

GROWTH CHARACTERISTICS OF THE
NORTHERN REDBELLY DACE CHROSOMUS
EOS (COPE) IN EXPERIMENTAL PONDS IN
NORTHERN MICHIGAN

Thesis for the Degree of M. S.
MICHIGAN STATE COLLEGE
Robert Bruce Chapoton
1955



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presented by IN NORTHERN MICHIGAN

Robert B. Chapoton

has been accepted towards fulfillment
of the requirements for

M. S. _____ Fisheries and Wildlife
_____ degree in _____

Peter J. Tack
Major professor

Date May 26, 1955



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IN EXPERIMENTAL PONDS IN
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by

Robert Bruce Chapoton

AN ABSTRACT

Submitted to the School of Graduate Studies of
Michigan State College of Agriculture and Applied
Science in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

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1955

Approved _____

The object of this problem was to determine the rate of growth of the Northern Redbelly Dace Chrosomus eos in small, farm-type fish ponds in Northern lower Michigan.

A total of 2,258 Northern Redbelly Dace was collected at nine to ten day intervals from four ponds and a larger reservoir during the summer, 1953. The ponds are located at the Lake City Experiment Station, Missaukee County, Michigan. The fish were collected by glass minnow traps, hand nets, and draining Pond B in the fall. Commercial inorganic fertilizer (6-12-6) was applied to Ponds B, E, and F at the rate of 100 pounds per acre of water surface.

The total lengths of all fish included in this study were measured to the nearest millimeter. The weights of approximately half of the total number of fish were determined to the nearest 0.01 gram.

A statistical comparison was made of the lengths of fish taken by glass traps on September 20, 1953 from Pond B with those removed from the pond by draining on October 24, 1953. The "t" test indicated no significant difference in lengths existed between these samples.

An analysis of variance of the fish in all samples from Pond E indicated significant differences between collections. A regression of length on time indicated a positive growth rate of 0.19 millimeter per day.

A decrease in the average total length of the fish, evident during the early summer, resulted from decreased proportion of the older and larger fish in the collections. After early July, these fish made an average daily increase of approximately 0.11 to 0.19 millimeter in length per day in all five bodies of water. Collections of young-of-the-year dace taken in the fall of their first year of life were approximately 30 millimeters in total length. No relationship to fertilization was evident from these data.

The length-weight relationship of the fish from each body of water was similar.

Based upon the findings of other workers, and on the data presented here, it was concluded that the Northern Redbelly Dace appears to be suited, biologically, for commercial bait production in Northern lower Michigan

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Introduction

In recent years, there have been numerous fruitful studies of growth rates of the game and panfishes. Much of this information forms the basis of many current management practices. There is, however, an apparent absence of information dealing with the growth rates, food habits, age, and similar fundamental facts about those fishes which comprise an important part of the food items of many of the economically important fishes. Hubbs and Cooper (1936) pointed out that the successful production of game species in our inland waters and in the Great Lakes may be attributed in a large degree to the abundance of the minnows which these fishes eat. According to Cooper (1936) the most important of the forage species are the daces, shiners, chubs, and minnows of the family Cyprinidae.

In conjunction with the indirect value of the forage fishes as food, is the direct economic importance as bait for the greatly increased fishing population. The sale of bait minnows, most of which are true minnows, constitutes an appreciable business in Michigan. During 1935, there were 886 bait dealers

in Michigan. As of May 20, 1954, the number of licensed retail bait dealers in the state has since risen to 1,726.

Despite this relatively large number of commercial bait dealers, the majority of which collect from natural sources, and the large numbers of minnows taken by fishermen, the demand is still greater than the supply, and a scarcity exists (Shull, 1952). This same problem is found in Minnesota, Ohio, and Illinois (Shull, op. cit.).

This scarcity has stimulated experiments on the culturing and harvesting of important bait minnows as a means of supplementing the natural supply (Shull, op. cit., Ball and Ford, 1953., Hedges, 1951., and Cooper, 1936.).

Although much has been done along these lines, information dealing with growth rates of many of the important bait species is either inadequate or totally lacking.

It is the object of this problem to determine the rate of growth of the Northern Redbelly Dace in small, farm-type fish ponds in the northern half of the lower peninsula of Michigan.

Description of Ponds and Reservoir

The experimental ponds are located at the Lake City Experiment Station, Missaukee County, Michigan. Six ponds were constructed during 1944 immediately downstream from an already existing 6.6 acre shallow

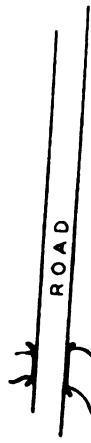
reservoir (Figure 1). Two of the four larger ponds are connected to the reservoir by short channels. Water flow is regulated by gates. The other two ponds receive water through underground pipes from the long pond. The long pond is in turn connected to the reservoir by an underground pipe. The flow of water through these pipes is regulated by control boxes.

The ponds are shallow, with maximum depths of six feet. The surface area of the largest pond included in this study is approximately 0.4 acre, that of the smallest pond about 0.3 acre. The banks of each pond are steep and have been stabilized by riprapping. The inlet and outlet structures are of poured concrete with adjustable gates which permit both control of the water depth and complete draining.

Water loss due to evaporation, outlet leakage, and basin seepage was only slight, and the water in each pond was kept at a nearly constant level for the entire summer.

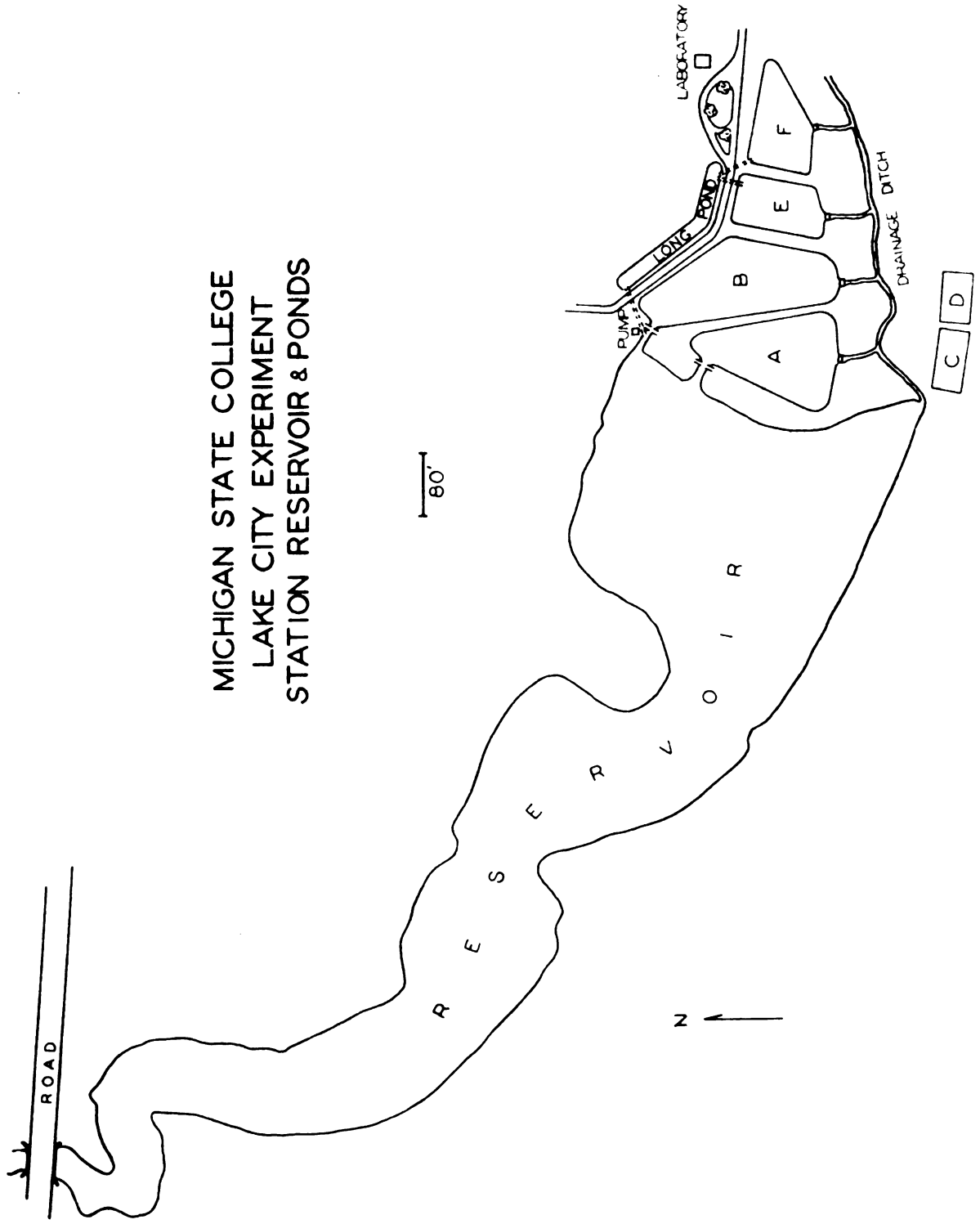
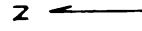
The reservoir had been formed by damming the upper basin of the Mosquito Creek. The maximum measured depth of the reservoir was approximately seven feet. The bottom is composed mostly of pulpy peat of variable thickness. In the shallow water there remain numerous tree stumps and trunks which were flooded when this impoundment was formed. Ex-

