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MICHIGAN DEPARTMENT OF CONSERVATION
Research and Development Report No. 23*

February 16, 1965

OBSERVATIONS ON THE NATURAL HISTORY OF THE RAINBOW TROUT AND RAINBOW TROUT FISHING IN THE EAST BRANCH OF THE AU GRES RIVER, IOSCO COUNTY, MICHIGAN[1]

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Introduction

Michigan anglers and the Michigan Department of Conservation have more than a passing interest in the rainbow trout (Salmo gairdneri) of the East Branch of the Au Gres River. This stream system is relatively close to southeastern Michigan population centers, and receives considerable angling pressure.

Since 1942 the Conservation Department's Fish Division has been involved in various investigations on this stream. Scale samples, measurements, and other life history data were collected from rainbow trout in the course of these investigations. The purpose of this paper is to consolidate the more pertinent findings in order to present a useful picture of the age and growth of these lake-run rainbow trout, and to discuss briefly some of the observations made on the East Branch of the Au Gres River during the past two decades.

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Angling results on various parts of the drainage are described in several earlier Institute for Fisheries Research reports (639, 734, 950, 1016, 1050, 1131, 1274, 1396, 1439, 1483).

Description of the drainage basin

The East Branch of the Au Gres River lies almost entirely in Iosco County, about 170 miles north of Detroit, and about 70 miles from the Bay City-Saginaw-Midland area. It is formed by the junction of Hale Creek, which rises in Long Lake, and Smith Creek which drains Loon Lake. These two streams are about 10 feet wide at normal summer level; original bank cover was dense cedar, most of which has been removed. The major tributary to the East Branch is Guiley Creek, formed by the junction of Pickett and Vaughn creeks, both of which drained dense coniferous swamps. The only other tributaries of consequence are Sand Creek and Saddler Creek, whose combined flow (mainly through farm land at present) is channeled into the East Branch by McMullen Drain.

About two miles downstream from McMullen Drain, the East Branch has been diverted 4.2 miles east by the Whitney "A" Drain and flows directly into Lake Huron. Prior to about 1920 the East Branch emptied into the main Au Gres River, which enters Saginaw Bay near the town of Au Gres. The drain was constructed to alleviate flood damage in the onion fields along the lower course of the main river. The geographical relationships are shown on the map (Figure 1).

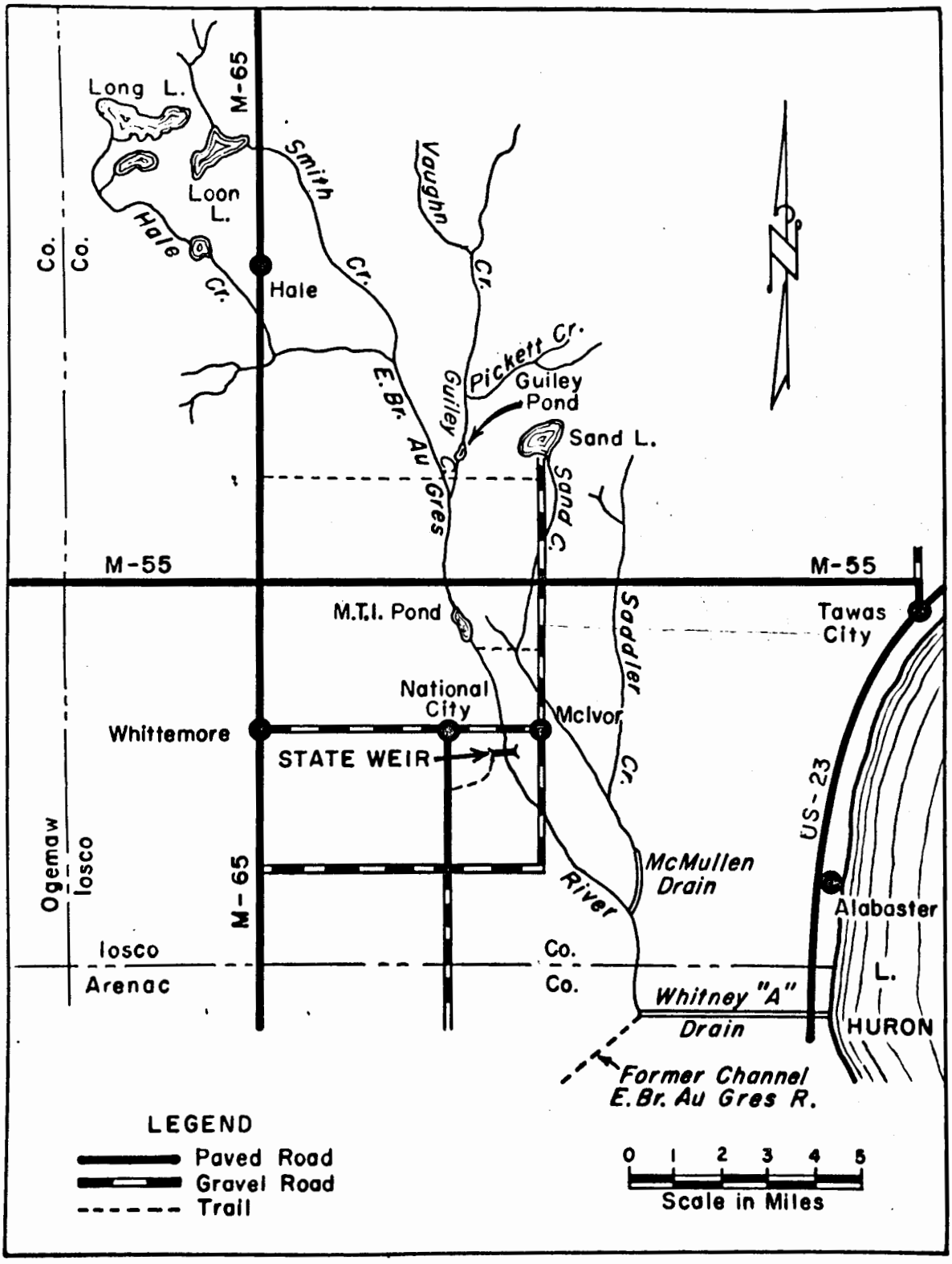

Fig. 1.--East Branch Au Gres River, Iosco and Arenac counties, Michigan.

The East Branch, from Lake Huron to the junction of Hale and Smith creeks, is approximately 20 miles long. Its drainage basin covers about 125 square miles.

Flow measurements and water temperatures for the period October 1951 to September 1952 were furnished by the Water Resources Branch, Geological Survey, U. S. Dept. of the Interior (courtesy of Dale Pettingill). The measurements were made on a Stevens A-35T Continuous Recorder with temperature attachment, housed in a small wooden building over a pipe well, at the bridge west of McIvor. Numerous discharge measurements at various gage heights were made with a Price Electric Current Meter until a satisfactory rating curve was developed. The mean flow for the 1951-1952 water year was 81.5 cfs. Monthly means varied from 43.0 (September 1952) to 235 cfs. (April 1952). The minimum flow noted was 35 cfs. during August 26-29, and the maximum was 865 cfs. on April 14, 1952.

Water temperatures at the McIvor Bridge stayed between 33° and 40° F. from December 10, 1951 to April 7, 1952. Maximum daily temperatures were 70° F. or more on 7 days in June and 10 days in July. The highest temperature noted was 75° F. Monthly means of flow and temperature are shown graphically in Figure 2.

Field observations in 1941-1942 indicated that numerous spawning areas for rainbow trout existed in the streams of the East Branch system upstream from the State Weir. Water temperature data indicate that thermal

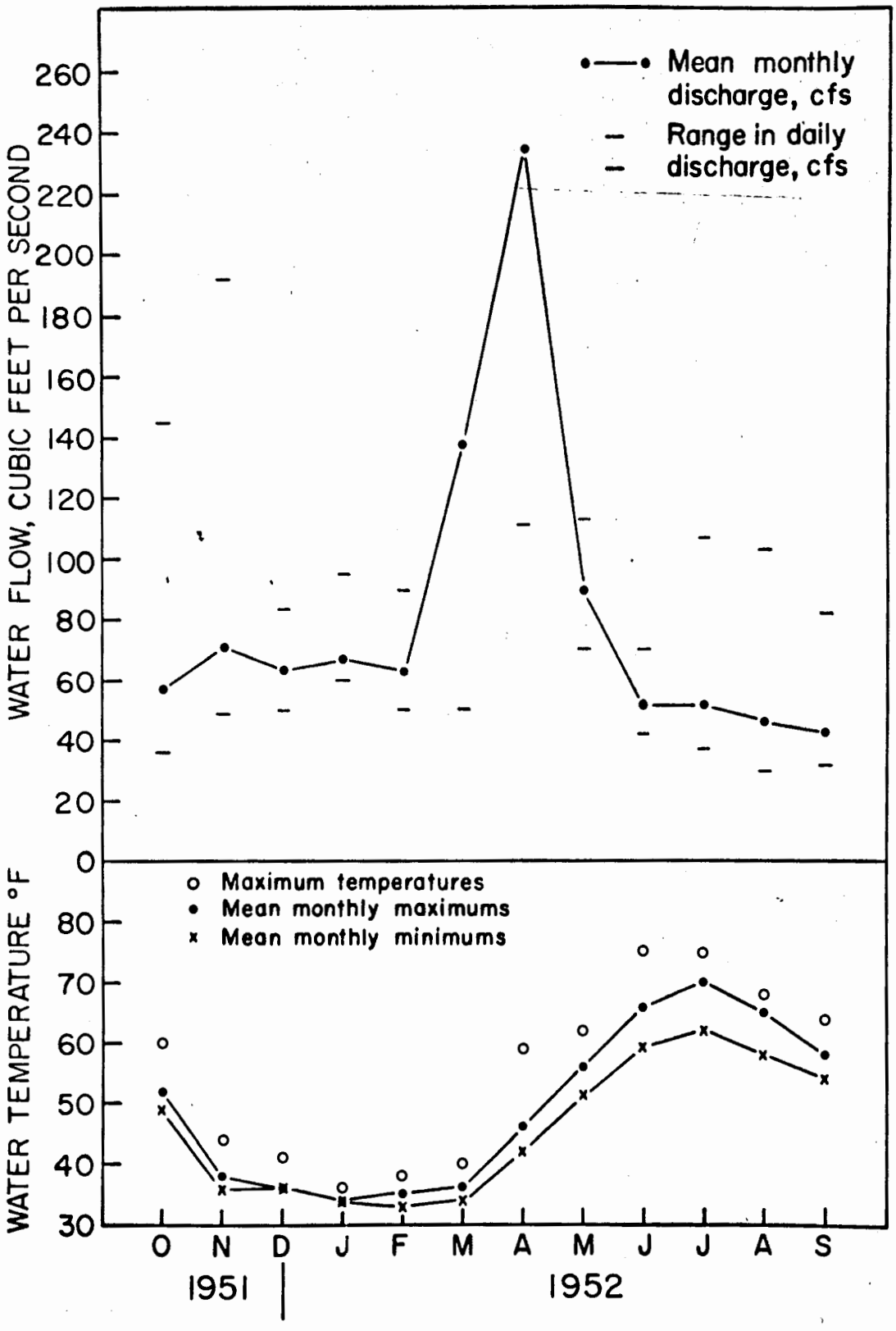

Fig. 2. --Discharge (cfs) and water temperatures (° F) McIvor Bridge, East Branch, Au Gres River, Iosco County.

conditions in the East Branch are suitable for trout, except that in very hot weather some of the stream below the National City-McIvor Road may become marginal.

The terrain through which the East Branch flows was lumbered off between 1865 and 1890. Much of the upland has since been farmed and pastured. The underlying clay or a clay-loam mixture contributes to a fast, turbid run-off following rains or snow melt. In the past two decades, highway construction and farm field ditching have silted in much of a formerly fine stretch of rainbow trout spawning territory between the M-65 bridge over Hale Creek and the junction of Guiley Creek and the East Branch.

Most of the data reported here, except for a few records of tagged trout caught in the lower drainage or in the Great Lakes, were obtained in the upper three-quarters of the East Branch, where ecological conditions were suitable for reproduction and growth of rainbow trout.

Spawning runs of the sea lamprey (Petromyzon marinus) have been noted in the East Branch annually since 1941. The rainbow trout is the dominant species of trout; however, brown trout (Salmo trutta) occur, and a moderate population of native brook trout (Salvelinus fontinalis) is still present. The stream was highly regarded for its brook trout fishing in earlier days. Other resident species include:

White sucker (Catostomus commersoni)
Hog sucker (Hypentelium nigricans)
Creek chub (Semotilus atromaculatus)
Blacknose dace (Rhynichthys atratulus)

Longnose dace (Rhynichthys cataractae)
Common shiner (Notropis cornutus)
Redbelly dace (Chrosomus eos)
Brassy minnow (Hybognathus hankinsoni)
Central mudminnow (Umbra limi)
Log perch (Percina caprodes)
Johnny darter (Etheostoma nigrum)
Blackside darter (Percina maculata)
Iowa darter (Etheostoma exile)
Bluegill (Lepomis macrochirus)
Black crappie (Pomoxis nigromaculatus)
Slimy sculpin (Cottus cognatus)
Mottled sculpin (Cottus bairdi)

The species listed were collected with D.C. electrofishing gear in August of 1950 and 1955 by field parties from the Institute for Fisheries Research. Collections were made at various points between the State Weir and the East Branch Bridge west of Guiley Pond (see map, Figure 1).

General pattern of rainbow trout runs

The upstream runs, consisting mostly of mature rainbow trout seeking spawning territory, may start during any mild period in midwinter, sometimes as early as January and rarely later than the middle of March. Along with the mature fish, a few others enter the stream.

The earliest arrivals at any blocking device are small males, 12-16 inches long, some of which are still immature. In company with these early migrants may be a number of immature 8- to 12-inch rainbows

that seem to be moving upstream with the older fish. Whether these smaller fish are lake-run individuals or stream residents is not known.

The spawning run generally reaches a peak sometime in late March or early April, depending upon the weather and water conditions. Spawning groups at the peak of the run are composed of mature individuals ranging in size from 2 to 10 pounds and occasionally larger. The run tapers off quite abruptly in May, but a few mature stragglers may be moving upstream as late as the first week in June.

Spawning takes place on well-aerated gravel-rubble riffles; there are numerous such areas on the East Branch and its tributaries. The spawning act has been described by Greeley (1932) and Shapovalov and Taft (1954) and their descriptions match observations made on several occasions along the East Branch.

When the spawning act is completed the spent fish begin to drift downstream. In years when the weather warms early, spawning may be almost entirely completed and the adults may have returned to Lake Huron before the trout season opens on the last Saturday in April.

On the East Branch as elsewhere a second upstream migration, for reasons as yet undetermined, occurs in late summer or early fall. Fish in this run are younger and smaller than those in the spring run. Usually they are very bright-colored, silvery fish and in peak condition. They provide fishing in the fall months. The larger fish in the fall run may remain in the river overwinter before spawning the following spring, or some may return downstream, or to Lake Huron.

