A study of a population of perch (Perca fluviatilis L.) in a eutrophic pond

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U N I V E R S I T Y   O F   D U R H A M

A STUDY OF A POPULATION OF PERCH (*Perca fluviatilis* L.) IN A EUTROPHIC POND.

by

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C O N T E N T S

CHAPTER ONE

INTRODUCTION

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The perch (Perca fluviatilis L.) is widely distributed throughout Europe, and is found in ponds, lakes and reservoirs, as well as slow or moderately quickly flowing rivers and streams. In fact, its distribution appears to be increasing rapidly as bodies of still water, which were once game-fisheries, are rapidly being taken over by the perch as the amount of eutrophication increases.

Most of the published work on the perch (references given later) has been done as a result of studies of comparatively large and deep lakes, such as Lake Windermere. Very little appears to have been done on small, shallow ponds which are eutrophic.

In order to obtain knowledge about a fish stock - its specific taxonomy, sex- and year-class composition, and the rates of growth, mortality and recruitment - it is necessary to obtain specimens from the stock, either alive or dead. For reasons of conservation it is obviously better if the specimens can be obtained alive, studied, and at least some of the specimens returned to the stock.

There are several methods of obtaining live samples, the main ones of which are:

Removal of water by draw-down* or pumping;

Anaesthesia;

Hook and line fishing;

*Electronarcosis or galvanotaxis;

Active netting (seine* nets, trawls*);

Impounding (traps*, weirs, set-back or swing nets).

The methods currently most widely used are asterisked. Obviously, not all methods are suitable for all environments, and this applies particularly to eutrophic ponds. The removal of water is expensive, and can permanently damage the habitat. Anaesthesia is still in its infancy. Electronarcosis or galvanotaxis may not be possible if the eutrophication is high enough to result in a high conductivity, and the presence of large beds of weeds will obviously inhibit active netting. This leaves two main methods which would appear to be suitable for the investigation of such a habitat - hook and line fishing, and impounding.

For the purpose of this study, therefore, it was decided to investigate a population of perch in a small eutrophic pond, and compare the findings with those obtained by other workers from larger, less eutrophic bodies of water. At the same time comparison would be made between the efficiency of two different methods of obtaining live samples from the environment. Hence the results from traps (a method currently widely used) are compared with those obtained by angling (a method not widely used in fish population studies).

Finally, it was hoped to establish the relationship between the food available and the Year-Classes of fish present in order to determine whether or not the pond was supporting its full potential of fish.

CHAPTER TWO

METHODS OF CAPTURE AND EXAMINATION

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2. 1. The Area of Study - Brasside Pond.

Brasside Ponds (N.G. Ref. NZ 292 455) lie two and a half miles North-East of Durham City. They are the result of extensive excavations into the laminated clays of the old submerged valley of the River Wear, (Maling, 1955), and there has probably been open water in this area for over fifty years.

The two main ponds are separated by a narrow strip of land ranging from two to twenty metres in width. It was decided to carry out this study on the smaller of these ponds for the following reasons:

a) An area of 3.4 acres (compared with the larger pond of 13.3 acres) appeared to be more suitable for a short term study.

b) Originally the smaller pond had been over nine acres in area but two thirds of it had been reclaimed as a result of infilling in the 1950s. The Northern and Eastern boundaries are now arable farmland which is regularly treated with artificial fertilisers, some of which is washed by rainfall into the smaller pond resulting in this being eutrophic.

c) In 1952 some toxic material was dumped in the smaller pond and apparently killed off all the fish life. Although no artificial re-stocking has taken place it now holds a stock of perch, which may have come from the larger pond. Prior to 1966 the water-table of the smaller pond was at a higher level than that of the larger pond but, as a result of bank erosion, the two ponds became connected by a shallow stream which would allow the passage of small fish.

The smaller Brasside Pond thus offered the right conditions for the proposed study. It was of a suitable size, was eutrophic, carried a dense crop of aquatic flora, and supported a population of perch.

An initial survey was carried out with the aid of a rubber dingy and a large raft in order to determine the hydrography, as a result of which the pond was divided into nine major areas (see Fig. 1). Areas 1, 2, 5 and 6 are bankside regions with an average depth of two metres. Area 6 varies, however, in that it gradually shallows to the East. Area 3 is very shallow, as are areas 8 and 9. The deepest part of the pond is found in areas 4 and 7 (average 3.5 metres) which are very similar and are separated purely for ease of sampling. The point at which areas 2, 4, 7 and 8 meet is a submerged island on which was anchored the raft when it was not in use.

When the study started, in May, 1974, over 70 per cent of the surface of the water was covered by vegetation. Even those areas which appeared to be clear, that is, the deeper areas, had dense vegetation growing to within a few centimetres of the surface. Initially, therefore, small areas were cleared in order to be able to fish for the perch. As the season progressed the amount of vegetation diminished, and this was aided by the presence of eight swans. Plates 1 to 4 show views of the water taken on August 13th, by which time comparatively large areas were clear of vegetation.

A summary of the distribution of the main species of weed is given in Table 1.

FIGURE 1. SKETCH-MAP OF THE POND TO SHOW MAIN HYDROGRAPHICAL REGIONS.

The letters A to G refer to Plates 1 to 4.

PLATE 1. View A --- B

PLATE 3. View D --- E

TABLE 1.

DOMINANT PLANT SPECIES

Margins and Shallow Water ($<$1.0 metre deep)

Typha latifolia

Juneus effusus

Alisma Plantago - aquatica

Hippuris vulgaris

Eurhynchium riparoides

Water $>$1.0 metre deep

Myriophyllum spicatum

Potamogeton friesii

2. 2. Methods of Capture.

The dense areas of aquatic vegetation were a limiting factor which determined the possible means of capturing the perch. Consequently two methods were used.

The Windermere perch trap (Worthington, 1950) essentially consists of three semi-circular fencing-wire hoops, 57cm. in height, covered with 1.3cm. hexagonal wire netting, to give a trap with a flat base 76 x 67 cm. At one end is a funnel directed inwards for 44cm. to an opening 8.5cm. in diameter; at the other end is a door for the removal of the catch. One of these traps was borrowed from the Freshwater Biological Association and a further two were made. The three traps were laid unbaited on the bed of the pond and lifted every 3 or 4 days. The position of the traps was marked by a float attached to the top of the trap by rope. The raft was used both to lay and lift the traps, and as a working platform for weighing and measuring the catch. This ensured that the fish were always returned to the area from which they were caught. On lifting, any fish were tipped into a large container of water from which they were lifted separately for examination.

The second method of capture, which was carried out concurrently, was angling with bait. In an endeavour to prevent this method being selective as regard size, the tackle was kept as fine as possible. The hooks used were size 16, attached to 750 gram breaking-strain line, and supported by fine quill floats. The use of long rods (4 metres) enabled one to fish over the peripheral vegetation, and into the holes in the weed beds. As the fish were caught they were placed in large keep-nets until they were examined.

Full details of all fish caught are given in the Appendix.

2. 3. Length Measurements.

The length of the fish was measured with the aid of a measuring board graduted in millimeters.

Initially two length measurements were taken:

a) Fork length, median length, Schmidt's length or AC length. This is measured from the anteriormost extremity of the fish to the tip of the median rays of the caudal fin.

b) Total length, absolute length or AB length. This is the greatest length of the fish from the anteriormost extremity to the end of the tail fin.

However, several of the fish captured in the traps were noticed to have frayed and shortened tail fins, as a result of abrasion with the netting. Consequently, the second measurement of length was discarded and all measurements given are fork length.

2. 4. Weight Measurements.

In the study of any fish population one of the most difficult measurements to make is that of weight, not only because of the large range in size, but also because of the varying amounts of water which are on or in the fish.

The balance used in this study was a beam balance designed for fishing matches, weighing up to ten pounds in 2 dram divisions, (2 drams = $\frac{1}{8}$ ounce = 3.54 grams). By careful manipulation it is possible to weigh to 1 dram.

The balance was zeroed for each weighing, and each fish was shaken carefully to remove surplus surface water. Periodically fish were weighed twice to check accuracy.

The weights given in the tables are in drams, but for comparative purposes with other studies the Means and other relevant data have been converted to grams.

2. 5. Age Determination.

From each fish caught was taken a sample of scales for the determination of the age of the fish by annual rings. All scales were removed, with the aid of forceps, from the area immediately behind the base of the pectoral fin. In this population of perch the annual rings were generally obvious (except for Year 1 fish - see later) but as a check on accuracy opercular bones were removed from fish which died, and examined according to the method of E. D. LeCren, (1947).

With the smaller fish it was noticed that annual rings were not always present, but transformation of the size-frequency curves using probability paper showed that those fish without annual rings belonged to the Year Class 1, and that annual rings only appeared after the second winter.

Perch tend to hatch in May / June, and the birthday of the fish has been brought forward to January 1st for Year Class determination. Thus, a fish hatching in June 1967 belongs to Year Class 0 until December 31st, 1967.

From January 1st, 1968 to December 31st, 1968 it is in Year Class 1.												
From	"	"	1969 to	"	"	1969	"	"	"	"	"	2.
From	"	"	1970 to	"	"	1970	"	"	"	"	"	3.

and so on. This is the system as proposed by Hile, (1945) for the ageing of fish in the Northern Hemisphere.

2. 6. Marking The Fish.

Characteristically, the perch has well separated dorsal fins, the first of which has thirteen to seventeen strong spines. Each fish caught was given an individual number by clipping these spines which were numbered according to the binary system. Thus, spine 1 = number 1

spine 2 = number 2

spine 3 = number 4

spine 4 = number 8 etc..

Figure 2 gives the full marking system, together with examples, and Plate 5 shows fish number 79 which was first caught and numbered on June 24th, 1974, and photographed on August, 13th, 1974.

The actual marking was done with sharp scissors whilst the fish was held under water.

2. 7. Stomach Analysis and Bottom Fauna.

