of Klacking Creek

	Upper section Sections 34, 35	Upper section below Gleason's dam	Central section
Hirudinea	Few	Few	Few
Gastropoda	...	Few	Few
Pelecypoda	...	Few	Few
Amphipods	Few	Numerous	Common
Hydracarina	Few	Few	Common
Ephemeroptera	Numerous	Numerous	Numerous
Anisoptera	...	Few	Few
Zygoptera	...	Few	Few
Trichoptera	Very numerous	Very numerous	Numerous
Coleoptera	Few	Few	Few
Chironomidae	Common	Common	Common
Other Diptera	Few	Common	Few
Plecoptera	Common	Few	Few

Caddis larvae and mayfly nymphs were the predominant organisms in the areas sampled. Midge larvae and scuds also appeared to be well distributed but were less abundant. On the whole, Klacking Creek is somewhat more productive than other tributaries of the Rifle River having a similar volume.

Rubble and gravel areas appear to remain in a fixed position and show no indication of being covered with shifting sand.

Three species of trout are present in Klacking Creek. Brook trout was the only species found above Gleason's Pond, although browns were quite numerous immediately below. It is quite obvious that the dam has served as

a barrier to the upstream movement of brown trout in the headwaters of Klacking Creek. The distribution of trout in the stream indicated a species preference for different areas. Below the dam in the upper section brook and brown trout were present in about equal numbers. In the central section rainbow and brown trout predominated, although a few brook trout were found. Extensive fish collections were not made in the lower section but results from a seining station in the lower part of the central section indicate that brown and rainbow trout also predominate in the lower area.

The following table presents angling returns from the stream as a unit.

Table 57

Trout taken from Klacking Creek by angling.

Bait (grasshoppers and flies)	Date - July 26 and 28, 1941		Air temperatures 85-94
	Brook trout	Brown trout	Rainbow trout
Sub-legal	21	6	7
Legal	3	7	2
Total	24	13	9

Eighteen of the 21 sub-legal brook trout shown in the above table were taken above Gleason's Pond. A well-conditioned 2 1/4-pound brown trout was taken in the upper section of this stream in the course of the survey. Fingerling brown trout predominated in the area between Gleason's Pond and the mouth of the stream and these represented approximately 70 percent of the catch in seining collections immediately below Gleason's Dam. Neither fingerlings nor adult rainbow trout were taken at this station. In the lower part of the central section fingerling brown, rainbow, and brook trout were collected in good numbers. Browns predominated and were followed by rainbows and brooks in respective order of abundance.

Table 58

Growth-rate of trout collected from Klacking Creek in 1941

	0	I	II	III	IV	V
Brook trout						
Number	5	6	17	1	0	0
Size range	2.1 - 3.0	4.3 - 5.4	4.7 - 8.2	7.1	...	...
Brown trout						
Number	14	8	0	3	2	1
Size range	2.1 - 3.3	5.2 - 7.1	...	9.6 - 12.5	9.9 - 14.2	18.6
Rainbow trout						
Number	3	10	1	0	0	0
Size range	1.7 - 2.3	5.5 - 7.2	7.1	...	...	...

Table 59

Stocking records for Klacking Creek, 1937 to 1940

	1937	1938	1939	1940
Brook trout	10,500 - 6-month	9,000 - 5-month	28,250 - 7- and 8-month	25,168 - 7-month
Rainbow trout	4,375 - 3-month	...	...	...

Stocking records prior to 1937 showed only one planting of brown trout for this stream. In 1936, a planting of 2,000, 6-month-old brown trout was introduced.

Klacking Creek is considered by many anglers to be the top stream of Ogemaw County. However, the upper section of the stream is fished very little and it was said that light fishing in this area is due to the fact that sub-legal brook trout greatly outnumber legal fish. Angling during the course of the survey substantiated this report. The central and lower sections are apparently fished rather heavily throughout the open season. One or two cars were usually parked along M-33 in the vicinity of Klacking Creek in July and August, 1941, indicating that the stream was fished rather intensively throughout the summer. It was reported that many anglers prefer to fish here after moderate rains.

From results of fish collections and reports, it appears that the relative abundance of the three species of trout in Klacking Creek has undergone a change in the past few years. Brown trout have become established either from the original planting in 1936 or from migration from the Rifle River. Prior to the survey the catch was reported as consisting of about 50 percent brook trout, 30 percent rainbow trout, and 20 percent brown trout. It has bnly been in the past three years that brown trout have been reported in the catch. Rainbow trout were apparently established at an early date, although preceded by brook trout. It was reported that rainbow trout in the anglers' catches usually run 9 inches or over.

Conditions in Klacking Creek are apparently favorable for reproduction and growth of brown trout throughout the central and lower sections. Brown trout fingerlings predominated in all the areas seined below Gleason's Dam. From results of the survey investigations, it is believed adult brown trout form a good percentage of legal fish in Klacking Creek, and in all probability will continue to increase in succeeding years.

Water temperatures remain sufficiently low through the entire length of the stream to support brook trout. This species will probably remain well distributed but may be handicapped by competition from an increase of brown trout. Rainbow trout also reproduce in Klacking Creek, but are confined to the lower half of the stream where faster water is found.

Management suggestions

The pools and cover of Klacking Creek between Gleason's Dam and the mouth could be appreciably improved by repairing old stream improvement structures and by adding new ones where these are needed. If this were to be done, it is suggested that the stream be traversed before installing new devices to learn which of the old ones have proven most successful under the conditions presented by this creek.

It was reported that 12- to 14-inch brook trout were taken in Gleason's Pond which is closed to public fishing. It seems probable that these represented fish from the headwaters that had sought deeper water. Although the dam acts as a barrier to both the downstream and upstream movements of fish, it is not considered detrimental since natural reproduction below the dam is adequate. Should the dam be removed, the most important return to the angler might be from a new source of large brook trout for the lower part of the stream.

Tributary Number 1-20

(Little Klacking Creek)

This brook is about 3/4 a mile long, 3 to 5 feet wide, 6 to 12 inches deep, and has a flow of less than 1 c.f.s. It is a brushy stream with a sand bottom. On July 26, 1941, air and water temperatures here were 89 degrees and 51 degrees respectively. At that time the temperature of Klacking Creek above the mouth of this tributary was 62 degrees. The smaller stream probably maintains low temperatures during the summer. Brook trout were reported present.

Tributary Number 21

(Prior or Priquiror Creek)

The outlet of Prior Lake T. 23 N., R. 2 E., S. 23 is the beginning of Prior Creek. Exclusive of its three tributaries, the stream is about 7 miles long. It flows in an easterly direction for about 4 miles, crossing M-33 in Section 19, and then flows southeast, entering the Rifle River in T. 22 N., R. 3 E., S. 4. The outlet of Prior Lake, springs, tributaries, and runoff contributes the water supply of Prior Creek.

At the time of investigation there was very little water in the outlet of Prior Lake. About 1/2 mile below the outlet the volume was increased to about 1 c.f.s., by springs and a tributary from the northwest. Additional

springs between this point and the M-33 bridge increased the volume to approximately 6 c.f.s. Ammond Creek, which enters the stream a quarter mile above the mouth, probably increases the volume to about 7 c.f.s., in the extreme lower portion. The velocity of the Prior on the whole is somewhat less than that of tributaries of similar size entering the Rifle River from the west. An average velocity of approximately 1 f.s. would be characteristic of this stream. Velocities above M-33 averaged more than 1 f.s. and those below less than 1 f.s. Above M-33 pools and riffle formations of average quality occur. Below the bridge long, shallow sand-bottom pools predominate. Pools in the upper half of Prior Creek would fall in a class of S_2 T_2 F_2 and those below, in S_1 T_3 F_1. Although the frequency and size of pools in the lower half are excellent, the type is poor, being shallow and possessing little cover.