Methods

Lengths and weights were obtained from numerous rainbow trout of all sizes. Data were obtained in all months except December, but most were secured in March-October. Most length measurements were made on a conventional measuring board with the rule inset on the bottom. Weights were usually obtained on a Chatillon balance of 20-pound capacity. Scales were taken from the lateral portion of the fish's dorsal region between the adipose and dorsal fins and placed between folds of a paper insert in the scale sample envelope to dry. Length, weight, sex, and site and date of collection were recorded on the scale envelope. Later, a jeweler's press was used to make impressions of the scales on plastic; the impressions and the scales were stored in the scale envelope. Aging was done at a magnification of 105 X on a scale-reading projector of the type described by Van Oosten, Deason, and Jobes (1934).

In certain years at Guiley Pond and More Trout, Inc. Pond, (referred to hereafter as MTI Pond), several hundred rainbow trout (all sizes) were jaw-tagged or fin-clipped. Recaptures provided information on growth, movements, and loss of weight incurred in spawning, as well as providing a measure of exploitation by angling.

In 1943 and 1944 ovaries from 12 mature female rainbow trout (9 from Guiley Pond, 3 from the Platte River) were preserved for direct egg counts to obtain information on the fecundity of the species.

Creel censuses of three types were operated. The data for Guiley Pond are believed to be complete for the years 1940-1949; in 1952, 1953, and 1955 records of total numbers of fish caught are probably accurate, but some unsuccessful trips were omitted. Minimal data on the catch and pressure during 1955 and 1961 at MTI Pond are also available. Here early-season crowds were so large that the limited number of creel census clerks could not obtain a complete record. The creel census in 1950-1952, conducted by Institute for Fisheries Research employees, covered some of the angling between Leggett's Bridge and M-55 Bridge; it was not designed to provide estimates of total pressure or total catch (Bush, Corbett, and Andersen, 1954).

The three sites where scale samples, measurements, and weights were collected were Guiley Pond, the State Weir, and MTI Pond (Figure 1).

Guiley Pond, 17 miles upstream from Lake Huron, has an area of 1.75 acres and a maximum depth of 6 feet. It was formed in the early 1930's by damming Guiley Creek with an earthen dam with a 6-foot head and a concrete spill. The original purpose was to generate electricity. In addition to the creel census, counts on the numbers of adult lake-run rainbow trout moving up to the dam were obtained here during the period 1942-1947. A total of 655 rainbow trout were tagged, mostly on the spawning migrations of 1941-1943. Most recaptures were made by anglers during the year of release. Rainbows for transfer to the pond

were captured by dip net, most of them in the 100 yards of stream below the dam. A permit for the operation was issued by the Michigan Department of Conservation.

The State Weir (10 miles from Lake Huron) was installed by the Fish Division in 1950. It consisted of a poured concrete base and frame with removable grate sections made of cast iron. The removable sections were 30 inches by 60 inches and the gratings were spaced 1 1/2 inches apart. The purpose of the weir was to confine lake-run fish in the stream so they could be fished over and to prevent their return downstream after spawning. The grates were put in place after the peak of the upstream movement and remained until about July 1. During the 1951 trout season when the grates were left in place until November 30, scale samples, lengths, and weights were taken from an unknown portion of the upstream migrants during the spring and fall runs; scales and measurements were collected from a considerable number of downstream migrants also. Trout were caught by removing a section of grating and placing box-like hardware cloth traps tightly against the opening.

MTI Pond, some 13 miles upstream from Lake Huron, is approximately 6 acres in area and has a maximum depth of 8 feet. It was completed in 1952 following construction of a dam with an 8-foot head. Land purchase and construction were financed by the sale of memberships and stock in a private Michigan corporation known as More Trout, Incorporated. Provision for public access and confinement of trout was assured by Michigan Conservation Department permits similar to those

issued for protecting the public's interest at Guiley Pond. Scale collections were made during the 1955 spawning run, and angler-caught fish were sampled during the creel census operations of 1955.

Several hundred scales and measurements were taken by creel census clerks from angler-caught trout during the 1950, 1951, and 1952 trout seasons. These trout came from all parts of the East Branch of the Au Gres River, but most were captured between M-55 and the Whitney "A" Drain.

A trapping device at the mouth of the Whitney "A" Drain would have permitted enumeration and study of the entire run entering the river. Because the various collecting sites were from 10 to 17 miles above the mouth, it was not possible to obtain a complete record of the run entering the stream in any year. Although most spawning fish probably moved past the State Weir in 1950, the structure was not so constructed that full-time trapping operations were possible. The scale collections, therefore, represent unknown fractions of the total run in the river. However, they provide an estimate of the age and size composition of the spawning populations sampled at the various points of collection.

The body-scale relationship for East Branch rainbow trout

The body-scale relationship was determined by the method outlined by Cooper (1952). Measurements and calculations were based on 3,225 scales from fish ranging from 2.0 to 31.5 inches in total length.

Scales came from Guiley Pond (743), MTI Pond (702), and the State Weir or various localities along the East Branch (1, 780). The body-scale relationship was found to be expressed by the formula,

$$\text{Anterior scale radius} = CL^n$$

$$= 1.07014\ L^{1.04876};$$

where C = a constant to be determined,

L = total length of fish,

n = a power to be determined.

Originally it was thought that the body-scale relationship of fish from separate areas might differ, but examination revealed no important differences, so all data were combined. The calculated body-scale curve of East Branch rainbow trout is shown in Figure 3. The data used in preparing the curve constituted the basis for construction of a nomograph with which total length at any age could be back-calculated, as described by Hile (1950).

Movements of the Au Gres rainbow trout

Although most recoveries of tagged rainbow trout were made in the Au Gres drainage, nine reports were mailed in from widely scattered points on the periphery of Lake Huron, the St. Clair River, and Lake Erie. These recaptures from points 55 to 430 miles away, emphasize the great distances this species may travel, and suggest that some fish do not always return to their natal streams. "Strays" also were noted for wild

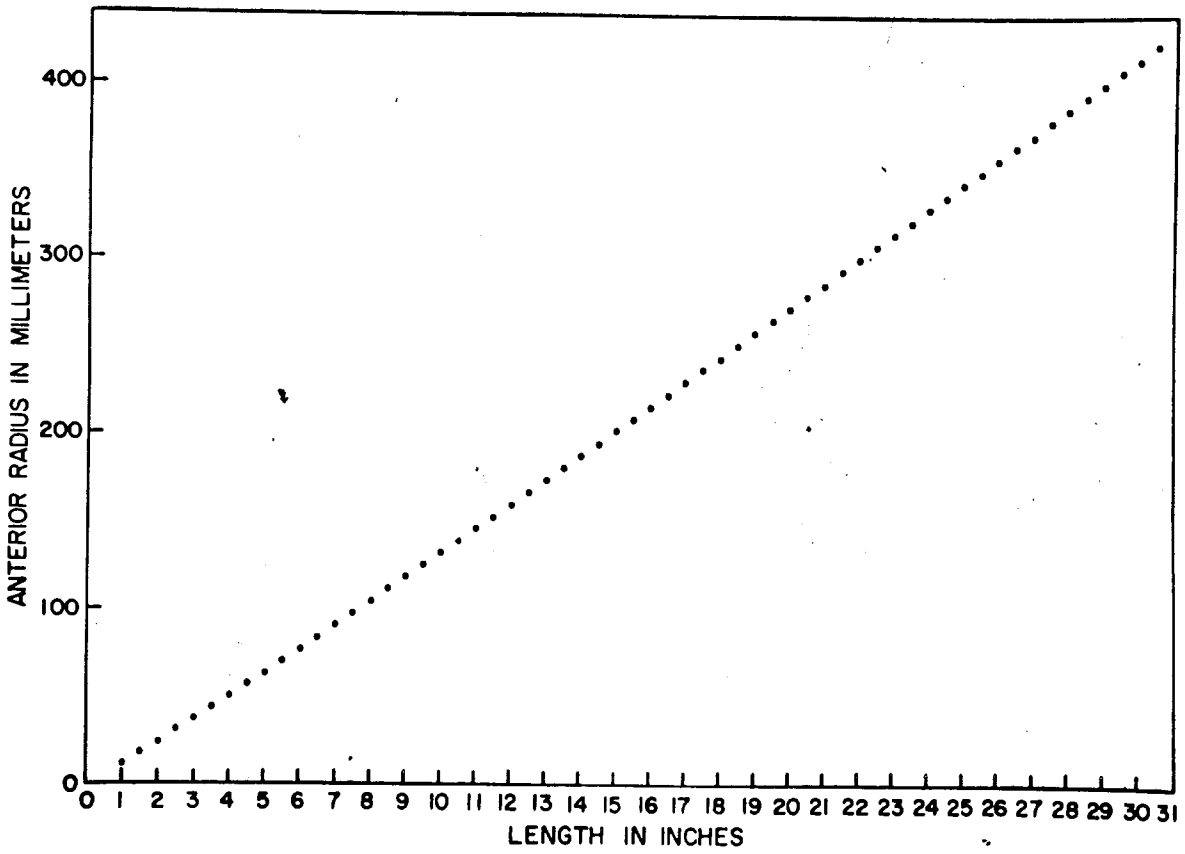

Fig. 3.--Body-scale relationship of rainbow trout, East Branch, Au Gres River, Iosco County, Michigan.

rainbow trout from several streams tributary to Lake Michigan (Shetter, 1937), and more recently for hatchery-reared rainbow trout (Hansen, I.F.R. Report No. 1607).

Pertinent facts regarding the nine "long-distance recoveries" made during this study are shown in Table 1 and Figure 4. Presumably, all but 2 of the 9 fish were stream residents when tagged. Comparison of the measured size at time of tagging in the Au Gres drainage with the lengths and weights reported at capture provides evidence of rapid growth during the period of lake residence.

It is hypothesized that the fish recaptured in the St. Clair River and Lake Erie came under the influence of the rapid current of the St. Clair River where it leaves Lake Huron. Further, because of the absence of any recovery reports from the deeper waters of the Great Lakes, and the numerous recaptures from tributary streams or in relatively shallow waters of the open lake, it is tentatively suggested that the movement of this species in the Great Lakes may be generally along shore at depths providing suitable temperature and food requirements.

Fecundity of rainbow trout

During 1943 and 1944, 12 (9 from Guiley Pond, 3 from Platte River) mature and presumably unspent female rainbow trout were killed for egg counts. Length of the specimens ranged from 21.5 to 31.7 inches; weight from 2.38 to 12.5 pounds. The eggs were enumerated individually, and the data are listed in Table 2.

Table 1.--Migration and growth of 9 rainbow trout tagged in the East Branch of the Au Gres River, Michigan, and recaptured elsewhere, 1941-1954

Date tagged	Date recovered	Size at tagging		Reported size at recovery		Recovery site[a]	Miles from tagging site	Tag number
		Length (inches)	Weight (pounds)	Length (inches)	Weight (pounds)			
1/13/41	6/2/42	8.0	0.19	22.0	4.0	L. Erie, 25 mi. NE of Pt. Pelee Ont. (C)	289	13805
2/19/41	6/23/42	7.5	0.13	18.0	5.0	L. Erie, near Long Pt., Ont. (C)	430	13865
4/17/41	6/18/42	26.4	7.25	27.0	6.0	2 1/2 mi. N. of St. Clair City, St. Clair R., Mich.	150	50372
4/15/41	4/13/43	22.3	4.93	26.0	9.8	L. Erie, near Kingsville, Ont. (C)	250	50445
4/20/41	5/-/45	7.0	0.09	24.0	6.8	Saugeen R., nr. Southhampton, Ont.	130	13884
3/25/44	5/6/45	7.8	0.17	21.0	3.2	L. Huron, nr. Bayfield, Ont.	120	25929
3/25/44	8/10/45	7.3	0.08	25.0	4.5	St. Clair City, St. Clair R., Mich.	155	25936
3/25/44	5/-/46	7.6	0.13	20.0	3.5	Saugeen R., near Southhampton, Ont.	130	25906
9/4/53	11/14/54[b]	8.8	0.31	20.0	3.5	Foote Dam, AuSable R., Mich.	55	87550

[a] (C) indicates capture in commercial fishing gear, all others by sport tackle.

[b] Tagged at MTI dam, all others at Guiley Pond.

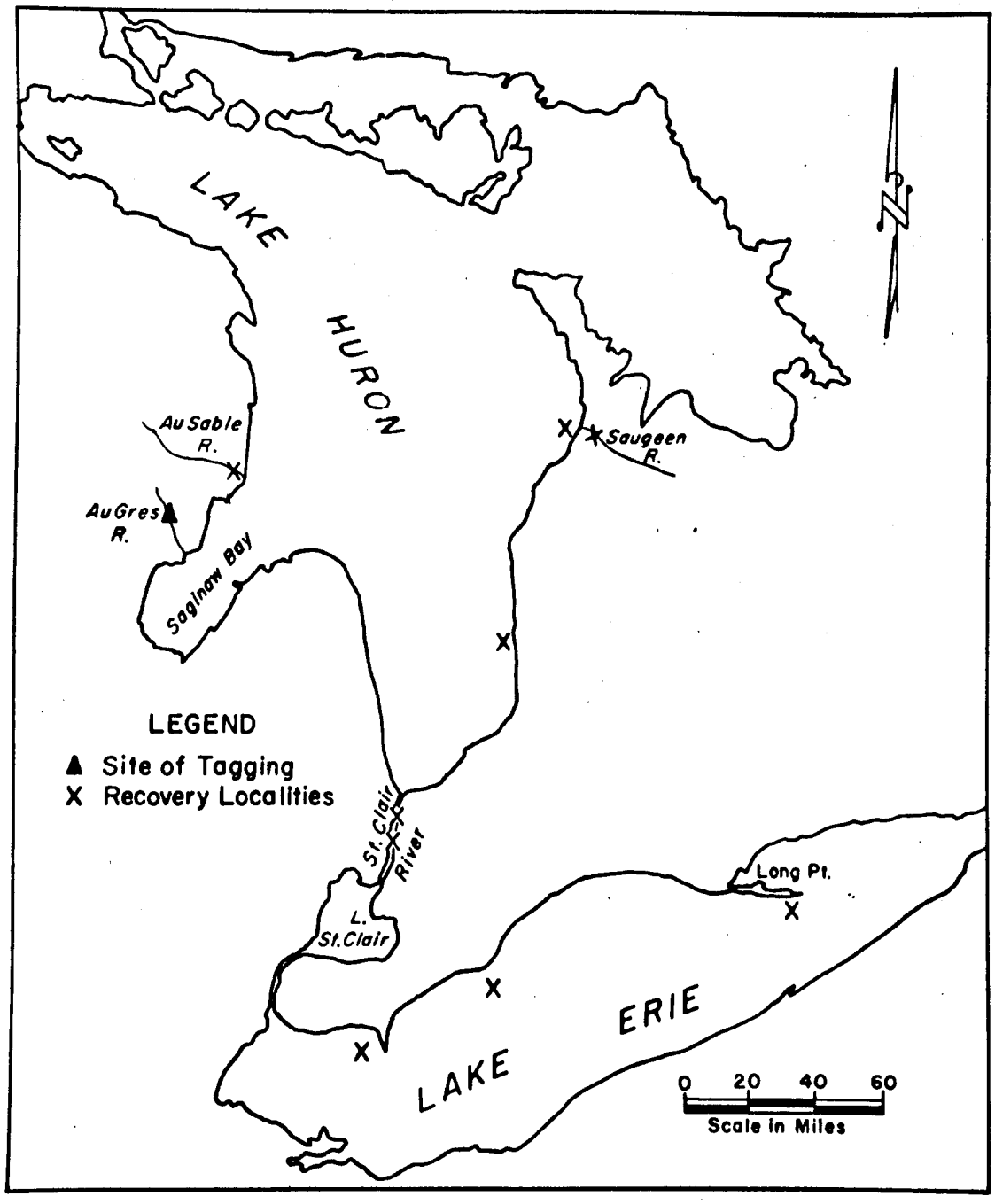

Fig. 4. --Recapture sites for 9 rainbow trout recovered outside Au Gres River drainage.

