# CREEL RETURNS OF CATCHABLE RAINBOW TROUT (SALMO GAIRDNERII) AND BROWN TROUT (SALMO TRUTTA) FROM AUGUSTA CREEK, KALAMAZOO COUNTY, MICHIGAN, 1952-1956

Thesis for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY

Wells E. Williams

1957

This is to certify that the

thesis entitled

Creel Returns of Catchable Rainbow Trout
(Salmo gairdnerii) and Brown Trout (Salmo trutta)
From Augusta Creek, Kalamazoo County, Michigan 1952-1956.

presented by

Wells E. Williams

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Ph. D. degree in Fisheries and Wildlife

Peter D. Tack
Major professor

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A THESIS

Submitted to the School for Advanced Graduate Studies of Michigan State University in partial fulfillment of the requirements for the degree of

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## ABSTRACT

Analysis of data collected by the application of a mandatory creel count on a 2.4-mile section of Augusta Creek in southwestern Michigan over a five-year period revealed the following information. Fishermen spent more than 20,700 hours angling, and caught 6,930 trout; 6,062 were planted rainbow trout, 479 planted brown trout, 384 brown trout assumed to be native to the stream or carried over from previous plantings, and one was a brook trout.

Nearly ninety percent of all trout creeled were taken by bait fishermen, seven percent by fly fishermen, and six percent by anglers using artificial plugs and spinners.

Of a total of 10,570 trout stocked in the stream section, 6,255 were taken in the year in which they were planted, and 267 were taken in subsequent years for an over-all return to the creel of 61.8 percent over the five-year period. This figure does not include trout caught outside the experimental stream section.

The average catch per angler dropped from 2.4 trout in 1952 to 1.3 trout in 1956. This decrease is attributed to the increase in angling pressure on the stream.

Approximately sixty percent of all angler visits to the stream resulted in zero catches. It seems apparent that the percentage of zero catches is a function of the number of hours fished, with the more "patient" anglers recording the largest catches.

Only 8.3 percent of the anglers accounted for more than fifty percent of the total number of trout caught during the five-year study period. The frequency distribution of various-sized catches can be represented by a curve similar to that of the Pareto distribution of special abilities as applied to incomes in a stable society or home runs in baseball. This implies that anglers' catches may be directly related to special abilities of fishermen, and that some individuals have an inherited or acquired ability to catch fish, while others are not so endowed.

The returns of planted trout from the Augusta Creek test stream indicate that the present stocking policy is adequately efficient, even though more than fifty percent of the anglers reported no trout to the creel. It is possible that a substantial percentage of planted trout are caught outside the experimental area, and that the returns reported should be considered minimum returns.

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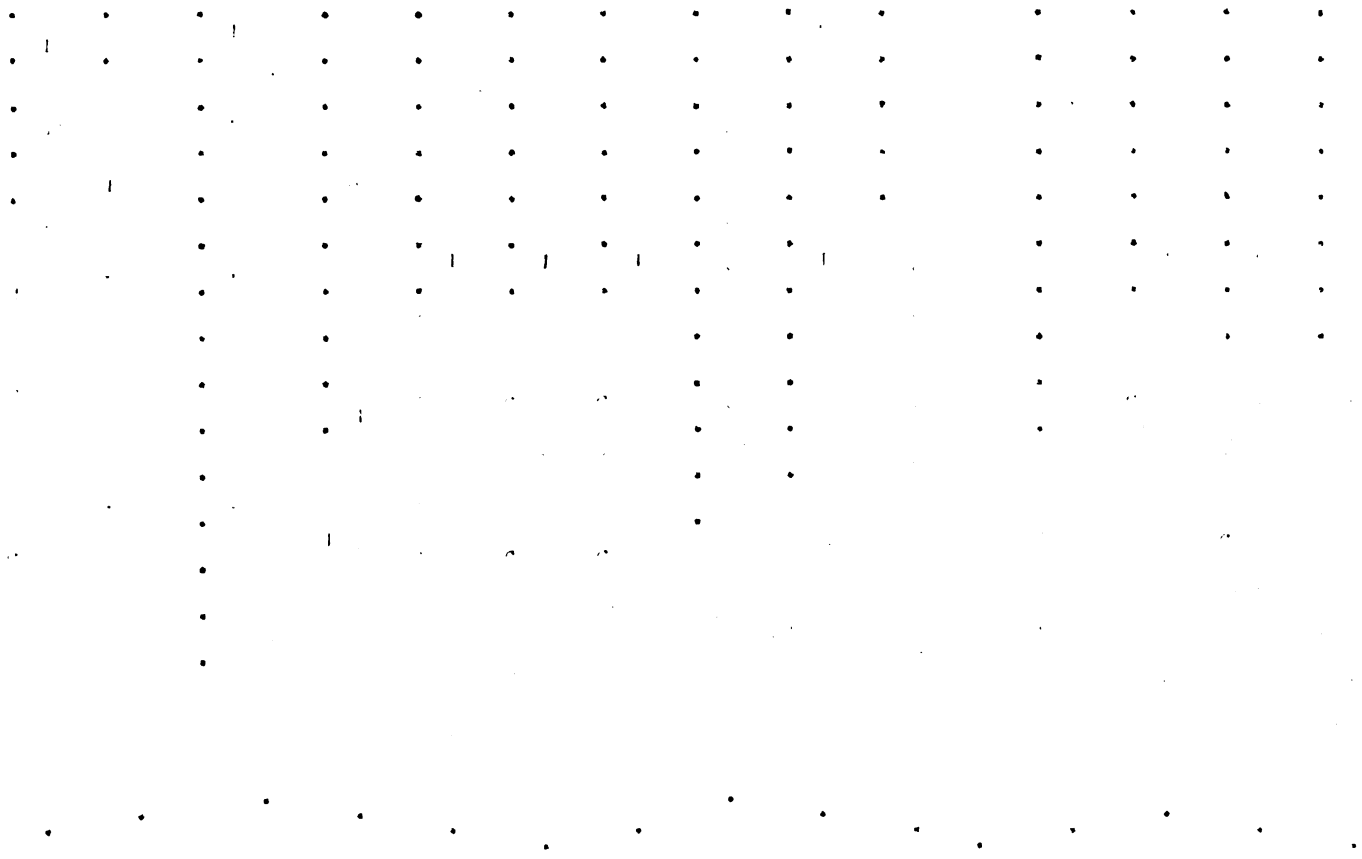

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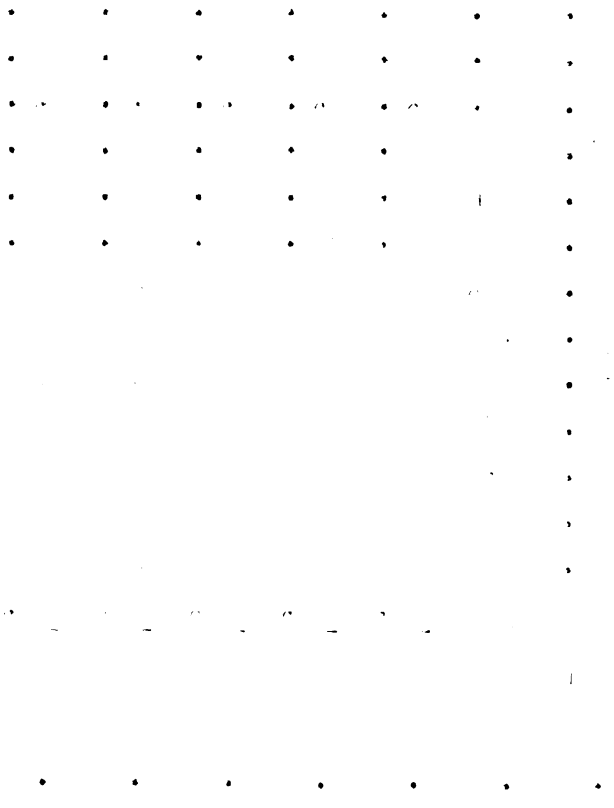

# INTRODUCTION

## Description and History of Augusta Creek

Augusta Creek is located in an area of glacial outwash plains north of the village of Augusta, Michigan, in the southwestern portion of the state.[1] The stream section under consideration lies in Ross Township, Kalamazoo County, Tier 1 south, Range 9 west, and flows generally southward through sections 21,22 and 27 (Fig. 1). The stream is approximately twenty-five miles long, and is joined by several small tributaries. It discharges into the Kalamazoo River in the village of Augusta.

The northern limit of the study area is highway 89; the southern limit is the south property line of a 485-acre tract of multiple-use forest land donated to Michigan State University in 1932 by the late W.K. Kellogg of Battle Creek, Michigan. This portion of the stream is approximately 2.4 miles in length (Fig. 1). The average width is thirty feet. The depth varies from as little as one foot in mid-stream riffle areas to more than four feet in some of the deeper pools. The stream gradient through the forest is approximately 6.5 feet per mile; the volume flow, measured to only moderate accuracy in the summer of 1957, was 61.0 cubic feet per second. Figures 2a and 2b give some indication of the appearance of the stream section through the forest.

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1 Source: Map of the Surface Formations of the Southern Peninsula of Michigan. Mich. Dept. Cons. Geol. Sur. Div., 1955.

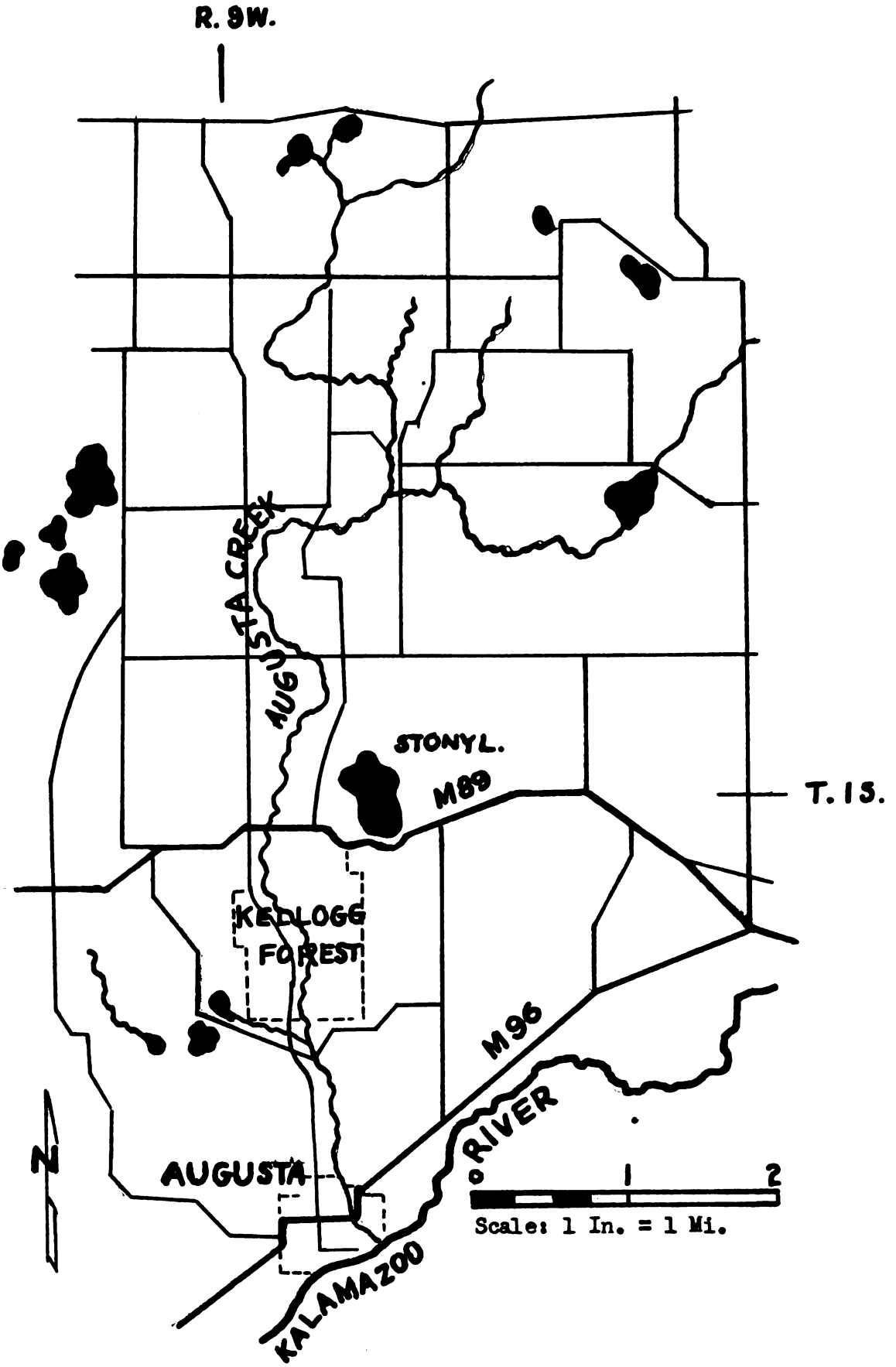


Fig. 1. Sketch map of Augusta Creek, Michigan, showing location of the Kellogg Forest

Figure 2a. Photograph showing a portion of Augusta Creek flowing through the Kellogg Forest in southwestern Michigan.

Figure 2b. Photograph of portion of Augusta Creek flowing through the Kellogg Forest. Note current deflectors at left and right of photograph.

Recent temperature records show summer stream temperatures to be fairly stable, ranging between fifty and seventy degrees Fahrenheit. Only seldom does the temperature rise to more than seventy degrees. The summer temperatures are regarded as being well within the tolerance limits for trout. Winter conditions are not especially severe compared with other portions of the state, and although the stream is covered by ice in most places during the months of December, January and February, there is seldom a snow covering over the stream for any extended period.

It is believed that originally most of the streams in the state of Michigan were devoid of trout, including the streams of the southern peninsula (Hubbs, Greeley and Tarzwell, 1932). Although Augusta Creek is not listed by Brown (1944), it is a permanent stream, and has been widely utilized by anglers for a number of years despite its moderate size.

## Early Investigations and Stocking Methods

Experimentation first began on Augusta Creek during the summer of 1934, when insect surveys and habitat alteration projects were initiated in an attempt to improve the stream for trout. A considerable number of stream alteration devices such as deflectors, wing dams and digger logs were installed, and plantings of willow cuttings and spruce and cottonwood seedlings were made along the stream banks. Angling was reportedly poor, and it was believed that increasing cover would reduce water temperatures, and installing improvement devices would aid in scouring out deeper pools

and removing silt accumulations from the stream bottom. Morofsky, Tack and Lemmien (1949) reported that the alterations resulted in increased numbers and types of trout food organisms, and also increased trout catches, but suggest that angling pressure increased even more rapidly than the yield.

Prior to 1946 the management policy was to stock the stream with eastern brook trout, Salvelinus fontinalis, since it was considered at that time to be a suitable brook trout stream. The species fared poorly; the stocking program failed to provide satisfactory angling except for a short period during the early part of the fishing season. Little sustained angling was offered after the first few weeks, and catches were relatively poor.

In 1946, the stocking program was altered to include the planting of brown trout (Salmo trutta) of catchable size (seven inches or more in length). It appeared that angling was provided on a more sustained basis, but returns were still less than efficient.

The planting program was again altered in 1952. It was then thought practical to replace brown trout plantings with those of catchable rainbow trout (Salmo gairdnerii). The present study deals primarily with the rainbow trout phase of the planting program.

## Reason for the Study

The purpose of the present study was to determine the effect of the rainbow trout stockings upon the angling returns, to find what the effects of increased exploitation have been upon the

fishery, and to compare catch returns for various years of the study. It was also of interest to determine whether catch distributions were a function of the number of hours fished, or if they were explained as distributions of special ability among anglers.

## Regulations and Creel Count

The primary objectives of the stream management program on Augusta Creek are 1) to provide recreational facilities for as many individuals as possible, and 2) to attempt to supply satisfactory angling for all fishermen utilizing the stream in the Kellogg Forest area.