Prior Creek is well shaded with the exception of a few small areas. Much of the stream is brushed over and unsuitable for fly casting.

Table 60

Chemistry and temperature data from Prior Creek

	Upper section below entrance of Tributary 3-20	Lower section Section 28
Date	July 29, 1941	August 4, 1941
Time	12:00 noon	3:30 p.m.
pH	8.3	8.4
Dissolved oxygen	9.2	8.9
Phenolphthalein	1.0	8.4
Methyl orange	202.0	208.0
Air temperature	80°	73°
Water temperature	57°	67°

The water temperature near the mouth of Prior Creek on July 28, 3:30 p.m. was 75 with a corresponding air temperature of 93 degrees. A comparable reading taken in the lower part of Klacking Creek one hour later on the

same date was three degrees lower. Other readings obtained during the course of the survey would indicate that water temperatures under 75° prevail from the headwaters to M-33. An open stretch of water about a half mile below M-33 permits the water temperature to rise rather rapidly on warm bright days. A temperature rise of 11° (64° to 75°) was recorded in this one mile stretch. From data obtained during the survey it is believed that water temperatures above M-33 remain suitable for brook trout throughout the summer, but water below M-33 is subject to a rapid rise in temperature during warm weather and on certain occasions exceeds 75 degrees. Although the lower portion of the stream may become too warm for brook trout, it remains suitable for brown and rainbow trout.

Water cress was the only vascular aquatic plant found in the stream and was confined to small beds in the headwaters.

The portion of Prior Creek above M-33 is rather productive of fish food. Gravel and rubble areas in this stretch were well above average in richness and in general compensated for the relative infertility of the sand areas. The sand bottom which predominates below M-33 is not productive, and fish food organisms in this section are few. Among the twelve groups of organisms found in this stream May flies, caddis flies, and amphipods predominated.

Three species of trout were taken in Prior Creek. Brown trout appeared to be distributed throughout the length of the stream. Brook trout were abundant in the colder water above M-33, but only a few were found in the lower section of the stream. Only two rainbow trout were taken in Prior Creek during the course of the survey.

Table 61

Growth rate of brook and brown trout collected from Prior Creek in 1941

Age group	0	I	II	III	IV
Brook trout					
Number	4	9	4	0	0
Size range	2.2-2.7	5.1-7.2	6.4-7.8	...	...
Brown trout					
Number	5	6	2	2	1
Size range	2.0-2.2	4.5-7.2	7.3-7.8	8.2-10.8	12.5

Natural reproduction of brook and brown trout undoubtedly occurs in Prior Creek as small fingerlings (fish of the year) of these two species were taken in survey collections. Brook trout from 4 1/2 to 6 inches were quite abundant above M-33. Larger brown trout were more abundant in the lower half of the stream. It is possible that natural reproduction of rainbow trout occurs, although returns from seining and observations gave no indication that fingerling rainbows were present.

Table 62

Stocking records for Prior Creek, 1937-1940

	1937	1938	1939	1940
Brook trout	5,000 - 6-Month	6,000 - 5-Month	6,250 - 6-Month	7,025 - 7-Month
Brown trout	....	9,000 - 7-Month	10,875 - 6-Month	5,028 - 7-Month
Rainbow trout	2,250 - 3-Month	12,540 - 4-Month	10,750 - 4-Month	5,000 - 5-Month

Brook trout have predominated in the anglers' catches on Prior Creek, although a good number of browns have also been taken. It was reported that only a few rainbow trout are caught each year. The beaver pond in the lower section produced several limit catches of brook trout in the spring of 1941. Reports indicate that Prior Creek is fished rather heavily throughout the season, although somewhat less than Klacking Creek.

Management Suggestions

The sharp rise in water temperatures which occurs in the lower section of Prior Creek during warm periods could be reduced by planting shrubs or trees. This part of the stream also could be improved by installing improvement devices for deepening the pools and providing additional cover. Such structures probably also would make conditions better for spawning and for small aquatic organisms by exposing areas of gravel.

The beaver pond in the lower section apparently was in a productive stage at the time of the survey; the yield should be determined by checks at later times. The dam ought to be removed as soon as possible after the pond has reached its most productive stage. No other beaver dams should be permitted to exist on the stream.

It is believed that further stocking of this stream is not necessary because natural reproduction of brook and brown trout appears adequate. Repeated plantings of rainbow trout apparently have not resulted in the establishment of this species in Prior Creek. It seems advisable that stocking of rainbows be discontinued unless there were a desire for providing anglers with hatchery fish.

Tributary No. 1-21 (Ammond Creek)

Ammond Creek is about 4 1/2 miles long. It has a flow of approximately 1 c.f.s. and the current is sluggish. Temperatures were taken on two different dates in Section 31. At 3:30 p.m. on July 28 the air and water temperatures were 90 degrees and 76 degrees respectively; at 3:00 p.m. on August 4 the temperatures were 79 degrees and 70 degrees.

No trout were taken or seen during the survey of this stream; their absence perhaps can be attributed to high water temperatures. Although Ammond Creek was planted with 2,075 brook trout (7-month) in 1940, no reports were heard of trout having been caught here.

Eight species of forage fish and one common sucker were taken by seine. The forage fish were creek chub, redbelly dace, finescale dace, fathead minnow, brassy minnow, Johnny darter, muddler (bairdii), and brook stickleback.

It is possible that this tributary could be made suitable for trout by providing shade in the open areas in the upper section.

Tributary No. 2-21

This stream was not investigated because of its small size and the difficulty of access.

Tributary No. 3-21

This tributary has a flow of about 60 gallons per minute. On August 4, 1941 the air temperature was 76° and the water temperature 68°. Gravelly areas here probably are used for spawning by trout from Prior Creek.

Tributary No. 4-21

This is a cold tributary to the upper section of Prior Creek. It apparently is not fished. Undoubtedly it serves as a spawning area for brook trout.

Tributary No. 22 - Houghton Creek

Houghton Creek begins in T. 24N. R. 3E., S. 18. It follows an irregular course to the south until reaching Rose City and then flows southeast to its mouth three-quarters of a mile below Devoe Lake. The stream is about 10 miles in length exclusive of its six tributaries. The water supply near its origin comes from springs and runoff in the low swampy area in Section 18. The volume of water is increased

considerably by springs and tributaries in the vicinity of Rose City. Wilkins Creek, Tributary No. 1-22, has a volume of about 12 c.f.s. at its junction with Houghton Creek. The volume of the latter as it enters the Rifle River is approximately 30 to 35 c.f.s. The following volume estimates have been made for various portions of Houghton Creek:

Upper Section	1 to 10 c.f.s.
Central Section	10 to 18 c.f.s.
Lower Section	18 to 35 c.f.s.

The velocity of Houghton Creek is rather rapid in the upper and central sections. In certain areas above Rose City, velocities exceed 2.5 f.s. An average for the upper and central sections are about 2 f.s., while that in the lower section range from 1.5 to 2 f. s.

The physical character of Houghton Creek varies considerably from source to mouth. Widths in the upper section vary from 1 foot to about 15 feet. Pools 15 to 20 feet occur from the entrance of Wilkins Creek to the mouth. Pools for the three sections (roughly thirds) have been classed as follows: upper section S_2 T_2 F_2, central section S_2 T_{1-2} F_1, lower section S_1 T_2 F_1. Bottom types of sand, gravel, rubble, clay, silt, and muck are present. Sand predominates in the extreme headwaters but is replaced by gravel and rubble as the stream approaches Rose City. Rubble, gravel, sand, and clay occur in the central section. Sand and silt are the predominant bottom types in the lower section, although a few gravel and rubble areas are found above the mouth. The stream is well shaded in the upper and lower sections but is somewhat open below Rose City. Water suitable for casting extends from the entrance of Simons Creek, 3/4 mile above Rose City to the mouth.