Table 2.--Fecundity data on female rainbow trout collected in 1943 and 1944, Guiley Pond and Platte River

Source	Date collected	Length (inches)	Weight (pounds)	Weight of ovaries (pounds)		Egg counts			Average egg diameter (mm.)	
				Right	Left	Right ovary	Left ovary	Total	Right ovary	Left ovary
Guiley Pond	4-7-44	21.5	3.88	0.19	0.22	1,601	1,867	3,468	4.34	4.20[d]
Guiley Pond	4-20-43	21.6	2.38	...	...	...	...	2,543[c, d]	...	...
Guiley Pond	3-23-44	22.6	5.00	0.25	0.23	2,441	2,200	4,641	3.74	3.78
Guiley Pond	4-30-44	25.2	6.38	0.44	0.44	3,959	4,377	8,336	4.38	4.04
Guiley Pond	4-21-43	25.5	7.38	...	...	....	...	6,361	...	...
Guiley Pond	4-20-43	25.1	5.97	0.50	0.56	3,331	3,725	7,056	...	...
Guiley Pond	3-31-44	27.8	7.56	0.47	0.50	2,876	3,139	6,015	4.52	4.52
Platte River	5-12-43	26.0	7.25	...	...	...	...	5,476[c]	...	...
Guiley Pond	4-10-44	28.9	11.38	1.28	1.06	4,603	3,780	8,383	5.58	5.74
Platte River	5-10-43	30.5	11.50	...	...	...	...	8,215	...	...
Guiley Pond	3-19-44	30.9	9.63	0.81	1.03	3,439	4,346	7,785	5.42	5.32
Platte River	3-25-43	31.7	12.50	0.93	0.92	4,007[a]	4,001[b]	8,008	...	...

[a] 67 broken eggs.

[b] 20 broken eggs.

[c] 1 broken egg.

[d] May have spawned.

The regression of egg number to fish length was calculated. The regression line, as determined from the 12 specimens, was found to be $Y = -5,715 + 456.57 X$, where Y = numbers of eggs, and X = total length of fish in inches. The regression line and its 95% confidence limits are shown in Figure 5, along with the observed values.

For 8 of the 12 specimens, weights and egg counts of right and left ovaries were recorded separately. Application of the standard t test indicated that there was no statistical significance to the slight differences noted in weights and egg counts between the ovaries. Data from these 8 fish indicated that ovarian weight constituted 15.8% of the total weight. Assuming that this small sample is representative of the species, and that the data on pre- and post-spawning weights obtained in 1941 and 1942 at Guiley Pond are representative, it appears that about 5% of the pre-spawning weight of females is lost due to energy expended in the reproductive act, as about 21% of the pre-spawning weight was lost during egg-laying.

Mortality to adult fish during and shortly after the spawning season

At Guiley Pond in 1941-1945 and at both Guiley Pond and MTI Pond in 1955, records were kept on the numbers of dead or dying rainbow trout picked up during and shortly after the spawning period. Many of them were found against the retaining screens where they were carried

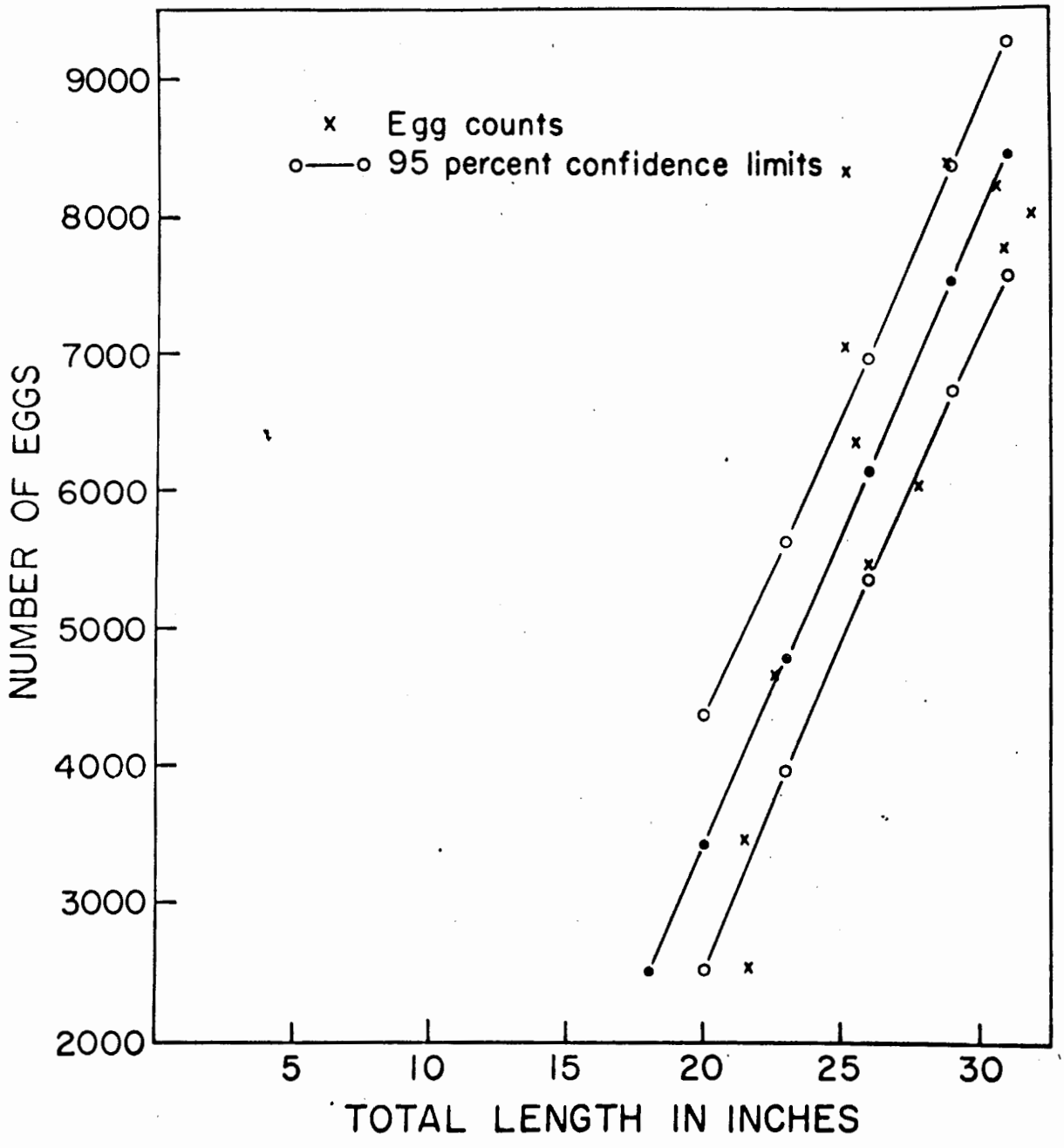

Fig. 5. --Regression of egg number on fish length, rainbow trout, East Branch Au Gres and Platte rivers, Michigan.

by the current. Others bearing scars suggestive of poachers' activities with snag hooks and spears were picked up. Numbers of dead spawners recorded in six different years ranged from 0 to 23, or from 0 to 7.4% of the 196 to 771 that were transferred in these years. Average loss incurred during the six years was 2.5%.

Guiley Pond

A complete creel census was obtained at Guiley Pond from 1940 through 1949. Slightly less complete creel census data were secured in 1952, 1953, and 1955.

The numbers of rainbow trout transferred over the dam in the years 1941-1947 and 1949 were recorded. In 1941 and 1942, all rainbow trout placed in the pond were jaw-tagged. The spawning run of 1942 will be discussed in detail because scale samples, lengths, and weights were obtained from about 40% of the transferred fish. In other years the scale sample data are of lesser value, since it was not possible for the single employee to net, measure, weigh, scale sample, and mark the fish during the peak of the run; therefore he recorded only lengths, weights, and sex.

Pertinent details concerning the 1942 spawning run at Guiley Pond are listed in Table 3. That year 153 male (total weight, 515.07 pounds; average total length, 20.1 inches) and 153 female rainbow trout (total weight, 715.99 pounds; average total length, 22.2 inches) were transferred into Guiley Pond. The run began February 24, was at its

Table 3.--Number of mature rainbow trout transferred into Guiley Pond, average daily hours of sunlight, average air and water temperatures, and average water level by weeks, during 1942

Weekly period 1942	Temperatures (°F.)			Water level	Sunlight	Number transferred into Guiley Pond			
	Maximum air	Minimum air	Water			Males	Total weight (pounds)	Females	Total weight (pounds)
Jan. 1-7	24	6	33	+3	3	..	...	..	...
8-14	20	2	33	N	4	..	...	..	...
15-21	32	18	34	N	2	..	...	..	...
22-28	34	23	37	N	3	..	...	..	...
Jan. 29-Feb. 4	22	8	33	N	2	..	...	..	...
Feb. 5-11	27	12	34	N	3	..	...	..	...
12-18	30	12	35	N	5	..	...	..	...
19-25	19	0	33	N	5	5	9.31	4	9.41
Feb. 26-Mar. 4	10	7	36	N	4	17	71.93	4	8.28
Mar. 5-11	27	21	35	+4	3	23	81.09	8	49.40
12-18	27	22	34	+4	3	21	83.53	16	80.03
19-25	32	22	36	+4	4	28	88.84	17	90.18
Mar. 26-Apr. 1	36	23	36	+4	4	21	63.12	18	89.61
Apr. 2-8	37	25	38	+7	6	11	26.75	26	120.47
9-15	47	29	40	+3	6	11	37.91	19	98.47
16-22	43	28	46	+1	8	9	29.53	26	112.53
23-29	64	36	48	N	9	1	3.00	3	15.53
Apr. 30-May 6	66	42	49	+2	4	2	9.28	6	23.97
May 7-13	57	38	45	+3	3	..	...	3	6.40
14-20	53	40	48	+8	5	1	1.93	2	9.21
21-27	57	37	47	+1	4	1	1.59	1	2.50
May 28-June 3	66	43	50	+6	3	1	1.88	..	...
June 4-10	76	43	53	+2	7	1	5.38	..	...
Total	..	..	..	..	..	153	515.07	153	715.99

peak between March 26 and April 8, and the last upstream migrant was captured on June 8.

A series of 125 scale samples (120 usable) with accompanying data were obtained from this run. Size distribution and sex ratio were known for all fish transferred. An estimate of the age distribution among the 306 transferred rainbows was obtained from the age (and size) distribution of the 120 fish from which scale samples were secured (Table 4).

Age composition and calculated growth, 1942 spawning run

Four groups, Age III and IV males and Age III and IV females, made up 81% of the run; 17% was represented by Age V males and females; and the remaining 2% was composed of Age II and Age VI fish.

The sex ratio varied among age groups but for the combined groups it was 1:1.

The scale samples were examined in detail and were divided into eight categories, depending on the number of years the fish had spent in the stream or in Lake Huron. For example, a fish which spent two years in the stream and one year in the lake prior to entering the stream for spawning was designated as 2/1. No attempt was made to determine the number of times any of the fish spawned.

The eight categories were 1/2, 1/3, 2/1, 2/2, 2/3, 2/4, 3/1, and 3/2 (Table 5). Lake growth was assumed to have taken place if the fish grew more than 6 inches between the last stream annulus and the

Table 4.--Length, sex, and estimated age composition of rainbow trout transferred into Guiley Pond in 1942

Total length (inches)	Age-group II ♂	II ♀	III ♂	III ♀	IV ♂	IV ♀	V ♂	V ♀	VI ♂	VI ♀	Totals ♂	Totals ♀
12.0-12.9	1	1	-	1	-	-	-	-	-	-	1	2
13.0-13.9	1	-	1	-	-	-	-	-	-	-	2	-
14.0-14.9	-	-	3	2	-	-	-	-	-	-	3	2
15.0-15.9	-	-	16	2	-	-	-	-	-	-	16	2
16.0-16.9	-	-	21	-	-	3	-	-	-	-	21	3
17.0-17.9	-	-	23	7	-	-	-	-	-	-	23	7
18.0-18.9	-	-	17	12	-	3	-	-	-	-	17	15
19.0-19.9	-	-	6	11	-	-	-	2	-	-	6	13
20.0-20.9	-	-	3	3	6	1	-	1	-	-	9	5
21.0-21.9	-	-	-	2	11	8	-	-	-	-	11	10
22.0-22.9	-	-	-	3	6	20	1	-	-	-	7	23
23.0-23.9	-	-	-	-	7	15	-	12	-	-	7	27
24.0-24.9	-	-	-	-	9	16	3	-	-	-	12	16
25.0-25.9	-	-	-	-	-	10	7	3	-	-	7	13
26.0-26.9	-	-	-	-	-	-	6	11	-	-	6	11
27.0-27.9	-	-	-	-	-	-	4	2	-	2	4	4
28.0-28.9	-	-	-	-	-	-	1	-	-	-	1	-
Totals	2	1	90	43	39	76	22	31	-	2	153	153
Average total length	13.0	12.5	17.8	18.9	22.8	23.0	25.6	25.0	-	27.7		

Table 5.--Growth categories, length, and sex of 120 rainbow trout transferred into Guiley Pond in 1942

Item	Growth category							
	III		IV			V		VI
	1/2	2/1	1/3	2/2	3/1	2/3	3/2	2/4
Females								
Number	1	25	---	35	---	15	3	1
Average length	22.2	18.7	---	23.0	---	25.4	22.9	27.7
Range	22.2	14.8-21.9	---	16.3-25.9	---	20.6-28.0	19.9-25.8	27.7
Males								
Number	1	17	3	8	4	7	---	---
Average length	20.4	17.6	23.0	22.6	23.2	25.6	---	---
Range	20.4	15.0-19.4	22.1-24.7	20.9-24.0	20.4-25.9	22.9-27.1	---	---

next succeeding annulus. Most fish spent two years in the stream before migrating to Lake Huron. Of 80 females in the sample, 76 had spent two years in the stream; of 40 males, 32 were stream residents for two years.