The angling regulations in effect on Augusta Creek are the same as for any other trout stream in the state of Michigan, but in addition, all anglers fishing the stream within the property boundaries of the Kellogg Forest must obtain a special permit, issued annually without cost by the forester in charge. There is also a stipulation that all anglers fishing the stream section are required to check out at the termination of each fishing trip and to supply information as to numbers and species of trout caught, hours spent angling, baits or lures used in taking fish, and markings on creeled fish (if any). There is no restriction made as to the number of special permits issued. This mandatory creel count has been in operation at the Kellogg Forest since 1941. All fishermen are directed to leave the property by a single roadway; this permits a complete intensive creel census of all catches made within the boundaries of the Kellogg Forest area.

## REVIEW OF LITERATURE

The creel count, or creel census, has been recognized as a primary tool in fishery research. In accomplishing a yield analysis, two methods are ordinarily adopted, 1) the general census, covering a random sampling of angling over a broad area, and 2) the intensive census, restricted to certain selected waters only. Both of the methods can provide valuable information. Lagler (1952) lists various data of importance that may be gathered by the use of the census.

A properly conducted creel count is known to furnish an excellent check on results of stocking procedures, exploitation of a fishery and the effectiveness of management methods. The ideal count is an intensive one, rarely achieved in practice, in which every angler on the stream is interviewed, and all catches are observed and recorded. Only a one-hundred-percent, seven-day-a-week creel count can achieve this ideal.

Studies by Mottley (1949) and Cooper (1951) suggest that variability of population estimates due to movement, catchability and mortality are minimal, and that little migration of trout from the stream section where plantings were made was noted. Shetter(1947) reported migrations of as far as ten miles from the point of release by rainbow trout. In a later study, Shetter (1950) reported that most hatchery fingerling trout recovered as legal fish were taken less than one mile from the locality of release.

Unconfirmed reports by anglers fishing Augusta Creek suggest some migration of planted trout. The forester in charge of the Kellogg Forest area asserted that "many" planted trout are taken each year both above and below the stream section in which they were released.

Schuck (1942) stated that the yield of trout is closely associated with the density of the trout population in a stream. On this basis, catches of planted trout should be directly dependent upon the actual number of stocked individuals, especially in those streams with little or no natural recruitment to the population. Chamberlain (1943) stated that the stocking of excess numbers of trout can be detrimental, and that the catch should determine the number to be stocked. He suggested that overstocking spoils the immediate fishing, and that most of the planted trout are lost, and do not enter materially into subsequent catches.

Chamberlain (1942) also found that stocking of legal-sized trout yielded the best returns where fishing pressure was intense, and that spring plantings gave higher returns than fall plantings. Experiments by Shetter and Hazzard (1941, 1942) demonstrated that in most Michigan streams, from two to six times as many hatchery trout were caught from spring plantings as from fall plantings. Smith (1941) conducted a creel census and tagging study on the Salmon Trout River in the northern peninsula of Michigan and found that fall plantings of legal-sized brook trout gave only a one percent return to the creel, while those stocked in the spring gave returns of nearly twenty percent. He made the further observation that the

spring-planted trout provided more sustained angling throughout the entire angling season than those planted in the fall. Investigations by Shetter (1947) afforded additional data in support of the view that spring plantings of legal-sized trout yield higher returns to the creel than fall plantings.

Other experiments indicate that plantings of fingerling or yearling trout are not profitable where fishing pressures are intense. A three-year investigation of several Michigan streams by Shetter (1939) disclosed that plantings of sub-legal (fingerling) trout were not practical. None of the streams provided returns of more than 1.6 percent of the total number stocked. Experiments at Hunt Creek, Michigan in later years by the same investigator (Shetter, 1950) gave returns of slightly more than two percent. Chamberlain and Halloway (1942) and Chamberlain (1943) also promulgated the view that fingerling trout plantings yield unsatisfactory returns in terms of catchable trout. Questionaires sent to various states to determine trends in current fishery programs during 1946 revealed that only three of twenty-one states questioned about trout propogation and planting reported good success with the stocking of fingerlings or trout fry in streams, while nine of them reported the practice as fair, and thirteen classified their results as poor. (Eicher, 1946).

Stocking of sub-legal trout at Augusta Creek was discontinued in 1946 because angler returns were considered unsatisfactory. A planting program providing immediate angling for increasingly growing numbers of fishermen on the stream was needed.

Plantings of legal-sized hatchery trout are now considered to be the most efficient for meeting demands of fishermen for trout. Information concerning creel returns from stocking catchable trout can be found in much of the literature (Shetter and Hazzard, 1941; Chamberlain, 1942; Schuck, 1942; Cooper, 1951; Vestal, 1954; Nielson, Reed, Reimers and Kennedy, 1957).

Another consideration involved in trout stocking is that of the inability of some species to survive winter conditions. This inability is believed to be characteristic of hatchery trout (Hewitt, 1938; Hazzard, 1941; Maciolek and Needham, 1952). The studies of Needham (1947) suggest that this inability is associated with the severity of winter conditions. He found over-winter loss of brown trout in Convict Creek, California to be about sixty percent, regardless of the age of the trout. Nielson, Reed, Reimers and Kennedy (1957) reported that some planted trout exibited an ability to survive equal to that of resident brown trout of comparable size.

Several states have used "test" streams (Lord, 1935) in studying mortality rates, exploitation, survival and catchability of trout. Among these test streams are Furnace Brook, Vermont; Rush, Convict and Squaw creeks in California; Pigeon River and Hunt Creek in Michigan. The studies on Augusta Creek can also be considered test stream experiments.

Most of the test streams have been provided with some type of stream alteration structures to alter habitat conditions. These

structures, and their relation to trout populations have been investigated by several noted workers. Among the investigations are those of Tarzwell (1931, 1935, 1936, 1937, 1938), Hazzard (1937), Shetter (1947) and Boussu (1954). Doctor Clarence M. Tarzwell could well be called the pioneer of stream alteration in Michigan.

One of the most comprehensive reports of the effects of stream alteration on trout populations was that of Shetter, Clark and Hazzard (1947) on Hunt Creek, Michigan. An eight-year study of changes in the stream attributed to the use of current deflectors showed a total catch increase of 120 percent, even with an increase of 64 percent in angling pressure. The studies were carried on for three years before alteration structures were installed and for five years following installations. Morofsky, Tack and Lemmien (1949) gave evidence that stream alteration structures placed in a section of Augusta Creek within the present study area resulted in increases in the numbers and types of trout food organisms, and also in increases in the total trout catch from the stream.

Of considerable interest to both the angler and the fishery biologist is the percentage yield of planted trout to the creel. The highest return noted in the literature was a record 92.2 percent return of planted catchable rainbow trout reported from Rush Creek test stream in California (Vestal, 1954). It should be emphasized that the experimental stream section in the above study

had been provided with weirs to prevent emigration of planted trout from the planting locality. Cooper (1951) reported returns of 31.5 to 39.7 percent from marked resident brown trout of the Pigeon River, Michigan. Returns from plantings of legal-sized trout at the Augusta Creek test stream reached 44 percent in 1947, and were thought to be unusually high for the state of Michigan at that time (Morofsky, Tack and Lemmien, 1949). Later analysis of creel count records from the same section of stream (Shideler, 1952) showed returns of 60.2 and 41.0 percent for the years 1950 and 1951 respectively. Chamberlain (1942) considered returns of planted trout to be adequate if they reached sixty percent of the number stocked.

## THE STOCKING PROGRAM

Studies first began on Augusta Creek on a continuous basis in 1934. Prior to 1946, the stream was regarded as a brook trout stream, as plantings indicate (table I). With the exception of three earlier brown trout plantings in 1924, 1927 and 1934, the stream had been planted consistently with brook trout (Morofsky, Tack and Lemmien, 1949). Fingerling and yearling trout were planted until 1944; after that time, only legal-sized trout have been planted. The stocking schedule for the years 1941 through 1951 is given in table I.

The creel count was not carried out on an organized basis before 1946, and results of the earlier plantings are not available. An interesting study of creel count data taken during the brown trout phase of management involving the same stream section was presented by Shideler (1952), in which data were grouped into visit categories in an effort to indicate a relationship between angling frequency and angling success. The conclusion made was that anglers frequenting the stream most often were able to take more trout because of familiarity with the stream.

Planting experiments with legal-sized rainbow trout began in 1952. A few brook trout continued to appear in angler's creels through 1952, but after that time, they disappeared entirely from the catch.

Table I

Planting Schedule for Augusta Creek in Kellogg Forest, 1941-1951.

| Year | Species | Average length | Number |
|---|---|---|---|
| 1941 | Brook trout | Yearlings | 1,000 |
| 1941 | Brook trout | 3 months | 6,000 |
| 1941 | Brook trout | 7 months | 1,000 |
| 1942 | Brook trout | Yearlings | 500 |
| 1943 | Brook trout | Yearlings | 1,200 |
| 1944 | Brook trout | 7" -10½" | 300 |
| 1945 | Brown trout | 8" | 700 |
| 1946 | Brown trout | 7" - 8" | 1,600 |
| 1947 | Brown trout | 8½" | 800 |
| 1948 | Brown trout | 7½"-9½" | 2,400 |
| 1949 | Brown trout | Legals | 2,300 |
| 1950 | Brown trout | " | 1.500 |
| 1951 | Brown trout | " | 500 |

The plantings were distributed more or less randomly throughout the stream section at various times during the fishing season, with planting frequencies ranging from as few as four in 1953 to nine in 1956. All trout planted were furnished by the state trout hatchery at Wolf Lake, Michigan, and were transported and released by personnel of the Michigan State Department of Conservation. The trout were variously marked either by tagging or removal of fins; in some cases, markings were not deemed necessary. A complete planting schedule is given in table II for years 1952 to 1956.

The department of Fisheries and Wildlife of Michigan State University is responsible for administering both the creel count and the management program, with forestry personnel residing on the property making the actual creel counts, and being paid a monthly stipend for the service.

As stated by Davis, 1938, two of the most important objectives in trout stream management are 1) to provide satisfactory fishing at a reasonable cost, and 2) to provide fairly good angling throughout the entire fishing season. These two objectives are considered of paramount importance in the management of the Augusta Creek fishery.

Table II

Planting Schedule for Augusta Creek in Kellogg Forest, 1952-1956.

| Planting Date | Species | Average size | Number Stocked | Identification mark |
|---|---|---|---|---|
| 4/11/52 | Rainbow trout | 7" - 9" | 500 | None |
| 5/16/52 | " " | 7" - 9" | 500 | " |
| 6/12/52 | " " | 7" -10" | 500 | " |
| 8/19/52 | " " | 7" -10" | 500 | " |
| 4/10/53 | Rainbow trout | 8½" | 500 | LV clipped |
| 5/22/53 | " " | 8½" | 500 | " " |
| 6/11/53 | " " | 8½" | 500 | " " |
| 8/26/53 | " " | 10" | 500 | " " |
| 4/12/54 | Rainbow trout | 10" | 500 | LP clipped |
| 4/27/54 | " " | 7" | 320 | Jaw-tagged |
| 5/13/54 | " " | 10" | 500 | LP clipped |
| 6/22/54 | " " | 8" | 500 | " " |
| 8/12/54 | " " | 9" | 500 | " " |
| 250 rainbow trout planted each week for seven weeks beginning on 4/26/55. One additional planting was made on 8/15/55. | | All legals 7" and over | 2,000 | None |
| Both rainbow and brown trout were planted, 125 of each species each week for the first eight weeks of the 1956 season, beginning on 4/24/56. One additional planting was made on 8/22/56 | | All legals 7" and over | 2,250 | AD clipped |

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## RESULTS OF THE CREEL COUNT

### 1952 Returns

The 1952 returns were based on a restricted, stratified sample of twenty-two days selected before the opening of the fishing season (Fig. 3a). On these sampling days, data were collected from both successful and unsuccessful anglers; on all other days during the season, records were kept only of the successful visits to the stream section. It was therefore necessary to extrapolate from the sampling data to determine zero catches and total hours spent angling. Thus zero catch figures and estimated total hours fished are accurate only in so far as the sample was representative of the entire fishing season.

During 1952, 607 anglers were issued special permits, and fished 108 days out of a total of 135 days in the fishing season. This was an increase of twelve percent in the number of anglers over the preceding year. A total of 1,251 visits were made to the stream, and anglers spent approximately 3,250 hours in the pursuit of their sport. The total yearly catch was recorded as 1,482 trout, of which 1,305 were rainbow trout (88.1 percent), 176 were brown trout (11.9 percent) and only one a brook trout. The 1,305 rainbow trout made up 62.5 percent of the 2,000 planted in 1952, for an increase of 24.2 percent over 1951 returns of planted trout.

Bait fishermen spent 886 hours at the sport during the twenty-two days sampled, and accounted for 90 percent of the total catch. Fly fishermen spent 789 hours and caught 9 percent of the trout, while anglers using plugs or spinners or spinners fished only 8 hours and

**Figure 3a.** Days selected for the random sample, 1952 angling season.

**APRIL**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | (26) |
| (27) | 28 | 29 | 30 | | | |

**MAY**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | | (1) | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | (10) |
| 11 | 12 | 13 | (14) | 15 | 16 | 17 |
| 18 | (19) | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | (30) | 31 |

**JUNE**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| 1 | 2 | (3) | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| (15) | 16 | (17) | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | (26) | 27 | 28 |
| 29 | 30 | | | | | |

**JULY**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| (6) | 7 | 8 | 9 | 10 | (11) | 12 |
| 13 | (14) | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | (23) | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | | |

**AUGUST**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | | | 1 | (2) |
| 3 | 4 | 5 | 6 | 7 | 8 | (9) |
| 10 | 11 | 12 | 13 | (14) | 15 | 16 |
| 17 | 18 | (19) | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | (27) | 28 | 29 | 30 |
| 31 | | | | | | |

**SEPTEMBER**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | (4) | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| (14) | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 28 | 29 | 30 | | | | |

**Days circled are those selected for the stratified sample for 1952.**

accounted for the remaining portion of the catch. The average catch per angler during 1952 was 2.4 trout per angler hour. There were 637 successful visits to the stream section, and approximately 614 visits yielded no trout to the creel. Only eleven percent of the total trips produced 55.9 percent of the entire season's catch. The most successful month was May, and the poorest was July. The angling intensity was also highest in May, and lightest in July. One angler caught thirteen trout, and one caught twelve (this was the last year that a fifteen-trout limit was in effect in Michigan). Eleven anglers caught ten trout each. Eighty-four rainbow trout of those stocked in 1952 were caught in the following year, bringing the total return of 1952 plantings to 69.4 percent. This return was the highest recorded for any year during the five-year study period. Monthly creel census data for 1952 are given in table III; a complete summary of data for the five-year period is shown in table IV.

Table III

Monthly Summary of Angling Data - Augusta Creek, Michigan, 1952.[1]

| | Apr. | May | Jun. | Jul. | Aug. | Sept. |
|---|---|---|---|---|---|---|
| Days in month | 30 | 31 | 30 | 31 | 31 | 30 |
| Days fished | 5 | 27 | 24 | 18 | 21 | 13 |
| Number of visits | 169 | 182 | 86 | 56 | 84 | 60 |
| Hours fished | 491 | 188 | 61 | 55 | 43 | 49 |
| Hours fished- bait | 462 | 162 | 46 | 52 | 31 | 37 |
| Hours fished - fly | 29 | 18 | 15 | 3 | 13 | 4 |
| Hours fished - plug | 0 | 8 | 0 | 0 | 0 | 8 |
| Average catch/visit | 1.8 | 2.3 | 2.9 | 2.1 | 2.7 | 2.4 |
| Rainbow trout catch | 248 | 360 | 232 | 111 | 212 | 142 |
| Brown trout catch | 64 | 59 | 23 | 8 | 17 | 5 |
| Total catch | 312 | 420[2] | 255 | 119 | 229 | 147 |
| Catch by bait | 278 | 363 | 223 | 110 | 191 | 123 |
| Catch by flies | 28 | 27 | 24 | 8 | 20 | 14 |
| Catch with plugs | 0 | 30 | 8 | 1 | 17 | 10 |

[1] Based on data from partially restricted random sampling of 22 days of the 1952 fishing season, plus records of successful trips only.