In the upper section snags, brush, cut banks, and stream improvement devices provide shelter. Cut banks, stream improvement structures, and brush are also found in the central section. No stream improvement devices are found in the lower portion, but adequate cover is present in the form of log jams, cut banks, snags, and deadheads. A good percentage of the improvement devices were functioning properly, but some were filled in and others had been made useless by eroded banks.

Table 63

Chemistry and temperature data from Houghton Creek

	Station 1 between upper and central sections	Station 2 at mouth
Date	July 30, 1941	July 26, 1941
Time	3:00 p.m.	11:00 a.m.
pH	8.4	8.4
Dissolved oxygen	9.5	10.1
Phenolphthalein	5.0	5.0
Methyl orange	169.0	175.0
Air temperature	81°	85°
Water temperature	65°	63°

Although temperatures were not obtained during critical periods, it is believed that sufficient data were obtained to draw some general conclusions regarding normal summer water temperatures in Houghton Creek. The volume of Houghton Creek is considerably larger than that of other streams of the Rifle River having similar lengths. All tributaries entering the stream are relatively cold and tend to cool the water below their entrance. Because of an abundant supply of cold water contributed by springs and tributaries in the relatively short length of the stream, temperatures over 70 degrees probably seldom occur. It is doubtful if Houghton Creek ever reaches 75 degrees during critical periods. It is believed that water

temperatures here represent optimum conditions for trout growth as they remain under the critical point and yet are sufficiently high for good growth.

Vascular aquatic plants in Houghton Creek were confined to small beds in the lower section in an area above the mouth. They have little value for providing cover or harboring fish food organisms considering the stream as a whole. Water weed and a pond weed were growing rather profusely at the mouth.

The upper and central sections of Houghton Creek were found somewhat above average in richness in the production of bottom organisms. The central section and lower part of the upper section produced an exceptionally large number of scuds and isopods. The lower section became progressively less productive as the stream neared the mouth. Caddis fly larvae and May fly nymphs were outstanding in regard to quantity. The three sections of Houghton Creek have been rated for food as follows: upper section - good to excellent, central section - good to excellent, lower section - fair. The gravel and rubble bottom types in the vicinity of Rose City were unusually productive and were largely responsible for the ratings given the upper and central sections.

Adult and fingerling brown trout predominated in collections from Houghton Creek. Brook and rainbow trout were present, but considerably less abundant. Yearling rainbows were quite common, but few smaller fish of this species could be found. Brook trout appeared to be confined largely to the headwaters in the upper section. No small brook trout were taken, but it is believed that natural reproduction occurs in the headwaters where the stream is well brushed over. Results from bob pole (set line) fishing in the lower section indicated the presence of many large brown trout.

Table 64

Growth rate of trout collected from Houghton Creek in 1941

Age group	0	I	II	III	IV	V
Brook trout						
Number	...	5	5	...	...	...
Size range	...	5.2-6.2	6.7-8.1	...	...	...
Brown trout						
Number	...	13	3	4	1	1
Size range	...	5.5-8.2	8.7-14.2	11.2-12.7	21.2	16.2
Rainbow trout						
Number	7	...	...	...	...	...
Size range	5.3-7.3	...	...	...	...	...

Natural reproduction of brown and rainbow trout obviously accounts for the presence of these two species as no plantings have been made since 1936 and 1937.

Table 65

Stocking Records for Houghton Creek, 1937-1940

	Brook trout	Rainbow trout	Brown trout
1937	2,500 - 6-month	3,000 - 3-month	...
1938	9,000 - 5-month	...	...
1939	22,000 - 7-8-month	...	...
1940	14,168 - 7-month	...	...

It is said that Houghton Creek formerly produced rainbow trout mostly, but in recent years brown trout have predominated. Undoubtably brook trout were the first to be introduced, although no reports on fishing in earlier years were obtained. The stream has a good reputation for producing good sized browns and rainbows. It was said that a dead brown trout 35 inches long was found along the bank of Houghton Creek in the spring of 1941.

Two and 3-pound fish were taken on bob poles in the lower section by the survey party. Local anglers were in agreement that the stream had produced fewer fish in 1941 than in any past season. The concentration of fishing is in the vicinity of Rose City.

Forage fish were neither abundant in number or species. Cottus cognatus and blacknose dace were taken in the central sections but did not occur in a blasting sample from near the mouth. Seining operations indicated that the concentration of suckers which appeared in the blasting sample were confined to the extreme lower section of Houghton Creek.

Table 66

A fish collection taken by blasting with dynamite at a point a quarter mile above the mouth of Houghton Creek, 1941

	Number	Lengths (inches)	Total weight
Brown trout	5	5 - 7	10 1/2 oz.
Rainbow trout	2	5 3/4 - 5	4.4 oz.
Common suckers	30	3 1/2 - 13 1/4	17 lbs. 10 oz.
Creek chubs	4	3 1/4 - 6 1/2	5.0 oz.
Common shiners	16	1 3/4 - 5	4.8 oz.
Hornyhead chubs	3	2 - 5	2.0 oz.

Returns from fish collections and angling are not commensurate with fish plantings. Although physical conditions of Houghton Creek apparently are suitable for brook trout, continued heavy plantings have not proven profitable.

Management Suggestions

Houghton Creek becomes quite turbid after heavy rains, and it is believed that erosion of cultivated land rather than creek banks is responsible for this condition. The speed of flow in the upper and central sections prevent

the deposition of sand and silt, but deep pools in the lower section may eventually suffer if heavy silting continues. It is suggested that further investigations regarding soil erosion be made in the drainage area above Rose City. Some control measures may be suggested to land owners within the area who might prevent excessive erosion by regulated planting, thereby cutting down the loss of soil from cultivated fields as well as preventing large amounts from entering the stream.

If new stream improvement devices are to be installed in Houghton Creek, it is suggested that the structures already there should be examined for determining what types are most effective for this water. Since parts of the central and lower sections are quite exposed to the sun, planting these areas with trees and shrubs should prove effective in reducing water temperatures of the lower sections of the creek. This also might be of benefit to the Rifle River.

In regard to artificial stocking, it is suggested that future plantings should consist of rainbow trout only. Plantings of brook trout in past years have produced very small returns and local sentiment seems to favor rainbow trout for this stream. Houghton Creek has a considerable number of fast runs in the vicinity of Rose City which are believed to be excellent areas for rainbow trout. The fishing intensity is very heavy here. Pools and available food have been designated as being above average. It is suggested that about 600 twelve-inch rainbow trout be distributed in early spring over a three-mile stretch of the stream between Simons Creek and Wilkins Creek.

Acquisition of frontage on Houghton Creek from Simons Creek to Section 10 should be considered.

Tributary No. 1-22

(Wilkins Creek)

Wilkins Creek arises in T. 23N., R. 2E., S. 2. From here it flows southward and then in an easterly direction, crossing M-33 three-quarters of a mile below Rose City, and entering Houghton Creek in T. 23N., R. 3E., S. 8. The stream is about 5 1/2 miles in length and is fed by two tributaries of minor importance.

The volume of flow out the mouth has been estimated as approximately 12 c.f.s. A volume reading of 10 c.f.s. was secured about midway along the stream. The cold springs in Section 2 produce a flow of about 3 c.f.s. Velocities of Wilkins Creek vary considerably. A measured velocity of 5 f.s. was obtained in the upper section. Headwater velocities averaged from 1 to 2 f.s. The central section had velocities from 2 to 5 f. s. Velocities in the lower section averaged from 2 to 3 f.s. In general, the average velocity of this stream is somewhat above that of most other tributaries of the Rifle River.