Figure 1. Outline Map of Experimental Ponds and Reservoir



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80'



tensive beds of Potamogeton natans and Chara exist. Along the edge of the reservoir grow white cedar and alder (Plate 1,2,3, and 4).

The soil type of the drainage area is mostly sandy loam with a forest cover of beech, hemlock, elm, and white pine (Veatch, 1953.). It was estimated that approximately twenty percent of the drainage area is forested, the remaining area being either under cultivation or in pasture.

Description of Northern Redbelly Dace

Hubbs and Cooper (1936) have described the Northern Redbelly Dace (Chrosomus eos) as being... "one of the smaller minnows of the state, for it rarely exceeds two and one-half inches in length. Its color is olive to dusky above and white below, with two broad, black bands extending along each side of the body. The very small scales, more than 75 along the side, are discerned only by close observation.

"In breeding males, the abdomen is a brilliant red, and the fins are highly colored with red and yellow. These colors produce a breeding fish whose splendor surpasses that of most, if not all, of our other native minnows." (Plate 5)

This species, together with the fine-scaled dace, Pfrittle neogaea (Cope), has been called

"leatherback" by sportsmen and minnow dealers.

Range and Habitat

The range of the Northern Redbelly Dace includes all of the northeastern and north-central United States. It occurs in Canada from northern British Columbia and the Hudson Bay drainage of Canada east to Nova Scotia (Hubbs and Lagler, 1949).

These minnows are commonly found in bog ponds, pot hole lakes, and sluggish creeks. In Minnesota it seems to prefer acid bog lakes (Dobie, Meehan, and Washburn, 1948). In Michigan, in addition to showing the same preference as is reported for Minnesota, it has also been reported abundant in small ponds where there was a heavy growth of Chara and a rapid deposition of marl (Hubbs and Cooper, 1936).

PLATE 1. Pond A, showing triangular shape of pond and outlet structure at far end. Photograph taken August, 1953.

PLATE 2. Pond B, showing outlet structure at far end. This pond has the largest surface area of the four ponds. Photograph taken August, 1953.



PLATE 3. Pond F, showing concrete outlet structure and high growth of Reed canary grass around edge of ponds. In the lower right is shown a part of Pond E. Photograph taken August, 1953.

PLATE 4. The Reservoir, showing stumps, logs, and some of the emergent vegetation. Photograph shows only a part of this body of water, remainder lies to the left. Photograph taken August, 1953.



Plate 5. Northern Redbelly Dace Chrosomus eos.
Adult males, about 2·X natural size



Methods and Materials

Samples of Northern Redbelly Dace, Chrosomus eos, were collected at intervals of nine or ten days from four of the five bodies of water during the study period. There were no collections from Pond F before July 27. The numbers of dace collected by all methods during the study period, and included in this report are as follows: Pond A, 138; Pond B, 617; Pond E, 551; Pond F, 329; and the Reservoir, 623; for a total of 2258.

Most of the collecting was done by glass minnow traps and seines. When Pond B was drained in the fall, 137 dace were preserved for this study.

The glass minnow traps were placed at various water depths and in different locations in the ponds. The number of glass traps used in a pond varied from one to as many as six. Usually, only one or two hours of fishing by each trap were required to obtain a suitable number (10 or more) fish. The traps were set during the early morning or late afternoon hours, because of convenience of operation.

Definite collection stations were not established in any of the ponds. The traps were moved

after each setting, regardless of the degree of success at a particular location in order to sample widely in a pond.

A four by eight foot minnow seine and a fifteen inch scap net were also used to collect specimens. These nets were not as productive as the minnow traps as judged by the number of fish caught. The weekly numbers of dace collected from each pond varied widely (Table 3). Immediately after capture, the fish were placed in jars containing 10 percent formalin. The pond, date and hour, and method of capture were recorded.

To explore the possibility of weight and length changes during storage in formalin, 25 fish were measured and weighed, and placed individually in vials containing 10 percent formalin on August 15, 1953. On October 20, 1954 (one year and 66 days later) these fish were again examined. Total length measurements were found to be the same (to the nearest millimeter) while weights of 21 fish were unchanged. Four fish had each gained 0.01 gram. It was concluded that changes in storage were not important.

Fish Lengths and Weights

The total length was measured to the nearest millimeter for all of the fish included in this

study. In weighing, the fish were first placed on dry absorbent paper toweling for a minute or two, the excess moisture blotted off with toweling, and the weight recorded to the nearest 0.01 gram.