[2] Total includes one brook trout

Table IV.

Summary of Angling Data from Augusta Creek, Michigan, 1952-1956.

| Year: | 1952 | 1953 | 1954 | 1955 | 1956 |
|---|---|---|---|---|---|
| Days in fishing season | 135 | 142 | 142 | 135 | 135 |
| Days actually fished | 108 | 114 | 136 | 126 | 132 |
| Number of anglers | 607 | 736 | 917 | 1,050 | 1,102 |
| Number of angler visits | 1,251 | 1,573 | 1,443 | 2,036 | 1,928 |
| Total hours fished | 3,252 | 4,096 | 3,683 | 5,254 | 4,482 |
| Average catch/visit | 1.2 | 0.7 | 1.0 | 0.7 | 0.7 |
| Average catch/angling hour | 0.4 | 0.3 | 0.4 | 0.3 | 0.3 |
| Mean average catch/angler | 2.4 | 1.5 | 1.6 | 1.4 | 1.3 |
| Number of rainbow trout caught | 1,305 | 1,065 | 1,426 | 1,377 | 872 |
| Number of brown trout caught | 176 | 62 | 58 | 51 | 527 |
| Number of visits/mile of stream/day | 6.4 | 7.7 | 5.9 | 8.9 | 8.1 |
| Hours fished/day/mile of stream | 16.7 | 19.9 | 15.0 | 23.2 | 18.8 |

## 1953 Returns

The creel count in 1953 was administered in much the same manner as in the previous year. Again, a 22-day sample was selected before the season's opening for a restricted, stratified sampling of the year's angling (Fig. 3b), and only partial data were taken on all other days from successful fishermen only.

Records indicate that 114 days were fished from a total of 142 days in the fishing season. A total of 736 anglers made approximately 1,570 visits to the experimental stream section and caught 1,127 trout, of which 1,065 were rainbow trout and 62 were brown trout. In all, 4,096 hours were spent fishing, and the average catch per angler visit was found to be 0.7 trout, or 0.3 trout per angling hour.

The number of unsuccessful visits increased considerably over the previous year, rising to 56.4 percent of the total in 1953 (table V). Thus, more than one-half of the fishermen trips resulted in no trout to the creel, with a small minority of anglers catching the greater portion of the trout (table VI).

The catch of 0.8 trout per angler hour in June was the highest rate of the year, and the lowest was recorded in the month of July (table VII). As in 1952, the largest monthly catch was in May, when angling intensity was high.

Figure 3b.

**APRIL**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | (25) |
| (26) | 27 | 28 | 29 | 30 | | |

**MAY**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | | | 1 | 2 |
| (3) | 4 | 5 | 6 | 7 | (8) | 9 |
| 10 | (11) | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | (20) | 21 | 22 | 23 |
| 24 | 25 | (26) | 27 | 28 | 29 | 30 |
| 31 | | | | | | |

**JUNE**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | (4) | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 | (13) |
| 14 | 15 | 16 | (17) | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | (27) |
| 28 | 29 | 30 | | | | |

**JULY**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | (3) | 4 |
| 5 | 6 | (7) | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | (16) | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| (26) | (27) | 28 | 29 | 30 | 31 | |

**AUGUST**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | | | | 1 |
| 2 | 3 | 4 | (5) | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 | (13) | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | (21) | 22 |
| 23 | 24 | (25) | 26 | 27 | 28 | 29 |
| 30 | (31) | | | | | |

**SEPTEMBER**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | (12) |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | | | |

Days circled are those selected for the stratified sample for 1953.

Table V.

Distribution of Unsuccessful Visits (Zero Catches)

| Year: | 1952 | 1953 | 1954 | 1955 | 1956 |
|---|---|---|---|---|---|
| Number of visits: | 614* | 887* | 855 | 1,305 | 1,270 |
| Percentage: | 49.1 | 56.4 | 59.2 | 63.9 | 65.8 |

* Figures are based on 22-day samples.

Table VI.

Distribution of Anglers Accounting for More Than Fifty Percent of Total Catch

| Year: | 1952 | 1953 | 1954 | 1955 | 1956 |
|---|---|---|---|---|---|
| Number | 117 | 94 | 126 | 181 | 178 |
| Percentage | 9.4 | 6.0 | 8.4 | 8.9 | 9.2 |

Table VII

Monthly Summary of Angling Data - Augusta Creek, Michigan, 1953 [1]

| Month: | Apr. | May | Jun. | Jul. | Aug. | Sept. |
|---|---|---|---|---|---|---|
| Days in month | 30 | 31 | 30 | 31 | 31 | 30 |
| Days fished | 6 | 28 | 27 | 22 | 21 | 10 |
| Number of visits | 180 | 205 | 121 | 87 | 50 | 43 |
| Total hours fished | 502 | 598 | 319 | 219 | 123 | 118 |
| Hours - bait | 492 | 488 | 254 | 131 | 99 | 98 |
| Hours - fly | 10 | 71 | 63 | 88 | 24 | 20 |
| Hours - plug | 0 | 0 | 2 | 0 | 0 | 0 |
| Average catch/ visit | 1.6 | 1.6 | 2.2 | 1.0 | 1.6 | 1.9 |
| Average catch/ hour | 0.6 | 0.6 | 0.8 | 0.4 | 0.6 | 0.7 |
| Rainbow trout caught | 266 | 301 | 260 | 83 | 78 | 77 |
| Brown trout caught | 14 | 34 | 4 | 3 | 3 | 4 |
| Total catch | 280 | 335 | 264 | 86 | 81 | 81 |
| Catch - bait | 273 | 282 | 225 | 64 | 74 | 69 |
| Catch - fly | 7 | 53 | 32 | 22 | 7 | 7 |
| Catch - plug | 0 | 0 | 4 | 0 | 0 | 0 |

[1] Based on data from partially-restricted random sample of 22 days of the 1953 season, plus records of successful trips.

The catch distribution by lure used varied only slightly from that of 1952, with bait fishermen again taking the greatest number of trout (table VIII).

Table VIII.

Percentage Distribution of Catch According to Lure Used

| Year: | 1952 | 1953 | 1954 | 1955 | 1956 |
|---|---|---|---|---|---|
| Lure: | | | | | |
| Bait | 88.9 | 87.6 | 91.4 | 88.3 | 79.0 |
| Flies | 9.1 | 11.4 | 5.1 | 2.3 | 8.5 |
| Plugs | 1.9 | 0.4 | 3.1 | 9.4 | 11.4 |

## 1954 Returns

In 1954, the 100-percent creel census was undertaken. All creels were closely checked, and fishermen were interviewed regardless of whether or not they were successful in taking trout. Accurate data on lures used, hours fished, total catch, species caught and planting marks (if any) were recorded. Although the method was known to be extremely time-consuming, it was thought necessary for collecting accurate data on yields and angling intensity.

The stream was fished on 136 days out of 142 in the 1954 season. Nine hundred seventeen anglers made 1,443 trips to the stream and spent 3,683 hours in catching 1,426 rainbow trout and 58 brown trout, or a total of 1,484 for the season.

The average catch per angler hour increased to 0.4, returning to the 1952 figure. The total catch for the year was the highest for any year during the study. The highest monthly catch and the most intensive angling effort occurred in May, but the most successful month as measured by the catch per angling hour was in June, when it rose to 0.6 trout. A complete summary of angling data for 1954 is given in table IX.

As in 1952 and 1953, more than one-half of the total year's catch was taken during the first few weeks of the fishing season. Returns show that nearly sixty percent of the catch was taken before the end of May, only 38 days after the opening of the season.

More than ninety percent of the year's catch was made by anglers using bait. The catch by fly fishermen declined from previous years, while plug fishermen increased their yield slightly over the 1952 figure (table VIII).

Nearly sixty percent of the fishermen visits in 1954 resulted in zero catches (table V). This high percentage of zero catches is an indication of the continuing increase in angling pressure on the stream.

The catch per angling hour was lower than in 1953 in every month, as seen from Fig. 4. The catch per hour was highest in the months of June and September, and lowest in July.

During the 1954 season, 320 rainbow trout "psychologically trained" by avoidance responses to take food only from underneath the water surface were planted in the experimental section of stream to test any possible differences in catchability between these trout and normally cultured rainbow trout planted at the same time. It was assumed that the conditioned trout would be more difficult to catch, and thus would provide more sustained angling throughout the entire fishing season. Experiments with the trained trout are presently being carried out at the Tobacco River in the central part of the state, but a comprehensive report of the work has not been published. According to data gathered from the Augusta Creek study, no significant advantage was apparent in stocking the trained trout. Of the 320 trained trout planted in 1954, sixty percent were returned to the creel, as compared to a return of approximately

Fig. 4. Catch per unit of effort by months, Augusta Creek, Michigan, 1953-1956

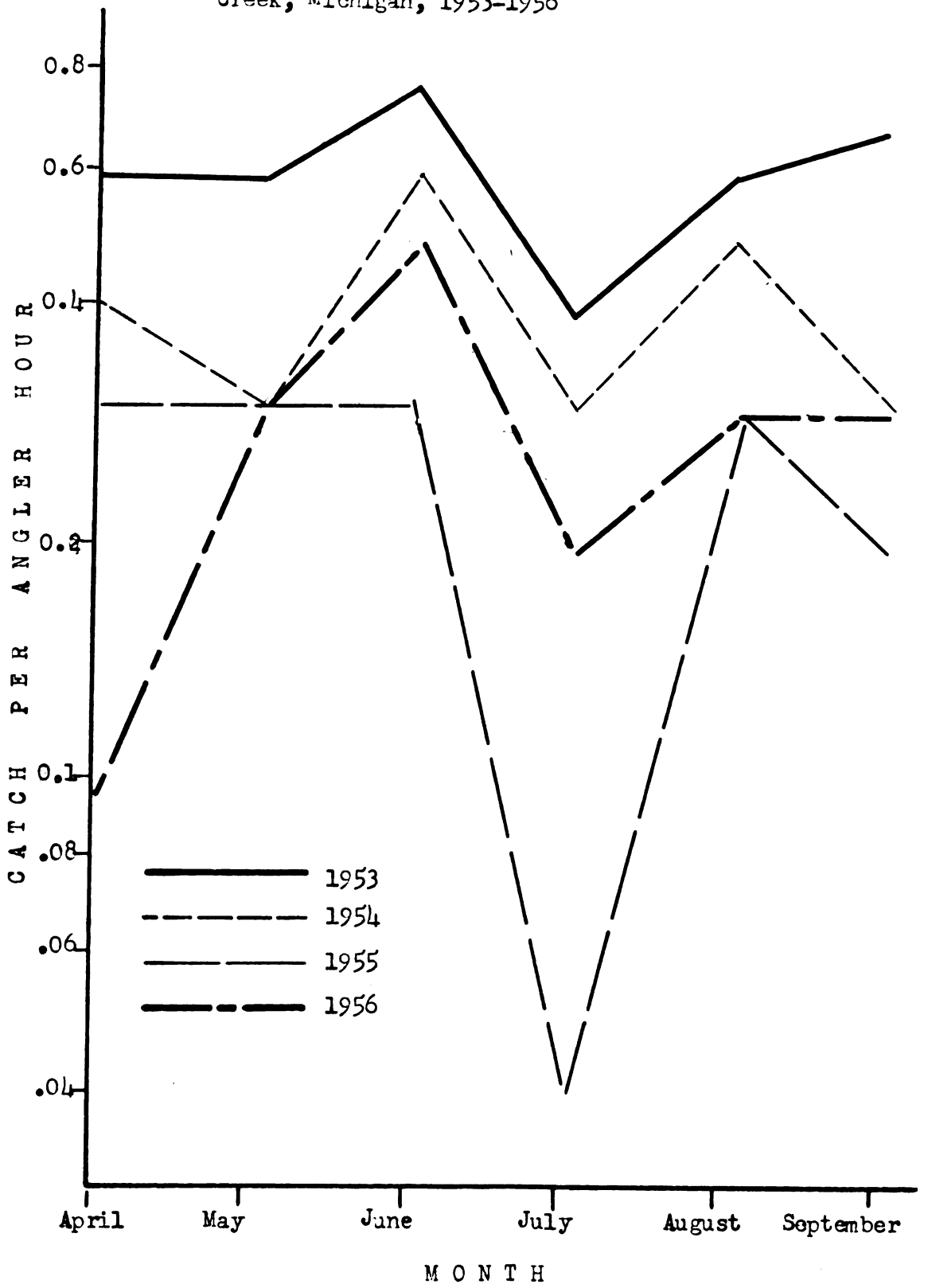


Table IX.

Monthly Summary of Angling Data - Augusta Creek, Michigan, 1954

| Month: | Apr. | May | Jun. | Jul. | Aug. | Sept. |
|---|---|---|---|---|---|---|
| Days in month | 30 | 31 | 30 | 31 | 31 | 30 |
| Days fished | 7 | 31 | 27 | 29 | 30 | 12 |
| Number of visits | 355 | 553 | 157 | 125 | 193 | 60 |
| Total hours fished | 1,022 | 1,350 | 375 | 340 | 463 | 134 |
| Hours-bait | 990 | 1,164 | 319 | 289 | 424 | 116 |
| Hours - fly | 17 | 124 | 40 | 41 | 30 | 252 |
| Hours - plug | 15 | 61 | 16 | 10 | 10 | 117 |
| Average catch/ visit | 1.1 | 0.8 | 1.5 | 0.9 | 1.3 | 0.7 |
| Average catch/ hour | 0.4 | 0.3 | 0.6 | 0.3 | 0.5 | 0.3 |
| Rainbow trout caught | 368 | 440 | 224 | 111 | 244 | 39 |
| Brown trout caught | 28 | 14 | 7 | 2 | 5 | 2 |
| Total catch | 396 | 454 | 231 | 113 | 249 | 41 |
| Catch - bait | 381 | 403 | 218 | 99 | 229 | 27 |
| Catch - fly | 7 | 22 | 6 | 12 | 15 | 14 |
| Catch - plug | 8 | 25 | 7 | 1 | 5 | 0 |

fifty-eight percent from the 2,000 normally-cultured trout planted during the same season.

## 1955 Returns

The stream was fished on 126 of the 135 days comprising the 1955 season. One-thousand-fifty fishermen spent 5,253 hours in catching 1,377 rainbow trout and 51 brown trout for a total yearly catch of 1,428 trout. Of the total number of rainbow trout taken, 1,325 were from the 1955 plantings. During the following year (1956), 53 additional rainbow trout from the 1955 plantings were taken, bringing the total of 1955-stocked rainbow trout to 1,378, nearly sixty-nine percent of the number planted.

The catch per angler hour was less than in the preceding year in all months except August and May; the figure for those months remained the same (Fig. 4). In July, the catch per unit of effort dropped to a new low of 0.04 trout per hour. During that month, anglers spent 269 hours in catching only twelve trout.

The percentage of zero catches increased to 63.9, despite the fact that more than 2,000 trout were planted. It is interesting to note that again, a very small number of anglers accounted for more than fifty percent of the total year's catch (table VI).

Bait fishermen again proved to be the most successful from the standpoint of numbers of trout caught. Fly and plug fishermen together took only a small part of the total catch (table VIII).

The number of anglers increased by nearly fifteen percent over the 1954 season, although the rate was less than in the previous year, when the number increased by 25 percent over 1953.

The average catch per angling hour dropped to 0.3 trout, returning to the 1953 level. The average annual catch per angler was 1.4 trout. In 1955, nearly 63 percent of the total year's catch was creeled in the first quarter of the fishing season. A complete summary of 1955 angling data may be found in table X.

Table X.