The upper section of Wilkins Creek flows through a dense cedar swamp which makes fishing difficult. Sand and silt are the predominant bottom types. The pools which are from 1 to 3 feet in depth, are quite common, although they are usually choked with water cress. It is doubtful if this section is used to any extent by anglers.

The central section, extending from Section line 11-12 to M-33, undergoes decided physical change. The upper part of this section flows through a swamp and is impounded by a beaver dam. Pools from 10 to 18 feet wide and 3 to 3 1/2 feet in depth are common. Sand and muck also predominate in this area. It is brushy until reaching the site of an old power dam in Section 12. From this point to M-33, rubble and gravel predominate, although some sand is present. The pools are somewhat shallower and lack

the abundance of cover found above.

The lower section has pools from 10 to 25 feet wide with depths ranging from 2 to 4 feet. Silt, muck and sand constitute most of the bottom type, although some areas of clay and rubble are also found. Cut banks, logs, and vegetation offer considerable cover in this section. The stream immediately below M-33 flows through an open meadow and has very few riffles. Pools in the lower portion are classified S_{1-2} T_{1-2} F_{1-2}.

Table 67

Chemistry and temperature data from the upper section of Wilkins Creek

Date	July 21, 1941
Time	10:30 a.m.
pH	8.0
Dissolved Oxygen	7.7
Phenolphthalein	2.0
Methyl orange	159.0
Air temperature	77°
Water temperature	47°

Temperatures in the headwaters probably remain quite low due to the considerable volume of spring water and excellent shade. A water temperature of 47 degrees was obtained in the headwaters at 10:30 a.m. on July 21. In the upper part of the central section a temperature of 55° was recorded at noon. A maximum temperature of 66° was obtained near the mouth of the stream at 5:30 p.m. when the air temperature was 86°. From these readings it appears that the waters of Wilkins Creek remain below 70° during the greater part of the summer and seldom, if ever, reach 75°.

Fish food organisms in Wilkins Creek seem to be well distributed regardless of bottom type. It is considered one of the most productive of all the streams tributary to the Rifle River. The upper section is the least productive of the three sections. In general, caddis larvae, May fly

nymphs, midges, and dragon fly nymphs were the predominant forms in the more productive areas.

Aquatic plants were quite abundant in the upper and lower portions of the stream. Water cress was growing profusely in the upper portion while dense beds of stiff water crowfoot were present in pools of the lower section having muck and silt deposits.

Three species of trout were collected in Wilkins Creek. Brook trout predominated in the upper section and were apparently the only fish capable of reproducing in this area. Many small brook trout were seined in the headwaters. Although no brown trout were taken in this section, it was reported that they occurred in the beaver pond in Section 12. A few legal and sub-legal rainbow trout were taken above and below the dam in this section. The central and lower sections have fish populations somewhat alike. Fingerling and legal brown trout predominate in this area. All three species apparently reproduce in the central section. Brown, brook, and rainbow fingerlings were present in that order of abundance.

Table 68

Growth rate of trout collected from Wilkins Creek in 1941

Age group	0	I	II	III	IV	V
Brook trout						
Number	...	2	9	4	1	1
Size range	...	4.7-5.3	6.3-7.0	7.1-7.5	8.2	10.7
Brown trout						
Number	7	7	1	1	1	...
Size range	1.8-3.2	6.4-7.2	8.9	17.0	13.6	...
Rainbow trout						
Number	...	6	1	...	...	...
Size range	...	5.6-7.0	9.1	...	...	...

Wilkins Creek has a good reputation among anglers of the vicinity. It is rated about equal to Klacking Creek by many anglers. The stream has produced some large fish in past years. One 5 1/2 pound brown trout was taken in the beaver pond in Section 12 during the summer of 1941.

Three species of forage fish were found in Wilkins Creek. The creek chub, mudminnow, and muddler (Cottus cognatus) were collected. Muddlers were the only forage fish present in the headwaters. A total of 47,667 five-to eight-month-old brook trout have been planted in Wilkins Creek since 1936. A planting of 3,000 three-month-old rainbows was made in 1936.

Management Suggestions

It is thought that the area of fish habitat in this creek could be appreciably increased by the installation of stream improvement structures in Sections 7 and 8. Since the beaver dam in Section 12 does not appear to produce any harmful effects on the stream below that point, it is suggested that it be retained.

If an increase of the rainbow trout population in this stream should be desired it is suggested that mature rainbows be planted early in the spring. Such plantings ought to be limited to 2 1/2 miles of stream in Sections 7 and 8. Using the types of pools and the quantity of food available as a basis of calculation, it is suggested that about a thousand 12-inch fish should be planted in this stretch.

Tributary No. 1-1-22

This stream enters Wilkins Creek in Section 7 and is about 1 1/2 miles long. It is 2 to 4 feet wide, 4 inches to 2 feet deep, has an estimated flow of 0.5 c.f.s., and the velocity is 0.5 f.s. The bottom types are sand and gravel. The stream flows through open meadow. Cover consists of cut

banks. Air and water temperatures at 2:30 p.m. on July 21, 1941 were 82° and 62°.

It was reported that this stream produces some large brown trout after heavy rains. Besides being utilized for fishing, it possibly also serves as a spawning area.

Tributary No. 2-1-21

This tributary carries a very small volume of water and is of little importance as a feeder stream of Wilkins Creek. The stream is not fished.

Tributary No. 2-22 (Beech Creek)

Beech Creek is somewhat over a mile in length and is impounded by a power dam in Rose City. The mill pond is owned by Charles Sanbeck of Rose City and was open to public fishing at the time of the survey. One 3 1/4 pound rainbow trout and seven brook trout from 9 1/4 to 14 inches were taken in a 5-hour set of two experimental gill nets. No small fish were taken and ages of adult fish ranged from 2 to 5 years. Choice locations were selected for the two net sets in the mill pond and it is possible that the catch was not representative of the area. Four rainbow trout and two brown trout were taken by angling between the mill dam and Houghton Creek. A legal brown trout and a legal rainbow were included in this group.

Observations on the pond and the stream below indicate that conditions remain favorable for trout throughout the year.

Table 69

Growth rate of trout collected from Beech Creek in 1941

Age group	I	II	III
Rainbow trout			
Number	2	2	...
Size range	5.5-7.0	6.1-6.3	...
Brown trout			
Number	1	...	1
Size range	7.0	...	9.2

Table 70

Growth rate of trout collected from the Rose City Mill Pond on Beech Creek in 1941

Age group	II	III	IV	V
Brook trout				
Number	1	3	2	1
Size range	9.2	11.6-12.2	10.5-13.8	14.1
Rainbow trout				
Number	0	0	0	1
Size range	...	...	...	20.1

Management Suggestions

It is thought that a plant of several hundred rainbow trout in the mill pond would improve fishing considerably. Assurance of public access to the pond should be secured from Mr. Sanbeck before plantings are made. The stream below the dam has a sufficient number of fish and does not need additional stocking.

Tributary No. 3-22 (Bixby Creek)

Bixby Creek enters Houghton Creek in Section 31 and is fed by one tributary, Barber Creek (1-3-22). Trout have been reported for Bixby Creek but it is too small to be considered as a fishing or spawning area. The stream and its tributary are brushed throughout most of their length. The following temperatures were obtained near the mouth: air-76°, water-64°; time: 11:00 a.m. July 30, 1941. No recommendations are offered for this stream because of its small size.