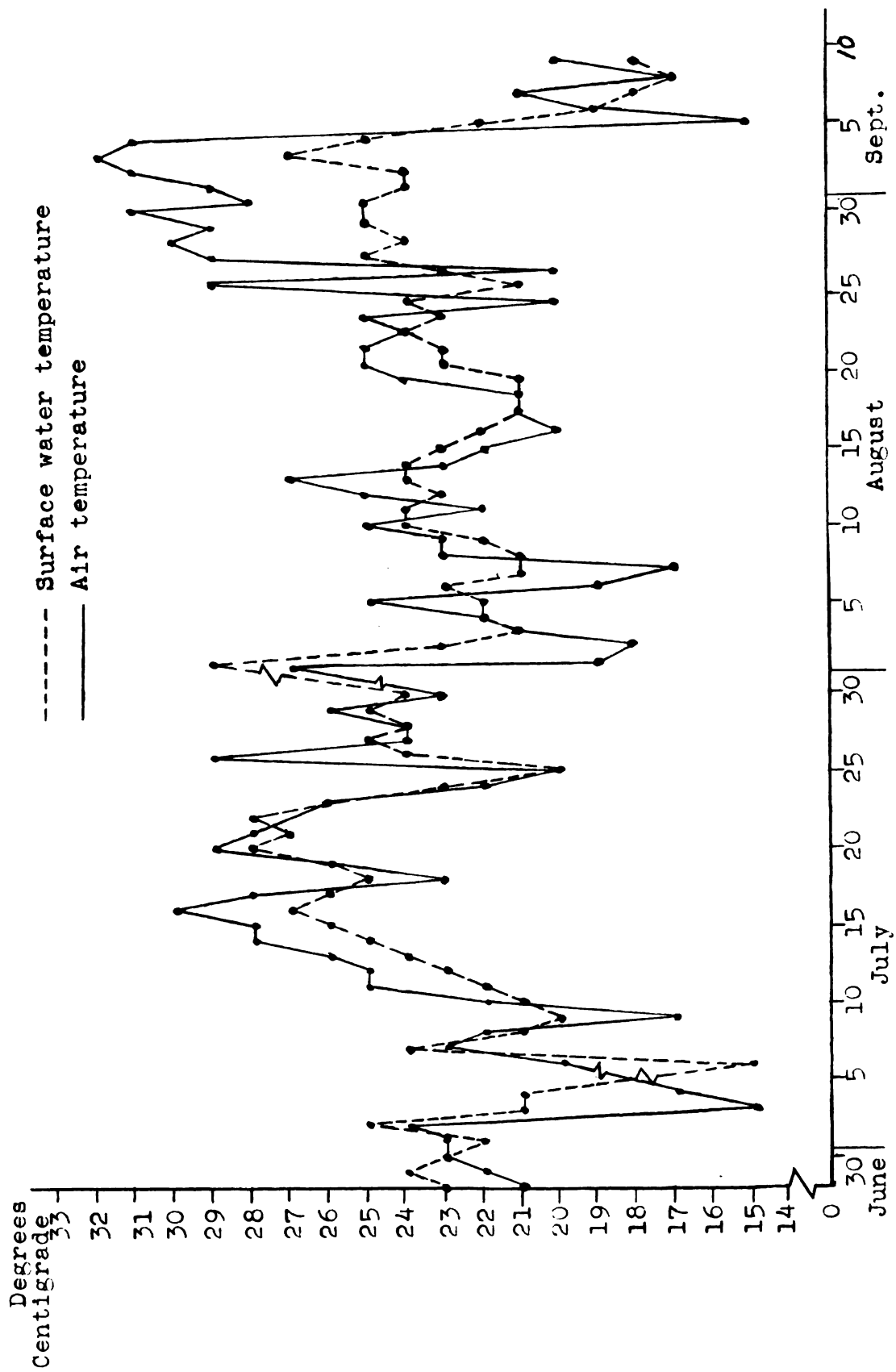
Fertilizer Applications

Commercial inorganic fertilizer was applied to Ponds B, E, and F four times, first on June 12 and then at three week intervals thereafter. The fertilizer was applied at the rate of one-hundred pounds per acre of water surface. The fertilizer had a formulation of six-12-six. Fertilizer was thrown into the ponds by an operator standing on the bank. Little was lost by wind action since it was granular in nature.

Surface Water and Air Temperature

Figure 2 shows the surface water temperatures and air temperatures for the period from June 28, 1953 to September 9, 1953. These temperatures were recorded for all but two of the 74 days. The average surface water temperature was 23° and the average air temperature was 24° C.

**Figure 2. Daily air temperatures and surface
water temperatures of Pond A, 1953**



Results

When Pond B was drained on October 24, 1953, a sample of the fish captured was preserved. Although it is suspected that a number of the smaller fry escaped through the screening at draining, the sample captured revealed the size composition of the rest of the population. This furnished a standard to which certain glass-trap samples were compared (Table 1). It may be noted that the sample at draining averaged practically the same length (difference not statistically significant) and the standard deviations were similar. Thus, there is some justification for viewing the fish taken in glass traps as representing the fish in the pond.

TABLE 1.
Standard deviation of Dace
captured by glass traps and by
by draining
Pond B, 1953

Method of capture	Date of capture	Number of fish	Mean T.L. mm	Pooled samples	Mean T.L. mm	Degrees of freedom	Mean square
glass trap	Sept.15	2	54.5				
glass trap	Sept.20	21	53.1	glass traps	52.3	37	53.76
glass trap	Sept.20	15	50.9				
pond drained	Oct. 24	137	52.8		52.8	136	53.18

Standard deviation (pooled glass traps) $\sqrt{53.76} = 7.33$
 Standard deviation (drained) $= \sqrt{53.18} = 7.29$
 "t" = 0.13

Figure 3 shows the seasonal changes of fish taken in glass traps from the five ponds during the summer of 1953. The points determining the curves in Figure 3 represent average lengths, usually for several samples pooled when not far apart in time. The data for each sample taken are shown in Table 2 , where brackets designate those samples which were pooled.

The average length of fish captured actually decreased during the early part of the season (Figure 3). Since we may exclude shrinkage of individual fish, causes of this phenomenon may include, aside from actual faulty sampling:

1. Rapid recruitment from classes of fish too small to be taken in traps.
2. Mortality of larger fish.

Examination of the frequency distributions of all samples suggests that both effects were operating during the early summer, resulting in the observed decrease in average length. For example, larger fish were taken early in the season, but not again in numbers until the smaller fish grew naturally into these sizes.

After this early period of decrease in average length, there was a gradual increase in length in all ponds. The differences in average size of fish in different samples could hardly have been due

Figure 3. Seasonal development of average size
of Northern Redbelly Dace trapped from
Ponds A, B, E, F, and the Reservoir, 1953.