Monthly Summary of Angling Data - Augusta Creek, Michigan, 1955

| Month: | Apr. | May | Jun. | Jul. | Aug. | Sept. |
|---|---|---|---|---|---|---|
| Days in month | 30 | 31 | 30 | 31 | 31 | 30 |
| Days fished | 1 | 31 | 30 | 27 | 27 | 10 |
| Number of visits | 170 | 986 | 532 | 122 | 160 | 66 |
| Total hours fished | 468 | 2,655 | 1,419 | 268 | 357 | 188 |
| Hours- bait | 444 | 2,383 | 1,259 | 205 | 285 | 136 |
| Hours - fly | 16 | 82 | 52 | 32 | 52 | 39 |
| Hours - plug | 8 | 190 | 108 | 31 | 20 | 13 |
| Average catch/ visit | 0.9 | 0.7 | 0.7 | 0.1 | 0.6 | 0.5 |
| Average catch/ hour | 0.3 | 0.3 | 0.3 | 0.04 | 0.3 | 0.2 |
| Rainbow trout caught | 153 | 703 | 379 | 11 | 95 | 36 |
| Brown trout caught | 10 | 22 | 17 | 1 | 1 | 0 |
| Total catch | 163 | 725 | 396 | 12 | 96 | 36 |
| Catch - bait | 158 | 635 | 358 | 10 | 77 | 23 |
| Catch - fly | 1 | 5 | 4 | 0 | 14 | 9 |
| Catch - plug | 4 | 85 | 34 | 2 | 5 | 4 |

## 1956 Returns

Angling permits were issued to 1,102 individuals during 1956, a slightly larger number than that issued in 1955. Anglers fished 132 days of a total 135 days in the 1956 fishing season. Fishermen made 1,928 visits to the stream, and expended 4,482 hours of effort in catching 1,399 trout, of which 872 were rainbow trout and 527 were brown trout. Of the rainbow trout creeled, 819 were from 1956 plantings and 53 from plantings of prior years. Four hundred seventy-nine of the brown trout entering the catch were from 1956 plantings. The return for rainbow trout was over 65 percent, and that for brown trout nearly 50 percent, bringing an over-all return to the creel of approximately 58 percent for the year. It is expected that a few more individuals from the 1956 plantings will appear in the 1957 catch.

Eighty-two percent of the total catch for the year entered into the creel before the season was one-half over. There were 1,270 unsuccessful visits made during the year, or 65.8 percent of the total visits made in 1956. This was the highest percentage of zero catches recorded during the five-year study(table V).

The average hourly catch was highest in June and lowest in April. However, only three days were fished in April, even though 275 fishermen visits were made.

One hundred seventy-eight anglers caught more than fifty percent of the total number of trout recorded in 1956. This makes up only 9.2 percent of the anglers (table VI).

In general, the rate of catch was higher than in 1955, although the lowest rate for the entire five-year period was recorded in April, 1956. The catch per angler hour was less than that of any month in either 1953 or 1954, with the exception of the month of May, when the rate was the same as in 1954.

A complete summary of 1956 angling data by months can be found in table XI.

Table XI.

Monthly Summary of Angling Data - Augusta Creek, Michigan, 1956

| Month: | Apr. | May | Jun. | Jul. | Aug. | Sept. |
|---|---|---|---|---|---|---|
| Days in month | 30 | 31 | 30 | 31 | 31 | 30 |
| Days fished | 3 | 31 | 30 | 29 | 31 | 8 |
| Number of visits | 275 | 1,031 | 298 | 141 | 111 | 71 |
| Total hours fished | 542 | 2,455 | 741 | 325 | 251 | 169 |
| Hours - bait | 525 | 2,155 | 537 | 241 | 182 | 154 |
| Hours - fly | 5 | 114 | 110 | 48 | 47 | 11 |
| Hours - plug | 12 | 186 | 94 | 36 | 22 | 4 |
| Average catch/ visit | 0.2 | 0.8 | 1.2 | 0.2 | 0.7 | 0.8 |
| Average catch/ hour | 0.1 | 0.3 | 0.5 | 0.2 | 0.3 | 0.3 |
| Rainbow trout caught | 46 | 464 | 220 | 30 | 60 | 52 |
| Brown trout caught | 19 | 331 | 133 | 22 | 20 | 2 |
| Total catch | 65 | 795 | 353 | 52 | 80 | 54 |
| Catch - bait | 65 | 664 | 236 | 36 | 61 | 44 |
| Catch - fly | 0 | 22 | 64 | 11 | 18 | 4 |
| Catch - plug | 0 | 100 | 53 | 5 | 1 | 1 |

## DISCUSSION AND ANALYSIS OF CREEL COUNT DATA

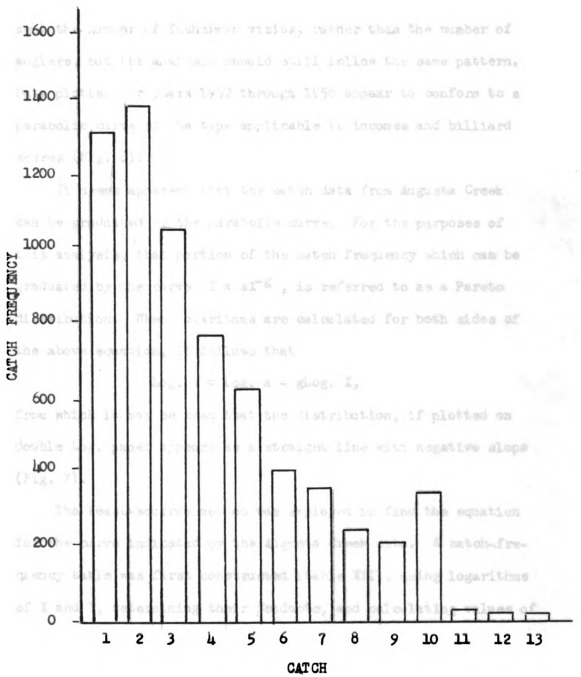
### The Catch Distribution Curves

During the five-year period, 2,922 fisherman trips resulted in catches of one or more trout. The catch frequency distribution is presented in Fig. 5. It is readily apparent that the distribution does not follow a normal bell-shaped curve, but that of a parabolic curve with essentially the same characteristics as that of the Pareto distribution applied to incomes. That is to say, it follows the general distribution of special abilities as described by Davis (1941) for billiard scores, home runs in baseball or incomes in a stable society. Although Pareto's law is not universally acceptable to all econometricians because of its rigid form and generality, no one has as yet exhibited a stable social order which has not followed the Pareto pattern (Davis, 1941).

The law, as modified by Davis can be stated as follows: When the origin of measurement is sufficiently high, the distribution of income in a stable society can always be given by the empirical formula $Y = aX^{-g}$, where $Y$ is the number of persons having an income of $X$ or greater, and $g$ is approximately 1.5.

It seems reasonable to the author that if angling catch distributions are in agreement with distributions of other special abilities, they should follow a similar distribution curve, and the law could be stated: The catch distribution in a stable fishery, when the origin of measurement is sufficiently high, will be given by the

Fig. 5. Catch frequency histogram from Augusta Creek data, 1952-1956



formula $Y = aX^{-g}$, where Y is the number of anglers catching X or more fish, and g is approximately 2.8.

Since the actual number of visits to the stream by individual anglers was not known, the Y values in this instance represent the number of fisherman visits, rather than the number of anglers, but the analysis should still follow the same pattern. Data plotted for years 1952 through 1956 appear to conform to a parabolic curve of the type applicable to incomes and billiard scores (Fig. 6).

It seems apparent that the catch data from Augusta Creek can be graduated by the parabolic curve. For the purposes of this analysis, that portion of the catch frequency which can be graduated by the curve $Y = aX^{-g}$, is referred to as a Pareto distribution. When logarithms are calculated for both sides of the above equation, it follows that

$$\text{Log. } Y = \text{Log. } a - g\text{Log. } X,$$

from which it may be seen that the distribution, if plotted on double Log. paper appears as a straight line with negative slope (Fig. 7).

The least-squares method was employed to find the equation for the curve indicated by the Augusta Creek data. A catch-frequency table was first constructed (table XII), using logarithms of X and Y, determining their products, and calculating values of squared X terms. Unsuccessful angler visits were excluded from the calculations for obvious reasons.

Fig. 6.
Catch frequency curves, 1952-1956 catch data

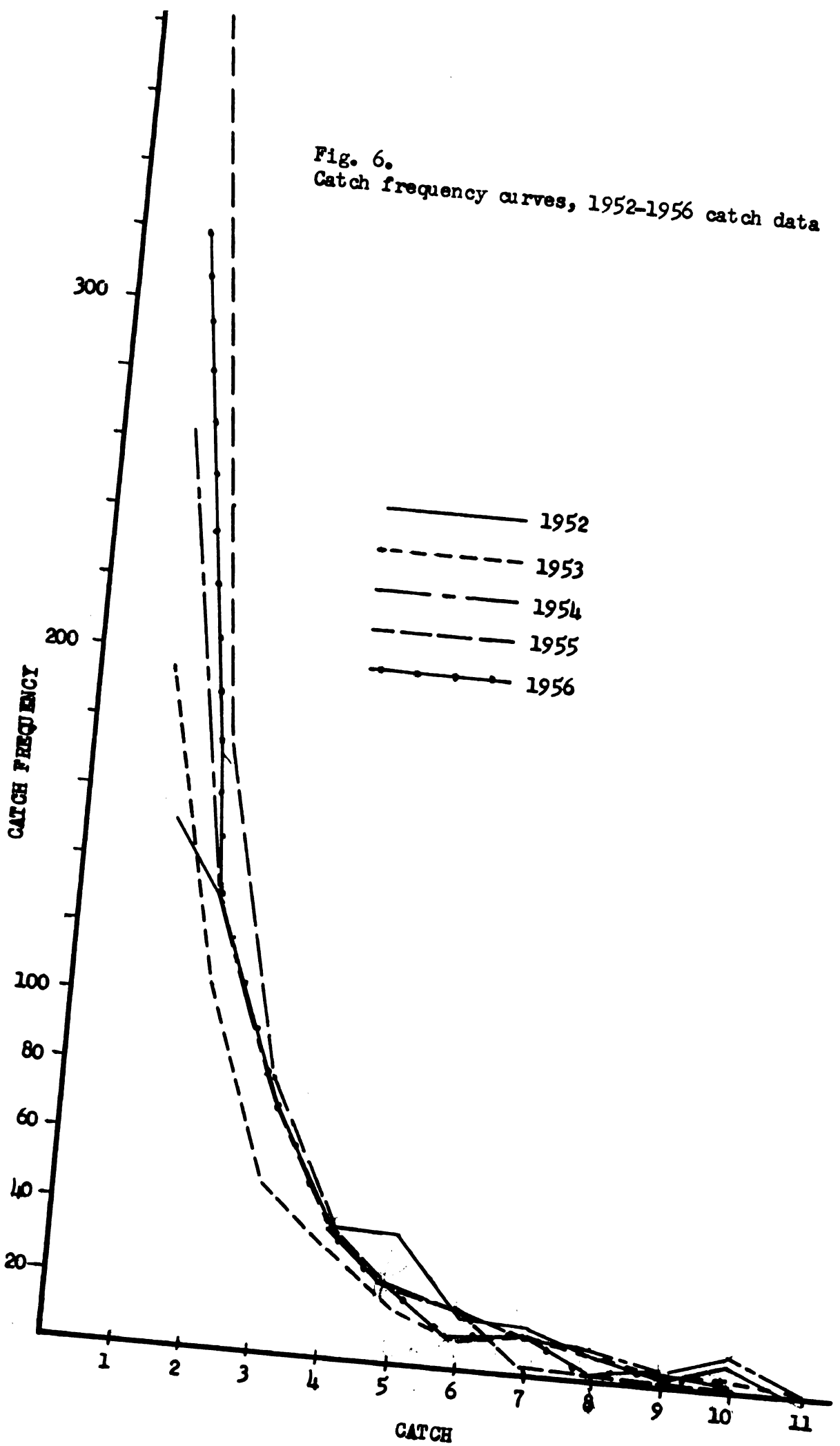


Fig. 7. Catch frequency curve as plotted on double-log paper, showing straight-line relationship

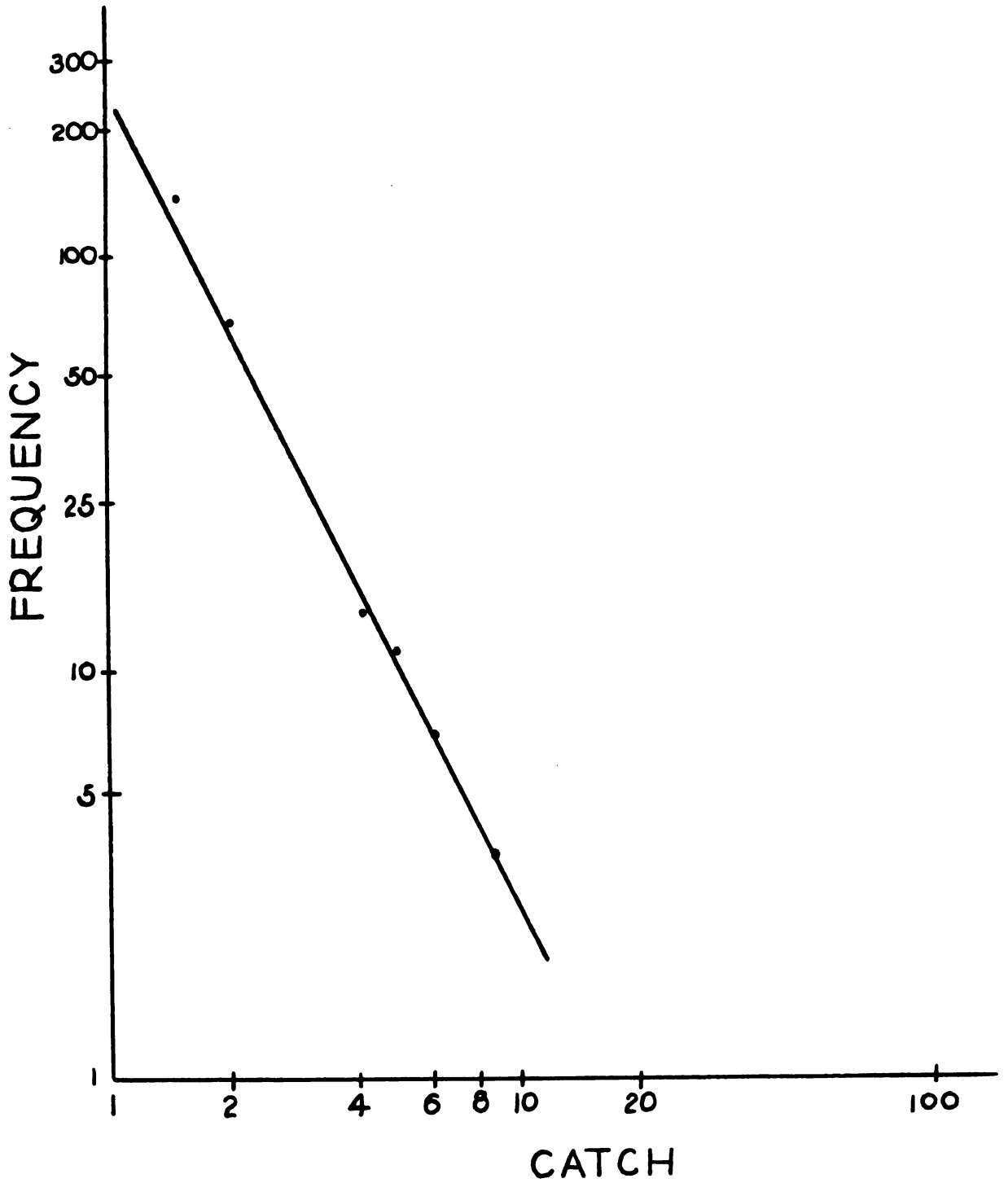


Table XII

Catch Frequency Table - Augusta Creek, Michigan, 1952-1956

| Catch (X) | Cumulative frequency (Y) | Log.X | Log.Y | Log.X·Log.Y | $(Log.X)^2$ |
|---|---|---|---|---|---|
| 1 | 2922 | 0.00000 | 3.46568 | 0.00000 | 0.00000 |
| 2 | 1604 | 0.30103 | 3.20520 | 0.96486 | 0.09062 |
| 3 | 901 | 0.47712 | 2.95472 | 1.40976 | 0.22764 |
| 4 | 544 | 0.60206 | 2.73560 | 1.64699 | 0.36248 |
| 5 | 345 | 0.69897 | 2.53782 | 1.77386 | 0.48856 |
| 6 | 220 | 0.77815 | 2.34242 | 1.82275 | 0.60552 |
| 7 | 151 | 0.84510 | 2.17898 | 1.84146 | 0.71419 |
| 8 | 97 | 0.90309 | 1.98677 | 1.79423 | 0.81557 |
| 9 | 64 | 0.95424 | 1.80618 | 1.72353 | 0.91057 |
| 10 | 41 | 1.00000 | 1.61278 | 1.61278 | 1.00000 |
| 11 | 5 | 1.04139 | 0.69897 | 0.72790 | 1.08449 |
| 12 | 3 | 1.07918 | 0.47712 | 0.51489 | 1.16463 |
| 13 | 1 | 1.11394 | 0.00000 | 0.00000 | 1.24086 |
| Totals: | | 9.79427 | 26.00224 | 15.83301 | 8.70513 |