Tributary No. 4-22 (Simon's Creek)

Simons Creek is about 1 1/2 miles in length. It is formed by a number of springs in Section 19, and additional springs contribute to the flow in Section 30. A volume of 1. c.f.s. was recorded near the origin,

but it is believed that the volume is approximately 2.5 c.f.s. at the mouth. A velocity of approximately 2 to 3 f.s. occurs throughout the length of the stream. Pools vary from 1 to 2 1/2 feet in depth and from 2 to 5 feet in width. They are usually well shaded and have excellent cover. Sand predominates in most pools, although a number of gravelly pools are present in the upper section.

Table 71

Chemistry data from the headwaters of Simon's Creek

Date	August 5, 1941
pH	8.0
Dissolved Oxygen	13.4
Phenolphthalein	4.0
Methyl orange	191.0

The water temperature of Simon's Creek apparently remains quite low throughout the summer. A maximum water temperature of 57 degrees was obtained below the beaver dam in Section 30 at 11 a.m. on August 5. It was found that cold spring water which enters the stream below the beaver dam reduced the temperature about 3 degrees. A temperature of 52 degrees was obtained about a half mile below the origin. Air temperatures from 75-80 degrees existed at the time of these investigations.

No aquatic plants were recorded for Simon's Creek. Fish food organisms were rated as fair to good in abundance.

Brook and brown trout are apparently well distributed over the length of the stream. Fingerling and sub-legal brook trout were rather abundant. Although a number of legal brown trout were taken above the beaver dam, fingerling browns were not as common as small brook trout. A 13-inch brown was taken about a quarter mile below the origin of the stream. It has been reported that the beaver pond in Section 30 produces a good number of brown trout. The stream in general is considered good fishing by local anglers.

Table 72

Growth rate of trout collected from Simon's Creek in 1941

Age group	0	I	II	III	IV
Brook trout					
Number	1	3	0	0	0
Size range	2.0	4.3-5.7	...	...	...
Brown trout					
Number	2	0	2	0	...
Size range	2.1-2.3	...	7.7-8.0	...	13.0

Management Suggestions

The beaver pond is an asset to the stream in that it not only produces fish, but also warms the colder water from above to stimulate trout growth below this point. For these reasons the dam should not be disturbed. Natural cover and pool formations in this stream appear to be adequate, so no improvement work is suggested. Simon's Creek evidently has sufficient natural reproduction of brown and brook trout.

Tributary No. 1 of Devoe Lake (Gamble Creek)

Gamble Creek is approximately 3 1/2 miles long and at the time of the survey about half of the stream was open to public fishing. The lower half of the stream lay within private land (the H. M. Jewett Estate), which was not open to public fishing.[3] The stream originates to the north and east of Lupton in Section 25 and flows in a general southerly direction, entering Devoe Lake in Section 11. The Gamble is fed by a number of tributaries of varying importance.

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[3] The water on this 4288—acre tract was opened to public fishing in 1945 when the Department of Conservation bought the estate which now is known as the Rifle River Area.

A volume of 13 c.f.s. and velocity of 1.8 f.s. was recorded for the central section of the stream where it enters what in 1941 was private land. Tributaries entering the stream below this point contribute a volume estimated to be in excess of 18 c.f.s., as based on headwater measurements. Only about a half mile of water above the Jewett Estate was found suitable for fly fishing as the stream above the junction of two tributaries in Section 36 is relatively small and brushed over. The pool classifications of Gamble Creek are as follows: upper section, $S_{1-2}\ T_2\ F_2$; central section, $S_{2-3}\ T_3\ F_3$; lower section, $S_2\ T_2\ F_1$. In general, pool formations in the central section are very poor in quality and offer little protection for larger game fish, although it was stated that this portion of the creek is used by spawning brown trout of Devoe Lake. The bottom type is predominatly gravel and rubble which appears to be excellent for redds. (See photo) It is believed that the central section is of greater value for spawning than fishing. Depths here vary from 8 to 18 inches and velocities average from 1.5 to 2 f.s. The upper and lower sections have much better pools but apparently lack suitable substrata for spawning, at least for larger fish.

Shade and cover in the upper and lower sections are very good.

A chemical analysis of the water in the central section indicated that all chemical factors for fish life were favorable.

Table 73

Chemical data for the central part of Gamble Creek in Section 35

Date	August 9, 1941
Time	1:00 p.m.
pH	8.3
Dissolved Oxygen	8.8
Phenolphthalein	5.0
Methyl orange	205.0

Water temperatures of Gamble Creek are excellent in the upper and central sections and part of the lower section. A water temperature of 63 degrees was obtained in the lower section on August 9, 1941 at 1:00 p.m. with a corresponding air temperature of 80 degrees. The creek becomes quite wide in the marsh area above Devoe Lake and at one place flows through a shallow pond. Although maximum summer temperatures were not obtained for Gamble Creek, it is believed that the water temperature remains sufficiently low for brook trout from its origin to a point about a quarter mile above Devoe Lake. Maximum summer water temperatures in the wide, shallow stretches of stream above the lake probably exceed 75 degrees. Vaughn Creek enters the stream in the lower section and undoubtedly lowers the water temperature, as daily records over a number of years indicate that the maximum summer temperature is about 62° and that an average maximum daily temperature would be about 55 degrees.

The number and volume of fish food organisms in Gamble Creek vary according to the bottom type. The mixed gravel and rubble bottom type of the central section was by far the most productive. An abundance of sand, silt, and organic debris in the lower section results in a limited number and volume of fish food organisms. The upper section is considered poor to average in richness. Scuds mayflies and caddis flies were the predominant fish food organisms. The productivity of Gamble Creek would be classed as poor in considering the three sections collectively.

Aquatic plants in Gamble Creek were confined to the lower and central sections. Small beds of Chara were found there and waterweed was unevenly distributed over the lower section. The beds of waterweed were usually associated with deposits of organic detritus.

Brooks and browns were the only trout recorded for Gamble Creek.

It is believed that this stream supports a relatively small number of adult trout. The lower section of the Gamble has many characteristics of a good trout stream with the exception of food production. Only a few legal fish were taken here contrary to the fact that it is fished very little. From these results it would appear that food may be a limiting factor, although growth rates are comparable to those of other tributaries of the Rifle River. The upper section of Gamble Creek produced a larger number of adult fish. Several legal trout were observed in the open central section.

Fingerling brown trout predominated throughout the central and lower sections of the stream, although brooks became progressively more abundant in the headwaters. It was reported that Gamble Creek at one time was an exceptionally good brook trout stream, and statements regarding limit catches of this species in past years seem to be authentic. In recent years the catch has been predominantly brown trout, although survey collections over the area indicate that about an equal number of brook trout are present.

Table 74

Growth rate of trout collected from Gamble Creek in 1941

Age group	0	I	II	III
Brook trout				
Number	0	3	5	0
Size range	...	5.7-6.2	6.5-9.4	...
Brown trout				
Number	10	5	3	1
Size range	2.2-2.8	5.1-7.0	5.7-7.1	11.0

Fish-collections were made in Devoe Lake which lay within the Jewett Estate. It was found that the lake supported a considerable number of exceptionally large brown trout. Twenty trout ranging from 10 1/4 to 24

inches were taken in gill nets and/on set-lines. The age of these fish ranged from two to five years. Judging from the age groups collected in the lower portion of Gamble Creek, it appears that most of the brown trout move down to Devoe Lake after the first annulus is formed. The only suggestion as to the apparent cause of this phenomenon is the shortage of food in the stream.