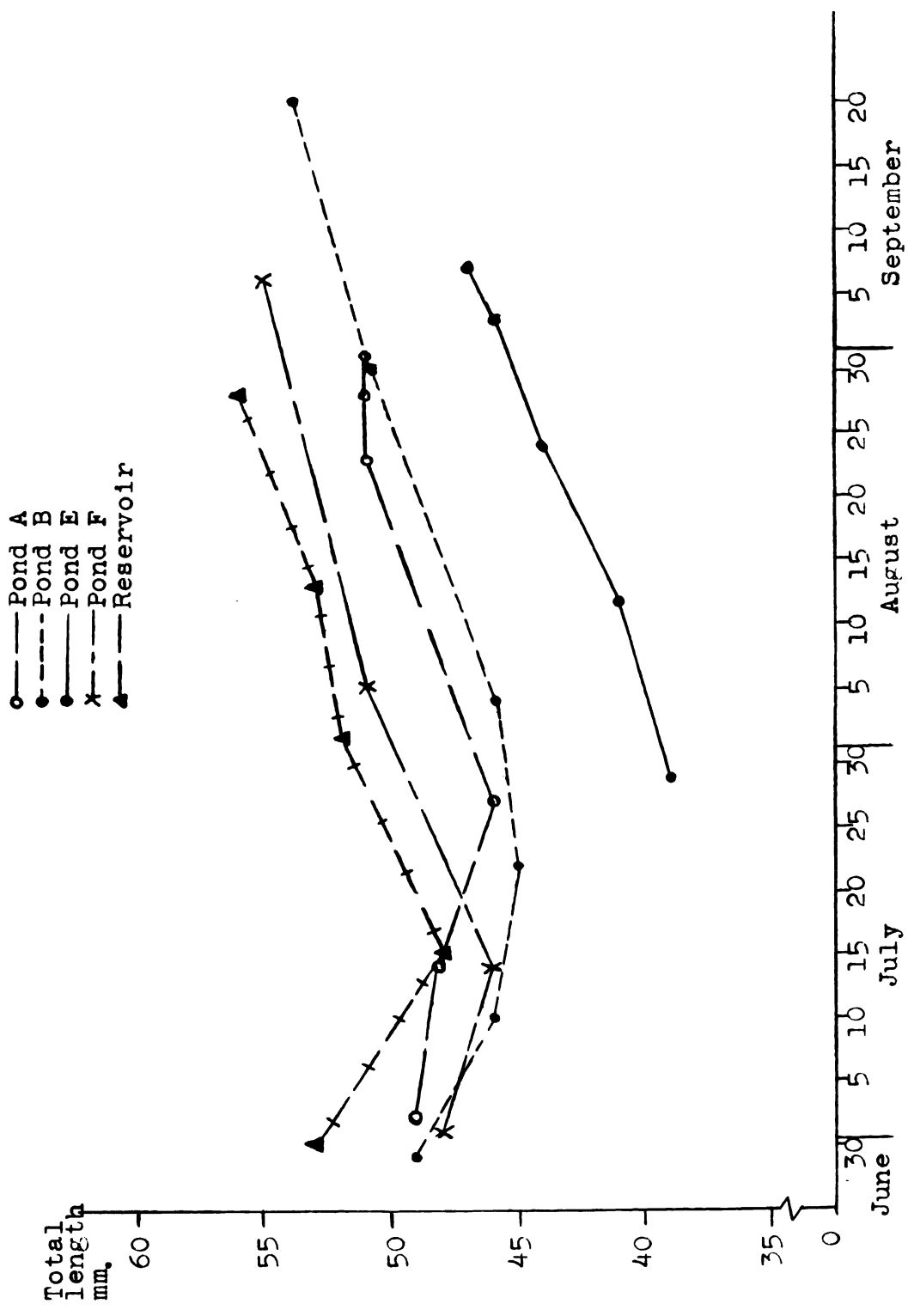


TABLE 2
Record of Northern Redbelly Dace
collections according to date, method of capture
and pond, 1953

Pond A

Sample no.	Date of capture	Method of capture	Number of fish	Mean T.L. mm.	Pooled mean T.L. mm.
1	July 2	glass	4	49.	48.
2	July 15	" trap	11	47.	
3	July 16	"	7	48.	
4	July 27	"	12	45.	46.
5	Aug. 1	"	4	48.	
6	Aug. 23	"	8	53.	51.
7	Aug. 25	"	12	49.	
8	Aug. 25	"	21	51.	
9	Aug. 28	"	17	51.	27.
10	Sept. 1	"	13	51.	
Sub total=109					
1	Aug. 10	netted	1	20.	22.
2	Aug. 12	"	10	22.	
3	Aug. 27	"	8	25.	27.
4	Sept. 1	"	7	27.	
5	Sept. 2	"	1	30.	
6	Sept. 2	"	1	23.	
Total =			138		
Pond B					
1	June 29	glass	106	48.	49.
2	June 29	trap	93	49.	
3	June 29	"	17	49.	
4	July 10	"	24	46.	51.
5	July 22	"	3	45.	
6	Aug. 5	"	8	46.	
7	Aug. 29	"	32	51.	53.
8	Aug. 31	"	48	51.	
9	Sept. 1	"	62	50.	
10	Sept. 15	"	15	51.	32.
11	Sept. 20	"	2	54.	
12	Sept. 20	"	21	53.	
13	Oct. 24	"	137	53.	
Sub total=568					
1	July 21	netted	18	20.	20.
2	July 22	"	1	18.	
3	Aug. 4	"	14	24.	32.
4	Aug. 29	"	12	32.	
5	Aug. 31	"	4	33.	
Total =			617		

TABLE 2 continued

Pond E

Sample no.	Date of capture	Method of capt.	Number of fish	Mean T.L. mm.	Pooled mean T.L. mm.
1	July 29	glass trap	70	39.	41.
2	Aug. 11	"	11	42.	
3	Aug. 12	"	75	41.	
4	Aug. 22	"	121	44.	44.
5	Aug. 25	"	53	43.	
6	Aug. 26	"	31	44.	
7	Aug. 27	"	41	43.	46.
8	Sept. 1	"	41	46.	
9	Sept. 2	"	4	43.	
10	Sept. 4	"	18	46.	
11	Sept. 5	"	38	46.	
12	Sept. 7	"	48	47.	
Total =			551		
Pond F					
1	July 1	"	10	48.	55.
2	July 14	"	2	46.	
3	Aug. 6	"	15	51.	
4	Aug. 25	"	17	46.	
5	Sept. 1	"	41	42.	
6	Sept. 4	"	111	55.	
7	Sept. 5	"	123	53.	
8	Sept. 7	"	10	56.	
Total =			329		
Reservoir					
1	July 1	glass trap	82	53.	53.
2	July 2	"	13	49.	
3	July 13	"	4	43.	
4	July 13	"	10	49.	48.
5	July 15	"	46	48.	
6	July 27	"	2	49.	
7	Aug. 1	"	7	52.	52.
8	Aug. 14	"	4	55.	
9	Aug. 24	"	24	55.	
10	Aug. 24	"	29	53.	56.
11	Aug. 24	"	31	56.	
12	Aug. 25	"	53	56.	
13	Aug. 27	"	49	54.	56.
14	Aug. 28	"	27	57.	
15	Aug. 31	"	62	55.	
16	Sept. 1	"	10	49.	23.
Sub total =			457		
1	Aug. 1	netted	1	21.	
2	Aug. 2	"	4	23.	
3	Aug. 15	"	24	26.	
4	Aug. 15	"	30	26.	
5	Aug. 15	"	62	28.	
6	Aug. 27	"	39	29.	
7	Aug. 27	"	10	28.	29.
Total =			623		

simply to chance of sampling, to judge from an analysis of variance of the measurements of fish taken in Pond E (Table 3). This analysis shows highly significant differences in length to exist among samples.

TABLE 3
Analysis of Variance of Length Measurements of Dace Collected from Pond E