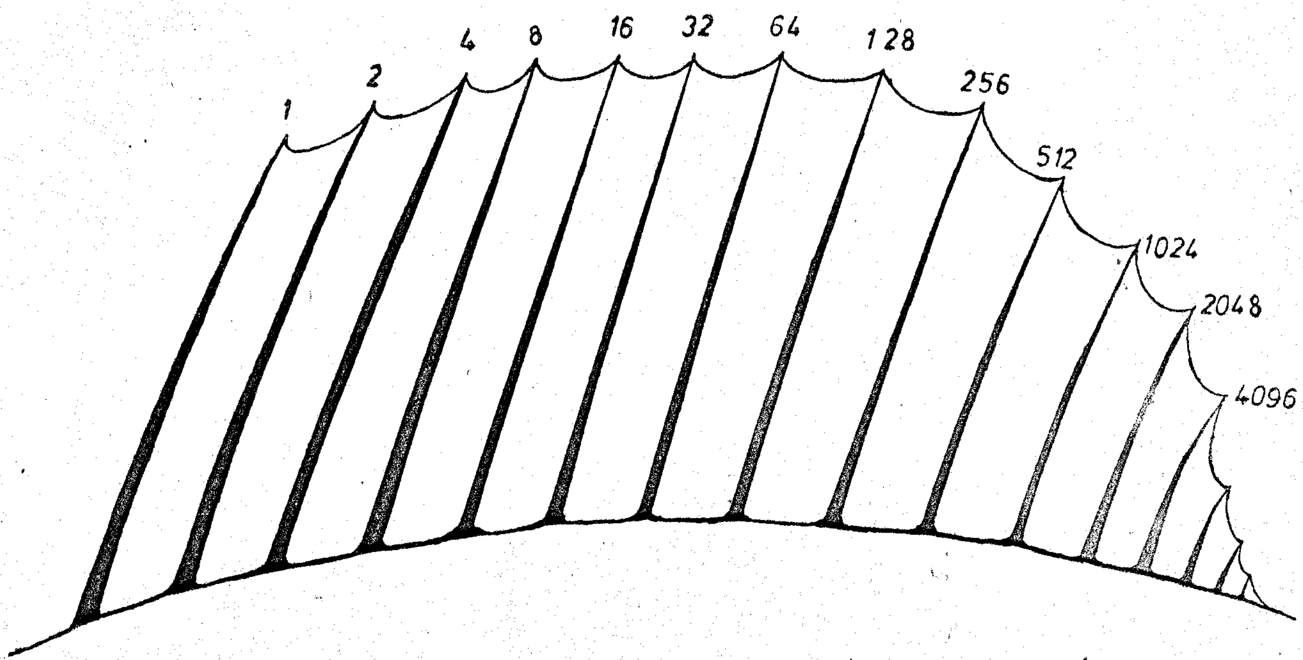
All stomach analyses were taken at the end of July, as were the samples of the fauna of the pond. For fish of Year Class 3 and older, a stomach pump as shown in Figure 3 was used. Water was pumped into the stomach until no more food was being washed out. The gills and throat were then examined to ensure that no organisms had become trapped in these regions. Although no dissections were performed to check on the efficiency of the pump, the fact that those fish caught with minnow-bait produced the minnow in their stomach washings indicates that the pump was able to remove food of any size that the fish may take. Plate 6 shows the pump in use.

For the younger fish no suitable pump could be made and so a different technique was used. Ten specimens of each of Year Classes 1 & 2 were caught and killed and their stomachs removed.

The contents of the stomachs of the larger fish, and the complete stomachs of the younger fish, were placed in individual specimen tubes, labelled, and preserved in 70% alcohol. Analysis was carried out by identification and counting under a binocular microscope.

Samples of the weed- and bottom- fauna were taken at the same time as the samples of fish used for stomach analysis. In each of the areas in which the fish were caught (i.e. areas 1, 2, 4, 5, 6 and 7) two separate square metres were sampled as follows. A metre quadrat was thrown randomly into the water over the shoulder. All plants present in the quadrat were cropped with a long-handled scythe, netted out, and placed carefully in polythene bags. Then the mud in the quadrat was sampled by sweeping a standard F.B.A. net along the bottom of the pond so that it picked up about

FIGURE 2. METHOD OF MARKING PERCH BY CLIPPING DORSAL FIN.



EXAMPLES:

FISH NUMBER.	SPINES CLIPPED.
11	1, 2, 8.
47	1, 2, 4, 8, 32.
123	1, 2, 8, 16, 32, 64.
192	64, 128.
312	8, 16, 32, 256.

TOTAL POSSIBLE INDIVIDUAL LABELLING USING THIRTEEN SPINES = 8,191 FISH.

FIGURE 3.

DESIGN OF STOMACH PUMP.

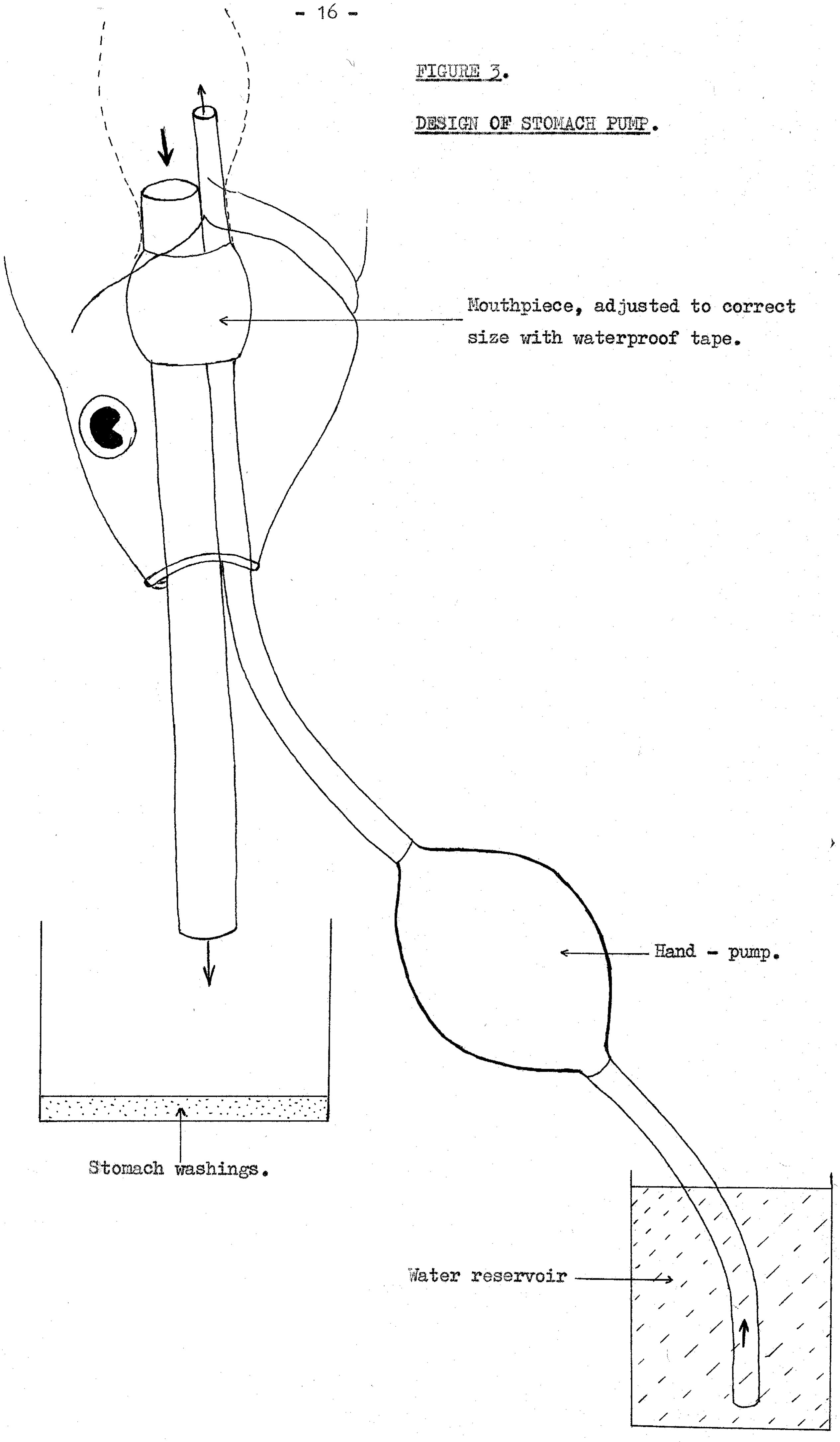


PLATE 5.

PLATE 6.

the top two centimetres of the bottom debris. The contents of the net were washed to remove fine mud, and the remainder was placed in large jars with ample water. The weed and mud samples were taken back to the laboratory where they were hand-sorted, and all animals present were identified and counted.

The figures for all twelve quadrats were combined to give an overall total of each species of animal present in the twelve square metres. These figures were then converted to 'percentage occurrence', which is the number of each species of animal expressed as a percentage of the total number of animals in the combined samples.

Almost certainly the methods used for sampling the weed and bottom fauna are prone to error - the net, for example, catching different animals with different efficiencies. However, the depth of water prevented one from enclosing a column of water to prevent animals escaping. As the selectivity of the net is probably in favour of the less motile animals, and the more motile animals would have a greater chance of similarly escaping from fish, it is probable that any errors in the sampling technicque are minimal.

2. 8. Final Recaptures for Population Estimate.

Initially it was intended to use a third method of capture for the final recapture for population estimate. This was to be by electrofishing with a pulsed direct current and an outfit was made, using a portable petrol Honda generator, to the design of W. H. Moore, (1968).

Unfortunately, the conductivity of the pond water was too high (1,200 + μmhos) and the generator was unable to produce sufficient output.

An examination of the data for running recaptures showed that of 121 fish originally caught in traps, only 2 were recaught by this method - indicating that the fish became trap-shy. However, of the 191 fish originally caught by bait, 21 had been recaptured by bait. Furthermore, most of the bait fishing had been done with maggot. Consequently, it was decided to do the final recaptures by angling, using earthworms as bait.