The following equations are derived from the above tables:

(1) 13 Log. a - 9.79427g = 26.00224

(2) 9.79427 Log. a - 8.70513g = 15.83301

From these equations,

Log. a = 4.13476, g = 2.83326

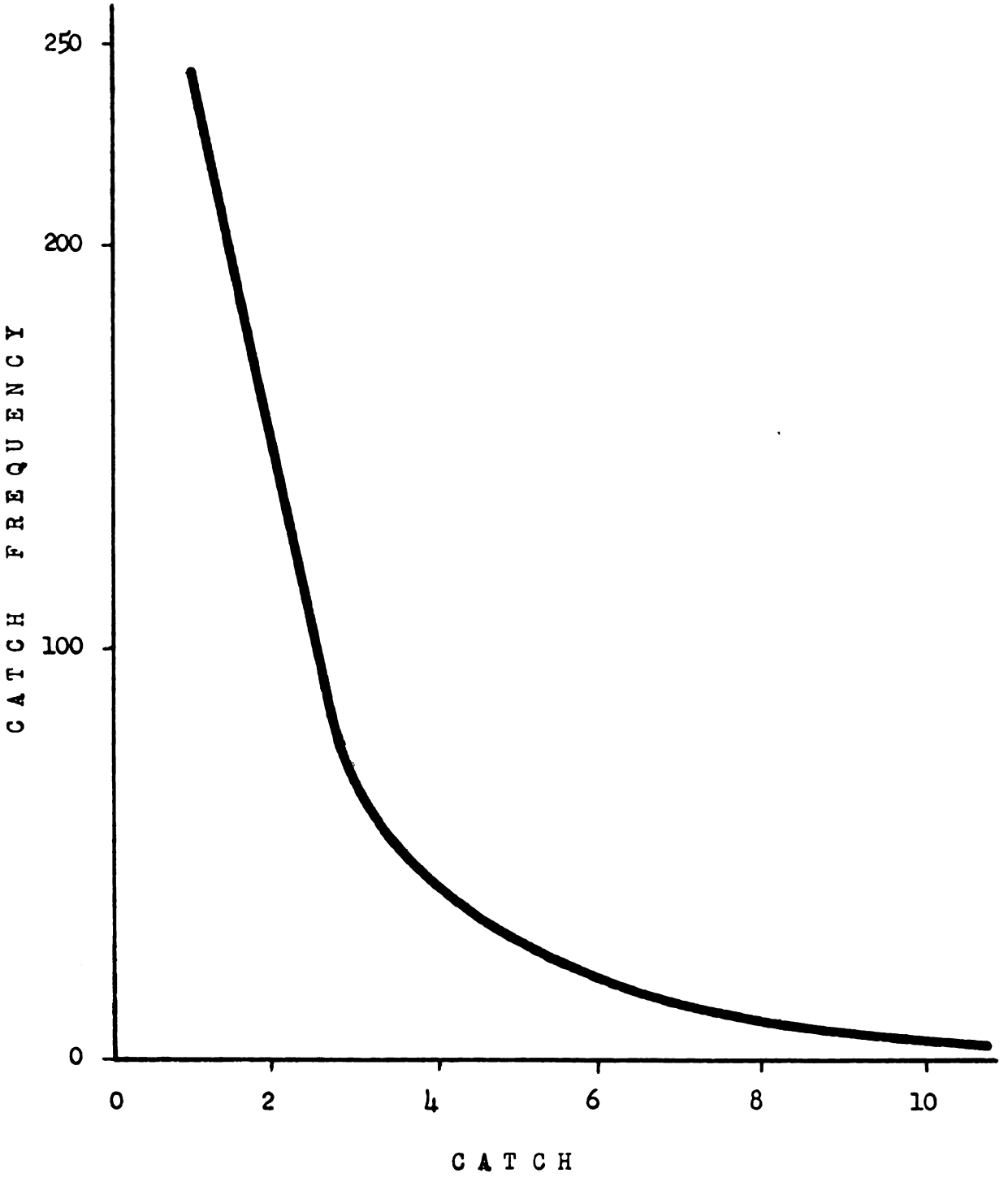
Thus, the curve in logarthmic form was found to be

$$\text{Log.}Y = 4.13476 - 2.83326\text{Log.}X.$$

It appears therefore, that if the distribution follows the Pareto pattern for a small sample such as that taken from Augusta Creek, it could also hold true for all stable fisheries, regardless of the type of gear used. The implication made here is that some anglers possess an inherent or acquired ability to catch fish, while others do not.

Frequency curves by years are represented by plotting the number of trout caught per trip against the catch frequency (Fig.6). A composite curve for the five-year period is shown in Fig. 8.

Fig. 8. Composite catch frequency curve, Augusta Creek data, 1952-1956



Since it appears that there may be a relationship between catch frequencies and special ability of fishermen which cannot be attributed to chance alone, it was of interest also to compare the precentage of unsuccessful trips with the number of hours fished. It would seem reasonable to assume that the proportion of unsuccessful visits grows less as the number of angling hours is increased. The percentage of zero catches (unsuccessful trips) would therefore be a function of the number of hours fished.

It was found that zero catches made up the greater portion of the catch frequency in nearly every hour category (table XIII); it would seem that catch alone is not a valid measure of the expertness of anglers. It is apparent however, that in general, the percentage of zero catches decreased as the number of angling hours increased.

In order to find a possible relation between zero catches (in this instance, those visits resulting in no trout to the creel) and time fished, the trips were grouped into classes according to the number of hours spent angling. The catch frequency was then determined for each of these catch categories or classes, and the percentage of the total number of visits in all categories was calculated. The relationships can be seen from table XIV. Only those days on which zero catches were recorded were included in the calculation. Thus only twenty-two days of the 1952 and 1953 seasons were used.

When the catch was held constant and the number of hours was plotted on semi-log paper against the catch frequency in each catch

Table XIII. Frequency Distribution of Angler Trips by Catches and Hours Fished, Augusta Creek, 1952-1956

| | C A T C H | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of trout caught per trip: | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Catch category (hours fished) | Catch frequency | | | | | | | | | | | | |
| 0.0-1.0 | 801 | 126 | 25 | 9 | 7 | 4 | - | 1 | 1 | - | - | - | - |
| 1.1-2.0 | 1456 | 403 | 170 | 69 | 7 | 10 | 5 | 4 | 1 | - | - | 1 | - |
| 2.1-3.0 | 900 | 419 | 222 | 92 | 32 | 26 | 18 | 8 | 11 | 4 | 8 | - | - |
| 3.1-4.0 | 392 | 161 | 115 | 74 | 58 | 26 | 17 | 13 | 6 | 6 | 2 | - | - |
| 4.1-5.0 | 95 | 64 | 47 | 28 | 36 | 11 | 7 | 5 | 3 | 2 | 2 | - | - |
| 5.1-6.0 | 44 | 21 | 14 | 13 | 9 | 9 | 8 | 5 | 3 | 2 | 2 | 1 | 1 |
| 6.1-7.0 | 12 | 8 | 6 | 6 | 16 | 1 | 2 | 3 | - | 1 | - | - | - |
| 7.1-8.0 | 10 | 6 | 5 | 6 | 3 | 1 | - | 1 | 2 | - | 1 | - | - |
| 8.1-9.0 | 5 | 9 | 2 | 1 | 3 | - | - | - | - | - | - | - | - |
| 9.1-10.0 | 1 | 2 | 1 | 1 | - | - | - | - | - | - | - | - | - |
| 10.1-11.0 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 11.1-12.0 | - | - | 1 | 2 | - | - | 1 | - | 1 | - | - | - | - |
| Totals: | 3717 | 1179 | 588 | 291 | 164 | 88 | 58 | 40 | 29 | 15 | 16 | 2 | 1 |

Table XIV. Percentage Frequency of Angler Trips by Catches and Hours Fished, Augusta Creek, 1952-1956.[1]

| Number of trout caught per trip: | Catch 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Catch category (hours fished) | Percentage frequency | | | | | | | | | | | | |
| 0.0-1.0 | 13.1 | 2.0 | 0.4 | 0.1 | 0.1 | 0.1 | - | - | - | - | - | - | - |
| 1.1-2.0 | 23.7 | 6.6 | 2.8 | 1.1 | 0.2 | 0.2 | 0.1 | - | - | - | - | - | - |
| 2.1-3.0 | 14.7 | 6.8 | 3.6 | 1.5 | 0.4 | 0.4 | 0.3 | 0.1 | 0.2 | - | 0.1 | - | - |
| 3.1-4.0 | 6.3 | 2.6 | 1.9 | 1.2 | 0.4 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | - | - | - |
| 4.1-5.0 | 1.5 | 1.0 | 0.8 | 0.4 | 0.2 | 0.2 | 0.1 | 0.1 | - | - | - | - | - |
| 5.1-6.0 | 0.7 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | - | - | - | - | - |
| 6.1-7.0 | 0.2 | 0.1 | 0.1 | 0.1 | - | - | - | - | - | - | - | - | - |
| 7.1-8.0 | 0.2 | 0.1 | 0.1 | 0.1 | - | - | - | - | - | - | - | - | - |
| 8.1-9.0 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 9.1-10.0 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 10.1-11.0 | - | - | - | - | - | - | - | - | - | - | - | - | - |

[1] No percentages less than 0.1 were recorded. All percentages were rounded to the nearest tenth.

class (one trout, two trout, three trout, et cetera), it was found that each of the plotted curves had a characteristic ascending left limb, a dome-shaped upper portion, and a long, descending right limb (Fig. 9). This was the type of curve described by Ricker (1948) as commonly characteristic of catch distributions of fisheries. In plotting the curves, however, Ricker plotted age classes of fish against catch frequencies, rather than hour categories against catch frequencies as plotted by the author from Augusta Creek data and shown in Fig. 9. The percentage of zero catches (unsuccessful visits) in each of the various hour or catch categories was also plotted; again, the characteristic catch curve was formed (Fig. 10).

It is evident from the above distribution curves that the percentage of zero catches may be a function of the number of hours spent angling, with the most patient anglers presumably obtaining the highest rewards in terms of numbers of trout creeled. Nevertheless, there may also be other variables which might effect the total catch structure. Such variables as weather, numbers of anglers fishing a given volume of water at a given time, the oportunity for anglers to encounter fish, the number of fish present and the probability of a fish accepting the proffered bait could act individually or collectively in complicating the analysis of catch data. More detailed studies of these and other variables, including individual differences among anglers are needed before a complete understanding of the total catch structure can be obtained.

Fig. 9. Catch frequency curves of catch classes plotted against hour categories.

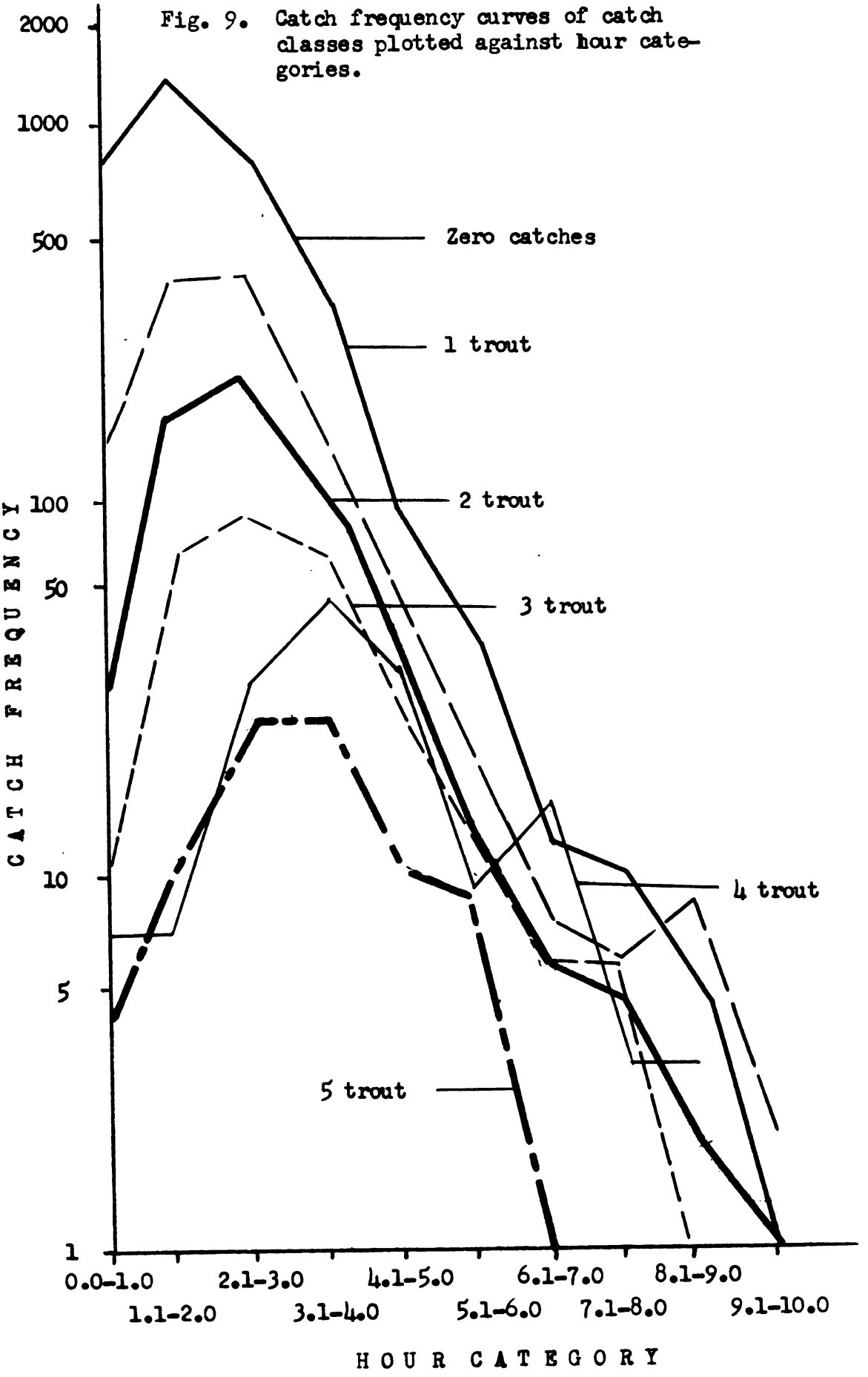
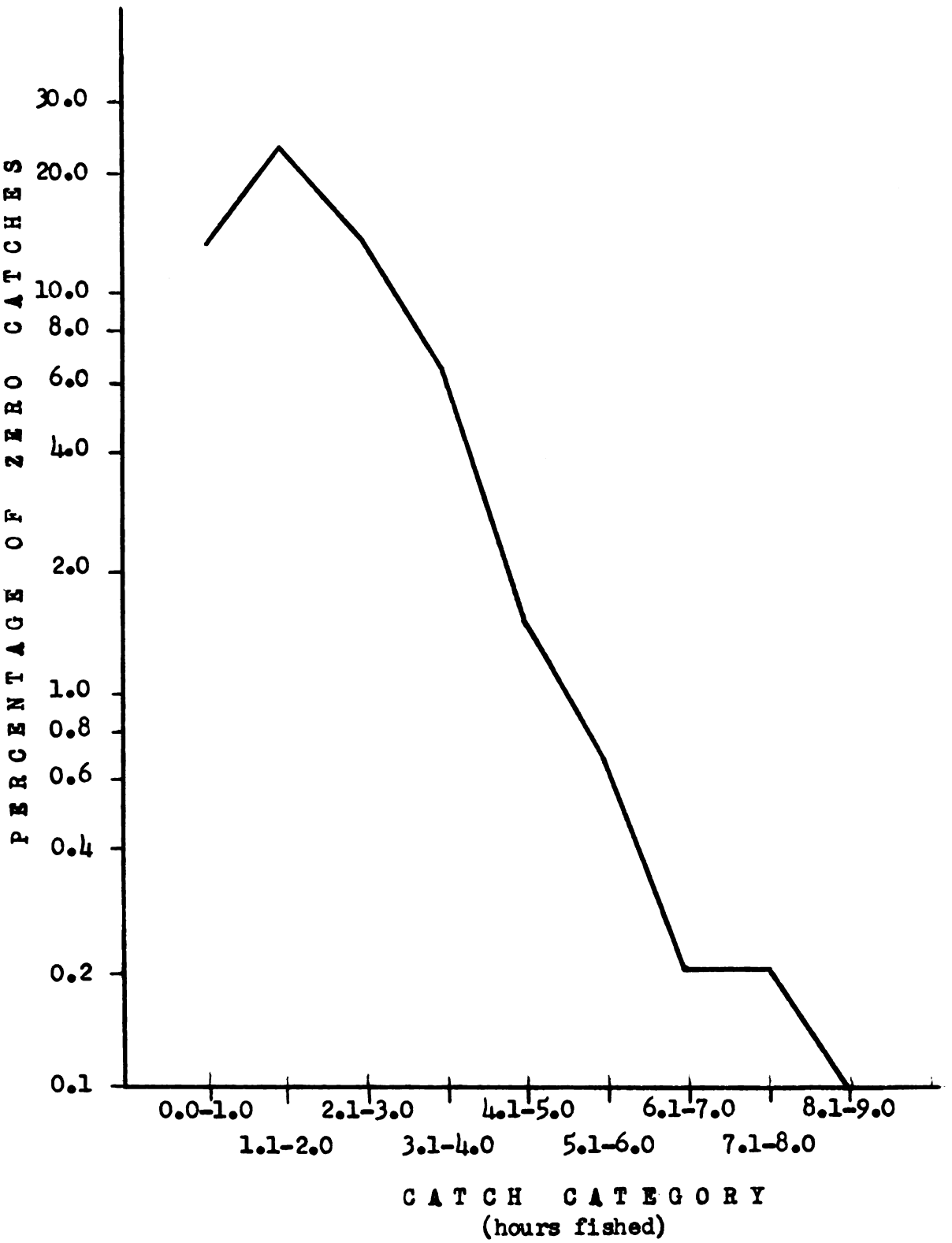