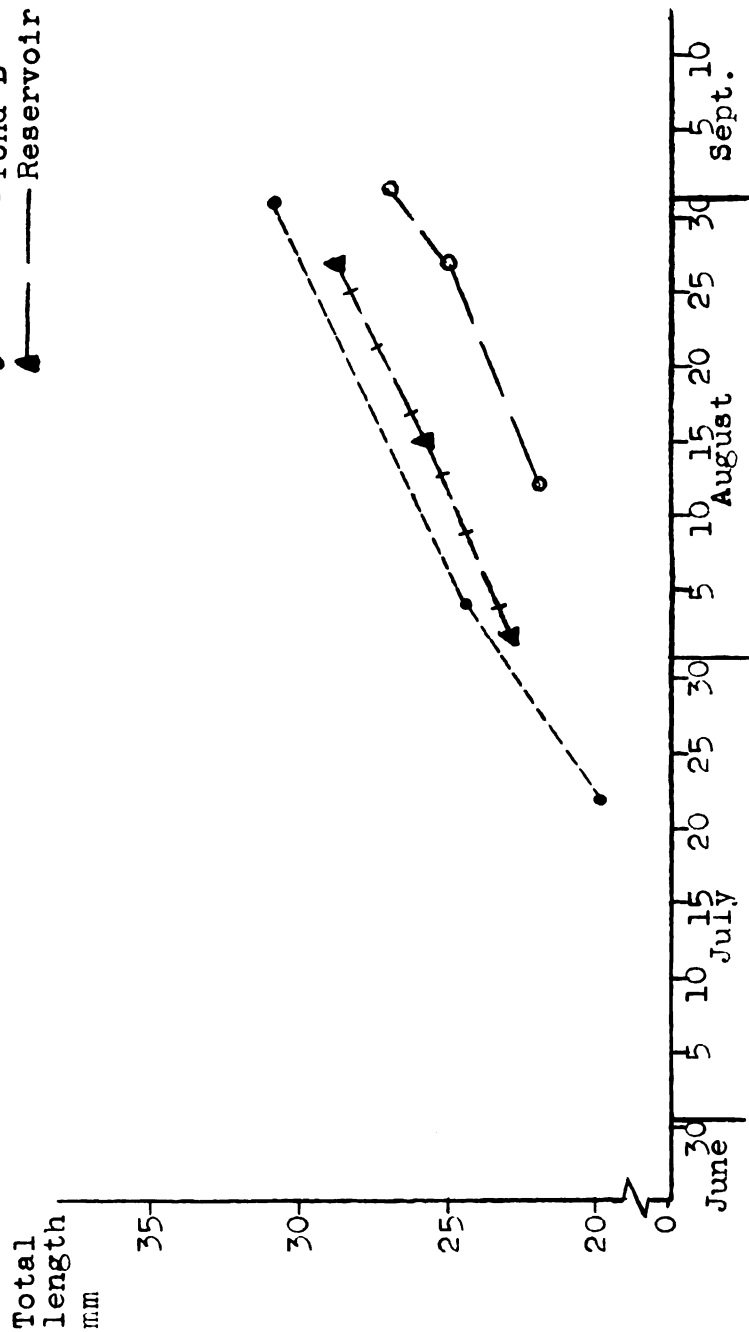
Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Between collections	11	3,332.8	302.9
Within collections	539	7,041.2	13.06
Total	550	10,374.0	----

Standard deviation = $\sqrt{13.06}$ = 3.61 mm.

The increase in length of those fish captured in seines and hand nets is shown in Figure 4. Apparently only young-of-the-year of certain sizes are taken by this means. Only in Ponds A, B and the Reservoir were there samples of reasonable size. The increase in average length apparent in Figure 4 is here, as previously, only a crude measurement of rate of growth, especially since summer-long recruitment to these sizes may be expected. This species spawns from May to August (Cooper, 1936).

Figure 4. Seasonal development of average size of netted young-of-the-year Northern Redbelly Dace collected from Ponds A, B, and the Reservoir, 1953.

○ — Pond A
 ● — Pond B
 ▲ — Reservoir



Approximate estimates of rate of growth, from Figure 4 are:

Pond A = 0.28 millimeter per day

Pond B = 0.27 millimeter per day

Reservoir = 0.23 millimeter per day.

The length-weight relationship for fish from each of the five bodies of water is shown graphically as a log-log plot in Figures 5, 6, 7, 8, and 9. Each point shows the weight and length of an individual fish. A subsample of the fish collected was weighed for this comparison. These fish were selected from the collection summary sheets after the total lengths of all the fish included in this study were determined. Fish were selected which would include the range of sizes collected from each pond.

The length-weight relationships in all ponds were similar, to judge by visual comparison. Had all the data been plotted on the same sheet, the five lines would have fallen so nearly in the same place as to be indistinguishable.

The rate of fish growth apparent in these ponds after the earlier decrease in average length is a population characteristic, and represents the growth rate of the individual fish, decreased first by the effect of disproportionate mortality among the larger fish, and decreased by recruitment from smaller fish. The apparent rate of growth evident

Figure 5. Length-weight relationship of 75
Northern Redbelly Dace collected
from Pond A, both sexes.

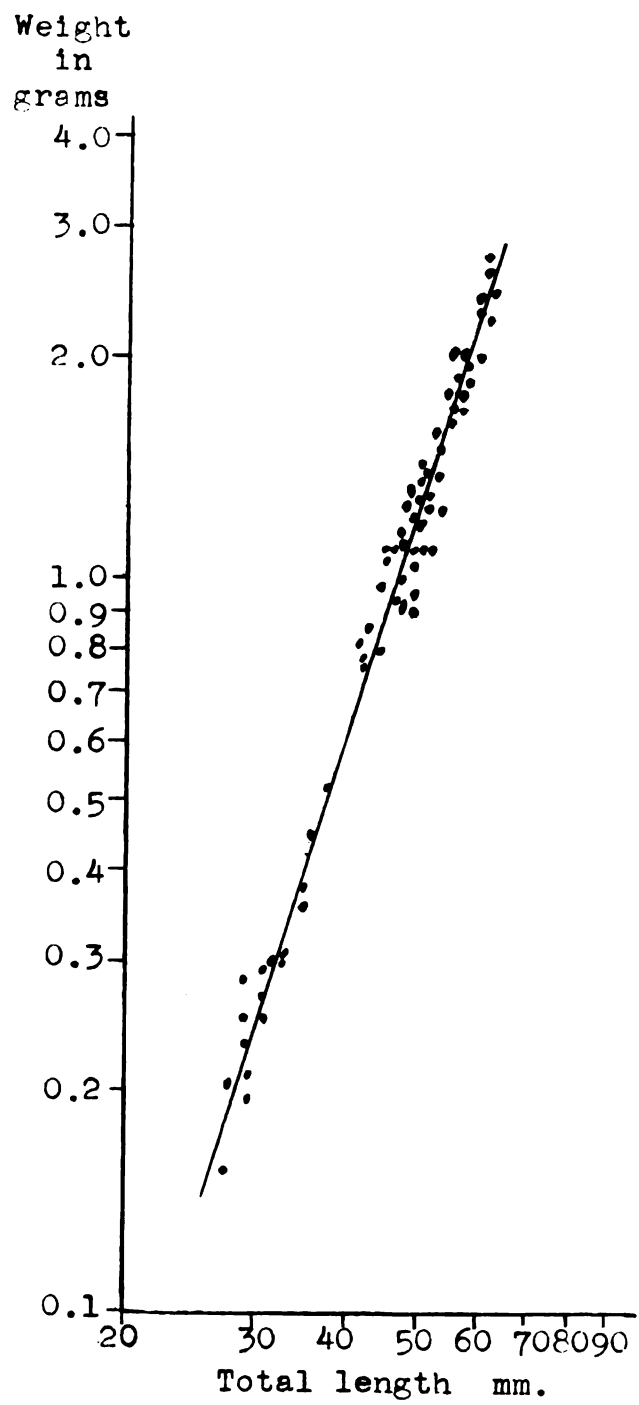


Figure 6. Length-weight relationship of 68 Northern Redbelly Dace collected from Pond B, both sexes.