An 'angling match' was organized and 15 competent anglers fished the pond for three hours. They were instructed to fish with small hooks (size 16) and fine tackle, and to use small brandling worms (Eisenia foetida) or tails of brandling worms as bait. The principal behind the capture was explained, and they were asked to endeavour to capture all Age-Classes. All fish caught were measured, weighed and had scales removed for age determination. A summary of the results is given in Table 11 (Appendix). All fish were returned, unmarked ones being marked.

Two weeks later, the procedure was repeated. This time, because of shortage of time, no lengths or weights were taken, only scales for Year-Class determination.

During both recaptures every effort was made to sample all areas in which fish were known to be from earlier investigations.

An estimation of the population structure from both these recaptures is given in Table 14 (page 42).

C H A P T E R   T H R E E

ANALYSIS OF RESULTS

CHAPTER THREE

ANALYSIS OF RESULTS

3. 1. Comparison of Methods of Capture.

Angling by hook and line, and passive capture by unbaited traps, are two rather different methods of capturing fish. The former, if done carefully, relies on the natural behaviour of the fish to take available food, whereas the latter must apparently rely on some form of curiosity. Since most fishing operations are selective, catches by different methods can produce very different results. Selectivity can result from extrinsic factors (for example, the form of the gear and its method of use) and intrinsic factors (such as behavioural differences among or within species according to sex, size, habits, season etc.).

For the purpose of this study it was necessary that both methods, as near as possible, gave similar samples of the fish population. The use of the Windermere perch trap is well established as a tool for the study of fish populations (e.g. Worthington 1950, Bagenal 1972), but in inland waters, other than sport fisheries, hook-and-line fishing methods have generally not been used in fish population studies. (K.F. Lagler in I.B.P. Handbook No. 3. 1968).

The following table shows the comparative catches by the two methods, in Year Classes, from 21. 5. 1974 to 6. 8. 1974.

YEAR-CLASS	1	2	3	4	5	6	7	Total
ANGLING	63	48	14	28	20	17	1	191
TRAPPING	1	42	20	24	19	11	4	121
Total	64	90	34	52	39	28	5	312

The major difference in the two methods is seen in Year-Class 1, where only one fish was caught in a trap. In fact, this individual had 'gill-netted' itself by trying to enter the trap through a distorted hole in the side netting (i.e. a hole that was smaller than normal). Presuming that this Year-Class does enter the traps, they either leave through the mesh openings or are eaten by any of the larger fish present. This latter hypothesis is a distinct possibility for, in the early stages of the study, it was noticed that if small fish were kept in keepnets with larger fish some of them disappeared. (Consequently, they were later kept separate). Unfortunately, no stomach analyses were done of trapped fish.

Year-Class 7 has insufficient data for statistical analysis, but a Chi-Square analysis of Year-Classes 2 to 6 shows that there is no significant difference in the two methods of capture for these Year-Classes.

It would therefore appear that, except for Year-Class 1, there is no significant difference in the selectivity of the two methods as regards Year-Classes. There is similarly no significant difference between the mean length for each Year-Class caught by each method.

There are significant differences in the mean weights of fish caught by the two methods for each Year-Class but this is not a function of selectivity, but the result of weight lost whilst in the trap. Further discussion of this will be considered with the recapture data.

Occasionally, eels appeared in the traps. It was stated by Worthington (1950) that 'The predaceous species which normally feed on perch or their spawn, namely pike and eel, often enter the traps ... they complicated the results in that, once a pike or an eel was inside, no more perch would enter the trap until the predator was removed', but no direct evidence for this was given. However, Bagenal (1972), in an analysis of perch-trap catches, found that, of sixty eight traps with eels present, forty three had larger-than-average perch catches. In an endeavour to solve this problem one of the traps was 'baited' with two live eels. Over a period of 200 hours, in several different regions of the pond where perch were known to be present, no perch entered the trap.

It would appear therefore that Worthington was right, and that the results of Bagenal can be explained by the larger-than-average numbers of perch attracting the eels to the traps.

The traps in the study were used for a total of 3,144 hours, during which time they caught 121 fish. In comparison, only 107 hours were spent angling in order to catch 191 fish. Angling would appear to be more efficient regarding time, but the following must be taken into consideration:

a) The traps can be left unattended most of the time.

b) The fish were only found to feed at certain times of the day (approximately two hours before sunset and two hours after sunrise) and hence the one hundred and seven hours represents about fifty angling sessions.

Lagler (I.B.P. Handbook No. 3, page 24) states: 'Ordinarily the size of the fish caught is positively correlated both with the size of hook and with the size of lure used'. For most of the study the bait used was blowfly larvae, and so occasionally the method was varied in an attempt to catch any larger fish present that may be selected against by maggot or trap.

The two other baits used were worm (hook size 14) and live minnow (hook size 10). Table 10 (Appendix) gives a summary of the results of the different methods of capture. Worms caught a representative sample of Year-Classes 1 to 7, and with a smaller hook would probably have caught more of Year-Class 1. (See data on recapture). Minnows were too large for the smaller perch, but did not catch any fish over Year-Class 6. A statistical comparison of the catches by maggot, worm and minnow is not feasible as they were used for different lengths of time and not all areas were fished with worm and minnow (there is evidence that the fish tend to shoal in particular areas - see recapture data).

3. 2. Length - Weight Relationship.

The relationship between length and weight in fish can be directed towards two rather different objectives. It can be used mathematically to show the relationship between length and weight so that one may be calculated from the other. This is particularly so in the calculation ofweight, for length is a much more easily determined measurement. Furthermore, it is possible to calculate the earlier lengths of the fish by back-calculation from scale annuli, and hence, if the length-weight relationship is known, its earlier weights.

Secondly, it is possible to measure the variation from the expected relationship for any fish or population of fish so that the general well-being, or fitness of the fish, can be indicated. Usually this second approach is termed the 'condition factor'.

In fish the weight usually varies with length according to the formula:

$$w = al^b$$

where w = weight

l = length

$\left.\begin{matrix} a \\ b \end{matrix}\right\}$ = growth coefficients.

This equation is usually converted to:

$$\log w = \log a + (\mathrm{Log}\ 1)^b.$$

X

If the log of the weight is plotted against the log of the length, and the regression line calculated (usually by method of least squares), then the regression coefficient is 'b' and 'log a' is the intercept of the line with the Y-axis.

Normally 'b' is an exponent with a value between 2 and 4, often close to 3. A value of 'b' = 3 describes symmetrical or isometric growth such as would characterise a fish having unchanging body form and constant specific gravity. Usually, however, in all but completely demersal fish, the specific gravity of the fish as a whole is maintained at that of the surrounding water by the swim bladder, and so changes in weight for length are the result of changes in body form or volume. Thus, changes in the value of 'b' can be the result of variations in stomach contents, time of year and spawning condition (Ricker, 1958).

As a result of the above conditions the length-weight relationships of the marked fish have not been used in the following analysis for they include fish captured over a considerable period, that is, fish ready to spawn, spent fish and recovered fish. Moreover, many of the fish caught in the traps have a low weight / length ratio because of loss of weight due to 'forced' starvation. Consequently, the data obtained on August 15th, for a population estimate (Table 14, page 42) is also used for the calculation of length-weight relationships.

During their development fish typically pass through several stages or stanzas, several of which may occur during their larval life. Each of these stanzas may have its own length-weight relationship. The 143 fish caught on August 15th, were separated into Year-Classes and their weights converted from drams to grams. The corresponding weight and length for each fish was then plotted as a 'dot diagram' on log / log graph paper and the line of 'best fit' by eye for each Year Class was drawn. (Graph 1.) These lines of 'best fit' are the approximate regression lines for each Year-Class, the slope of which is the value of 'b'.

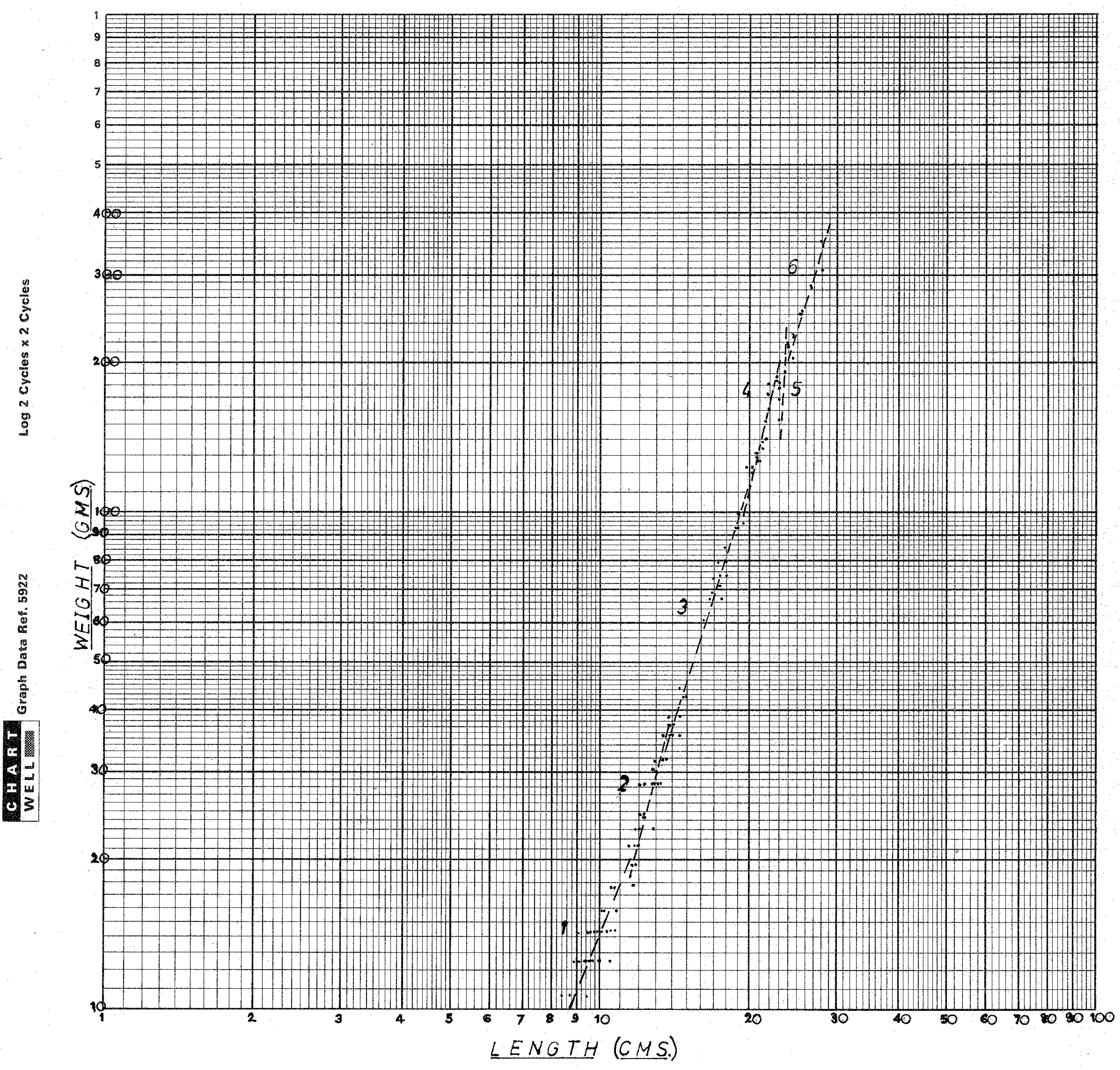
The same length and weight data was then converted to log values, and with the aid of a computer, the values of the regression line, intercept and correlation coeffieient for each Year-Class was calculated. Year-Classes 1 and 2 combined, and Year-Classes 3 to 6 combined, were similarly treated.