Calculated lengths at the end of each year of life were derived from scale measurements; the data were used to obtain averages (Table 6) and a growth curve (Figure 6) was plotted from them. Growth of the sexes was similar. Wherever differences were an inch or more, the standard t test was applied to test for significance at the 95% level of confidence. In only three instances were calculated total lengths for the two sexes significantly different (III's at III, IV's at II, all males versus all females at II--see Table 6).

At any age, females averaged 0.2 to 0.6 of a pound heavier than males (Figure 6).

Length-weight relationship of mature rainbow trout

The length-weight relationship for 118 fish in the spring run of 1942 at Guiley Pond was determined. Sexes were combined and the method outlined by Lagler (1952) was used. The relationship is described by the formula: $W = a L^n$;

where W = weight in pounds, L = total length in inches, and a and n are constants to be determined. The data provide the following solution in logarithmic terms: $\log W = -3.50224 + 3.07511 \log L$.

Table 6.--Calculated growth of the 1942 rainbow trout transferred into Guiley Pond, by sexes, and sexes combined

(Numbers in parentheses indicate numbers of measurements where entire sample was not usable)

Age group	Sex	Number	Average calculated length (inches) at annulus						Average weight (pounds)	C
			I	II	III	IV	V	VI		
III	♀	26	3.1	7.4	18.9[a]	...	...	...	2.70 (25)	40
	♂	18	3.2	7.3	17.8	...	...	...	2.10 (17)	37
IV	♀	35	2.9(34)	6.7(34)	17.9(34)	23.0	...	...	5.07	41
	♂	15	3.2	8.9[a]	16.4	22.8	...	...	4.86	41
V	♀	18	2.9(15)	6.1(15)	15.9(15)	22.2(15)	25.0	...	6.45	41
	♂	7	3.3	6.8	18.6	23.8	25.6	...	6.01	36
VI	♀	1	3.7	7.1	17.3	23.3	26.1	27.7	8.72	41
	♂	...	...	...	...	...	...	...	...	..
All	♀	80	3.0	6.8	17.8	22.7	25.0	27.7	...	40
Number of measurements			76	76	76	51	19	1	...	79
All	♂	40	3.2	7.8[a]	17.4	23.1	25.6	...	...	38
Number of measurements			40	40	40	22	7	...	...	39
All fish		120	3.1	7.2	17.7	22.9	25.2	27.7	...	40
Number of measurements			116	116	116	73	26	1	...	118

[a] Difference significant at the 95% level of confidence.

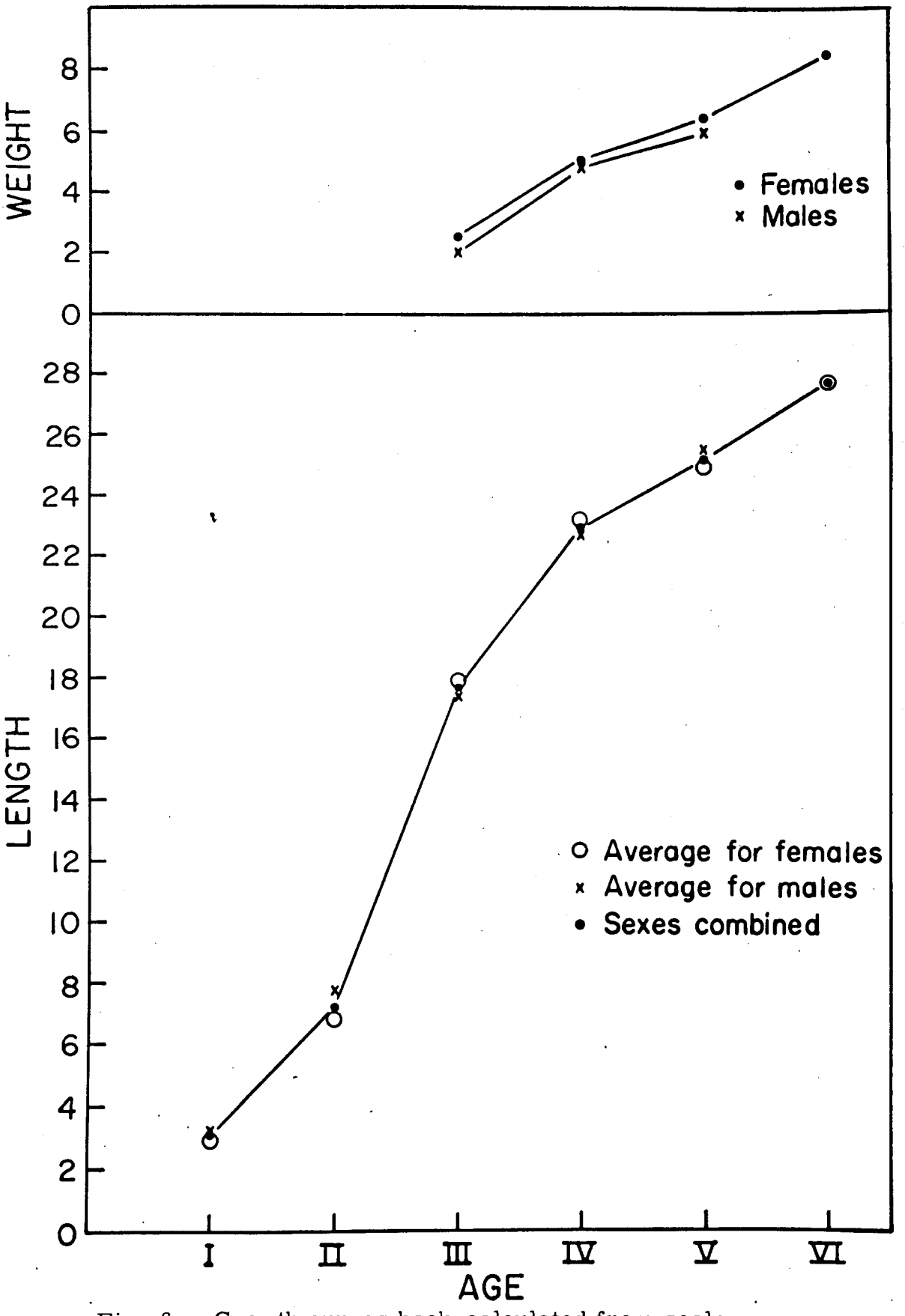

Fig. 6. --Growth curves back-calculated from scale measurements for 120 rainbow trout from Guiley Pond, 1942 spawning run. Upper: average weight in pounds for females and males separately. Lower: average length in inches at each annulus for both sexes combined.

The theoretical curve, derived from the above, is shown in Figure 7. The observed values (Table 7) are plotted also and agreement between observed and theoretical values is close.

Weight loss from spawning

Of the rainbows tagged at Guiley Pond in 1941 and 1942, 175 fish (94 males, 81 females) that had been weighed and measured before spawning were recaptured after spawning. Only those tagged and recovered prior to June 30 were considered.

The mature fish were tagged, weighed, and measured at the time of transfer into Guiley Pond. The operation was conducted between January and June. All recaptures were made by angling in and above the impoundment sometime between the last Saturday in April and June 30. This method of collecting data on loss in weight resulting from spawning presented some unavoidable complexities. Some marked fish were transferred into the pond shortly (3-10 days) ahead of the opening day and were recovered on opening day or soon thereafter. These probably provided incomplete data on loss of weight from spawning, as some probably were recaptured before they were completely spent. The weight losses noted for both sexes should be regarded as minimal.

The data are summarized in Table 8 and Figure 8 for males and females separately by 1-pound categories. Before spawning, the 81 females ranged in size from 12.8 inches and 0.87 pound to 27.0 inches and 8.81 pounds. Losses by females varied from 2% to 31% of the

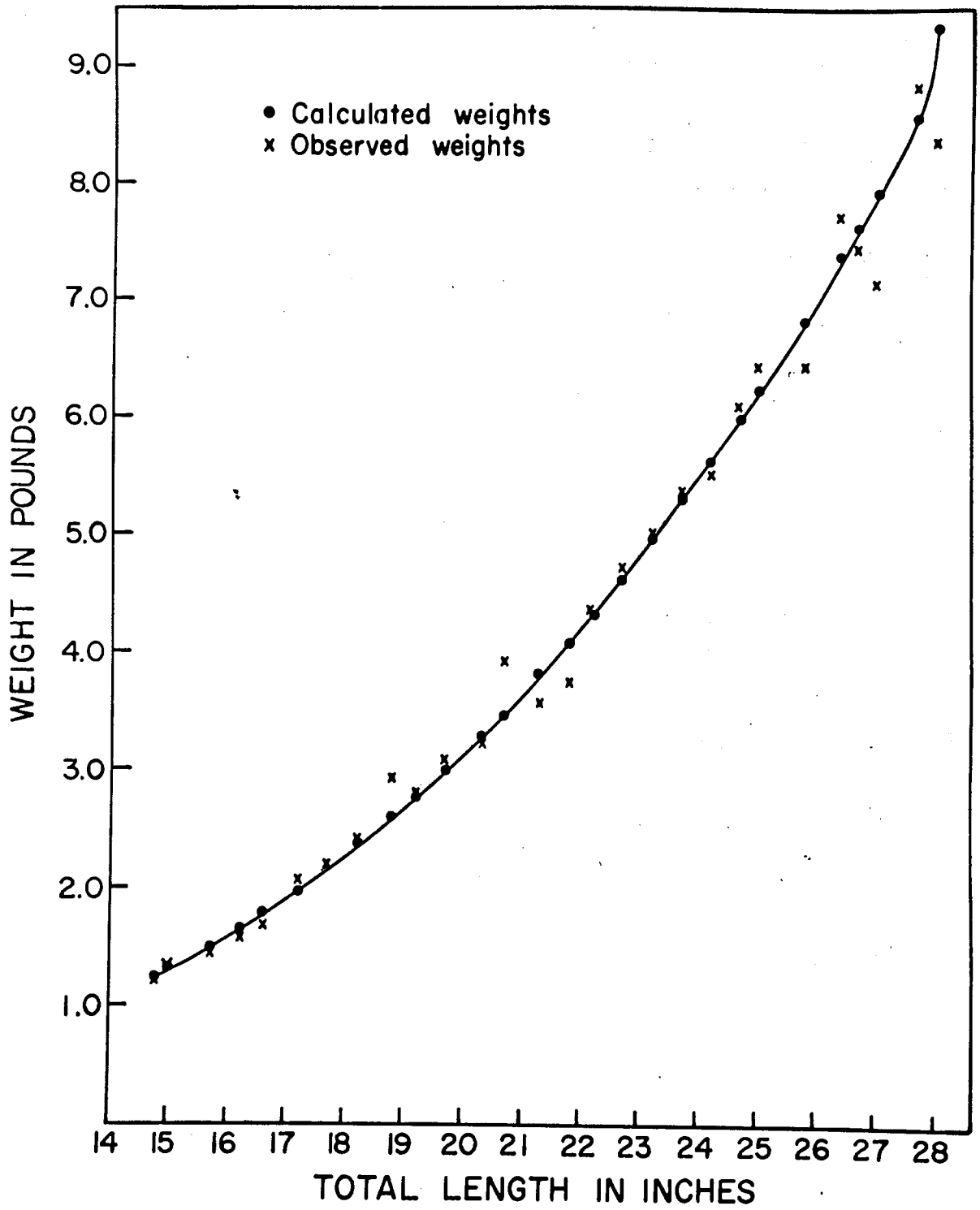

Fig. 7. --Length-weight curve, Guiley Pond, spring run, 1942.

Table 7.--Actual and calculated weights of rainbow trout of various lengths, 1942 spawning run, Guiley Pond, sexes combined

Length group (inches)	Number of fish	Average measured length (inches)	Average weight (pounds)	Average calculated weight (pounds)
14.5-14.9	1	14.8	1.22	1.24
15.0-15.4	1	15.0	1.31	1.30
15.5-15.9	1	15.7	1.47	1.50
16.0-16.4	3	16.2	1.60	1.65
16.5-16.9	3	16.6	1.59	1.79
17.0-17.4	3	17.2	2.08	1.97
17.5-17.9	3	17.7	2.18	2.18
18.0-18.4	10	18.2	2.41	2.37
18.5-18.9	3	18.8	2.93	2.60
19.0-19.4	7	19.2	2.79	2.78
19.5-19.9	6	19.7	3.08	3.00
20.0-20.4	4	20.3	3.28	3.30
20.5-20.9	3	20.7	3.94	3.48
21.0-21.4	1	21.3	3.59	3.82
21.5-21.9	6	21.8	3.75	4.10
22.0-22.4	9	22.2	4.34	4.33
22.5-22.9	5	22.7	4.75	4.65
23.0-23.4	7	23.2	5.04	4.99
23.5-23.9	8	23.7	5.40	5.33
24.0-24.4	8	24.2	6.04	5.65
24.5-24.9	5	24.7	6.12	6.01
25.0-25.4	1	25.0	6.47	6.26
25.5-25.9	7	25.8	6.49	6.86
26.0-26.4	2	26.4	7.75	7.40
26.5-26.9	5	26.7	7.48	7.64
27.0-27.4	3	27.0	7.18	7.96
27.5-27.9	2	27.7	8.83	8.58
28.0-28.4	1	28.0	8.37	8.87

Table 8.--Loss in weight attributed to spawning activities, rainbow trout, Guiley Pond, 1941 and 1942. Weights given in pounds.