Fig. 10. Percentage zero catches by catch categories



## Fishing Success and Intensity

Data collected from the controlled creel counts over the five-year period revealed that the stream section was fished on 616 days of a total of 689 days comprising the five angling seasons. Four thousand, four hundred twelve anglers spent more than 20,700 hours fishing, and caught 6,930 trout, of which 6,062 were planted rainbow trout, 479 were planted brown trout, 384 were brown trout assumed to be native or carried over from previous plantings, and one was a brook trout. Rainbow trout made up the greater portion of the total catch in every year (Fig. 11).

Nearly ninety percent of all trout taken were caught by anglers using bait, seven percent by those using dry or wet artificial flies, and six percent by those using artificial plugs or spinners (table VIII).

Of the total of 10,570 trout stocked in the stream section during the five-year period, 6,255 were taken in the year they were planted, and 267 in subsequent years for an over-all return to the creel of 61.7 percent. Catches for the year of planting averaged 58.5 percent, ranging from 49.1 percent in 1953 to 66.2 percent in 1955 (table XV).

Since the stream section within the Kellogg Forest has no weirs or restraining structures to prevent emigration of trout, it can be assumed that some of the planted individuals did not remain in the planting locality. Indeed, numerous reports of catches of marked trout both upstream and downstream from the Kellogg Forest property would seem to imply that an appreciable

Fig. 11. Percentage distribution of trout catches from Augusta Creek, Michigan, 1952-1956.

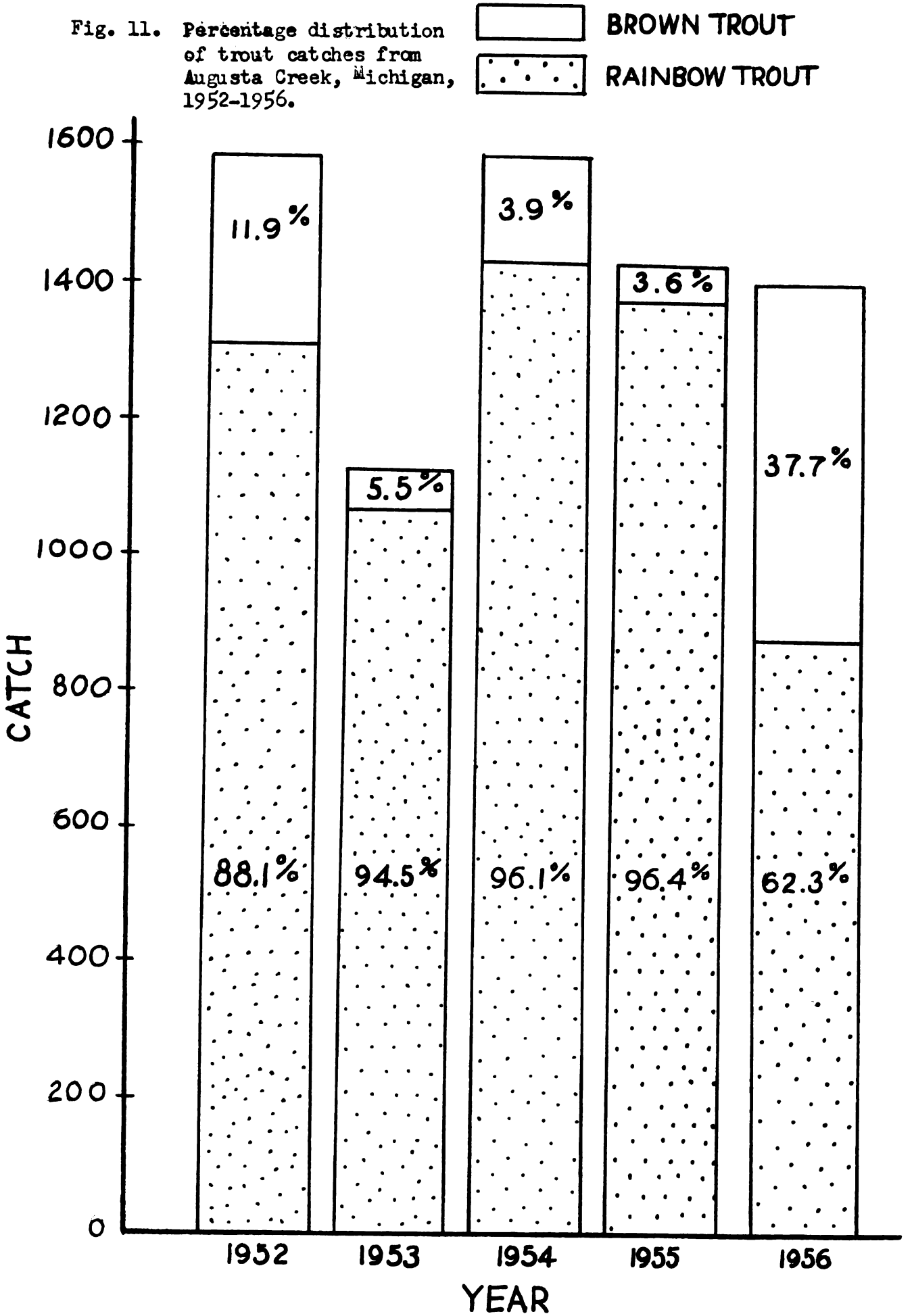


Table XV.

Returns to Creel of Catchable Trout Plantings - Augusta Creek, Michigan - 1952 - 1956

| Year of planting | Species | Number Planted | Number taken first year | Number taken after first year | Total Catch | Percent return first year | Percent total return |
|---|---|---|---|---|---|---|---|
| 1952 | Rainbow trout | 2,000 | 1,305 | 84 | 1,389 | 62.5 | 69.4 |
| 1953 | " " | 2,000 | 981 | 78 | 1,059 | 49.1 | 53.0 |
| 1954 | " " | 2,320 | 1,346 | 52 | 1,398 | 58.0 | 60.2 |
| 1955 | " " | 2,000 | 1,325 | 53 | 1,378 | 66.2 | 68.9 |
| 1956 | " " | 1,250 | 819 | - | 819 | 65.5 | 57.7[1] |
| 1956 | Brown trout | 1,000 | 479 | - | 479 | 49.9 | |
| Totals and/or averages: | | 10,570 | 6,255 | 267 | 6,522 | 58.5 | 61.8 |

1 Total returns for 1956 plantings do not include trout entering the catch in the following year.

percentage of planted trout not only left the planting locality, but found their way into anglers' creels as well. It is evident, therefore, that returns of stocked trout indicated by creel count records taken within the property boundaries should actually be considered as minimal. It might well be that from ten to thirty percent of the planted trout are not recorded merely because they were caught outside the study area where the mandatory creel census is in effect. Assuming only ten percent of the planted trout are taken by anglers outside the boundaries of the experimental area, the overall return over the five-year period may easily have been in excess of seventy percent, an extremely satisfactory return from stocked trout in Michigan.

The average catch per angler dropped from 2.4 trout in 1952 to 1.3 trout in 1956 (Fig. 12). This decrease may be related to the increase in angling intensity on the stream, since zero catches have also increased. As stated previously, the increase in angling pressure has been accompanied by a corresponding increase in the numbers of zero catches. With the exception of 1956, zero catches have risen steadily each year as the numbers of anglers have increased. In 1951, only 542 fishermen obtained the special permits to fish the stream, and in 1956, 1,102 individuals were issued permits. This is an actual increase of 103 percent over the five-year period. Of 8,231 visits to the stream during the same period, nearly 5,000 visits resulted in zero catches. Thus approximately sixty percent of the angler visits were unsuccessful. The percentage distribution of zero catches by months is given in

Fig. 12. Average annual catch per angler, 1952-1956

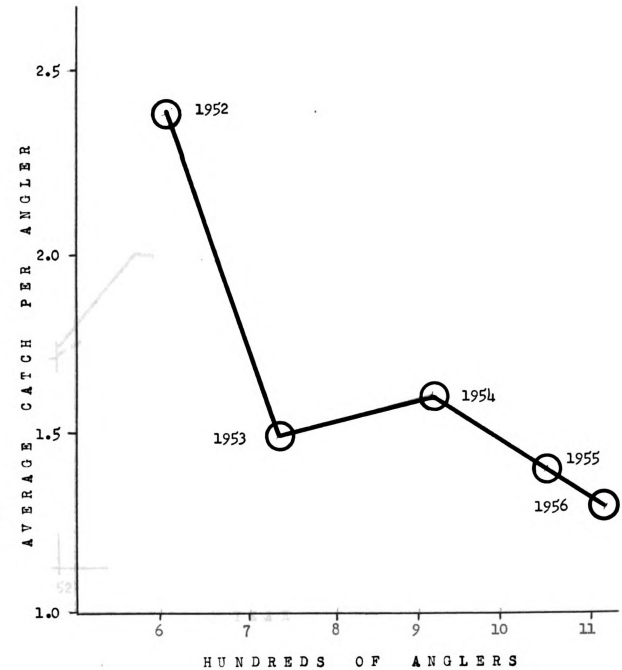


Fig. 13. Relationship between zero catches and numbers of anglers, Augusta Creek, 1952-1956

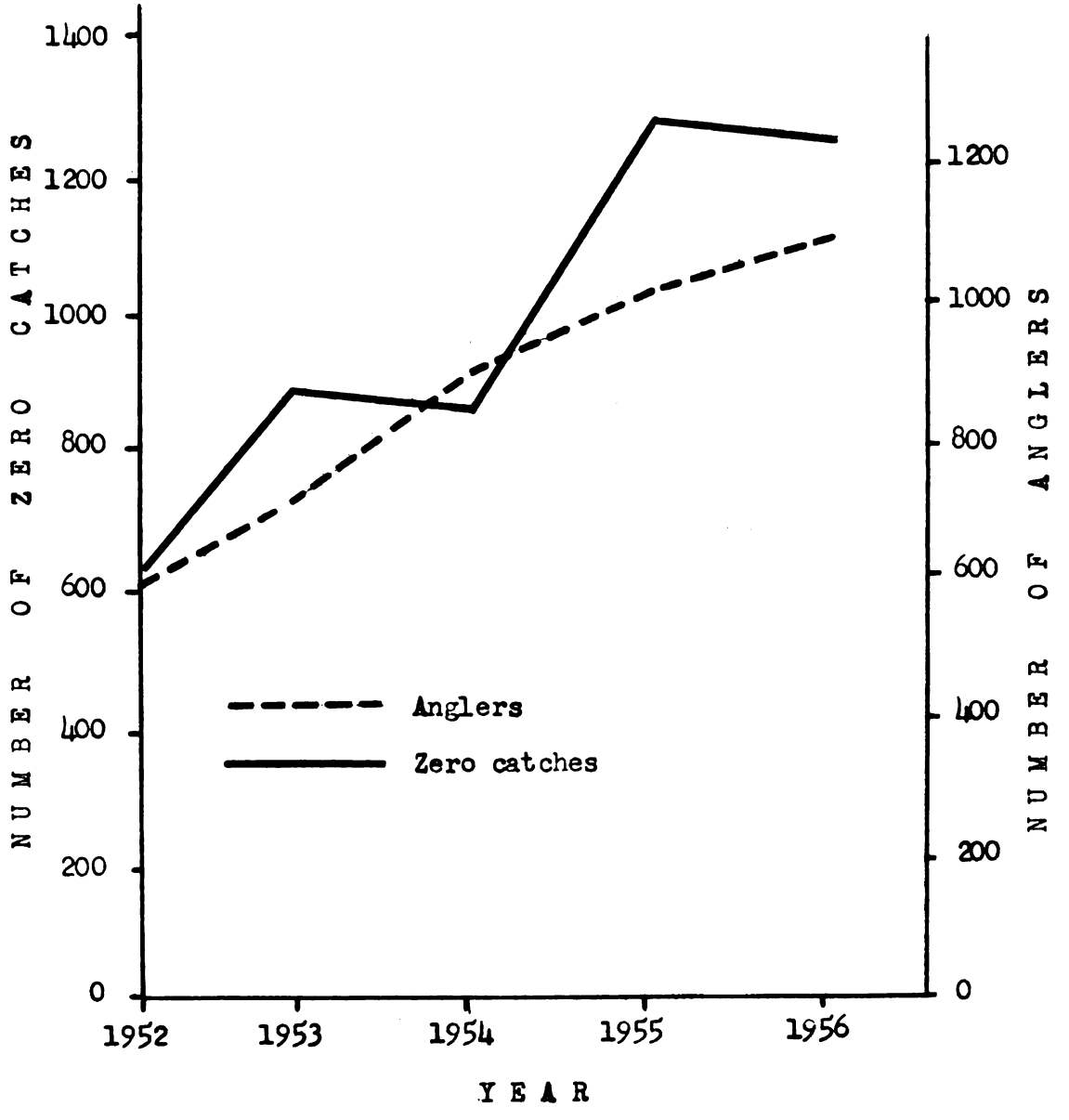


figure 14. Again, it is emphasized that figures for the years 1952 and 1953 are based on a restricted, stratified sample of twenty-two days from the fishing season.