For Year-Classes 1, 2, 3, 4 and 6 the correlation coefficient in all cases gave a value of $P = < 0.001$ and the calculated regression line is very similar to that drawn by eye. However, a further calculation of the 't' test on the standard errors of these slopes showed that they are not significantly different.

The data for Year-Class 5, with a value of 'b' > 7, can be explained

GRAPH 1.

'DOT DIAGRAM' OF WEIGHT AGAINST LENGTH, PLOTTED ON DOUBLE LOGARITHMIC AXES. THE REGRESSION LINES FOR EACH YEAR-GROUP HAVE BEEN DRAWN BY EYE.



by the small sample with a correlation coefficient of $P = < 0.1$.

Thus, with the separate Year-Classes, there appears to be no definite stanzas. However, with the combined results a different picture emerges.

	Correlation Coefficient	Regression Line ('b')	Intercept ('a')
Year-Classes 1&2	$P = < 0.001$	2.957	6.14
Year-Classes 3 to 6	$P = < 0.001$	3.716	7.45

The value of 'b' for Year-Classes 1 and 2 is not significantly different from the isometric value of 3, whereas the value of 3.716 for Year-Classes 3 to 6 is significantly different. This indicates that a change in growth pattern occurs between Year-Classes 2 and 3, and is obviously the result of the fish developing sexually. The growth of gonads and change in body form results in a 'stockier' fish with a higher weight / length ratio.

These results are very similar to those of Le Cren (1951) but the value of 'b' for the mature fish is higher (3.7 compared with 3.4 in Le Cren's work).

Obviously, then, no single formula will give the length / weight relationship for perch and, in fact, Le Cren showed that there was a different significant value of 'b' for larval fish of 3.59163.

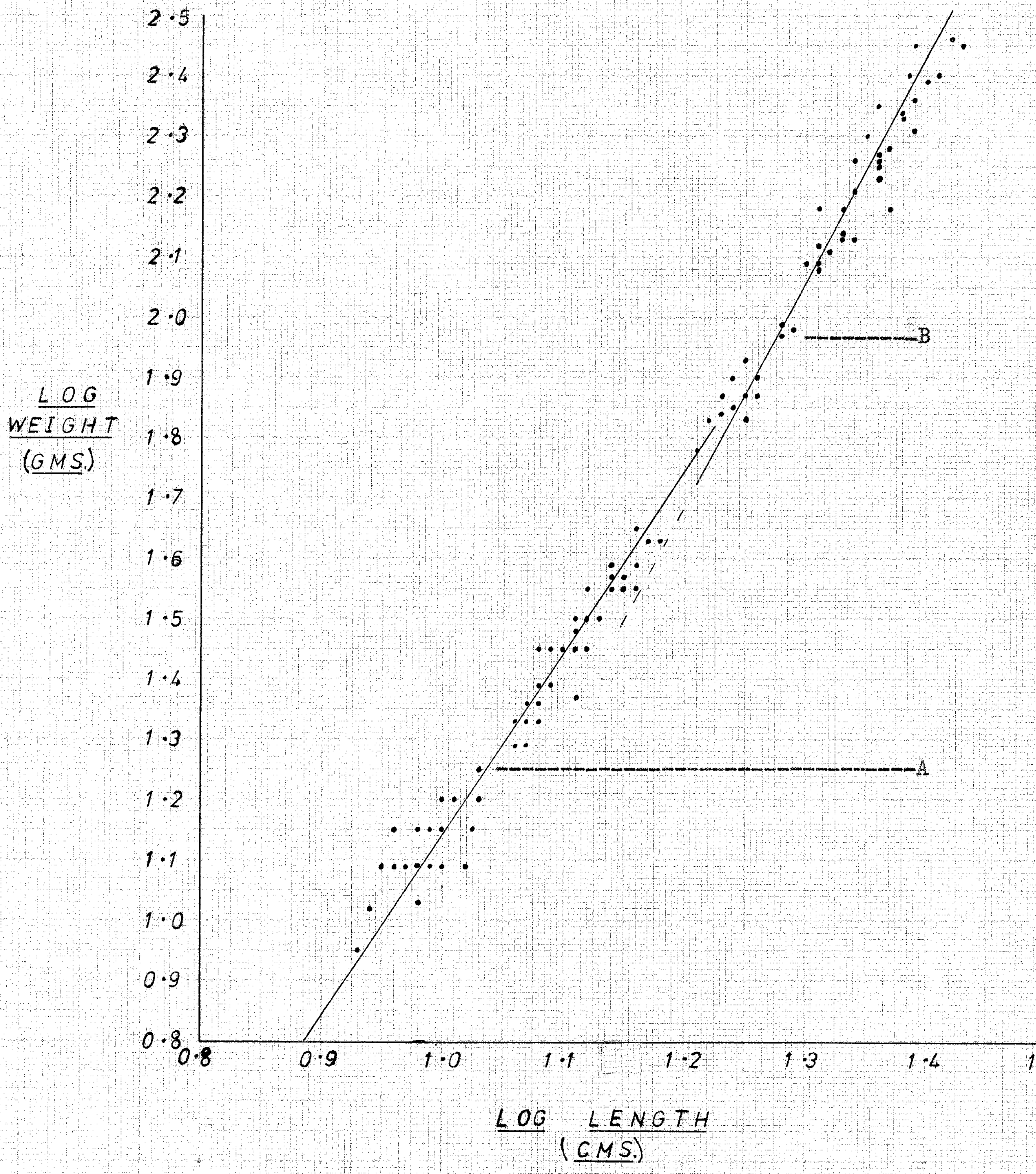
Graph 2, of log weight x log length on linear paper, shows the two significant regression lines and points of intercept for the population of perch in Brasside.

GRAPH 2.

COMPUTED REGRESSION LINES OF LOG. WEIGHT - LOG. LENGTH FOR:

A - YEAR-CLASSES 1 & 2

B - YEAR-CLASSES 3 to 6.



3. 3. Feeding and Growth.

Several methods for the enumeration of stomach contents have been employed by different workers, but in most studies substantially the same comparative results are obtained with all of them.

Briefly, the main approaches are:

a) Frequency of occurrence - where the number of stomachs in which a particular food item occurs is recorded and expressed as a percentage of the total number of stomachs examined.

b) Numerical method - this is the quotient of the total number of a particular item of food and the grand total of all items of food.

c) Volumetric method - here the volume of each type of food item is expressed as a percentage of the total volume of food.

d) Gravimetric method - which is essentially the same as the volumetric method except that volume is replaced by either dry weight or wet weight.

e) 'Points' method - essentially an approximate volumetric method. Each food item is allotted 'points' depending upon size and abundance. The food items are graded as 'common', 'frequent', etc., and one large item is considered equivalent to many small. All the points gained by each food item are summed and scaled down to percentages, to give percentage composition of the food of all the fish examined.

f) Dominance method - involves determining the food type which is both numerically and volumetrically the chief constituent of all stomachs examined - and is expressed as a percentage of all stomachs examined.

Obviously each method has inherent drawbacks and often a combination of methods is used.

The aim of the gut analyses in this particular study was two-fold. Firstly, to see if there was any difference in the types of food consumed by the different Year-Classes and, secondly, to investigate whether or not all the available food items were utilised fully by the population of perch.

The practical techniques for obtaining the samples has been explained in Chapter 1. For the analysis of the data obtained it was decided to use the same method as Neill (1938). He compared the percentage by number of each food species in the fish with the percentage by number of the same species present in samples of the environmental fauna. Form this he obtained data on the availability of food species and selection by the fish.

Hess and Swartz (1941) termed this index 'forage ratio', i.e.

$$\text{Forage ratio} = \frac{s}{b}$$

where; s = percentage representation of a food organism in the stomach

b = percentage representation of the same organism in the environment.

They state that the percentage representation can be numerical, volumetric or gravimetric. They also argue that, knowing these ratios for every member of the edible fauna, it is possible, on the basis of simple faunal counts, to discover what density of fish a given habitat is able to support, and they therefore claim that knowledge of these ratios is an important tool in fisheries research.