Sex, range in weight	Number of specimens	Size at tagging			Losses noted at recovery		Average days free	Percentage loss in weight
		Mean length (inches)	Total weight (pounds)	Mean weight	Total loss	Mean loss		
Females								
0-0.99	2	13.3	1.78	0.89	0.17	0.08	61	10
1-1.99	6	16.2	9.84	1.64	1.07	0.18	46	11
2-2.99	17	18.5	43.68	2.57	8.01	0.47	38	18
3-3.99	14	20.3	46.86	3.35	8.47	0.60	37	18
4-4.99	13	22.2	56.76	4.37	11.51	0.88	38	20
5-5.99	13	23.4	69.72	5.36	16.42	1.26	50	24
6-6.99	10	25.2	65.12	6.51	15.67	1.57	44	24
7-7.99	5	26.1	36.87	7.37	8.75	1.75	61	24
8-8.99	1	27.0	8.81	8.81	2.69	2.69	48	30
Totals and averages	81	21.3	339.44	4.19 ±0.20	72.76	0.90 ±0.06	43	21
Males								
0-0.99	4	13.6	3.72	0.93	0.27	0.07	41	7
1-1.99	38	15.8	56.98	1.50	6.90	0.18	39	12
2-2.99	31	18.1	73.27	2.36	11.93	0.38	49	16
3-3.99	8	21.0	28.03	3.50	4.28	0.53	45	15
4-4.99	8	22.6	35.39	4.42	5.01	0.63	34	14
5-5.99	3	24.2	16.59	5.53	1.99	0.63	35	11
6-6.99	1	24.4	6.09	6.09	1.53	1.53	70	25
7-7.99	1	26.1	7.08	7.08	0.77	0.77	17	11
Totals and averages	94	17.9	227.15	2.42 ±0.13	32.68	0.35 ±0.03	43	14

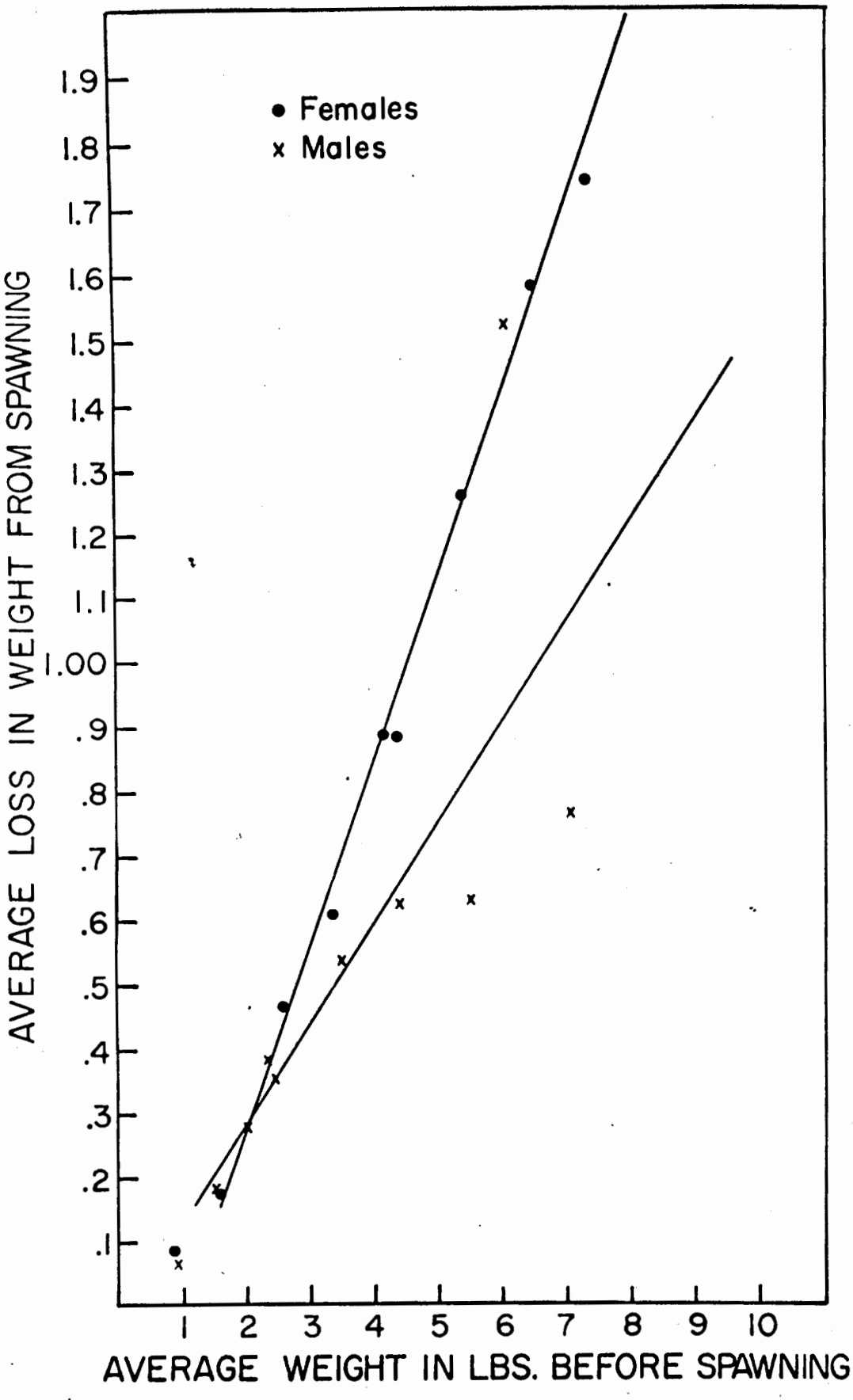

Fig. 8. --Average loss in pounds from spawning.

pre-spawning weight in 4 to 125 days. The 81 females averaged 21.3 inches in length and their average pre-spawning weight was 4.19 pounds (standard error, 0.20 pound). The average loss was 0.90 pound (standard error, 0.06 pound) in an average period of freedom of 43 days, or a mean loss of 21% of the pre-spawning weight. The 94 males varied between 13.4 inches and 0.81 pound and 26.1 inches and 7.08 pounds. Weight losses among the males ranged from 0% to 26% of the pre-spawning weight in period of freedom that varied between 3 and 95 days. The 94 males averaged 17.9 inches and 2.42 pounds (standard error, 0.13 pound); the average loss in weight was 0.35 pound (standard error, 0.03 pound) in an average period of freedom of 43 days, or a 14% loss in weight attributable to spawning.

These findings agree well with those of Mottley (1938) for Paul Creek, British Columbia. He found the average weight loss by spawning males to be 16.7% of pre-spawning weight; that of females was 25.2%.

Difference in weight losses between the sexes was tested for significance by determining the regression coefficients of weight loss from pre-spawning weight for both sexes (females, 0.2863 ± 0.0413; males, 0.1580 ± 0.0142). The standard t test (173 d.f.) indicates that the difference was significant above the 99% level of confidence. The regression lines for both sexes are shown in Figure 8, along with the tabular values for the various 1-pound intervals (the regression coefficients were calculated from 94 males and 81 females, not from the 17 weight classes). The data in Table 8 indicate that females heavier

than 2 pounds before spawning lose proportionately more than do those lighter than 2 pounds; males weighing more than 1 pound before spawning lost relatively more weight than those weighing less.

Angling at Guiley Pond

The dam and impoundment were located on property owned by E. Parker, and there is State-owned stream frontage above and below this site. So that the public's fish could be held in the pond to be fished over, Parker was given a permit to capture and transfer trout to the pond above the dam. In return he guaranteed access over his property to the angling public, and kept such records as were requested. This arrangement with Parker was continued through the period 1941-1949, and with Elmer Stensrud for the period 1950-1956. Between 1951 and 1956 the pond was classed as a Special Regulation Trout Pond by the Conservation Commission.

The regulations under which the pond was fished were:

1. Only artificial flies permitted as lures
2. Minimum size limit, 8 inches total length
3. One fish daily of 5 pounds or larger
4. Creel limit, 5 pounds or 10 trout.

Parker was hired on a part-time basis during the period 1941-1949. At times of peak activity he was aided by the author and other Fish Division employees, time permitting. Anglers' results were recorded on standard creel census blanks.

The confined adult rainbow trout were the prime targets of the anglers, although in many seasons more wild and hatchery-reared brook trout were captured. These will not be discussed in this report.

Numbers of rainbows transferred, their weight, numbers of rainbow trout taken by angling, angling pressure, and catch per hour of rainbow trout are given in Table 9. The normal spawning runs to Guiley Pond dam contained from 141 to 329 mature fish; total weight of the transferred fish varied from 452 to 1,231 pounds. The dam failed during the 1948 transfer operations, and the 1949 data are aberrant, in that a majority of the 999 rainbow trout transferred into the pond were dipped from localities downstream from Guiley Pond on the main East Branch of the Au Gres River, and were not migrants to Guiley Creek.

During 1940-1947 the anglers' catches of transferred fish varied between 69 and 195 trout weighing 164 to 491 pounds. Of the transferred spawners, anglers removed from 41% to 70% by number and 18% to 48% by weight. This harvest was accomplished under angling pressures which ranged from 768 to 3,071 hours of angling per acre. Angling quality varied from a low of 0.04 adult rainbow trout per hour (1941) to 0.11 adult rainbow trout per hour (1943). The presence of an abnormally large population in the pond in 1949 was accompanied by an increase in angling pressure to over 4,000 hours per acre, but angling quality (catch per hour, 0.08) was little different from the average of the earlier years.

Table 9.--Numbers of spawning rainbow trout transferred and numbers later recovered by angling, Guiley Pond and MTI Pond

Site and year	Rainbow trout transferred		Rainbow trout caught by angling		Percent caught by angling		Angling pressure (hours per acre)	Rainbow per hour
	Number	Weight (pounds)	Number	Weight (pounds)	Number	Weight		
Guiley Pond								
1940	...	...	150	244.4	...	...	1,162	0.10
1941	252[b]	1,031.2	104	193.6	41.3	18.8	1,952	0.04
1942	306[b]	1,231.1	195	490.9	63.7	39.9	3,071	0.05
1943	329	961.8	195	460.7	59.3	47.9	1,412	0.11
1944	196	806.1	138	362.7	70.4	45.0	1,244	0.06
1945	269	912.3	189	414.2	70.3	45.4	1,169	0.09
1946	149	546.1	74	197.7	49.7	36.2	768	0.06
1947	141	452.4	69	164.3	48.9	36.3	859	0.05
1948[a]	...	...	41	79.6	...	...	333	0.07
1949	999	2,915.3	580	1,349.4	58.0	46.3	4,004	0.08
1952	...	...	153	...	...	...	2,201	0.04
1953	...	...	81	...	...	...	...	...
1955	...	...	78	...	...	...	...	...
MTI Pond								
1955	768[b]	...	488	...	63.5	...	...	...
1961	538[c]	...	313	...	58.2	...	...	...

[a] Dam failed in this year.

[b] In these years, all transferred adults were either fin-clipped or jaw-tagged.

[c] Estimate based on data from previous years' recovery averages at MTI and Guiley ponds.

State Weir

Spring spawning run

Because of exceptionally high water, only a portion of the spawning run was taken by trapping operations in 1951. Migrants were captured, when water levels permitted, by lifting out one of the removable grates and placing a trap box made from 1/2-inch hardware cloth and wooden framing directly upstream from the opening.

During April, May, and June, 1951, 448 rainbow trout were measured and scale samples collected (Table 10). The sex distribution was 89 males, 357 females, 2 judged as immature, for a ratio of slightly less than 1 male to 4 females. The mature males ranged in size from 14.0 inches and 1.1 pounds to 28.7 inches and 8.6 pounds; females from 14.1 inches and 1.4 pounds to 31.3 inches and 15.0 pounds.

The most abundant age groups noted in this collection were: III females (54.9%); IV females (14.5%); III males (14.3%); V females (6.7%); IV males (3.8%). The remaining 5.8% consisted of II's, VI's, and one each of age-groups VII and VIII.

The calculated growth history, as determined from ages and scale measurements of 448 rainbow trout sampled in 1951 is given in Table 11 and is shown graphically in Figure 9 along with curves for Guiley Pond (1942) and MTI Pond (1955). The sexes were combined. The major difference between the calculated growth curves for the fish from the State Weir and those from Guiley Pond is in the second year of

Table 10.--Age, total length and sex distribution of 448 rainbow trout trapped at the State Weir, East Branch Au Gres River, April, May and June, 1951

Length group (inches)	Age-group II[a] ♂	II[a] ♀	III ♂	III ♀	IV ♂	IV ♀	V ♂	V ♀	VI ♂	VI ♀	VII ♀	VIII ♀	Total ♂	Total ♀
14.0-14.9	2	1	-	-	-	-	-	-	-	-	-	-	2	1
15.0-15.9	-	1	-	-	-	-	-	-	-	-	-	-	-	1
16.0-16.9	2	5	1	1	-	-	-	-	-	-	-	-	3	6
17.0-17.9	1	2	1	4	-	-	-	-	-	-	-	-	2	6
18.0-18.9	-	1	2	13	-	-	-	-	-	-	-	-	2	14
19.0-19.9	-	-	2	22	1	-	-	-	-	-	-	-	3	22
20.0-20.9	-	-	8	20	-	1	-	-	-	-	-	-	8	21
21.0-21.9	-	-	8	32	2	3	-	-	-	-	-	-	10	35
22.0-22.9	-	-	11	69	3	11	-	3	-	-	-	-	14	83
23.0-23.9	-	-	11	49	4	16	-	6	-	-	-	-	15	71
24.0-24.9	-	-	16	21	4	14	-	3	1	1	-	-	21	39
25.0-25.9	-	-	3	14	2	12	-	4	1	-	-	1	6	31
26.0-26.9	-	-	1	1	-	4	-	3	-	1	-	-	1	9
27.0-27.9	-	-	-	-	1	4	-	5	-	1	-	-	1	10
28.0-28.9	-	-	-	-	-	-	-	3	1	1	-	-	1	4
29.0-29.9	-	-	-	-	-	-	-	1	-	-	-	-	-	1
30.0-30.9	-	-	-	-	-	-	-	2	-	-	-	-	-	2
31.0-31.9	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Totals	5	10	64	246	17	65	-	30	3	4	1	1	89	357
Av. total length	15.5 (17)[a]		22.2 (310)		23.9 (82)		25.9 (30)		26.6 (7)		31.3 (1)	25.4 (1)	(448)	

[a] Two immature fish less than 14.0 inches long were included in Age-group II.

Table 11.--Average calculated growth of rainbow trout in 1951 spawning run at State Weir site (in inches), both sexes combined

Age-group	Number	Average calculated length (inches) at annulus								Measured total length	Average weight	Average C
		I	II	III	IV	V	VI	VII	VIII			
II	17	3.9	15.5	--	--	--	--	--	--	15.5	1.56	40
III	310	3.1	14.4	22.1	--	--	--	--	--	22.2	4.38	39
IV	82	2.8	10.4	18.4	23.9	--	--	--	--	23.9	5.40	39
V	30	2.9	10.6	18.0	22.6	25.9	--	--	--	25.9	6.82	38
VI	7	3.3	9.2	16.4	20.8	24.5	26.6	--	--	26.6	6.81	36
VII	1	2.2	5.1	9.1	20.6	23.4	28.8	31.3	--	31.3	15.0	41
VIII	1	2.9	7.3	11.3	16.7	19.4	22.1	23.9	25.4	25.4	7.4	45
Totals	448	3.1	13.4	21.0	23.4	25.4	26.3	27.6	25.4			
		(448)	(448)	(431)	(121)	(39)	(9)	(2)	(1)			