The average catch per angler visit for the five-year period was 0.8 trout. The yearly figure has not exceeded 1.0 since 1952 (table IV). The average catch per angling hour has remained relatively stable, with the most impressive catches appearing in the 1953 and 1955 angling seasons. Figure 15 shows the average catch per hour of angling by months. It can be readily seen that catches were highest in the month of June, when angling pressure was heaviest. The relationship between numbers of anglers, yearly catches and angling hours is indicated by figure 16.

It was evident from the study that the most sustained yields of planted trout are apparent when stocking is accomplished on a nearly continuous basis during the fishing season. There appears to be a short time lag of one or two days before the catch reaches a definite peak after each planting. The relationship can be clearly seen from the daily catch graphs for each of the five years during which the study was conducted. In nearly every instance, the total catch shows a very noticeable rise shortly after the planting dates. Graphic representations of daily catches and planting dates are given in figures 17 through 21.

Fig. 14. Percentage of zero catches by months, Augusta Creek data, 1952-1956

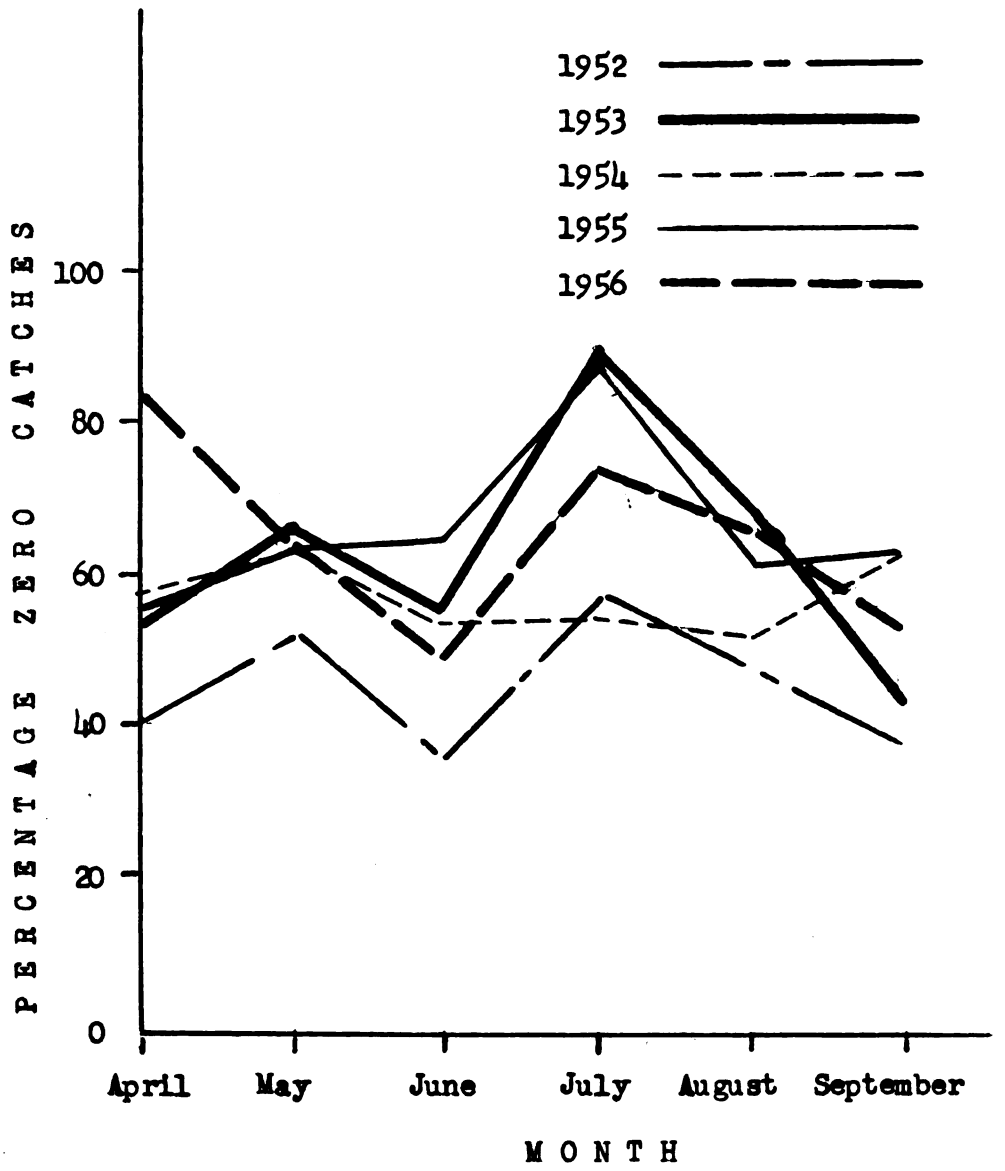


Fig. 15. Average catch per angler hour by months, 1952-1956

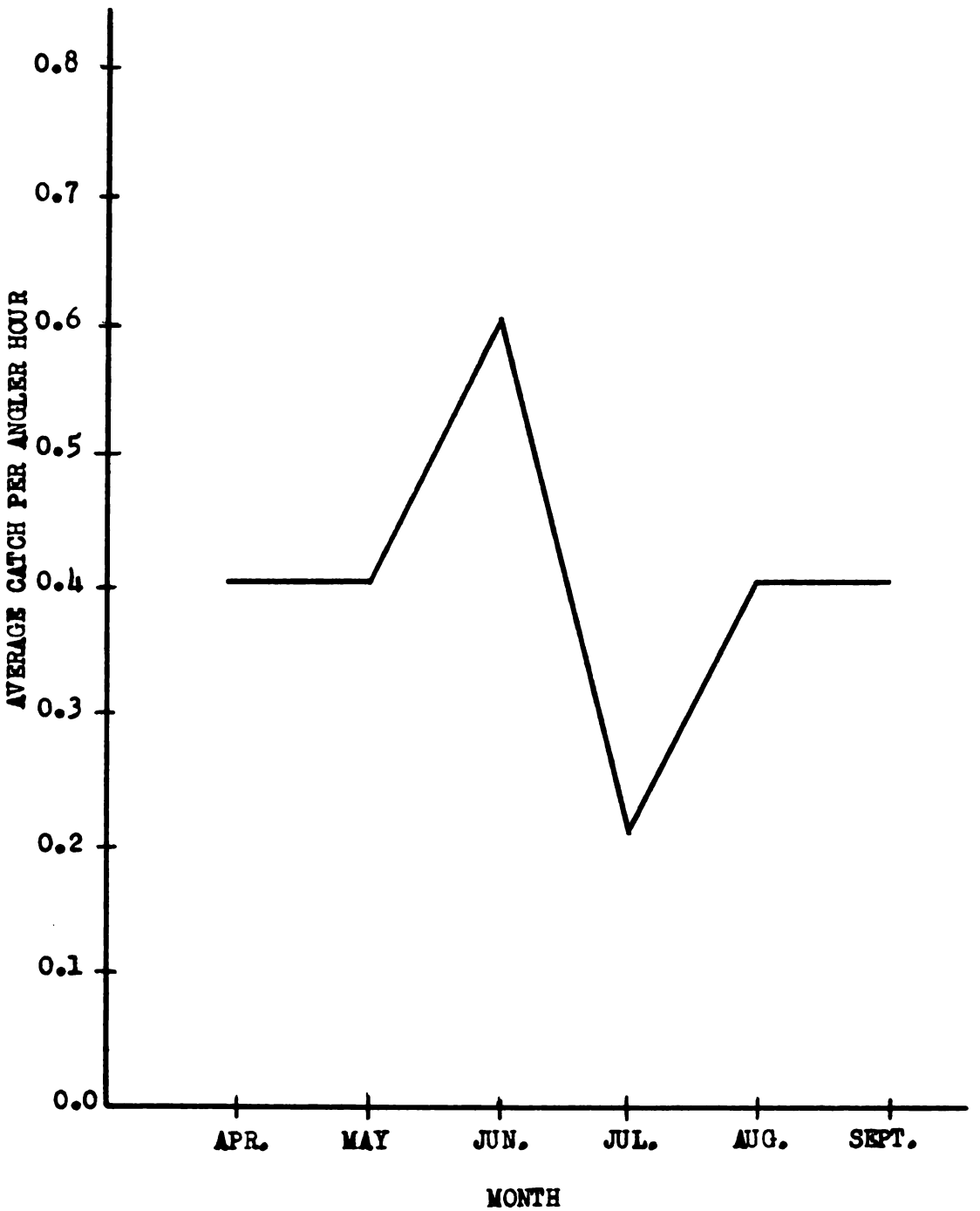


Fig. 16. Graph indicating relation between numbers of anglers, angler hours and trout caught for years 1952-1956

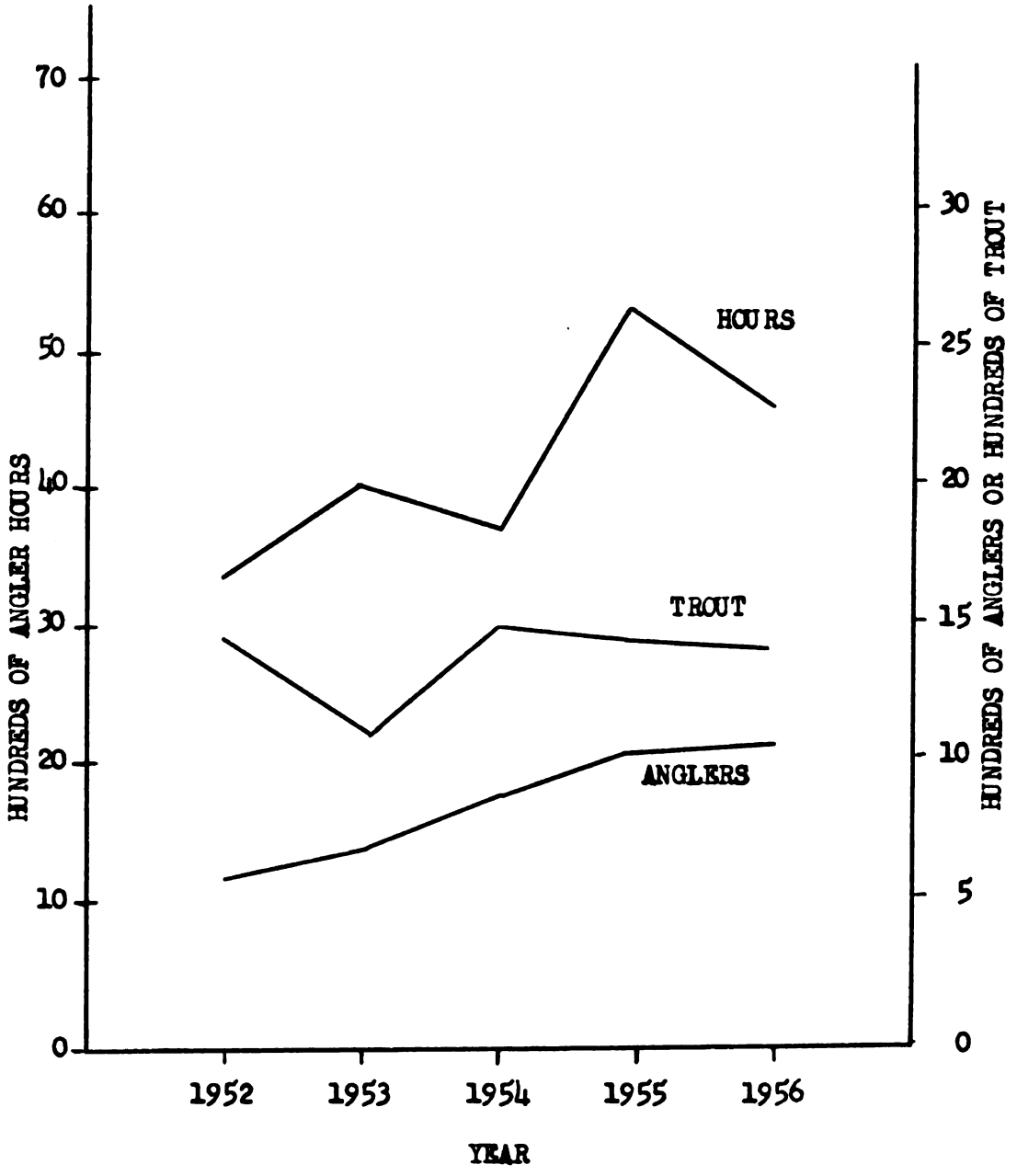


Fig. 17. Anglers' daily catches from Augusta Creek, Michigan, 1952 angling season

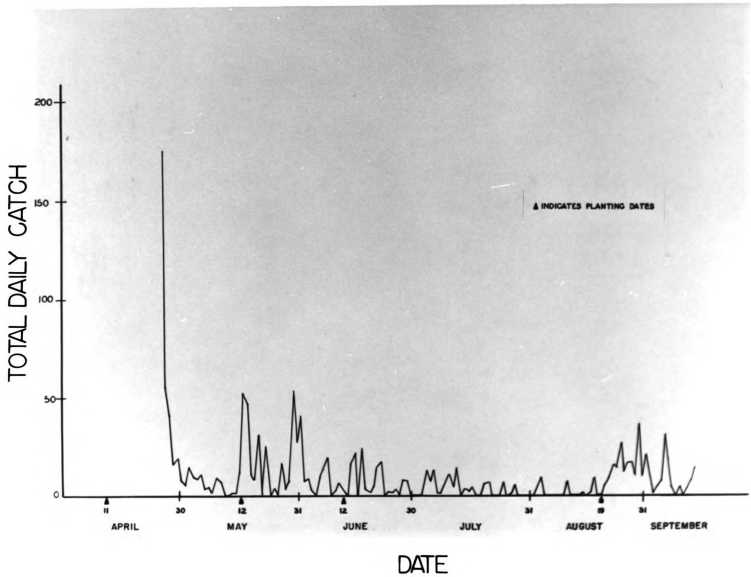

TOTAL DAILY CATCH
200
150
100
50
0
▲ INDICATES PLANTING DATES
▲ 11
30
▲ 12
31
▲ 12
30
31
▲ 19
31
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
DATE

Fig. 18. Anglers' daily catches from Augusta Creek, Michigan, 1953 angling season.

TOTAL DAILY CATCH
250
200
150
100
50
0
▲ INDICATES PLANTING DATES
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
DATE

Fig. 19. Anglers' daily catches from Augusta Creek, Michigan, 1954 angling season.