Table 75

Growth rate of brown trout collected from Devoe Lake in 1941

Age group	II	III	IV	V
Brown trout				
Number	2	7	6	6
Size range	10.1-11.4	11.1-18.7	16.3-22.5	20.2-23.7

Management Suggestions

Under present conditions Gamble Creek, its tributaries, and Devoe Lake are somewhat separated from the Rifle River by a dam which increases the level of the lake and forms a barrier to the upstream movement of fish. Surface water temperatures in summer would also tend to limit a downstream movement of trout. Because of the dam, the water tributary to the Rifle River above this structure is more or less of a separate unit.

Reports of spawning activities in Gamble Creek and the netting results on Devoe Lake indicated that the population of spawning brown trout moving from the lake to the central section of Gamble Creek is sufficient to merit the construction of a weir from which spawning brown trout could be taken for stripping. Thus, the present population of large trout could be utilized, to some extent, to reduce the cost of raising adult fish in hatcheries. It has been reported that under normal conditions the spawning run persists over a very short period of time.

The open water in the central section could be advantageously modified by installing stream improvement devices which would form pools and provide cover.[4]

It is believed that natural reproduction of brook and brown trout in the stream is adequate under the present conditions, making artificial stocking unnecessary.

Tributary No. 1-1, Devoe Lake (Brown Trout Creek)

This stream is about 3 1/2 miles long, 2 to 15 feet wide, and averages about 6 inches deep. Its water supply is derived from springs and two tributaries--Mayhue and Oyster creeks. At the headwaters it was found to have a volume of 0.8 c.f.s. while at the mouth the volume was about 12 c.f.s. Velocities ranged from 0.5 to 1.5 f.s.

Andrews (or Brown Trout) Creek is a brushy stream, well shaded, but the few pools are relatively shallow. The bottom soils consist mostly of sand, silt, and muck, with gravel in the headwaters. Temperatures in the lower section at 11 a.m. on August 8, 1941 were air, 85 degrees and water, 64 degrees; temperatures in the upper section at 3 p.m. on the same date were air, 78 degrees and water, 60 degrees.

Table 76

Chemistry data for Andrews Creek, taken where Mayhue Creek enters

Date	August 1, 1941
pH	8.3
Dissolved Oxygen	9.2
Phenolphthalein	0.0
Methyl orange	122.0

[4] A total of 97 stream improvement structures were installed in Gamble Creek and 55 in the Rifle River in or about 1931. For a description of these devices and their early effects on the streams see: Tarzwell, Clarence, Institute Report No. 185, A Report on the Improvement Work on the Gamble and Rifle Rivers.

Leafy pondweed (Potamogeton epihydrus) was found in this stream.

The production of fish food organisms was found to be good in Sections 28 and 33 (the upper part of the stream) but poor in Sections 2 and 3 (the lower part of the stream).

Brook trout are the most common fish of this stream. There also are a few brown trout.

Table 77

Growth rate of brook trout collected from Andrews Creek in 1941

Age group	0	I	II
Brook trout			
Number	4	6	4
Size range	1.6-2.6	4.2-5.4	5.7-7.3

Around the time of the survey only a small part of Andrews Creek was fished, probably largely because the lower half of the stream lay in private land. The upper part of the creek is too small to be of significance for fishing. Extensive beaver work in the lower section apparently was responsible for heavy deposits of silt and muck.

No management suggestions are offered for this stream.

Tributary No. 1-1-1, Devoe Lake (Oyster Creek)

Oyster Creek, a tributary of Andrews Creek, is about 2 1/2 miles long, 2 to 5 feet wide, and has depths ranging from 6 inches to 2 feet. Its water supply comes from springs. The volume of flow in the central section was 2.5 c.f.s. and at the mouth 3 c.f.s. The velocity was 1.5 f.s.

This is a brushy stream and is well shaded. The pools are from 10 inches to 2 feet deep. The bottom soil is mostly sand. There is gravel in the upper section. Temperatures in the central section at 4:30 p.m. on

August 12, 1941 were air, 69 degrees and water, 56 degrees.

The only fish collected from this stream were brook trout, and none of these was of legal length. Possibly brown trout occur in the lower part of the stream.

Table 78

Growth rate of brook trout collected from Oyster Creek in 1941

Age group	0	I
Brook trout		
Number	3	1
Size range	2.0-3.0	5.5

No aquatic vegetation was found here.

In the production of fish food organisms Oyster Creek rates from poor to fair, with scuds predominating.

This stream is fished lightly, although it produces a few legal brook trout.

No management suggestions are offered.

Tributary No. 2-1-1, Devoe Lake (Mayhue Creek)

This tributary of Andrews Creek is about 2 1/2 miles long, 3 to 5 feet wide, and 2 inches to 2 feet deep. The water supply is derived from springs. The volume of flow at the mouth was 6 1/2 c.f.s. and the velocity at the same point was 2.4 f.s.

This also is a brushy, well-shaded stream. The pools are of average quality for a stream of this size. The cover, which consists of brush and cut banks, is good. The bottom types are sand, clay, and gravel. Air and water temperatures at the mouth at 3 p.m. on August 8, 1941 were 78° and 58° respectively.

Table 79

Chemistry data from Mayhue Creek

Date	August 8, 1941
pH	8.4
Dissolved Oxygen	9.8
Phenolphthalein	8.0
Methyl orange	198.0

No aquatic plants were found in this stream.

Mayhue Creek rated average in the production of fish food organisms in the lower half and good in the upper half.

The fish in this stream are predominantly brown trout, but brook trout are also present The upper part of the stream contained a rather large population of both legal and sub-legal brown trout at the time of investigation.

Table 80

Growth rate of trout collected from Mayhue Creek in 1941

Age group	I	II	III	IV
Brook trout				
Number	2	3	0	0
Size range	4.7-5.0	5.7-6.4	...	...
Brown trout				
Number	2	2	5	1
Size range	5.6	6.7-8.5	8.2-9.7	9.2

No recommendations are offered for Mayhue Creek as it apparently supports a maximum population of legal brown trout under present conditions.

Tributary No. 2-1, Devoe Lake (Vaughn Creek or Fontinalis Creek)

This tributary of Gamble Creek has its origin in a cedar swamp northwest of Lupton. It is four miles long, 3 to 12 feet wide, and 1 to 3 1/2 feet deep. Springs supply its water. The volume of flow in the upper and central sections and at the mouth was 4.5, 8, and 10 c.f.s., respectively. Velocities ranged from 1 to 1.5 f.s.

The stream is brushy and the shade, cover, and pools are excellent. The bottom types are mostly sand and clay, with some gravel. Maximum summer temperatures probably do not exceed the low sixties.

Table 81

Chemistry data from Vaughn Creek

Date	August 12, 1941
pH	8.4
Dissolved Oxygen	10.2
Phenolphthalein	3.0
Methyl orange	212.0

Chara occurs in this stream.

The rating of Vaughn Creek in the production of fish food organisms was as follows: upper section, poor; central section, fair; lower section, good.

Brook and brown trout were found in this stream but both appeared few in number. Two beaver dams that had been recently constructed will undoubtedly benefit the stream by increasing water temperatures and providing good fishing in the impoundments.

No management suggestions are offered.

Tributary No. 3-1, Devoe Lake

This tributary was traversed but was not investigated in detail. In general the stream is of the bog type and contained the remains of

three beaver dams. One dam impounded about 3 acres of water while the other 2 had been opened. Since no recent beaver workings were observed, the dam impounding water was broken out at the time of the survey. The stream supports a small number of brook and brown trout.

Pollution in the Rifle River and Its Tributaries

Three forms of pollution have been observed and reported for the Rifle River drainage system. When the survey was made, perhaps the most constant source of pollution was from the producing oil fields in the Mansfield area. The Stream Control Commission has made numerous investigations regarding the chloride content of Mansfield Creek water, and the tests showed an alarmingly heavy concentration. Investigations by the survey party relative to the flora and fauna conclusively showed that extreme pollution occurred throughout a large portion of the stream.