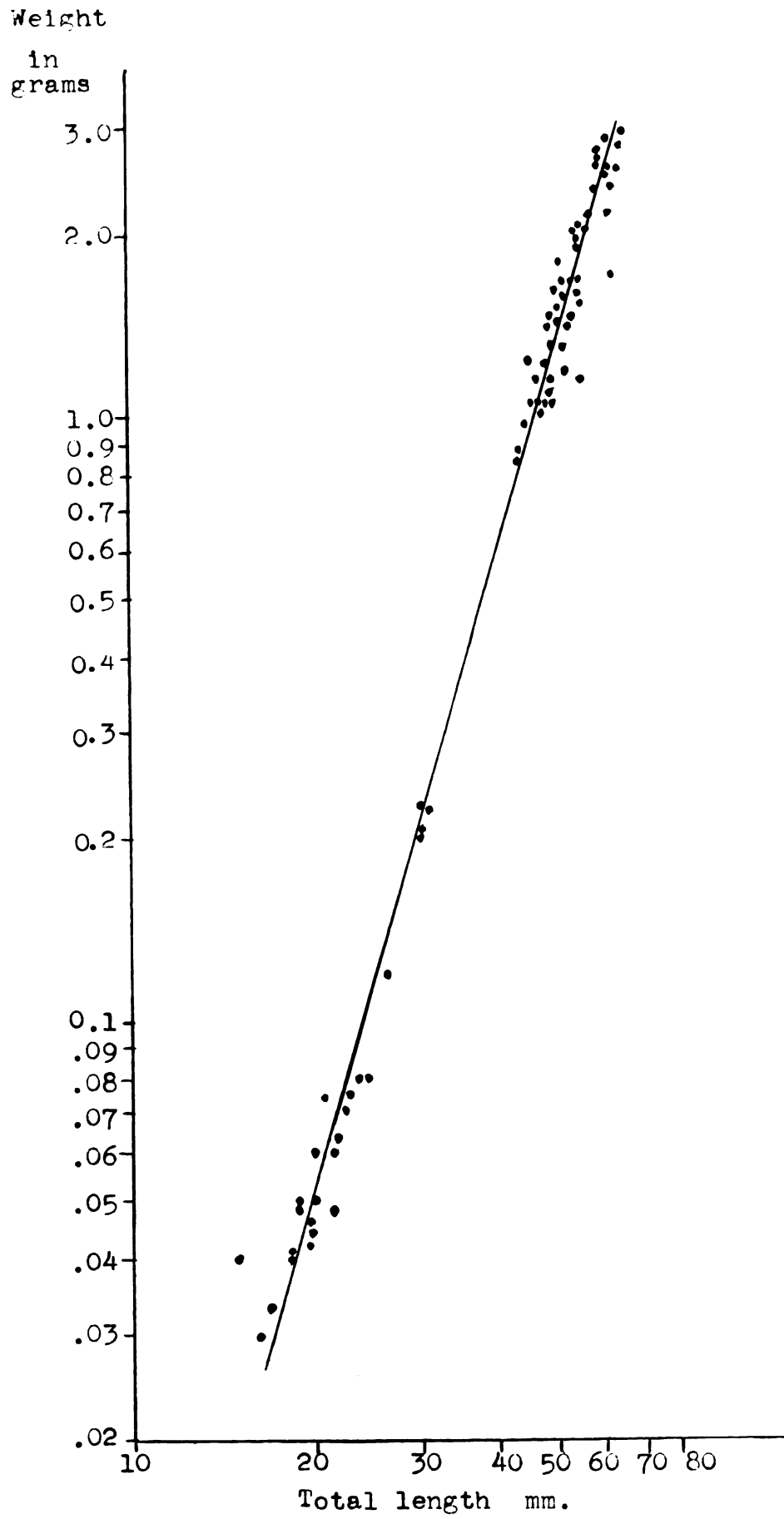


Figure 7. Length-weight relationship of 61
Northern Redbelly Dace collected
from Pond E, both sexes.

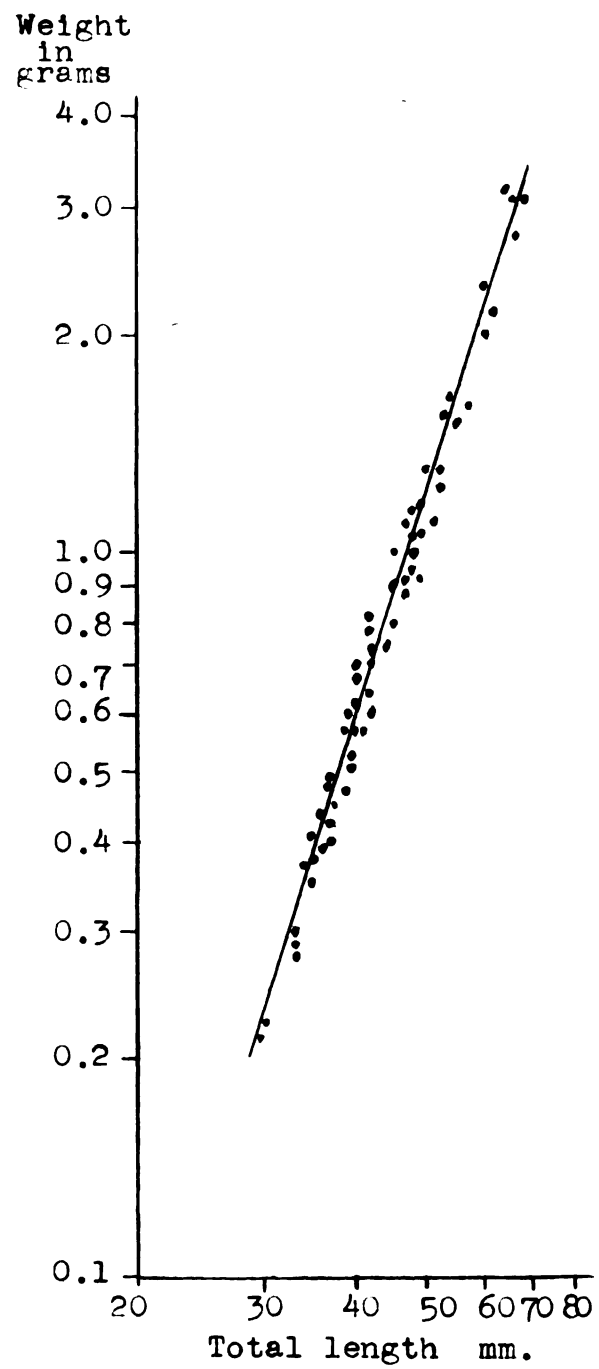


Figure 8. Length-weight relationship of 79 Northern Redbelly Dace collected from Pond F, both sexes.