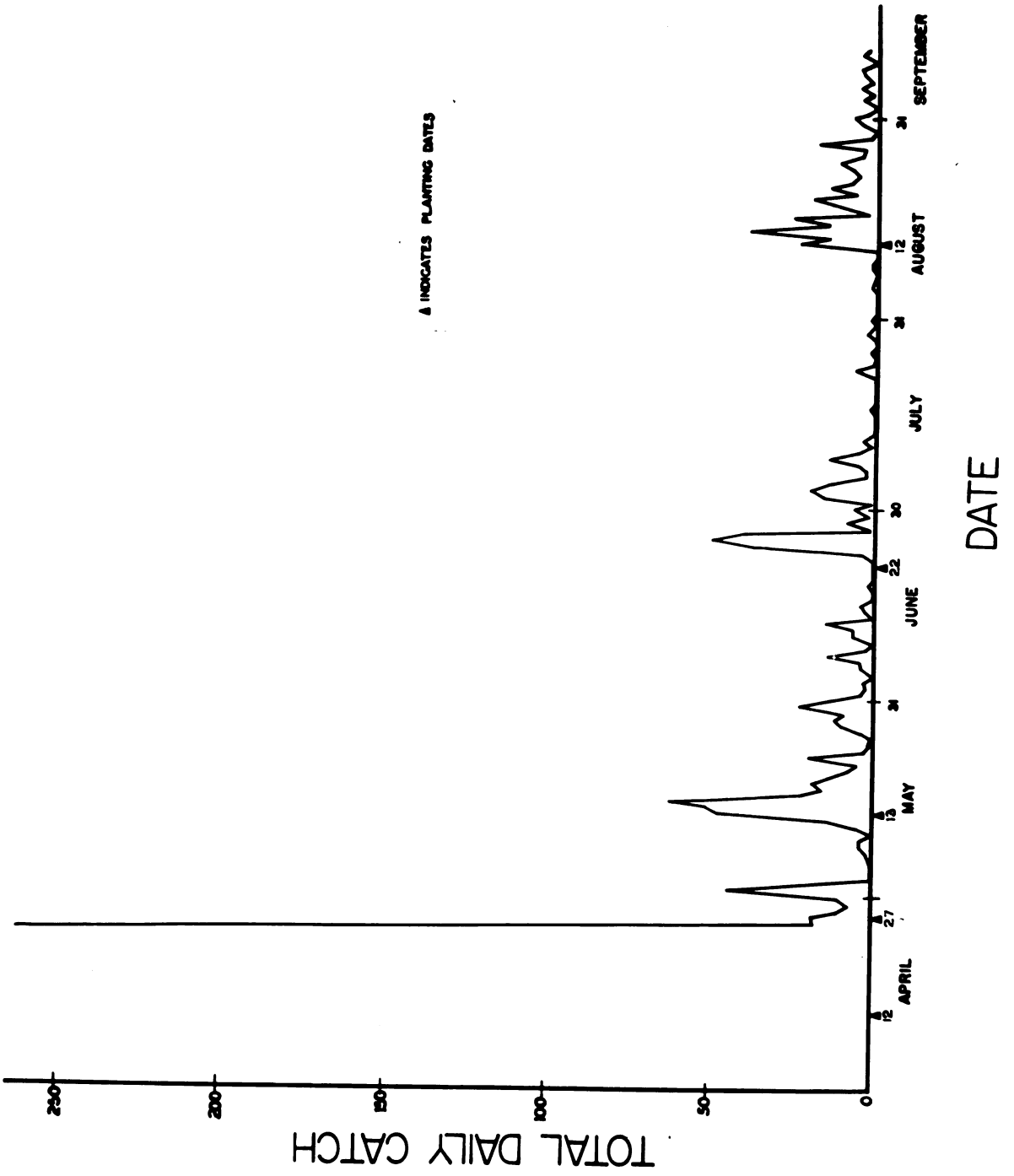

TOTAL DAILY CATCH
250
200
150
100
50
0
12
APRIL
27
MAY
15
31
JUNE
22
30
JULY
31
AUGUST
12
31
SEPTEMBER
DATE
Δ INDICATES PLANTING DATES

Fig. 20. Anglers' daily catches from Augusta Creek, Michigan, 1955 angling season.

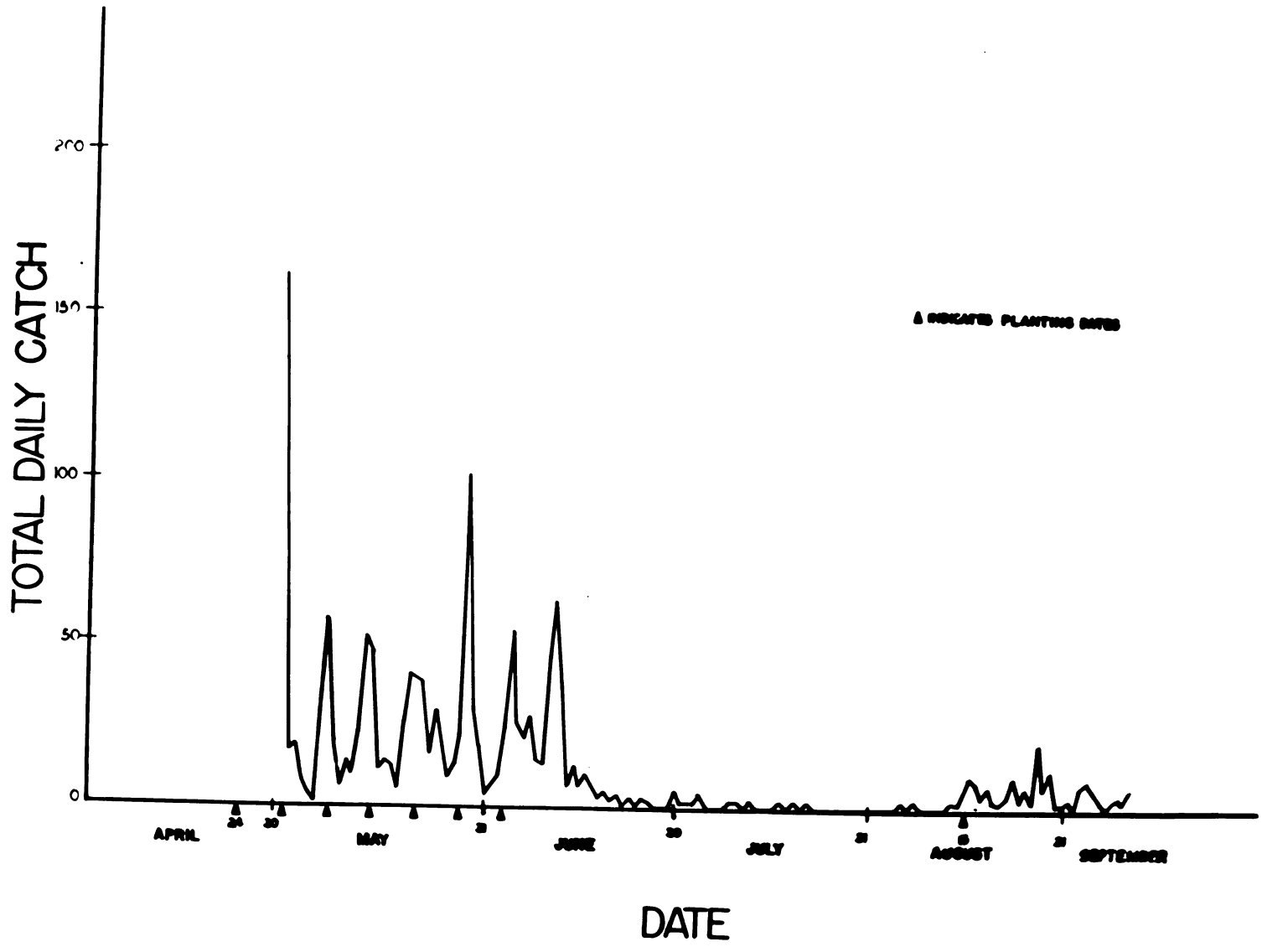
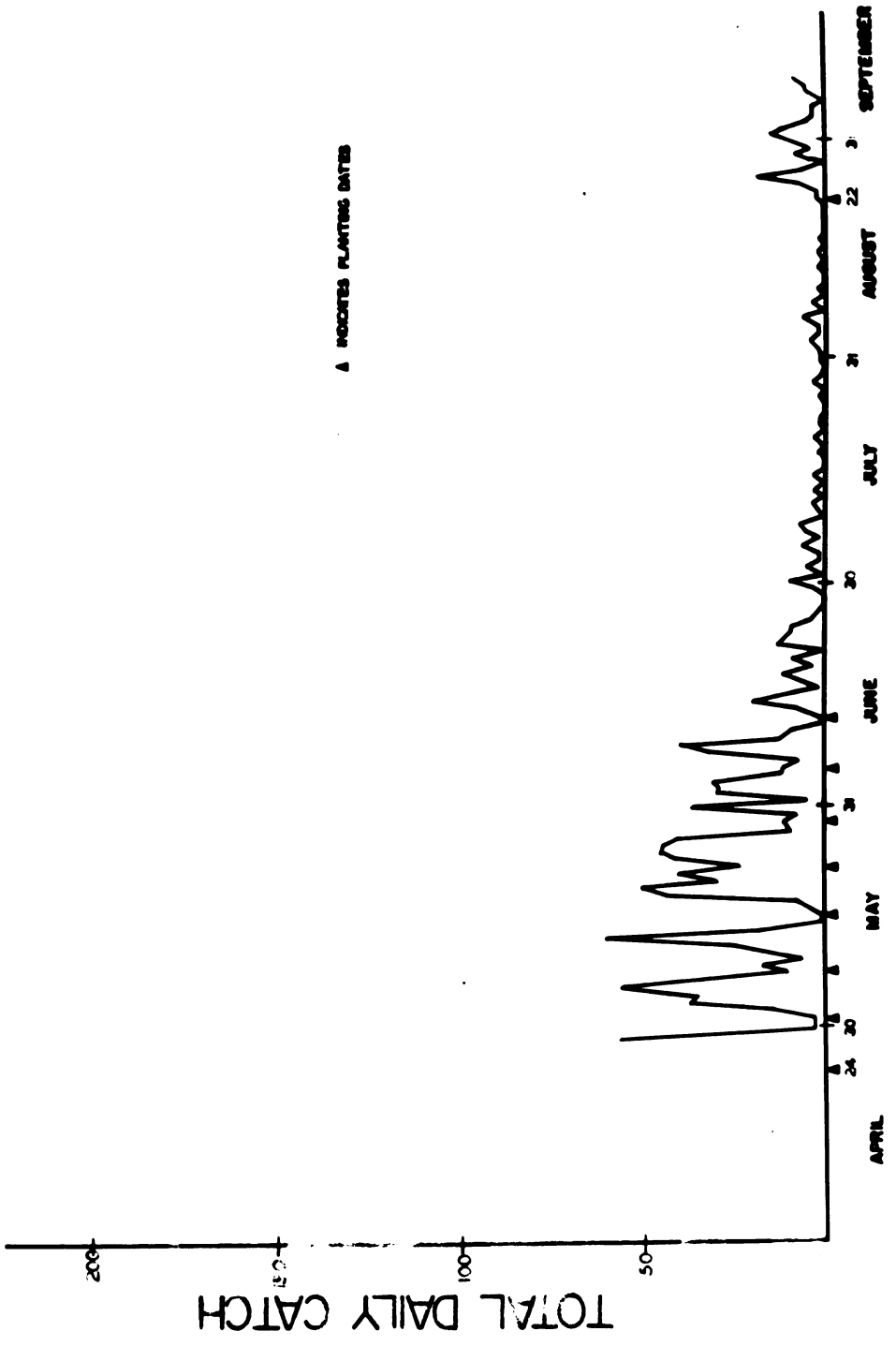

TOTAL DAILY CATCH
200
150
100
50
0
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
DATE

Fig. 21. Anglers' daily catches from Augusta Creek, Michigan, 1956 angling season.


TOTAL DAILY CATCH
200
100
50
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
DATE
▲ ROCKFISH PLANTING DATES

# SUMMARY

Analysis of data collected by the use of a mandatory creel count on a 2.4-mile section of Augusta Creek in southwestern Michigan over a five-year period revealed the following information:

Fishermen spent more than 20,700 hours in the pursuit of their sport, and caught 6,930 trout, of which 6,062 were planted rainbow trout, 479 were planted brown trout, 384 were brown trout assumed to be native to the stream or remaining from previous plantings, and one was a brook trout.

Approximately ninety percent of all the trout creeled were caught by fishermen using bait, seven percent by those using dry or wet artificial flies, and six percent by anglers using artificial plugs or spinners.

Of the 10,570 trout stocked in the stream section over the five-year period, 6,255 were taken in the year in which they were stocked, and 267 in following years for an over-all average return of 61.8 percent over the period. This figure should be considered a minimum return, since some trout were reported caught outside the experimental area and were not recorded in the creel count.

The average catch per angler declined from 2.4 trout in 1952 to 1.3 trout in 1956. This decrease is attributed to the increase in angling pressure on the stream during the same period.

Approximately sixty percent of all fishermen visits to the experimental stream section resulted in no trout to the creel. It seems evident that the percentage of zero catches is a function of the number of hours fished, with the more "patient" anglers reporting the largest numbers of trout.

Only nine percent of the anglers fishing Augusta Creek test stream accounted for more than fifty percent of the total catch over the five-year period. This implies that angler success may be due to an inherited or acquired ability to catch fish. Statistical analysis of Augusta Creek creel census data gave evidence to support this implication. It was found that the frequency distribution of catches of various sizes may be represented by a curve similar to that of the Pareto distribution of special abilities as applied to home runs in baseball or incomes in a stable society. Thus it seems that successful anglers possess special abilities enabling them to catch fish, while unsuccessful anglers do not.

Present creel returns indicate that the current stocking policy at Augusta Creek is sufficiently adequate, even though a considerable number of fishermen reported no trout caught. If catches outside the experimental area are considered, the returns for the stream are exceptionally high for the state of Michigan.

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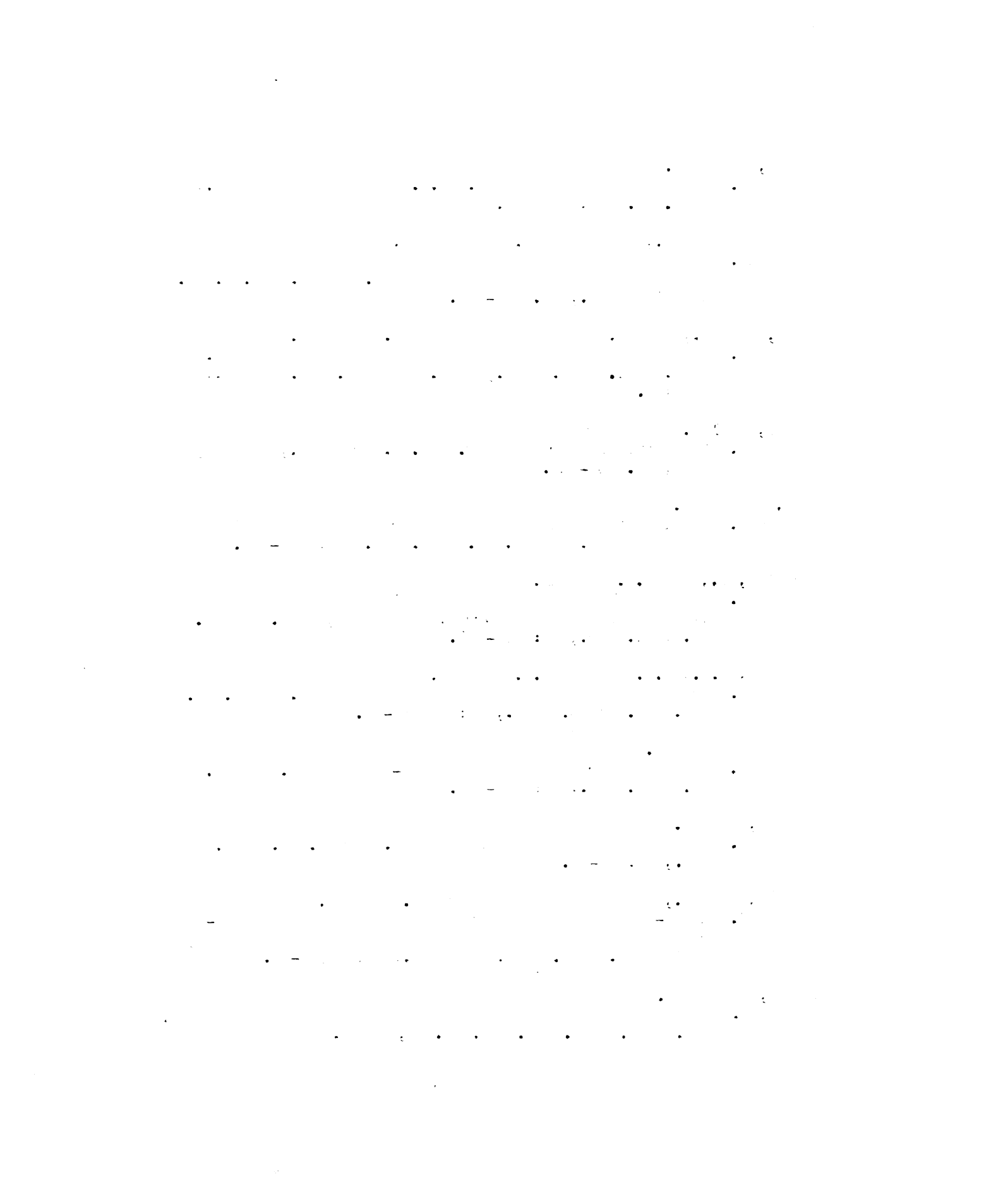

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