Routine chemical and biological checks were made just below and above the source of pollution. Although our series of tests for the chemical content of water do not include a test for chloride, a heavy concentration of chloride was indicated by the precipitation of some chemicals, while determinations for other values were being made. The water just below the source of pollution was tasted by some members of the party and was found comparable to a strong salt-water solution. Bottom samples taken in this area revealed only one form of organism, the larvae of an unidentified fly.

Further investigation in this area revealed an old oil well, which had been converted into a brine well, flowing about 60 gallons a minute. The water coming from this well was believed to be almost a saturated salt solution. Although the brine was absorbed by sand before reaching the

stream, the evidence of its underground travels was obvious from dead timber in the area. Reports from the Stream Control Commission indicated a large amount of pollution coming from this source.[5] However, the quantity of brines coming from the oil wells in this area has been reduced to a minimum because of protective measures taken by the operators. But even if all forms of oil and salt well pollution were eliminated here it would undoubtedly take considerable time for the stream to regain its original productivity, due to the vast quantity of sub-surface salt brine that has accumulated. (Pollution in Mansfield Creek has also been discussed on Pages 80-82.)

Two forms of pollution occurred in the West Branch of the Rifle River at the time of the survey. There also was a possibility of a third source which was revealed by our investigations.

An oil refinery, located just south of West Branch, had diverted headwaters of the North Fork of Eddy Creek to the West Branch of the Rifle River. This spring-fed stream supplied water for the refinery and provided means of disposal for refinery wastes. During the survey our attention was directed to a certain area of the West Branch below the mouth of C. K. Eddy Creek (the name given to the diversion stream). In seining operations on this part of the West Branch many fish were observed in various stages of decomposition, and others that had been dead only about a day. The situation gave every evidence of recent pollution, and officials of the

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[5] For results of subsequent studies of the problem presented by Mansfield see: Washburn, George and John Greenbank, Institute Report No. 805, Preliminary Inspection of Mansfield Creek, Arenac County, with Respect to Salt-Water Pollution.

Hubbs, Carl L. and George N. Washburn, Institute Report No. 863, Experimental Work on the Toxicity of Michigan Oil Brines to Fishes.

Stream Control Commission were notified. The following day Mr. L. F. Oeming visited our camp and accompanied us to the polluted area, but subsequent tests revealed neither depletion of oxygen nor the presence of phenol, a chemical often associated with pollutants coming from oil refineries. While no specific cause for the loss of fish could be determined, it was thought that a phenol concentration had passed through this section of the stream. Because this chemical is subject to rapid decomposition, tests for it often prove negative.

The day following our first observation of dead fish along the banks, forage fish were taken in this section of the stream, indicating that a rather limited area had been affected. Reports of fish killings in this portion of the West Branch have come up from time to time.

Another pollutant entering the West Branch was of organic nature. Raw domestic sewage from the town of West Branch entered Ogemaw Creek (locally known as the West Branch) a short distance above Flowage Lake. Although tests made below the sewer outlet gave no indication of oxygen depletion, a deposition of organic wastes on the bottom was observed which might well have had a contaminating effect, as tubificids were found below the lake. The presence of these worms is one of the best indicators of organic pollution. Organic waste materials in streams, such as were found in the West Branch, may not be dangerous at all times, but they can be a potential menace to fish populations. Besides, the esthetic value of a stream is greatly reduced by their presence.

A third possible form of pollution occurring in this stream was that of oil sludge from the oil field northwest of West Branch. This material was of considerable importance in former years, but with the decline of oil production in this area and possibly also because of improved methods

of waste disposal here sludge probably was of minor importance in the stream in 1941.

Oil sludge appeared to have greater significance in Rifle Creek. But here, too, the consequences of pollution appeared limited because of the relatively small area affected and also because the stream in other respects was found not generally suited for trout. Most bottom samples below the oil fields exposed a dark, oily sludge. In all instances when this sludge was brought to the surface, it disintegrated to leave an oil film on the water. The fact that bottom samples taken below the oil fields revealed very few organisms, while samples above were average in richness, indicates that the stream is affected by this pollutant. Some evidence of the sludge was also found on the bottom of Flowage Lake.

Summary of Pollution in the Rifle River Drainage

Undoubtedly the most serious pollution in the Rifle River drainage system occurred in Mansfield Creek. This tributary had many characteristics favorable for trout, but pollution by chloride waste had made it virtually sterile for fish and fish food organisms. Just to what extent the Rifle River was affected by the salt brine carried by Mansfield Creek is not known, although it seems probable that dilution considerably reduced the effects of the chloride suspension when it reached the much larger stream.

The West Branch of the Rifle River and its tributaries probably were affected by three types of pollution. One of these was oil refinery wastes which were thought to contain phenol; this affected a limited area of the West Branch immediately below C. K. Eddy Creek and was believed responsible for some fish mortality. The second was domestic sewage discharged by the town of West Branch into Ogemaw Creek; the most obvious effect of this was

a deposition of waste on the bottom and which apparently mostly involved a nuisance problem. A third form of pollution was oil sludge which at the time of the survey occurred mainly in Rifle Creek; this had become of less importance because of the decline of oil production in this area and the better control of oil wastes.

Appendix I

List of Common and scientific names of fishes referred to in this report

Game Fish	
Smelt	Osmerus mordax
Brook trout	Salvelinus f. fontinalis
Brown trout	Salmo trutta fario
Rainbow trout	Salmo gairdnerii irideus
Northern pike	Esox lucius
Perch	Perca flavescens
Rock bass	Ambloplites rupestris
Pumpkinseed	Lepomis gibbosus
Smallmouth bass	Micropterus d. dolomieu
Longear sunfish	Lepomis megalotis peltastes
Coarse Fish	
Common white sucker	Catostomus commersonnii
Hog sucker	Hypentelium nigricans
Golden redhorse	Moxostoma erythrurum
Greater redhorse	Moxostoma rubreques
Northern redhorse	Moxostoma aureolum
Northern black redhorse	Moxostoma d. duquesnii
Yellow bullhead	Ameiurus n. natalis
Brown bullhead	Ameiurus n. nebulosus
Black bullhead	Ameiurus m. melas
Forage Fish	
Common shiner	Notropis cornutus
Rosyface shiner	Notropis rubellus
Hornyhead chub	Nocomis biguttatus
Creek chub	Semotilus atromaculatus
Pearl dace	Margariscus margarita nachtriebi
River chub	Nocomis micropogon
Brassy minnow	Hybognathus hankinsoni
Brook stickleback	Eucalia inconstans
Blacknose shiner	Notropis heterolepis
Blackchin shiner	Notropis heterodon
Barred Fantail	Catonotus f. flabellaris
Johnny darter	Boleosoma nigrum
Channel darter	Cottogaster copelandi
Blackside darter	Hadropterus maculatus
Iowa darter	Poecilichthys exilis
Logperch	Percina caprodes
Rainbow darter	Poecilichthys caeruleus
Blacknose dace	Rhinichthys atratulus
Stoneroller	Campostoma anomalum
Banded killifish	Fundulus diaphanus
Lake emerald shiner	Notropis atherinoides
Spottail shiner	Notropis hudsonius

Forage Fish

Spotfin shiner	Notropis spilopterus
Mimic shiner	Notropis volucellus
Fathead minnow	Pimephales promelas
Western mudminnow	Umbra limi
Tadpole madtom	Schilbeodes mollis
Michigan brook lamprey	Ichthyomyzon fossor
American brook lamprey	Entosphenus lamottenii
Longnose dace	Rhinichthys cataractae
Northern redbelly dace	Chrosomus eos
Bluntnose minnow	Hyborhynchus notatus
Stonecat	Noturus flavus
Slimy muddler	Cottus cognatus
Least darter	Microperca m. microperca
Northern muddler	Cottus b. bairdii
Finescale dace	Pfrille neogaea

Obnoxious Fish

Sea lamprey	Petromyzon marinus
Carp	Cyprinus carpio
Mud pickerel	Esox vermiculatus

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RIFLE RIVER WATERSHED

OGEMAW AND ARENAC COUNTIES

T 18-24 N, R 1-5 E

WATERSHED AREA 390 SQ. MI.