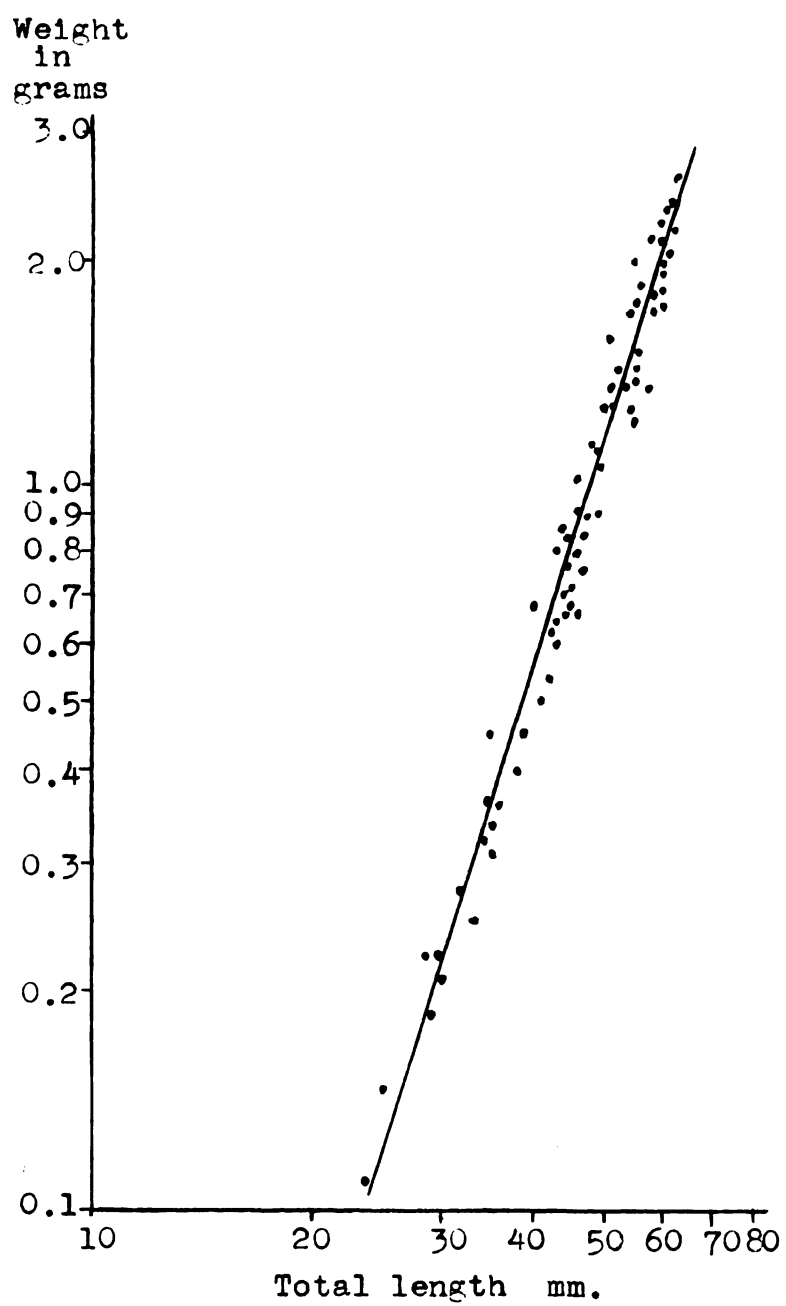
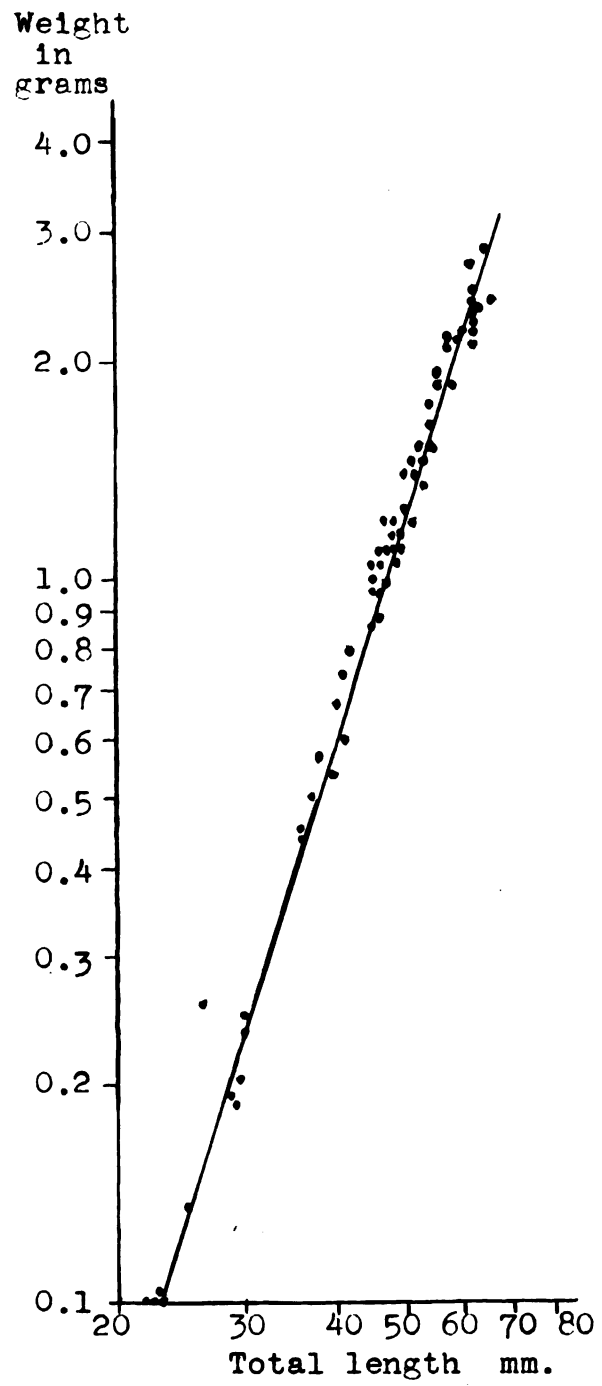


Figure 9. Length-weight relationship of 65 Northern Redbelly Dace collected from the Reservoir, both sexes.



from Figure 3 is then a minimum rate, probably well below the true rate. Comparisons of rates between ponds require an assumption of similar effects of mortality and recruitment in those ponds compared. This assumption is not entirely reasonable, especially considering the differences between the more artificial conditions in the four ponds proper, contrasted with the more natural conditions in the reservoir.

Nevertheless, inspection of Figure 3 shows that apparent rates of growth did not differ markedly in these ponds. Crude estimates of rate growth were made by fitting a line by eye to the trend of the growth in each pond after late July, and calculating the slope of the line. These approximate estimates of rate of growth are:

Pond A	(not fertilized) = 0.14 millimeter per day
Pond B	(fertilized) = 0.11 millimeter per day
Pond E	(fertilized) = 0.20 millimeter per day
Pond F	(fertilized) = 0.15 millimeter per day
Reservoir	(not fertilized) = 0.15 millimeter per day

No relationship to fertilization can be seen, but, of course, many other important factors, such as population density, cannot be taken into account here.

The rate of growth seems somewhat greater in Pond E than in the other bodies of water. Although

no test has been made of this difference, it may be pointed out that the Pond E fish were smaller and might, under equivalent conditions, be expected to exhibit greater relative growth, and at certain stages, greater absolute growth.

A more precise determination of the apparent rate of growth in Pond E was made by an analysis of variance technique (Table 4).

Using the Formulae

$$\text{Slope} = \frac{\text{SXY} - \frac{(\text{SX})(\text{SY})}{n}}{\text{SX}^2 - \frac{(\text{SX})^2}{n}}$$

where

$$\text{SX}^2 = \sum (n_c X_c^2) ,$$

$$\text{SX} = \sum (n_c X_c) ,$$

$$\text{SXY} = \sum (X_c S_c Y) ,$$

and

X = time covered by all collections in days

X_c = time of the individual collections in days

Y = total length of fish in each collection

n = number of fish in all collections

n_c = number of fish in each collection

the slope of the line, representing regression on time was calculated and indicated an increase in total length of 0.19 millimeter per day over the 41 days, and this trend could scarcely be a matter

of chance ($F = 22.80^{**}$, see Table 4). The analysis also showed that fitting a linear regression on time did not explain all differences among the collections, but that some significant non-linear effect remained. The approximate nature of the apparent rate of growth made further analysis seem futile.