Table 12 summarises the analyses of fifty eight guts, and gives the average percentage occurrence of each food item for each Year-Class. Table 13 gives the percentage occurrence of each food item in the environment, followed by the forage ratios for each Year-Class. The lower limit for the forage ratio is zero and is indicated by '-'; the upper limit is infinitely large.

A forage ratio of 1 shows no selectivity on the behalf of the fish, a higher result indicated that the fish is selecting that food item, whilst a lower figure indicated that the fish is taking that particular food item less frequently than its occurrence would allow.

The two most common food items in Brasside Pond are Asellus (Isopoda) and zooplankton. In this latter group I have included all the 'microscopic' animals such as Daphnia, Bosmina, Copepods, etc. As these latter animals were present in extremely large numbers in the environmental samples, and only appeared in the gut analyses of Year-Class 1, I have omitted them from the 'Percentage occurrence' and 'Forage ratio' figures.

The fact that the samples were only taken over a short period of time,

KEY.
N. = Nymph
L. = Larva
P. = Pupa
A. = Adult

YEAR-CLASS		ISOPODA	EPHEMEROPTERA N.	GASTROPODA	CHIRONOMIDAE	OTHER DIPTERAN L.	DIPTERAN P.	TUBIFICIDAE	ZYGOPTERA N.	TRICHOPTERA L.	HYDRACARINA	COLEOPTERA L.	COLEOPTERA A.	CORIXIDAE	ZOOPLANKTON
1	ANIMALS IN 10 GUTS	51	31	1	37	2	4	4	0	0	0	15	0	5	93
	PERCENTAGE OCCURRENCE	20.7	15.1	0.3	14.8	0.6	1.5	1.5	0	0	0	5.9	0	2.2	38.3
2	ANIMALS IN 10 GUTS	522	79	4	5	0	5	0	0	0	0	1	0	1	0
	PERCENTAGE OCCURRENCE	84.4	12.8	0.7	0.9	0	0.9	0	0	0	0	0.2	0	0.2	0
3	ANIMALS IN 8 GUTS	1084	24	0	14	0	6	6	0	0	0	6	0	2	0
	PERCENTAGE OCCURRENCE	94.9	2.1	0	1.2	0	0.5	0.5	0	0	0	0.5	0	0.2	0
4	ANIMALS IN 10 GUTS	571	14	9	6	0	4	0	1	0	0	9	1	1	0
	PERCENTAGE OCCURRENCE	92.7	2.2	1.5	1.0	0	0.6	0	0.2	0	0	1.5	0.2	0.2	0
5	ANIMALS IN 10 GUTS	1593	80	9	89	0	30	5	3	5	0	20	0	4	0
	PERCENTAGE OCCURRENCE	86.7	4.4	0.5	4.8	0	1.8	0.3	0.2	0.3	0	1.2	0	0.2	0
6	ANIMALS IN 10 GUTS	2520	34	4	8	0	12	0	16	6	2	18	2	0	0
	PERCENTAGE OCCURRENCE	96.1	1.3	0.2	0.4	0	0.6	0	0.8	0.5	0.1	0.9	0.1	0	0

TABLE 12. GUT ANALYSES.

N.B. PERCENTAGE OCCURRENCE = number of that sp. expressed as a percentage of the total no. of animals in gut sample.

KEY.

N. = NYMPH
P. = PUPA
L. = LARVA
A. = ADULT

	ISOPODA	EPHEMEROPTERA N.	GASTROPODA	CHIRONOMIDAE	OTHER DIPTERAN L.	DIPTERAN P.	TUBIFICIDAE	ZYGOPTERA N.	TRICHOPTERA L.	HYDRACARINA	COLEOPTERA L.	COLEOPTERA A.	CORIXIDAE	ZOOPLANKTON
NUMBER OF ANIMALS IN COMBINED WEED AND BOTTOM SAMPLES	10072	541	682	133	229	196	84	238	539	187	54	325	25	∞
PERCENTAGE OCCURRENCE	77.1	3.9	4.9	0.9	1.6	1.4	0.6	1.6	3.9	1.3	0.4	2.3	0.2	
YEAR CLASSES	FORAGE RATIOS													
1	0.3	3.9	0.1	16.4	0.1	1.1	2.7	-	-	-	16.3	-	15.4	
2	1.1	3.3	0.2	1.0	-	0.7	-	-	-	-	0.5	-	1.3	
3	1.2	0.5	0.1	1.4	-	0.4	0.9	-	-	-	1.5	-	1.2	
4	1.2	0.6	0.1	1.1	-	0.5	-	0.1	-	-	4.0	0.1	1.4	
5	1.1	1.1	0.1	5.4	-	1.2	0.5	0.1	0.1	-	3.0	-	1.4	
6	1.3	0.3	0.1	0.3	-	0.3	-	0.4	0.1	0.1	1.9	0.1	-	

TABLE 13. POTENTIAL FOOD AND FORAGE RATIOS.

N.B. FORAGE-RATIO $= \dfrac{\text{PERCENTAGE OCCURRENCE IN GUT}}{\text{PERCENTAGE OCCURRENCE IN WATER}}$

and that the number of gut analyses is not very large, means that only general conclusions can be drawn from the data. However, several obvious differences can be seen.

Year-Class 1 is the only group which appears to be selecting against Asellus, and shows extremely high forage ratios for Chironomids, Coleoptera larvae and Corixids. There would appear to be two possible explanations for this. Most of these fish are to be found in Area 6 (see Table 2 - Appendix) and it is possible that at the time of capture of the fish used for gut analyses the fauna of this area was significantly different from that of the pond in general. However, it is felt that this is not the case and that the difference probably results from the fish showing selection of their food according to size - the Isopods being generally too large. This is supported by the high percentage of Zooplankton and the fact that it was noticed at the time of analysis that the contents of the guts were generally of a small size (i.e. early larval instars).

K. R. Allen (1935), working on Windermere perch, found that fish of less than fourteen centimetres in length fed chiefly on plankton, and that the smaller the fish, the smaller was the food it ate. Whereas one cannot state that equivalent fish in Brasside Pond feed chiefly on plankton, it certainly constitutes a high percentage in numbers, though not in volume. The fish of seven to ten centimetres in this habitat would appear to depend mainly on small insects and isopods for the bulk of their food.

The forage ratios for Isopoda for Year-Classes 2 to 6 are near enough to unity to indicate no selection. Further, the percentage occurrence in the guts is always very high - 84% to 96%. Obviously, then, Asellus forms the main food item for these Year-Classes, possibly because it is an animal which is present in very large numbers, and only moves slowly.

The other food items which the perch generally make full use of are Ephemeroptera nymphs, Chironomidae, Coleoptera larvae and Corixidae. In fact, Table 13 shows that at times particular groups are apparently 'searched for' as the forage ratios are occasionally quite high.

Some food items, however, are not fully utilised. These include Dipteran larvae other than Chironomids, Zygoptera nymphs, Trichoptera larvae, Gastropoda, Hydracarina and Coleoptera adults. This is probably explained by the fact that these animals are either buried in the mud, can bite, have hard indigestable cases or can swim quickly, whereas there is a plentiful supply of more easily obtained food in the form of the Isopods. However, it does indicate that the pond has the potential to support a higher population of fish. A possible explanation of this is given later, in the discussion of the population size.

During the analysis of the gut contents it was noticed that Year-Classes 2 to 6 contained all sizes of Asellus, and there was no obvious indication of the larger fish eating mainly larger specimens. This would suggest that the larger fish have to work much harder in order to obtain sufficient calories for maintenance and growth.

However, two potential items of food that are present in the pond do not appear in either Table 12 or 13. These are perch fry, and a fairly large population of sticklebacks (Gasterosteus aculeatus). Their absence from the environment samples can be explained by their speed of swimming - they were able to avoid the comparatively small net. No remains of Vertebrates were found in the 58 gut samples, and yet Allen found that fish over 14.5 cms. (Year-Class 3 at Brasside Pond) were able to feed on small fish, whilst those over 18 centimetres in length fed mainly on small fish. The answer to this anomaly probably lies in the dense weed beds present during the period of study. Apparently, the perch fry and the sticklebacks are able to shelter in the vegetation and so avoid predation.

Graph 3 shows the mean lenghts of each Year-Class for each month of the period of study. If, however, it is also taken to represent the growth rate of a typical fish over a period of seven years then it correlates with what has been discussed about the food in Brasside Pond, and the findings of Allen.

Year-Classes 1 and 2 show significant growth over the four-month period and as these fish feed solely on Zooplankton and Invertebrates this is to be expected. However, none of the Year-Classes 3, 4, 5, 6 or 7 indicate much growth over the same four months, but there is a significant difference in the mean lengths for each Year-Class. Consequently a lot of growth must occur between the months of September and April.

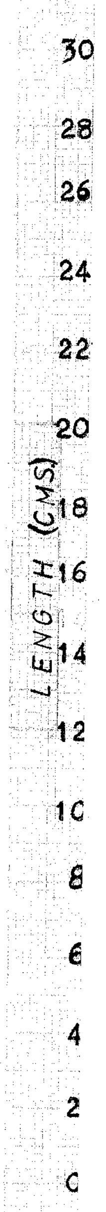
It would appear, therefore, that in a eutrophic environment such as Brasside Pond a fish is able to show the normal growth pattern for the first two years of its life, when it is feeding on invertebrates. Thereafter, the pattern changes. Perhaps this is because during the Spring and Summer months, when the vegetation is dense, the fish are only able to obtain maintenance calories in the form of invertebrate food. During the Autumn, as the vegetation dies back, the small vertebrates will become more accessible and so a fish will be able to increase its daily intake of calories and so produce growth. It would also appear, if this is the case, that the size of the perch in Brasside Pond is being limited, not by lack of food, but by the absence of some herbivore to keep the vegetation grazed to lower levels.