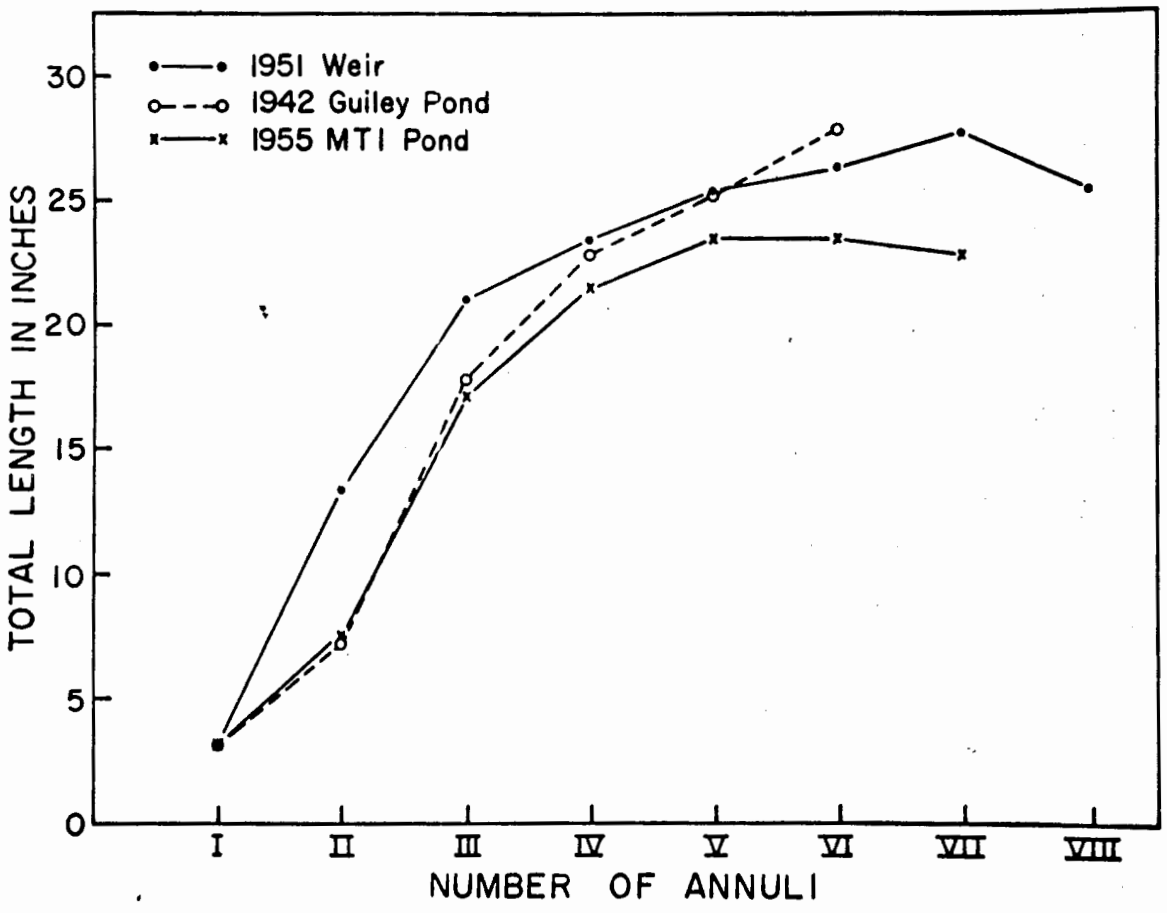

Fig. 9.--Calculated growth curves for 1942, 1951 and 1955 spring-run rainbow trout, East Branch Au Gres River.

life. Many more of the fish collected at the State Weir spent only one year in the stream before migrating to Lake Huron than did members of the 1942 collection at Guiley Pond. Consequently the trout sampled at the State Weir site were somewhat larger in age-groups II through IV than were Guiley Pond fish.

The scale samples from the 1951 spring spawning run were broken down further into 12 age and growth categories involving the number of years of stream and lake growth (Table 12). Females were found in the 1/1, 1/2, 1/3, 1/4, 2/1, 2/2, 2/3, 2/4, and 3/4 categories, while most males were 1/1, 1/2, 1/3, 2/1, and 2/2.

Scales collected at the State Weir in 1951 showed that most fish had spent only one year in the stream (254 of 337 females and 70 of 83 males), whereas at Guiley Pond in 1942 most had spent two years in the stream (76 of 80 females and 32 of 40 males).

Fall run

The so-called "fall run" may start as early as mid-August, or in years of low water, not until October or early November, when the water level is raised by autumn rains. The sample of fresh-run fish during the 1951 fall run consisted of 4 fish taken in August, 23 in September, and 99 in October. Fishing during the extended fall season (third Monday in September to November 30) is carried on between Lake Huron and the State Weir; consequently fish trapped at the weir probably were not entirely representative because of removals by angling. The age and size composition, as determined from the scale samples available,

Table 12.--Numbers and average lengths of the various growth categories observed in the spring runs of East Branch Au Gres rainbow trout, 1942, 1951, 1955, and fall run, 1951

Item	Growth categories																	
	II	III		IV			V			VI			VII		VIII			
	1/1	1/2	2/1	1/3	2/2	3/1	1/4	2/3	3/2	1/5	2/4	3/3	2/5	3/4	2/6			
Spring runs																		
1942 Number	..	2	42	3	43	4	..	22	3	..	1	..	..	..	..			
(120) Av. Length	..	21.3	18.2	23.0	22.9	23.2	..	25.5	22.9	..	27.7	..	..	..	..			
1951 Number	17	269	41	38	44	..	15	11	4	1	6	..	..	1	1			
(448) Av. Length	15.5	22.7	19.1	24.3	23.6	..	27.2	24.8	24.1	28.5	26.2	..	..	31.3	25.4			
1955 Number	24	1	115	3	90	..	..	34	1	..	4	2	2	..	..			
(276) Av. Length	16.6	24.4	18.2	21.3	22.8	..	..	23.8	22.4	..	24.4	23.6	22.8	..	..			

	Growth categories				
	I	II		III	IV
	1/+	1/1+	2/+	2/1+	2/2+
Fall run					
1951 Number	85	6	32	2	1
(126) Av. Length	14.3	21.0	17.4	22.5	26.0

is shown in Table 13. Most of the fish in the 1951 sample of fall-run fish were males (93/126), and more than two-thirds of them were fish which had spent one year in the stream followed by one summer in the lake. The fall run was noticeably different from the spring run in that very few fish older than two years plus one summer were collected (two III's, one IV). Five categories (1/+, 1/1+, 2/+, 2/1+, and 2/2+) were represented, and as in the spring run, the majority of fish, 91 of 126, had spent one year in the stream before moving to the lake (Table 12).

Downstream run

As with the upstream run, the fraction of the fish trapped while moving downstream is not known. Scales from 627 downstream migrating trout were collected--574 in May, 37 in June, 1 in August, 2 in September, and 13 in November. Of these fish 430 (158 I's, 257 II's, and 15 III's) were moving downstream for the first time--no lake growth was evident on their scales. Of the rest, 181 were returning downstream after spawning, as inferred from their low average coefficients of condition and the dates of capture (April-July); the 16 captured in August-November were mature fish that had relatively high coefficients of condition, had apparently moved upstream in the fall, remained above the weir for a short time and returned downstream.

In 1951, scale sample collections were made from six (different) segments of the rainbow trout population: (1) upstream migrants in the spring, (2) downstream migrants in spring and summer, (3) fish

Table 13.--Age, size and sex composition of a sample of the upstream fall run of rainbow trout, East Branch Au Gres River, August-October, 1951

Range in total length (inches)	Age-group I ♂	I ♀	I Imm.	II ♂	II ♀	III ♂	III ♀	V ♂	V ♀	Totals ♂	Totals ♀	Totals Imm.
Less than 14.0	15	4	6	..	..	..	..	..	..	15	4	6
14.0-14.9	28	4	..	2	1	..	..	..	..	30	5	..
15.0-15.9	23	2	1	2	1	..	..	..	..	25	3	1
16.0-16.9	1	1	..	6	..	..	..	..	..	7	1	..
17.0-17.9	..	..	..	3	4	..	..	..	..	3	4	..
18.0-18.9	..	..	..	6	4	..	..	..	..	6	4	..
19.0-19.9	..	..	..	2	..	..	..	..	..	2	..	..
20.0-20.9	..	..	..	1	1	..	..	..	..	1	1	..
21.0-21.9	..	..	..	2	1	1	..	..	..	3	1	..
22.0-22.9	..	..	..	1	..	..	..	..	..	1	..	..
23.0-23.9	..	..	..	..	..	..	..	..	..	..	..	..
24.0-24.9	..	..	..	..	1	..	1	..	..	..	2	..
25.0-25.9	..	..	..	..	..	..	..	..	..	..	..	..
26.0-26.9	..	..	..	..	..	..	..	..	1	..	1	..
Totals	67	11	7	25	13	1	1	..	1	93	26	7
Average total length	14.3			18.0		22.5		26.0		..	..	..

caught by anglers in spring and summer, (4) upstream migrants in fall, (5) downstream migrants in fall, and (6) fish caught by anglers in the fall. The calculated growth of the fish in the various samples was markedly different (Table 14). Assuming that the sample from the trap-caught upstream migrants (1) was reasonably representative of the upstream run, the growth curve calculated from these scales is probably the "best" one. The calculations from angler-caught fish (3) are too heavily weighted with fish that had not yet migrated to the lake (age-groups I and II). Calculations based on downstream migrants (2) also were influenced by many I's and II's which had not yet migrated to Lake Huron, and by the fact that anglers removed the faster growing individuals of each age group. The very noticeable differences in growth between upstream migrants in the spring (1) and in the fall (4) might be confusing until one realizes that the I's in the fall actually have completed almost two full growing seasons. Comparison of measured and calculated lengths suggests that the bulk of the I's collected in the fall were fish which spent their first year in the stream, migrated downstream to Lake Huron early in the second spring or summer, and moved back upstream mainly in October, after growing an average of 11 inches. Most of the II's were fish which spent two years in the stream, before moving lakeward and returning during the fall of the third year, and they grew approximately 10 inches during the third summer. Calculation of growth increments suggests that, except for the I's, the fall-run fish grow more slowly during the first two years than those of the spring run.

Table 14.--Measured lengths and calculated lengths at various ages, 1951 scale sampling, East Branch Au Gres River

Origin of samples 1951	Length at annulus							
	I	II	III	IV	V	VI	VII	VIII
Measured lengths								
(1) Spring spawning run	...	15.5 (17)	22.3 (310)	24.1 (82)	26.0 (30)	27.7 (7)	31.3 (1)	25.4 (1)
(2) Spring and summer downstream run	4.8 (158)	8.7 (269)	19.9 (101)	22.3 (61)	23.6 (24)	24.8 (6)	29.3 (2)	...
(3) Spring and summer angling	7.4 (8)	10.9 (162)	21.1 (172)	23.1 (76)	25.1 (23)	26.1 (1)	...	...
(4) Fall upstream run	14.3 (85)	18.0 (40)	22.5 (2)	26.0 (1)	...	...	...	...
(5) Fall downstream run	15.3 (5)	17.2 (6)	21.6 (4)	24.0 (1)	...	...	...	...
(6) Fall angling	14.2 (194)	16.9 (67)	21.3 (6)	24.2 (2)	26.7 (3)	...	...	...
Calculated lengths								
for (1)	3.1	13.4	21.0	23.4	25.4	26.3	27.6	25.4
(2)	3.2	8.7	17.8	21.5	23.5	25.5	29.3	...
(3)	3.1	10.9	19.6	22.7	25.1	26.1	...	...
(4)	3.3	8.1	17.3	21.9	...	...	...	...
(5)	3.5	10.9	21.2	24.0	...	...	...	...
(6)	3.2	8.8	17.8	23.1	26.7	...	...	...

Stream angling for rainbow trout

Although most of the stream between the Whitney "A" Drain and the headwaters is wadable, many anglers fish from the bank and use various baits such as salmon eggs, spawn sacks, night crawlers, mayfly larvae, or minnows. The accepted technique is to find a deep hole with a comfortable bank, cut a forked stick, insert it at the water's edge so the rod may be conveniently propped, cast the properly weighted lure into the upper end of the hole, and let nature take its course. The results of partial creel census operations during the 1950, 1951, and 1952 seasons were described by Bush, Corbett, and Andersen (1954). They found that the catch per hour per angler did not vary appreciably from 0.05 rainbow trout during the three years. Fall fishing sometimes appeared to be slightly better than during the regular season. Creel census statistics are summarized in Table 15. The size frequency of the fish in the anglers' catch is shown in Figure 10. From 61% to 65% of the measured fish exceeded 15 inches, and each year at least two dozen specimens between 25 and 31 inches were observed in the catches.

The data of Table 15 were compared with the creel census summary for the Sacramento River in California for the period 1953-1959 (Halloch, Van Woert and Shapovalov, 1961). Allowing for the fact that the census of the East Branch checked only a portion of the users, the comparison suggests that the 10 miles of the East Branch were fished at rates of well over 1,400 hours per mile each season, whereas the much larger California stream was never fished in excess of 1,150 hours per mile in any season.

Table 15.--Summary of partial creel census of East Branch Au Gres River trout angling, 1950, 1951, and 1952 in the stream proper

(Data from Bush, Corbett and Andersen, 1954)

Year and season	Total trips recorded	Percentage successful	Hours of fishing	Trout caught				Catch per hour per angler
				Brook	Brown	Rainbow	Totals	
1950								
Regular	3,134	14.4	16,136	2	5	715	722	0.05
Fall	592	12.8	3,155	0	0	150	150	0.06
Total	3,736	14.6	19,291	2	5	865	872	0.05
1951								
Regular	2,317	15.5	10,953	7	8	517	532	0.05
Fall	693	23.7	3,744	0	0	278	278	0.07
Total	3,010	17.4	14,697	7	8	795	810	0.05
1952								
Special spring[a]	345	7.5	1,609	0	0	39	39	0.02
Regular	1,537	14.8	7,054	0	3	304	307	0.05
Fall	1,066	14.7	4,939	0	0	219	219	0.04
Total	2,948	13.9	13,602	0	3	562	565	0.05

[a] In this year there were special early seasons in effect on a number of Michigan rainbow trout streams in an effort to give the anglers more opportunity to harvest the lake-run fish. In 1952 it extended from April 12 to April 25, the normal opening day (last Saturday of April). The fall season extended from the third Monday in September through November 30.