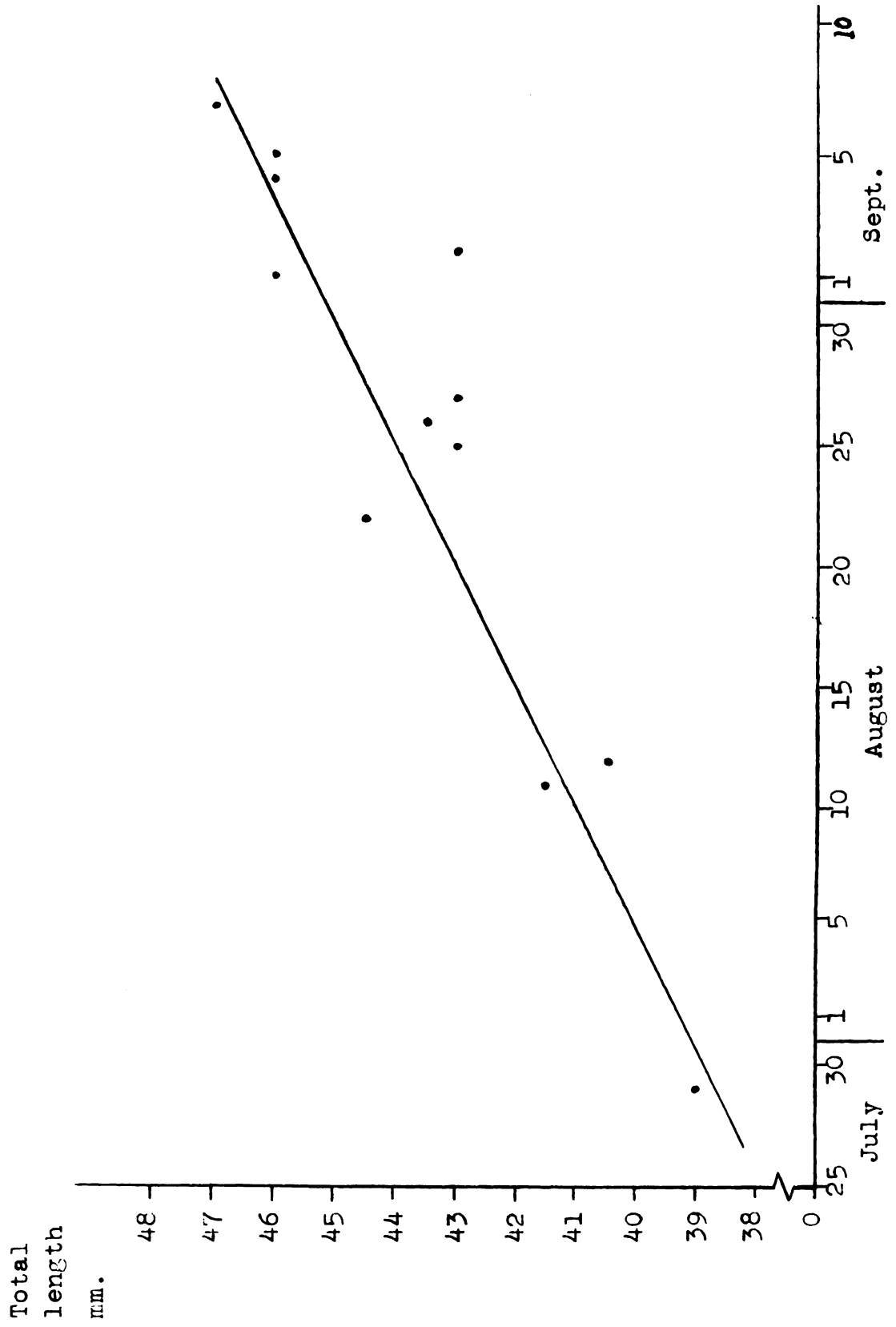
TABLE 4
Analysis of Variance of the Total
Lengths of Northern Redbelly Dace, Pond E

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Due to regression	1	2,978.3	2,978.3
About regression	549	7,395.7	----
Collection means about regression	10	354.5	34.45
About collection means	539	7,041.2	13.06
Among collection means	11	3,332.8	----
Total	550	10,374.0	----

$$F = \frac{2978.3}{13.06} = 22.80^{**}$$

$$F = \frac{35.45}{13.06} = 2.71^{**}$$

Figure 10. Regression line of the collections
made from Pond E, 1953.



Discussion

The effects of the four applications of fertilizer could not be detected in these data. The very important factor of population density is here an unknown. No important difference in rate of growth could be detected. The fish in Pond E (fertilized) were noticeably smaller than those in other fertilized and unfertilized ponds. The method of estimating growth rates was not capable of showing differences between ponds unless the mortality and recruitment relationships were identical.

Water samples were taken for quantitative plankton evaluation. The results are not presented here, but it may be mentioned that phytoplankton was present in Pond A and B this summer with approximately twice as much plankton in Pond B (fertilized) as in Pond A (not fertilized) over the entire summer.

To judge by the collections of young-of-the-year dace, these fish reach a total length of approximately 30 millimeters near the end of their first summer of life. Because growth during the winter is probably slight, the young-of-the-year

fish may be expected to start the next season at approximately this same size.

The collections made during the first two or three weeks of sampling contained a large number of large dace. The fish were probably entering their third growing season. They soon disappeared, to be replaced by the young of the year before. The important production (growth) of minnows took place in this class which showed a more-or-less uniform rate of increase in size for the remainder of the summer (Figure 3).

The feasibility of commercially propagating bait minnows probably depends upon three major biological factors: reproductive success, presence of suitable habitat, and rate of growth. Regarding reproduction, Cooper (1935) observed in experiments conducted near Grand Rapids, Michigan, that a brood stock of 2,700 Northern Redbelly Dace per acre produced over 125,000 young, or a total weight of fish produced of approximately 240 pounds per acre. The question of waters suitable for propagation of the Northern Redbelly Dace should not be a limiting factor, especially in northern Michigan, because of the tolerance of this fish for acid bog lakes, slow creeks, and small ponds. Thirdly, the growth rate of this species in question should be such as to yield a suitable number of bait-sized minnows

in a relatively short time. The collections made during the course of this study and those at the time of draining the ponds contained a high percentage of fish measuring between 29 and 55 millimeters ($1\frac{1}{2}$ - $2\frac{1}{4}$ inches) in total length. According to Ball and Ford (1953) with the Golden shiner and the fathead minnow, all minnows over $1\frac{1}{2}$ inches were of salable size.

The Northern Redbelly Dace is of suitable size for sale as bait for panfishes and the smaller game fishes. From the data presented in this study, the fish making up the $1\frac{1}{2}$ to $2\frac{1}{4}$ inch class would be age class I, II, and perhaps older. It would, therefore, seem likely that the reproductive potential, environmental requirements and growth rates of the Northern Redbelly Dace satisfy the requirements for bait production on a commercial scale.

Summary

1. A total of 2,258 Northern Redbelly Dace was collected from four ponds and a larger reservoir during the summer of 1953. The total length was determined for each fish. Approximately one-half of the total number of fish were weighed.
2. In total length, most of the fish were between 45. and 55. mm., with a range of from 15. to 72. mm.
3. A decrease in the mean length of fish was evident during the early summer, caused by a decreased proportion of older and larger fish in the collections. After early July there was an apparent gradual increase of about 0.14 to 0.19 millimeter per day in all five bodies of water.
4. Statistical analyses of the collections from Pond E indicate positive growth of the population of fish during the summer.
5. The length-weight relationship of the fish from each body of water was similar.

6. Young-of-the-year fish reached a total length of approximately 30 millimeters by the end of the first growing season.
7. A small percentage of the fish were of salable size at the end of their first growing season, and the remainder reached this size during their second summer.
8. The Northern Redbelly Dace appears suited, biologically, for commercial bait production in Northern lower Michigan.

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