I propose to carry out further re-captures during the Autumn and Winter to see if the size of the fish increases as postulated.

Also, from Graph 3, it can be seen that by August the mean length of the fish of Year-Class 1 is almost that of the May result for Year-Class 2. There is a small difference in the mean weights - 13.7 gms. to 14.4 gms. There are two possibilities for this which warrant further study. The amount of food of a suitable size may now diminish and so slow down the growth-rate of Year-Class 1. Alternatively, this may be a 'stronger' population of fish which will continue to produce a larger than normal fish. The 'stronger' population could be the result of either:

a) an increase in the zooplankton and small invertebrates as a result of increased eutrophication, or,

b) an increase in predation, during larval stage, resulting in an increase of suitable food per surviving fish. This is possible if, as will be discussed later, the population of perch is increasing in number, as a result of it only being present for a few years i.e. seven.


LENGTH (CMS)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0

3. 4. Analysis of Recapture Data.

During the period of May to August, when the fish population was being sampled by trapping and angling, several of the fish which had been previously caught and marked were recaptured. Thus, for some of the fish, data is available on their weight, length and location on different occasions. A summary of this data is given in Table 9 (Appendix).

Of the original 255 fish which were marked, 51 were recaptured between May 5th and August 15th, (i.e. 20%). Thirty eight of these were recaught only once, 11 were recaptured twice, and two were recaught thrice.

The shortest interval between capture and recapture was shown by fish number 22, with a time interval of only one day. In contrast, fish numbers 10 and 6 were originally caught on May 22nd, and not recaptured until August 15th - a time interval of 85 days, only one day less than the tatal length of the study period. Similarly, four fish (Numbers 6, 10, 11 and 12) showed an identical time interval between capture and final recapture, but had other recaptures within this period. The mean interval between recaptures for the 51 fish recaught was 26 days. When considering this figure it must be born in mind that not only was the study-period limited to 86 days, but that the fish were being caught and marked throughout this period.

One of the aims of the running - recaptures was to investigate the effects of the general 'handling' of the fish on the fish themselves, so that some conclusion could be reached on the suitability of the techniques for further studies. The best way to do this initially appeared to be a comparison of the weight and length of recaptured fish with the mean weights and lengths of newly caught fish, of the same Year-Class, at the same time.

However, each Year-Class has such a range of length and weight that a recaptured individual could have shown normal growth since its original capture and still be considerable less (or more) than the mean weight or length of its Year-Class. Further, it has already been pointed out (page 35) that Year-Classes 3 to 7 showed very little growth over the study period. Thus, any comparison of growth rates can only be superficial. Bearing this in mind, it was felt that a minimum period of 30 days was necessary between capture and recaptured for any results to be at all valid. If the study had been over a longer period of time a longer time interval would obviously have been better. Of the 51 fish recaught, 25 gave time intervals of more than 30 days. These low numbers of suitable recaptured fish prevent statistical analysis, for growth rates must be considered in Year-Classes. However, a general comparison of the weights and lengths of recaptured fish Table 9 - Appendix) with those of the newly-caught fish (Table 2 to 8, and 11 - Appendix) gives the following indications:-

a) For all recaptured fish there are no obvious differences in their growth rates in length compared with what would have been expected had they not been caught and marked.

b) The increase in weight of the fish caught and recaptured by angling is also what would have been expected had they not been caught and marked.

c) Fish originally caught by angling, and then recaptured by trap, often show a lower weight than would be expected.

These results would seem to indicate that;

a) The marking system used on the perch appears to have no adverse effect on the fish.

b) Angling appears to have little adverse effect on the fish, but trapping can affect their weight measurements.

This latter point is perhaps more obvious if one considers the figures for some of the fish which were recaptured after a period of less than thirty days, as shown in the following table:

Fish Number	Original Weight (gms.)	Time Interval Between Captures (days)	Weight Loss (gms.)	Percentage Weight Loss
9	279.5	15	32	11.4
12	134.5	15	14	10.5
16	297.0	15	32	10.5
68	72.5	17	6.0	8.3
141	44.0	22	12.5	28.0
67	24.5	14	5.5	21.5

These weight losses are almost certainly due to forced starvation during the period in the trap, and will obviously depend upon the time interval spent in the trap. (In this work the traps were emptied every 3 to 5 days). If the traps are lifted too frequently, in an endeavour to minimize this weight loss, then the likelyhood of fish entering the traps will probabl~~e~~ be reduced.

Consequently, it is obvious that care must be taken in using weight readings from trap-caught fish in studies of length-weight relationships, or of condition factor.

Of the one hundred and twelve fish originally caught by trap, only two were recaptured by this method - clear proof that the fish become 'trap-shy'. Thus, in population studies, it would appear that any figures which rely solely on the sampling of the population by traps must be suspect. No

Conversely, Table 10 (Appendix) indicates that with angling, particularly if the bait is varied, there is little indication of 'shyness' developing.

Table 9 (Appendix) also gives the area in which each fish was caught, both for the original capture and all subsequent recaptures. If these areas are considered, in conjunction with Figure 1 (Page 7), the following emerges:

Number of recaptures in the same area where originally caught = 54

Number of recaptures in an area adjacent to original area = 8

Number of recaptures in an area distant from original area = 4

It would appear, therefore, that the perch have 'territories', that is, areas away from which they seldom move. This, of course, is only over a period of three months and it will be interesting to see what the distribution of the fish is in the proposed Autumn and Winter recaptures. However, the fact that the pond is generally very uniform in depth would suggest that these territories will be maintained.

3. 5. Population Estimation.

Details of the method used for the final recaptures for the estimation of the populating size are given in Chapter 2, and the results of these are shown in Table 14.

As there was no migration from, or immigration into, the population, the formula used for the estimation of the population was the Simple Lincoln Index, namely:-

$$N = \frac{mc}{r}$$

where: N = Total number of fish in the population

m = Total number of marked fish in the population

c = number of fish in the sample

r = number of marked fish recaptured in the sample.

The standard error of N, designated by S.E.(N), was estimated by the formula:

$$S.E.(N) = N\sqrt{\frac{(N - m)(N - c)}{mc(N - 1)}}$$

The two successive estimations of the population size are very similar, both in the numbers of each Year-Class, and the numbers of the total population. The second estimate, because of its lower standard errors, is probably the most accurate.

As the numbers of an animal population are generally naturally regulated, often by available food, it might be concluded that the optimum population of perch in Brasside Pond is the one given in Table 14. However, in the discussion on food and forage ratio, it was pointed out that there apppeared to be an excess of food which the perch were not utilising. Consequently, the population of perch in the pond may not be a stable one, but one which has not yet reached its maximum numbers.

In Chapter 2 it was noted that the pond was polluted in the 1950's, and that all fish life was killed. Further, bank erosion at the end of 1966 led to a stream connecting the pond with its larger neighbour. This stream disappeared when the levels of the two ponds became equal, and is now only seen as a small trickle after long periods of heavy rain. It is therefore suggested that, during 1967, whilst the stream was still flowing, some perch fry moved from the larger pond into the smaller one, by which time the pollution had cleared. These perch formed the basis of the present population, which has not yet reached its maximum in either numbers or Year-Classes. It is intended to continue fishing the pond over the next few years to see if this is the case.

TABLE 14. MARK - RECAPTURE RESULTS

15TH AUGUST, 1974

YEAR-CLASS	TOTAL MARKED	TOTAL RECAP.	MARKED RECAP.	POPULATION ± S.E.
1	62	45	3	930 ± 506
2	60	38	5	456 ± 182
3	27	22	5	119 ± 42
4	41	19	8	97 ± 23
5	35	8	4	70 ± 23
6	22	9	3	66 ± 17
7	5	2	1	10 ± 6
			TOTAL	1748

27TH AUGUST, 1974

YEAR-CLASS	TOTAL MARKED	TOTAL RECAP.	MARKED RECAP.	POPULATION ± S.E.
1	104	63	7	936 ± 322
2	93	52	10	484 ± 130
3	42	30	10	126 ± 28.5
4	52	28	14	104 ± 16.9
5	39	13	7	72 ± 16.7
6	28	15	6	70 ± 19.8
7	6	3	2	9 ± 3.2
			TOTAL	1801

C H A P T E R   F O U R

SUMMARY

CHAPTER FOUR

SUMMARY

1) A study was carried out on a population of perch in a eutrophic pond in County Durham.

2) Analysis of the length-weight relationship showed that the growth for Year-Classes 1 and 2 is isometric (cuboid), but that for Year-Classes 3 to 7 it is allometric - the fish growing heavier in relation to their length.

3) An investigation of gut analyses and available food showed that the young fish had ample food, and were able to grow successfully during the Summer months. The older fish, however, showed little growth during this period and were possibly only able to obtain sufficient food (largely *Asellus*) for maintenance because of the temporary non-availability of the larger food items.

4) A comparison of angling and trapping as tools in fishery research is made, and in the particular situation investigated angling generally proved to be the better method.

5) An estimate of the population size and age structure is given, and suggestion is made that this particular population is still developing and has not yet reached its potential proportions.

CHAPTER FIVE

APPENDIX

FULL FIELD DATA

TABLES 2 to 11

TABLE 2. YEAR CLASS 1 - NUMBERED

DATE	LENGTH	WEIGHT	METHOD	AREA	NUMBER
21. 5. 74	7.0cm.	4dr.	Maggot	6	2
22. 5. 74	6.5cm.	4dr.	"	"	5
"	6.7cm.	4dr.	"	"	10
29. 5. 74	7.5cm.	3dr.	"	"	19
"	6.3cm.	4dr.	"	"	25
"	7.0cm.	4dr.	"	"	26
"	7.2cm.	3dr.	"	"	30
"	7.0cm.	3dr.	"	"	31
"	7.2cm.	3dr.	"	"	32
"	7.0cm.	3dr.	"	"	33
"	7.1cm.	3dr.	"	"	36
"	6.4cm.	2dr.	"	"	38
14. 7. 74	9.5cm.	7dr.	Worm	2	163
15. 7. 74	8.7cm.	6dr.	Trap	1	164
19. 7. 74	9.8cm.	7dr.	Worm	2	187
6. 8. 74	9.9cm.	8dr.	Maggot	6	220
"	9.6cm.	7dr.	"	"	221
"	9.0cm.	6dr.	"	"	222
"	9.5cm.	7dr.	"	"	223
"	9.4cm.	7dr.	"	"	224
"	9.7cm.	7dr.	"	"	225
"	9.0cm.	7dr.	"	"	227
"	8.0cm.	5dr.	"	"	228
"	9.8cm.	7dr.	"	"	229
"	9.0cm.	7dr.	"	"	230
"	8.9cm.	7dr.	"	"	231
"	9.5cm.	7dr.	"	"	232
"	9.5cm.	7dr.	"	"	234

TABLE 2. (Cont.)