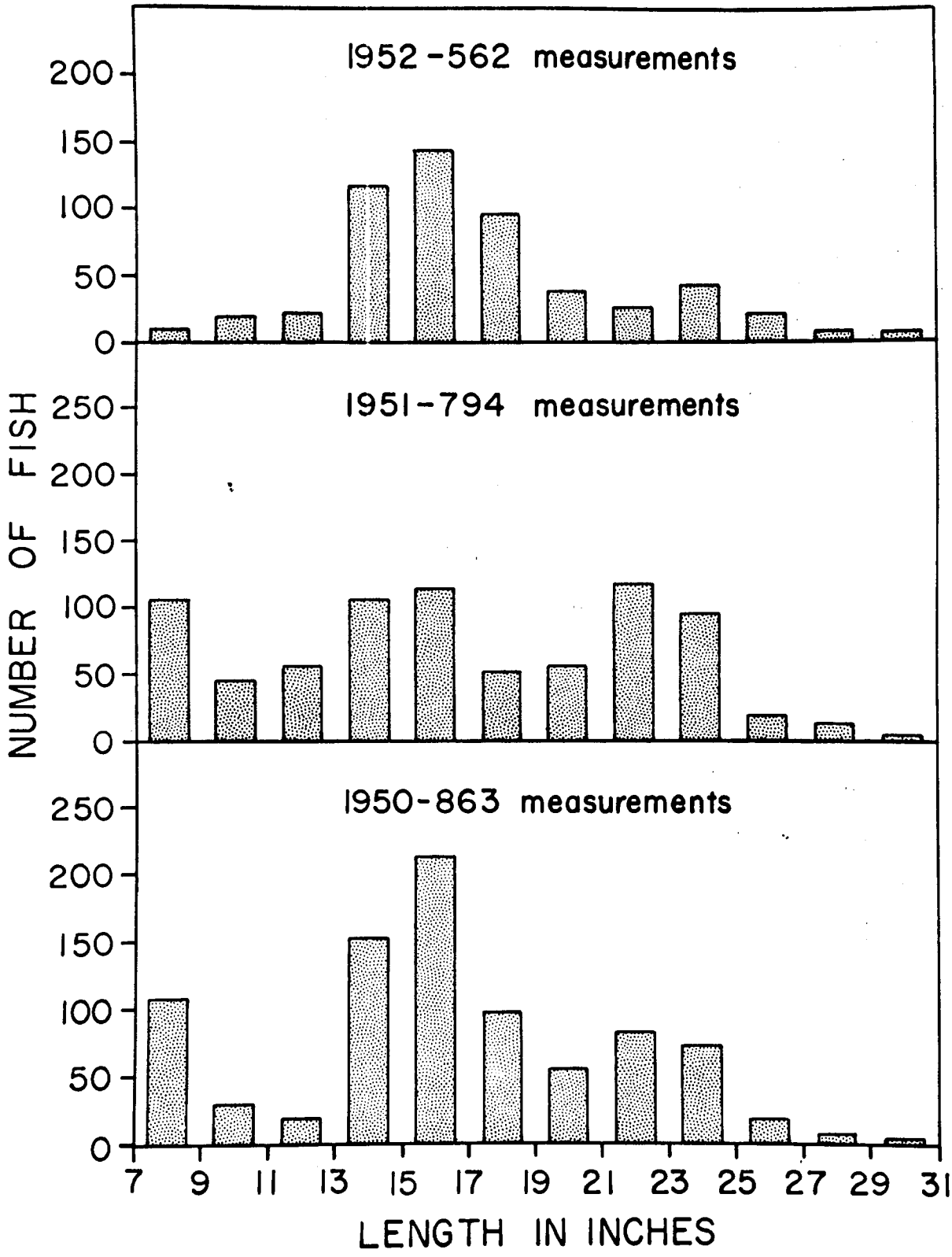

Fig. 10.--Size frequency distribution of anglers' catches of rainbow trout, East Branch Au Gres River, 1950-1952.

The recorded catch of the East Branch, which is a minimum figure, ranged from 56 to 87 rainbow trout per mile; in the Sacramento the catch per mile ranged from 68 to 94--slightly better. The average catch per hour per angler on the Sacramento was 0.12, on the East Branch of the Au Gres, 0.05.

MTI Pond

A description of the spring spawning run passing the MTI dam in 1955 was given in IFR Report 1483 (unpublished). A total of 771 rainbow trout were transferred over the dam; 3 brook trout and 1 brown trout also were put over. Transferred fish (except for 3 rainbow trout) were either jaw tagged or fin clipped (adipose fin removed); in 1955, 149 tagged and 619 fin-clipped rainbow trout were available to anglers in the drainage above MTI dam. The water and air temperatures (taken just upstream from the dam), and the numbers and sexes of the transferred migrants are listed in Table 16. The sex ratio of 734 individuals was approximately 1 male to 1.5 females; some of the 31 classed as immature may have spawned before reaching the MTI dam.

The run presumably started prior to April 1 when transfer operations began, as 49 fish were taken on that date. The peak of the run occurred between April 10 and 14, when 55, 189, 58, 15 and 47 fish were transferred. The last fish was transferred on June 7. Length measurements were made on 65 males, 204 females and 29 fish judged to be immature. The average total lengths (with standard errors) of

Table 16.--Daily air and water temperatures and numbers of rainbow trout transferred into MTI Pond, 1955

Date		Temperature (°F.)[a]		Rainbow trout transferred		
		Air	Water	Immature	Males	Females
1955						
April	1	66	45	...	39	10
	2	56	45	...	21	15
	3	61	44	...	11	7
	4	..	..	...	5	3
	5	..	..	...	9	8
	7	38	40	...	11	8
	8	40	47	...	6	9
	9	..	..	...	6	3
	10	72	52	...	30	25
	11	..	..	...	77	112
	12	60	50	2	14	42
	13	57	51	1	5	9
	14	..	..	1	15	32
	15	60	50	...	5	10
	16	60	52	6	3	12
	17	66	53	4	5	7
	18	66	53	2	5	17
	19	50	47	...	3	3
	20	..	..	...	...	5
	21	..	..	3	2	8
	22	52	52	1	2	11
	23	..	..	...	...	...
	24	48	47	...	...	2
	26	48	52	2	5	10
	27	60	56	5	4	16
	28	58	57	...	1	7
	29	60	58	...	1	7
	30	66	59	...	1	5
May	2	60	70	1	1	11
	4	76	62	2	4	7
	6	..	..	...	1	6
	14	..	..	...	2	3
	15	..	..	1	...	...
	17	..	..	...	2	3
	19	..	..	...	...	1
	22	..	..	...	...	1
	28	..	..	...	1	1
June	7	..	..	...	...	1
Totals[b]		..	..	31	297	437

[a] Taken on indicated dates, mainly between noon-5 PM.

[b] This total run was composed of the 765 indicated fish, plus 6 rainbows (sex ?), 3 brook trout, 1 brown trout.

these various groups were:

Males	20.24 ± 0.42 inches
Females	21.07 ± 0.19 inches
Immatures	16.55 ± 0.53 inches

Length distribution by inch groups is shown in Table 17.

Scale samples from 64 male, 186 female and 26 immature rainbow trout were secured; age, size, and sex distribution of these fish is shown in Table 18. Data from the scale samples were used to estimate age, size and sex distribution of the 734 adult rainbow trout in the 1955 spring spawning run (Table 19). The 37 immature fish of undetermined sex were excluded. Slightly more than 73% of the run was composed of age III and age IV fish; almost 15% were age V and the remainder were in age groups II, VI, and VII.

The calculated growth history, as determined from ages and measurements on 276 rainbow trout from the 1955 spawning run, is given in Table 20 and Figure 9. The curve is similar to that calculated for the sample from Guiley Pond in 1942.

Scale examination of 276 rainbow trout that were transferred over the MTI dam in the 1955 spawning run showed that 10 growth categories were present: 1/1, 1/2, 1/3, 2/1, 2/2, 2/3, 2/4, 2/5, 3/2, and 3/3 (Table 12). About 90% of the fish had spent two years in the stream before migrating to the lake, about 10% had gone to the lake sometime during their second year of life, and a few (3) had spent three years in the stream before moving to Lake Huron. These data are similar to those recorded at Guiley Pond in 1942 but differ from those

Table 17.--Sex and length distribution of 298 rainbow trout, 1955 spawning run MTI Dam, East Branch Au Gres River

Length of fish (inches)	Males	Females	Immature	Totals
Less than 14.0	...	...	4	4
14.0-14.9	...	...	1	1
15.0-15.9	6	3	4	13
16.0-16.9	7	9	4	20
17.0-17.9	10	14	6	30
18.0-18.9	3	27	9	39
19.0-19.9	10	29	...	39
20.0-20.9	4	11	1	16
21.0-21.9	4	23	...	27
22.0-22.9	3	30	...	33
23.0-23.9	6	30	...	36
24.0-24.9	4	18	...	22
25.0-25.9	7	6	...	13
26.0-26.9	...	2	...	2
27.0-27.9	...	1	...	1
28.0-28.9	...	1	...	1
29.0-29.9	...	...	...	...
30.0-30.9	...	...	...	...
31.0-31.9	...	...	...	...
32.0-32.9	1	...	...	1
Total measured	65	204	29	298

Table 18.--The age, size and sex distribution of 276 rainbow trout, 1955 spawning run MTI Dam, East Branch Au Gres River (Immature fish listed in parentheses)

Length range (inches)	Age-groups II ♂	II ♀	III ♂	III ♀	IV ♂	IV ♀	V ♂	V ♀	VI ♂	VI ♀	VII ♂	VII ♀	Totals ♂	Totals ♀
Less than 14.0	.. (4)	..	..	..	..	..	..	..	..	..	..	..	.. (4)	..
14.0-14.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..
15.0-15.9	3 (1)	2	1 (3)	1	..	..	..	..	..	..	..	..	4 (4)	3
16.0-16.9	2 (1)	6	6 (3)	1	..	1	..	..	..	..	..	..	8 (4)	8
17.0-17.9	2 (1)	3	10 (3)	7	.. (1)	1	..	..	..	..	..	..	12 (5)	11
18.0-18.9	.. (1)	..	2 (5)	29	1 (1)	..	..	..	..	..	..	..	3 (7)	29
19.0-19.9	..	1	6 (1)	23	2	4	..	..	..	..	..	..	8 (1)	28
20.0-20.9	..	..	2 (1)	4	2	5	..	..	..	..	..	..	4 (1)	9
21.0-21.9	..	..	1	3	3	15	..	2	..	..	..	1	4	21
22.0-22.9	..	..	..	..	2	18	2	8	..	1	..	..	4	27
23.0-23.9	..	..	..	..	3	20	2	5	..	4	..	..	5	29
24.0-24.9	..	..	..	1	2	7	2	5	..	..	1	..	5	13
25.0-25.9	..	..	..	..	3	2	4	3	..	..	..	..	7	5
26.0-26.9	..	..	..	..	..	..	..	1	..	..	..	..	..	1
27.0-27.9	..	..	..	..	..	..	..	1	..	..	..	..	..	1
28.0-28.9	..	..	..	..	..	..	..	..	..	1	..	..	..	1
29.0-29.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..
30.0-30.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..
31.0-31.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..
32.0-32.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Totals	7 (8)	12	28(16)	69	18 (2)	73	10	25	..	6	1	1	64(26)	186

Table 19.--Estimated age, size and sex distribution 1955 spawning run at MTI Pond, 1955

Length range (inches)	Age-groups												Total		All fish
	II		III		IV		V		VI		VII				
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
0-13.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
14.0-14.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
15.0-15.9	20	4	7	2	..	..	..	..	..	..	..	..	27	6	33
16.0-16.9	8	14	24	3	..	2	..	..	..	..	..	..	32	19	51
17.0-17.9	7	8	39	19	..	3	..	..	..	..	..	..	46	30	76
18.0-18.9	..	..	9	58	5	..	..	..	..	..	..	..	14	58	72
19.0-19.9	..	2	31	51	15	9	..	..	..	..	..	..	46	62	108
20.0-20.9	..	..	9	15	9	10	..	..	..	..	..	..	18	25	43
21.0-21.9	..	..	4	7	14	36	..	4	..	..	..	2	18	49	67
22.0-22.9	..	..	..	..	7	43	7	19	..	2	..	..	14	64	78
23.0-23.9	..	..	..	..	14	44	13	10	..	10	..	..	27	64	91
24.0-24.9	..	..	..	3	7	21	7	15	..	..	4	..	18	39	57
25.0-25.9	..	..	..	..	13	5	19	8	..	..	..	..	32	13	45
26.0-26.9	..	..	..	..	..	..	..	4	..	..	..	..	..	4	4
27.0-27.9	..	..	..	..	..	..	..	2	..	..	..	..	..	2	2
28.0-28.9	..	..	..	..	..	..	..	..	..	2	..	..	..	2	2
29.0-29.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
30.0-30.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
31.0-31.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
32.0-32.9	..	..	..	..	..	..	..	..	2	..	3	..	5	..	5
Totals	35	28	123	158	84	173	46	62	2	14	7	2	297	437	734

Table 20.--Calculated growth of the 1955 rainbow trout transferred into MTI Pond, sexes combined (includes 64 males, 186 females, 26 immature fish)

Age-group	Number of scales in sample	Average calculated total length at annulus (inches)							Average length	Average[a] Weight	C
		I	II	III	IV	V	VI	VII			
II	27	4.1	15.6	...	...	...	...	...	15.9	1.67 (21)	40
III	113	3.0	6.7	18.5	...	...	...	...	18.7	2.67 (63)	40
IV	93	3.2	6.6	16.0	22.2	...	...	...	22.3	4.35 (39)	38
V	35	3.3	6.1	15.9	20.3	23.8	...	...	23.8	5.16 (13)	36
VI	6	3.7	6.4	14.8	18.9	22.5	24.1	...	24.1	3.62 (1)	32
VII	2	2.6	5.7	11.4	15.6	19.0	21.3	22.8	22.8	4.25 (2)	36
Totals and averages	276	3.2 (276)	7.4 (276)	17.1 (249)	21.5 (136)	23.5 (43)	23.4 (8)	22.8 (2)	...	...	..

[a] Numbers in parentheses show numbers of fish with weights available.

at the State Weir in 1951, where individuals spending only one year in the stream predominated in the sample. The differences noted between the three collections may be related to the habitats existing above the barriers. It is conceivable that young rainbow trout might not move downstream from a pond (Guiley or MTI) as soon as from a stream environment (above State Weir) where they are more constantly under the influence of a current. Other possible reasons for the differences are sampling error or inherent differences between years (samples were collected in 1942, 1951 and 1955).

Angling

Creel census records are available for some of the fishing in this pond for 1955 and 1961. In 1955, efforts were made to obtain records of all tagged and adipose-fin-clipped trout taken by angling. However, in the "early" season, and during the forepart of the regular season, some anglers were fishing throughout the entire 24 hours each day. Each day several hundred anglers were involved, and the one or two clerks assigned to the task by More Trout, Incorporated could not interview all of them. The catch data for MTI Pond (Table 9) should be regarded as minimal. In 1955, angling was carried on under the usual Michigan trout stream regulations (7-inch minimum size limit, 10 trout or 10 pounds and 1 fish, any lure). No wading or fishing from boats was permitted. All types of gear and lures were seen. One of the favorite combinations was spinning tackle terminated by a No. 12 hook, baited with mayfly nymphs, floated by a clear plastic spinning bobber, along with the ubiquitous crotched stick.

Angling pressure and angling quality appeared to be about the same as on Guiley Pond, but we have no good measure.

In 1961, MTI Pond was fished under regulations which stipulated flies only, 5 fish per day, and 7-inch size limit. The MTI management recorded the number of trout caught (Table 9).

The creel census data turned over to the Fish Division indicate that a minimum of 63.5% of the 768 rainbow trout in the 1955 spawning run were captured by MTI anglers during 1955. It was estimated that in 1961 MTI anglers captured approximately 58% of the spawning run of that year. The fractions of the spawning run taken during the same year are similar to those noted for Guiley Pond during the 1940's.

Angling during 1955 at MTI Pond, Guiley Pond, and in the river between the two impoundments accounted for 567 of 768 tagged and fin-clipped fish which were transferred, or a minimum of 73.8% exploitation of the 1955 spawning run past MTI Pond.

The exploitation of the mature rainbow trout in the East Branch is at a significantly higher rate than in the Sacramento River. In six different seasons Hallock, et al. (1961) recorded that from 20.1% to 36.5% (average 29.5%) of the spawning runs were captured by anglers. The data from the various localities on the East Branch suggest minimum estimates ranging from 41.3% to 73.8% (average 59.5%).