MAP MODIFIED FROM MICHIGAN STATE HIGHWAY, AND CONSERVATION DEPARTMENT MAPS

MAP 1. The division of the Rifle River into three sections (I, II, III), and of each section into three portions (lower, central and upper), for purposes of the present biological survey; and the locations of field inventory stations.

Section I
Section II
Section III
Lower portion
Central portion
Upper portion

Chemistry station
Fish-collection station
Bottom-sample station

W.L.C.

RIFLE RIVER WATERSHED

OGEMAW AND ARENAC COUNTIES

T 18-24 N, R 1-5 E

WATERSHED AREA 390 SQ. MI.

MAP MODIFIED FROM MICHIGAN STATE HIGHWAY, AND CONSERVATION DEPARTMENT MAPS

MAP 2. Classification of the Rifle River and its tributaries according to trout water and pollution.

- Warm-water areas
- Trout waters
- Marginal trout waters
- Areas polluted, or subject to pollution

W.L.C.

RIFLE RIVER WATERSHED

OGEMAW AND ARENAC COUNTIES

T 18-24 N, R 1-5 E

WATERSHED AREA 390 SQ. MI.

MAP MODIFIED FROM MICHIGAN STATE HIGHWAY, AND CONSERVATION DEPARTMENT MAPS

MAP 3. Classification of the Rifle River and its tributaries according to type of game fish best suited to the water, and according to method of fishing possible.

- Brook trout
- Rainbow trout
- Brown trout
- Smallmouth bass
- (dotted line) Brush stream, no fly-fishing
- (solid line) Open stream fly-fishing possible

W.L.C.

RIFLE RIVER WATERSHED

OGEMAW AND ARENAC COUNTIES

T 18-24 N, R 1-5 E

WATERSHED AREA 390 SQ. MI.

MAP MODIFIED FROM MICHIGAN STATE HIGHWAY, AND CONSERVATION DEPARTMENT MAPS

MAP 4. Classification of the Rifle River and its tributaries according to pool types.

Pools poor
Pools average
Pools good

W.L.C.

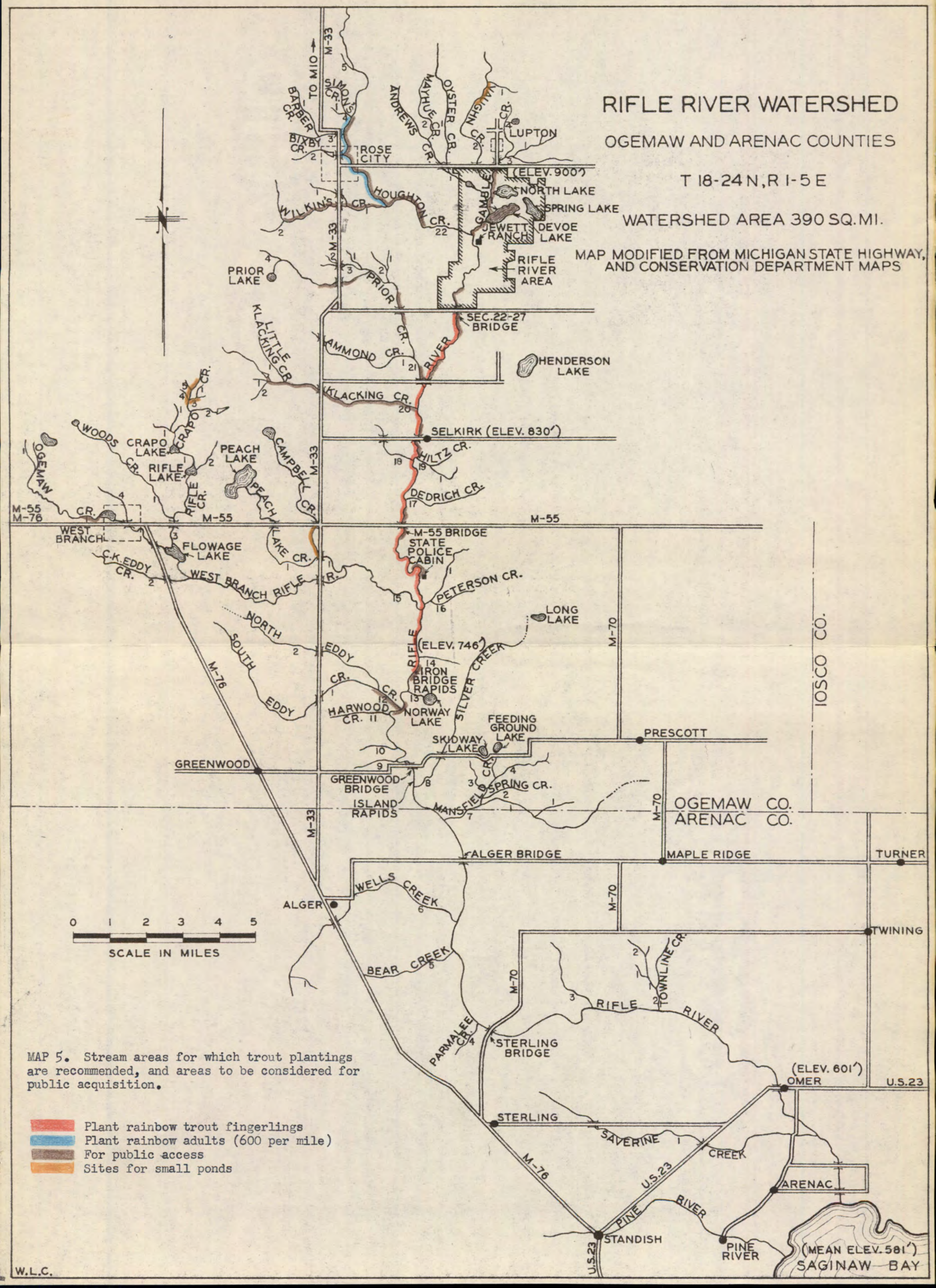
RIFLE RIVER WATERSHED

OGEMAW AND ARENAC COUNTIES

T 18-24 N, R 1-5 E

WATERSHED AREA 390 SQ. MI.

MAP MODIFIED FROM MICHIGAN STATE HIGHWAY, AND CONSERVATION DEPARTMENT MAPS



MAP 5. Stream areas for which trout plantings are recommended, and areas to be considered for public acquisition.

- Plant rainbow trout fingerlings
- Plant rainbow adults (600 per mile)
- For public access
- Sites for small ponds

W.L.C.

RIFLE RIVER WATERSHED

OGEMAW AND ARENAC COUNTIES

T 18-24 N, R 1-5 E

WATERSHED AREA 390 SQ. MI.

MAP MODIFIED FROM MICHIGAN STATE HIGHWAY, AND CONSERVATION DEPARTMENT MAPS

MAP 6. Proposed stream improvement, and records of beaver dams on Rifle River and tributaries.

- Proposed stream diversion
- Stream sections needing improvement
- Stream areas for impounded trout waters
- Probable extension of trout water resulting from stream improvements
- Active beaver dams (in 1941)
- Abandoned beaver dams (as of 1941)

W.L.C.