6. 8. 74	9.3cm.	7dr.	Maggot	6	235
"	9.5cm.	5dr.	"	"	239
"	9.8cm.	5dr.	"	"	240
"	9.0cm.	4dr.	"	"	241
"	9.5cm.	5dr.	"	"	242
"	8.5cm.	3dr.	"	"	243
"	9.1cm.	4dr.	"	"	244
"	9.0cm.	4dr.	"	"	245
"	9.1cm.	4dr.	"	"	246
"	9.1cm.	4dr.	"	"	247
"	8.5cm.	3dr.	"	"	248
"	9.0cm.	4dr.	"	"	249
"	9.1cm.	4dr.	"	"	250
19. 7. 74	9.4cm.	6dr.	Worm	2	184A

2 (Standard Error)

TOTAL MEAN LENGTH	8.6	$\pm$	0.3	cm.
MEAN LENGTH - May	6.9	$\pm$	0.2	cm.
MEAN LENGTH - July/Aug.	9.2	$\pm$	0.2	cm.
TOTAL MEAN WEIGHT	5.0 =8.9	$\pm$	0.5	dr. gr.

TABLE 3. YEAR CLASS 2 - NUMBERED

DATE	LENGTH	WEIGHT	METHOD	AREA	NUMBER
22.5.74	9.0cm.	6dr.	Maggot	6	3
"	10.0cm.	11dr.	"	"	4
"	12.0cm.	14dr.	"	"	6
"	10.5cm.	8dr.	"	"	14
"	10.5cm.	8dr.	"	"	15
"	9.5cm.	8dr.	"	"	18
27.5.74	9.8cm.	8dr.	"	"	20
28.5.74	10.4cm.	8dr.	"	"	22
"	8.5cm.	6dr.	"	"	23
"	9.5cm.	8dr.	"	"	24
29.5.74	10.7cm.	8dr.	"	"	34
"	11.0cm.	10dr.	"	"	35
"	10.0cm.	7dr.	"	"	37
"	9.2cm.	4dr.	"	"	39
6.6.74	10.0cm.	6dr.	Trap	6/7	50
"	11.2cm.	8dr.	"	"	51
13.6.74	11.4cm.	8dr.	"	"	1A
"	11.4cm.	8dr.	"	"	56
"	8.6cm.	2dr.	"	"	57
"	9.2cm.	3dr.	"	"	58
"	13.0cm.	18dr.	Maggot	6	59
24.6.74	10.7cm.	14dr.	Trap	1	66
"	11.0cm.	14dr.	"	"	67
"	13.2cm.	22dr.	"	"	69
"	12.2cm.	19dr.	"	"	70
"	11.1cm.	16dr.	"	"	71
26.6.74	12.2cm.	14dr.	Maggot	2	93
"	10.5cm.	8dr.	"	"	94

TABLE 3. (Cont.)

26. 6. 74	12.4cm.	14dr.	Maggot	2	95
2. 7. 74	11.4cm.	12dr.	Trap	4	106
"	11.5cm.	10dr.	"	"	107
"	10.6cm.	10dr.	"	"	108
"	10.9cm.	10dr.	"	"	109
"	11.7cm.	11dr.	"	"	110
"	11.5cm.	10dr.	"	"	111
7. 7. 74	12.0cm.	12dr.	Maggot	2	116
"	12.1cm.	13dr.	"	"	117
"	10.5cm.	8dr.	"	"	118
"	12.4cm.	13dr.	"	"	119
"	11.4cm.	12dr.	"	"	120
8. 7. 74	12.5cm.	14dr.	Trap	1	124
"	12.1cm.	13dr.	"	"	125
"	14.5cm.	23dr.	"	"	126
"	14.0cm.	20dr.	"	"	127
"	12.3cm.	14dr.	"	"	128
"	11.4cm.	8dr.	"	5	132
"	12.4cm.	13dr.	"	"	133
"	11.4cm.	9dr.	"	"	134
11. 6. 74	13.3cm.	15dr.	Trap	1	142
12. 7. 74	12.5cm.	18dr.	Maggot	2	128A
14. 7. 74	12.0cm.	16dr.	Worm	2	162
15. 7. 74	14.6cm.	24dr.	"	"	168
"	12.5cm.	17dr.	"	"	169
"	13.1cm.	19dr.	"	"	172
"	12.9cm.	17dr.	"	"	173
"	12.7cm.	17dr.	"	"	174
"	12.9cm.	17dr.	"	"	175

TABLE 3. (Cont.)

15. 7. 74	12.4cm.	14dr.	Maggot	2	176
17. 7. 74	11.2cm.	11dr.	Trap	7	179
"	12.1cm.	12dr.	"	"	180
"	10.6cm.	9dr.	"	"	181
19. 7. 74	12.3cm.	15dr.	Worm	2	185
"	12.1cm.	15dr.	"	"	186
22. 7. 74	13.2cm.	16dr.	Trap	7	192
"	12.9cm.	14dr.	"	5	196
"	11.4cm.	9dr.	"	"	199
"	10.9cm.	8dr.	"	"	200
"	10.3cm.	6dr.	"	"	201
31. 7. 74	12.5cm.	11dr.	"	2	203
"	13.1cm.	13dr.	"	"	204
"	11.2cm.	6dr.	"	"	205
"	12.6cm.	8dr.	"	"	211
"	11.2cm.	9dr.	"	"	212
"	13.9cm.	19dr.	"	"	213
"	13.4cm.	18dr.	"	"	214
"	12.2cm.	13dr.	"	"	215
1. 8. 74	13.3cm.	17dr.	Worm	"	218
6. 8. 74	11.5cm.	13dr.	Maggot	6	219
"	13.6cm.	20dr.	"	"	226
"	13.0cm.	18dr.	"	"	233
"	11.6cm.	14dr.	"	"	236
"	11.8cm.	11dr.	"	"	238

TABLE 3. (Cont.)

			2 (Standard Error)	
TOTAL MEAN LENGTH	11.7	±	0.2	cm.
MEAN LENGTH - May	10.0	±	0.5	cm.
MEAN LENGTH - June	11.2	±	0.7	cm.
MEAN LENGTH - July	12.2	±	0.3	cm.
MEAN WEIGHT - Trap	11.9	±	1.5	dr.
	=21.0			gr.
MEAN WEIGHT - Bait	12.7	±	1.5	dr.
	=22.5			gr.

TABLE 4. YEAR CLASS 3. - NUMBERED

DATE	LENGTH	WEIGHT	METHOD	AREA	NUMBER
21. 5. 74	16.0cm.	28dr.	Maggot	6	1
22, 5. 74	16.0cm.	32dr.	"	"	13
29. 5. 74	17.0cm.	36dr.	"	"	40
6. 6. 74	17.0cm.	34dr.	Trap	6/7	44
"	14.7cm.	24dr.	"	"	49
12. 6. 74	17.0cm.	36dr.	Maggot	1	53
24. 6. 74	16.8cm.	40dr.	Trap	1	65
"	16.3cm.	41dr.	"	"	68
26. 6. 74	17.2cm.	38dr.	Maggot	2	87
"	17.2cm.	42dr.	"	"	96
2. 7. 74	16.0cm.	32dr.	Trap	1	104
8. 7. 74	17.7cm.	40dr.	"	5	131
"	14.5cm.	23dr.	"	1	126
9. 7. 74	15.2cm.	25dr.	Maggot	2	141
11. 7. 74	17.4cm.	38dr.	Trap	1	144
14. 7. 74	15.1cm.	24dr.	Minnow	"	157
"	16.2cm.	36dr.	Worm	2	161
15. 7. 74	19.5cm.	64dr.	"	"	171
17. 7. 74	17.4cm.	40dr.	Trap	7	178
22. 7. 74	17.9cm.	44dr.	"	"	158
"	17.5cm.	32dr.	"	"	190
"	15.7cm.	31dr.	"	"	191
"	18.1cm.	46dr.	"	5	195
"	16.4cm.	32dr.	"	"	198
31. 7. 74	17.2cm.	38dr.	"	2	202
"	18.2cm.	36dr.	"	"	209
"	16.6cm.	28dr.	"	"	210

TABLE 4. (Cont.)

	2 (Standard Error)	
TOTAL MEAN LENGTH	16.7 ± 0.4	cm.
MEAN LENGTH May/June	16.5 ± 0.5	cm.
MEAN LENGTH July	16.9 ± 0.6	cm.
MEAN WEIGHT - Trap	35.2 ± 3.2 =62.0	dr. gr.
MEAN WEIGHT - Bait	36.1 ± 3.6 =63.9	dr. gr.