Experiments with direct feeding

of rainbow trout

In the period 1953-1955, Mr. Eddie Parker, acting on his own initiative, developed what he thought to be a satisfactory food for stream and pond feeding of trout. Parker obtained trash fish and offal from a commercial fisherman, ground it to varying degrees of fineness, and froze it in blocks of convenient size. To introduce it into the stream or pond, blocks were anchored at various sites and allowed to melt and disintegrate. Examination of samples of the diet as prepared by Parker was made in June, 1955, under the direction of Dr. Peter I. Tack of Michigan State University. According to a communication from Dr. Tack to F. A. Westerman dated June 16, 1955, three samples contained the following percentages of ash, crude fiber, ether extract, water, protein, and nitrogen-free extract.

Sample number	Ash	Crude fiber	Ether extract	Water	Protein	Nitrogen-free extract
1A	1.00	0.02	0.78	91.55	6.65	0.00
3A	2.36	0.03	0.84	89.33	7.41	0.03
5A	1.58	0.30	4.98	79.63	13.28	0.28
Average	1.7	0.1	2.2	86.8	9.1	0.1

Comparison of the averages obtained by Tack for Parker's diet with those listed by Phillips (1954) for natural food suggests that the prepared frozen food contained somewhat more water and somewhat less protein. Further Leitritz (1959) has pointed out the

potential losses in food value from improper storage and long periods of retention for frozen fish foods, as well as the fact that slow thawing is responsible for a high loss of water-soluble vitamins.

During 1953 all feeding was done in the stream below the pond. In 1954 feeding was carried on in a limited way in the pond and more extensively below the dam from the middle of April until the middle of July. Thereafter, up to 100 pounds of food per day were put in the pond and a lesser amount below (letter, Parker to Shetter, 1/1/55). During 1955, about 100 pounds of food were put in the pond each day.

By agreement among the Fish Division, Parker, and the officers of More Trout, Incorporated, the 1955 spawning run was netted, counted and transferred. All transferred fish were fin-clipped (adipose fin) or jaw-tagged. Thus lake-run rainbow trout placed in MTI Pond from downstream were later identifiable in the catch. Scale samples from the unmarked fish in the 1955 catch at MTI Pond provided some data for evaluating the effect of feeding, inasmuch as unmarked rainbow trout present in the pond on April 1, 1955, were retained there by the 1 1/2-inch gratings for varying periods of time prior to the 1955 spring spawning run, depending on whether they were larger or smaller than 14 inches long at their time of entry or placement. However, precise evaluation of the effect of the feeding on growth of rainbow trout was not possible under the experimental conditions existing at the time. Numerous comparisons were rejected because the origin and history of the fish being compared was uncertain. Possible difference in growth between years of scale-sampling eliminated other comparisons.

There is some evidence that the fish fed in MTI Pond grew more slowly than those which had free access to Lake Huron, particularly the mature individuals. In Table 21 the average total lengths of age-groups II through V of unmarked fish caught by anglers in MTI Pond in 1955 are compared with fish of the same age groups from the 1955 spawning run. The differences in mean length for each age group in the two lots were subjected to the standard t test for statistical significance at the 95% level of confidence.

Fish of age-groups II, III, and IV in the spawning run were significantly longer (by from 4.6 to 4.9 inches) than unmarked fish of the same ages taken by angling in MTI Pond in 1955, even though the calculations on the MTI angling specimens included 1955 growth as late as November, whereas those in the spawning run were collected in April or May. The small difference (0.5 inch) between the two groups of age-group V fish was not significant, although the difference favored the spawning run specimens. No comparison for age-group I fish was possible as there were none in the spawning run.

The MTI fish (subjected to feeding and unmarked) taken by angling in 1955 were compared with Guiley Pond fish (not subjected to feeding) taken by angling in 1955. Samples from age-groups I through V were available. Of the Guiley Pond fish, age-groups III, IV, and V were all marked fish that were fin-clipped or tagged as they were transferred over MTI dam, and which continued their run to some point above Guiley Pond dam, utilizing the simple step fishway; those in

Table 21.--A comparison of the total lengths (inches) of rainbow trout of the same age in the MTI spawning run, MTI Pond angling, and Guiley Pond angling, 1955

Item	Age groups sampled				
	I	II	III	IV	V
MTI run (marked)					
Number sampled ..		27	113	93	35
Av. total length ..		15.8[a]	18.5[b]	22.3[b]	23.8
Std. error ..		0.496	0.137	0.186	0.241
MTI angling (unmarked)					
Number sampled	79	91	59	17	5
Av. total length	8.7[c]	11.0	13.6	17.7	23.3
Std. error	0.145	0.246	0.401	1.000	1.181
Guiley Pond angling (both marked and unmarked)					
Number sampled	8	11	36	22	7
Av. total length	7.4	10.1	18.0[b]	20.3[a]	21.3
Std. error	0.193	0.740	0.844	0.480	1.148

[a] and [b] Indicates these fish were significantly larger than fish of the same age in the MTI angling at the 95% and 99% confidence level, respectively.

[c] Indicates these fish were significantly larger than Guiley Pond fish of the same age at the 99% confidence level.

age-groups I and II were mostly unmarked immature fish. Since access to or egress from Guiley Pond was prevented only during the trout season, age-groups I and II might have spent a part of their life elsewhere than in Guiley Pond.

Age-group I from 1955 angling at MTI Pond was found to have a significantly greater average length than the age-group I sample from 1955 angling at Guiley Pond; differences in average total length of age-groups II and V were not statistically significant; III's and IV's in the Guiley Pond collections were significantly longer than their counterparts from MTI Pond. The significantly greater length of age-group I in MTI Pond may be the result of habitat, size of sample in Guiley Pond, or the result of the feeding in MTI Pond during 1955 and 1954. For the older groups it was concluded that the growth under feeding in MTI Pond was not equal to that made in Lake Huron (Table 21).

Feeding may have influenced favorably the growth of age-group I fish in MTI Pond during 1955, but it had little or no effect on the growth of rainbow trout in age-group II or older. The 1955 growth data for MTI Pond fish, which were confined for unknown periods up to a year or more, further suggest that the confined fish grew more slowly than those which returned to Lake Huron after spawning.

Comparison of the upstream runs

Age distribution of the fish in the three different spring spawning runs (1942, 1951, 1955) was compared. The dominant age groups were III's and IV's in all years. The actual data, shown in Table 22, were subjected to Chi-square analysis; results indicated that the various age groups contributed significantly different fractions of the totals in the three samples ($P = 99.5\%$). However, except for age-group II, the samples from Guiley Pond in 1942 and MTI Pond in 1955 were much alike. The significant differences noted between the age composition of the three spring spawning runs may have been due to differences between years or between localities.

The samples from the fall run were considerably different from those from the spring runs; the dominant age groups were I's (66.4%) and II's (31.2%).

Summary

1. The location and the physical characteristics of the East Branch of the Au Gres River drainage were described.

2. Resident fish species, including three species of trout and the sea lamprey, were listed.

3. General pattern of the upstream runs of rainbow trout was described.

4. The methods for collection of data and the collection sites were listed.

Table 22.--Comparison of the age composition of the upstream runs, East Branch Au Gres River

Origin of sample and date	Number of rainbow trout in age-group								Totals
	I	II	III	IV	V	VI	VII	VIII	
Guiley Pond									
Spring, 1942	...	5	132	114	53	2	...	...	306
		(1.6)	(43.1)	(37.3)	(17.3)	(0.7)			(100.0)
State Weir									
Spring, 1951	...	17	310	82	30	7	1	1	448
		(3.8)	(69.2)	(18.3)	(6.7)	(1.6)	(0.2)	(0.2)	(100.0)
MTI transfer									
Spring, 1955	...	63	281	257	108	16	9	...	734
		(8.6)	(38.3)	(35.0)	(14.7)	(2.2)	(1.2)		(100.0)
State Weir									
Fall, 1951	85	38	2	1	...	...	...	...	126
	(67.5)	(30.1)	(1.6)	(0.8)					(100.0)

5. The body-scale relationship for East Branch rainbow trout was calculated from 3,225 scales collected from fish between 2.0-31.5 inches in length. It is expressed by the formula: Anterior scale radius = $1.07014L^{1.04876}$.

6. The transfer of mature rainbow trout at Guiley Pond in 1942 was described in detail. The sex ratio of 306 mature rainbow trout transferred was 1:1. Age III and Age IV fish made up about 81% of the total, Age V about 17%, and Ages II and VI combined about 2%. Ninety-six of the 120 fish aged had spent two years in the stream before moving to the lake.

7. Data from Guiley Pond in 1942 were used to determine the length-weight relationship, expressed by the formula

$$\text{Log } W = -3.50224 + 307511 \text{ Log } L.$$

Agreement between observed and theoretical values was good.

8. Tagging experiments conducted at Guiley Pond during 1941 and 1942 provided information on loss of weight by spawning rainbow trout. From recapture of 94 males and 81 females, it was determined that females lost an average of 21% of the pre-spawning weight and males, 14%.

9. Angling at Guiley Pond in 1940-1949 was by fly-fishing. Pressure ranged between 768 and 3,071 hours of angling per acre. Anglers caught 69 to 195 mature rainbow trout from transfers which varied between 141 to 329 fish; exploitation varied between 41% and

70% by number and 18% and 48% by weight. Angling quality varied between 0.04 and 0.11 rainbow trout per hour in the various years.

10. Scale collections at the State Weir in 1951 suggested a sex ratio of 1 male to 4 females in the spawning run. As at Guiley Pond in 1942, Age-groups III and IV predominated in the sample (86% of the total). When a growth curve was calculated, it was found that at the second annulus fish from the State Weir in 1951 were about 6 inches longer than those from Guiley Pond in 1942, presumably because many more of them had migrated to Lake Huron during the second year of life.

Most of the fall-run fish were males (93/126) and mainly (91/126) fish which had spent only one year in the stream before migrating to the lake.

Only two II's and one IV were observed in the trap collections.

Downstream migration of immature fish apparently took place mainly in May.

Stream angling for rainbow trout in the East Branch during 1950, 1951, and 1952 was carried on by all methods, but mainly by bank and wading anglers using various forms of natural baits. The catch per hour per angler did not vary significantly from 0.05 fish during the three years of census operation.

11. The 1955 spring spawning run of rainbow trout transferred over MTI dam numbered 771 fish. The sex ratio of 734 fish was 1 male

to 1.5 females. The run began sometime prior to April 1 and was at its peak between April 11 and 14; the last mature fish was put over on June 7. Males (65) averaged 20.2 inches long; females (204), 21.1 inches; immature fish (29), 16.6 inches. Age-groups III and IV made up 73% of the total run. The calculated growth curve was similar to that for fish from Guiley Pond in 1942.

Partial creel census records from MTI Pond, Guiley Pond, and the stream between accounted for 567 of 768 marked rainbow trout transferred above MTI dam, or a 73.8% exploitation (minimum) of the spawners transferred.

12. An experimental diet, developed by E. Parker for direct feeding of stream trout, was described. The effect of feeding approximately 100 pounds daily in MTI Pond was assessed by comparing average total lengths of unmarked (and fed) rainbow trout caught in MTI Pond in 1955 with average total lengths of fish in the same age groups captured on the 1955 spawning run. Fish of Age-groups II, III, and IV from the spawning run were significantly longer than those which had been confined to MTI Pond and fed; there was no significant difference between Age-group V fish.

Unmarked fish, caught by anglers in MTI Pond in 1955, were compared with unfed fish of the same age taken by angling at Guiley Pond in 1955. Growth rate of Age-group I fish from MTI Pond was significantly better, but for fish of Age-group II and older, differences in growth were either not statistically significant, or favored the Guiley Pond fish.

13. Nine recoveries of tagged rainbow trout at distances of 55 to 430 miles from the release sites indicate that some "straying" took place. Recaptures were recorded from both shores of Lake Huron, the north shore of Lake Erie and the St. Clair River.

14. Measurements and egg counts were taken on 12 mature female rainbow trout killed in 1943 and 1944; size of the fish varied between 21.6 inches and 2.38 pounds and 31.7 inches and 12.5 pounds. The regression of egg number to fish length was found to be $Y = -5,715 + 456.57 X$. Records obtained at Guiley Pond indicate that on the average spawning resulted in a 21% loss in weight by females; on the average ovaries represent about 16% of the pre-spawning weight; hence energy expended in spawning resulted in a 5% loss of weight.

15. Records of observed mortalities following spawning were kept. The percentage of observed mortality (which should be regarded as a minimum figure) ranged from 0% to 7.4% (average 2.5) of the total handled during six transfers.

16. The age distribution of the fish in four upstream runs was compared and found to vary significantly between runs. Age distributions of the fish in the spring upstream runs from Guiley Pond in 1942 and MTI Pond in 1955 were similar, except for Age-group II. The fall run sampled in 1951, differed markedly from the spring run in that approximately 2/3 of the rainbow trout were in Age-group I. No Age-group I fish were obtained in the spring upstream runs.

Suggestions for future research and management

1. There should be on record for a number of rainbow trout streams, counts, or reliable estimates of the numbers of mature spawners ascending and the resultant numbers of young fish returning to the lake. A sampling program, similar to that described for the Sacramento River in California (Hallock, Van Woert, and Shapovalov, 1961) would provide the desired information. A year-round program of trapping and marking, coupled with creel sampling during the angling seasons, would aid in better understanding of the "fall" runs that occur in many Michigan rainbow trout streams.

2. The maintenance of the best water quality and bottom conditions by in-channel improvements, bank stabilization, run-off control, and pollution control is necessary to maintain the proper ecological conditions for the early life history stages of rainbow trout. Such work should be extended to some of the smaller drainages (examples: Ocqueoc River, Presque Isle County; Black River, Mackinac County) where relatively small numbers of lake-run rainbow trout have been noted from time to time.

3. Further restrictions on the catch should be considered because of increased angling pressure and predation by the sea lamprey since 1940.

The type of restrictions depend in part on what kind of sport is to be encouraged. It has been the author's observation that fish in

the fall run are in the best condition for the table and also the most vigorous on the end of a line; hence we should bend our efforts toward increasing the fall runs. Since there is some evidence that the fall runs are composed of younger fish, their numbers might be increased by protecting the immature downstream migrants during the spring and early summer, either by a closed season, a higher minimum size limit and/or a low bag limit, or some combination thereof.

For streams where lake-run rainbow trout predominate, the following regulations might exert a favorable influence on the rainbow trout population and still provide reasonable sport for all species of trout over most of the trout seasons:

From the last Saturday in April to May 31

Daily creel limit, 2 trout
Minimum size limit, 14 inches,
Any lure.

From June 1 to November 30

Daily creel limit, 10 fish, or 10 pounds and 1 fish
Minimum size limit, 6 inches but no more than 2 fish longer than 14 inches permitted
Any lure.

4. Despite weaknesses in experimental procedure, results of direct artificial feeding indicated that benefits, if any, were not commensurate with the effort and the expense involved. The best growth is made by those fish which return to the lake between spawning runs, and by those which migrate to Lake Huron sometime early in their second year of life. This suggests strongly that free movement of immature fish should be provided at all times.

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