TABLE 5. YEAR CLASS 4 - NUMBERED

DATE	LENGTH	WEIGHT	METHOD	AREA	NUMBER
22. 5. 74	19.5cm.	64dr.	Maggot	6	7
"	20.5cm.	72dr.	"	"	8
"	19.0cm.	52dr.	"	"	11
"	20.5cm.	76dr.	"	"	12
"	20.5cm.	72dr.	"	"	17
29. 5. 74	22.2cm.	84dr.	"	"	21
6. 6. 74	21.5cm.	78dr.	Trap	6/7	45
"	21.0cm.	74 dr.	"	"	47
12. 6. 74	21.5cm.	82dr.	Maggot	1	52
"	21.0cm.	80dr.	"	"	54
20. 6. 74	20.5cm.	52dr.	"	6	62
24. 6. 74	22.6cm.	84dr.	Trap	2/8	72
"	22.0cm.	86dr.	"	"	74
"	20.5cm.	70dr.	"	"	75
"	20.2cm.	58dr.	"	"	77
"	20.5cm.	66dr.	"	"	78
"	19.6cm.	62dr.	"	"	79
26. 6. 74	20.0cm.	65dr.	Maggot	2	83
"	21.0cm.	72dr.	"	"	84
"	22.1cm.	84dr.	"	"	86
"	22.0cm.	86dr.	"	"	91
"	21.5cm.	84dr.	"	"	92
28. 6. 74	21.8cm.	87dr.	Trap	2/8	99
"	21.0cm.	76dr.	"	"	101
"	20.6cm.	72dr.	"	"	102
"	19.4cm.	58dr.	"	"	103
4. 7. 74	20.5cm.	68dr.	"	5	113
8. 7. 74	19.7cm.	60dr.	"	1	122

TABLE 5. (Cont.)

8. 7. 74	18.7cm.	45dr.	Trap	5	136
9. 7. 74	18.4cm.	51dr.	Maggot	2	139
11. 7. 74	19.9cm.	64dr.	Trap	1	129
"	20.3cm.	68dr.	"	5	146
12. 7. 74	19.5cm.	66dr.	Maggot	1	156
15. 7. 74	22.1cm.	95dr.	Minnow	2	167
17. 7. 74	22.8cm.	100dr.	Trap	7	176A
"	21.4cm.	80dr.	"	"	182
"	20.4cm.	66dr.	Minnow	1	184
21. 7. 74	21.9cm.	86dr.	Worm	2	189
22. 7. 74	22.5cm.	80dr.	Trap	5	194
"	19.5cm.	56dr.	"	"	197
6. 8. 74	20.8cm.	76dr.	Maggot	6	237

			2 (Standard Error)	
TOTAL MEAN LENGTH	20.8	±	0.3	cm.
MEAN LENGTH May/June	20.9	±	0.4	cm.
MEAN LENGTH July	20.5	±	0.8	cm.
MEAN WEIGHT - Trap	71.1 =125.9	±	5.6	dr. gr.
MEAN WEIGHT - Bait	73.4 =129.9	±	5.6	dr. gr.

TABLE 6. YEAR CLASS 5 - NUMBERED

DATE	LENGTH	WEIGHT	METHOD	AREA	NUMBER
28. 5. 74	23.5cm.	115dr.	Maggot	1	28
"	23.0cm.	107dr.	"	"	29
4. 6. 74	23.0cm.	106dr.	Minnow	4	42
6. 6. 74	23.5cm.	98dr.	Trap	6/7	43
"	23.5cm.	108dr.	"	"	46
"	22.5cm.	84dr.	"	"	48
12. 6. 74	22.5cm.	98dr.	Maggot	1	55
13. 6. 74	23.0cm.	99dr.	"	6	60
20. 6. 74	24.0cm.	113dr.	"	"	61
24. 6. 74	21.7cm.	92dr.	Trap	1	64
"	22.5cm.	98dr.	"	2/8	73
"	24.7cm.	136dr.	"	"	80
"	23.0cm.	106dr.	"	"	81
"	23.3cm.	106dr.	"	"	82
26. 6. 74	23.7cm.	108dr.	Maggot	2	85
"	25.0cm.	132dr.	"	"	88
"	24.5cm.	135dr.	"	"	90
28. 6. 74	20.7cm.	74dr.	Trap	2/8	100
4. 7. 74	22.5cm.	84dr.	"	5	112
7. 7. 74	21.0cm.	84dr.	Maggot	2	115
8. 7. 74	22.3cm.	84dr.	Trap	5	135
"	21.0cm.	80dr.	"	1	123
"	22.2cm.	103dr.	"	"	121
"	21.0cm.	76dr.	"	5	137
11. 7. 74	22.7cm.	94dr.	"	"	145
"	21.1cm.	76dr.	"	"	147
12. 7. 74	22.5cm.	112dr.	Minnow	"	154
"	23.0cm.	105dr.	Maggot	1	155

TABLE 6. (Cont.)

14. 7. 74	24.5cm.	134dr.	Worm	2	160
15. 7. 74	25.4cm.	158dr.	Minnow	"	165
"	24.0cm.	112dr.	"	"	166
"	25.5cm.	154dr.	Worm	"	170
17. 7. 74	23.0cm.	108dr.	Trap	7	177
22. 7. 74	24.0cm.	106dr.	"	5	193
31. 7. 74	22.5cm.	92dr.	"	2	208

		2 (Standard Error)	
TOTAL MEAN LENGTH	23.0	± 0.4	cm.
MEAN LENGTH May/June	23.2	± 0.5	cm.
MEAN LENGTH July	22.8	± 0.7	cm.
MEAN WEIGHT - Trap	94.9 =117.6	± 7.1	dr. gr.
MEAN WEIGHT - Bait	117.0 =207.1	± 10.1	dr. gr.

TABLE 7. YEAR CLASS 6 - NUMBERED

DATE	LENGTH	WEIGHT	METHOD	AREA	NUMBER
22. 5. 74	25.0cm.	158dr.	Maggot	6	9
"	26.0cm.	168dr.	"	"	16
28. 5. 74	25.5cm.	150dr.	"	"	27
24. 6. 74	26.0cm.	166dr.	Trap	1	63
"	24.5cm.	130dr.	"	2/8	76
26. 6. 74	26.3cm.	160dr.	Maggot	2	89
28. 6. 74	27.3cm.	172dr.	Trap	2/8	98
2. 7. 74	26.2cm.	140dr.	"	4	105
4. 7. 74	26.0cm.	168dr.	Maggot	5	114
8. 7. 74	24.2cm.	108dr.	Trap	"	138
9. 7. 74	24.0cm.	132dr.	Maggot	2	140
11. 7. 74	24.0cm.	124dr.	Trap	5	143
"	23.8cm.	108dr.	"	"	148
12. 7. 74	23.0cm.	104dr.	Minnow	2	149
14. 7. 74	25.0cm.	140dr.	"	1	150
"	25.0cm.	140dr.	"	"	151
"	25.0cm.	134dr.	"	2	152
"	25.0cm.	148dr.	"	"	153
"	25.0cm.	156dr.	"	"	159
21. 7. 74	26.0cm.	158dr.	Worm	"	188
31. 7. 74	26.0cm.	99dr.	Trap	4	216
1. 8. 74	25.7cm.	120dr.	Worm	2	217

TABLE 7. (Cont.)

		2 (Standard Error)	
TOTAL MEAN LENGTH	25.2	± 0.4	cm.
MEAN LENGTH May/June	25.8	± 0.7	cm.
MEAN LENGTH July	24.9	± 0.5	cm.
MEAN WEIGHT - Trap	130.9	± 19.1	dr.
	=231.7		gr.
MEAN WEIGHT - Bait	145.4	± 9.9	dr.
	=257.4		gr.

TABLE 8. YEAR CLASS 7 - NUMBERED

DATE	LENGTH	WEIGHT	METHOD	AREA	NUMBER
28. 6. 74	28.5cm.	184dr.	Trap	4	97
8. 7. 74	28.5cm.	216dr.	"	5	130
17. 7. 74	29.0cm.	224dr.	Worm	6	183
31. 7. 74	28.0cm.	158dr.	Trap	2	206
"	28.5cm.	190dr.	"	"	207

		2 (Standard Error)	
TOTAL MEAN LENGTH	28.5	± 0.3	cm.
MEAN WEIGHT - Bait	224.0 =396.5		dr. gr.
MEAN WEIGHT - Trap	187.0 =331.0	± 23.8	dr. gr.

TABLE 9. RECAPTURES.

NUMBER	YEAR-CLASS	DATE	(DAYS) INTERVAL	METHOD	AREA	LENGTH	WEIGHT
10	1	22. 5. 74	85	Maggot	6	6.7cm.	4dr
		15. 8. 74		"	"	10.7cm.	8dr.
25	1	28. 5. 74	79	Maggot	6	6.3cm.	4dr.
		15. 8. 74		"	"	9.1cm.	8dr.
32	1	29. 5. 74	78	Maggot	6	7.2cm.	3dr.
		15. 8. 74		"	"	9.5cm.	7dr.
6	2	22. 5. 74	85	Maggot	6	12.0cm.	14dr.
		15. 8. 74		Worm	"	13.9cm.	21dr.
22	2	28. 5. 74	1	Maggot	6	10.4cm.	8dr.
		29. 5. 74		"	"	10.4cm.	8dr.
67	2	24. 6. 74	14	Trap	1	11.0cm.	14dr.
		8. 7. 74		"	"	11.3cm.	11dr.
109	2	2. 7. 74	5	Trap	4	10.9cm.	10dr.
		7. 7. 74	12	Maggot	2	11.1cm.	10dr.
		19. 7. 74		Worm	"	11.7cm.	11dr.
117	2	7. 7. 74	8	Maggot	2	12.1cm.	13dr.
		15. 7. 74		"	"	12.5cm.	13dr.
120	2	7. 7. 74	25	Maggot	2	11.4cm.	12dr.
		1. 8. 74		Worm	"	12.2cm.	14dr.
172	2	15. 7. 74	31	Worm	2	13.1cm.	19dr.
		15. 8. 74		"	"	13.8cm.	20dr.
173	2	15. 7. 74	17	Worm	2	12.9cm.	17dr.
		1. 8. 74		"	"	13.5cm.	18dr.
174	2	15. 7. 74	4	Worm	2	12.7cm.	17dr.
		19. 7. 74		"	"	12.9cm.	16dr.
185	2	19. 7. 74	13	Worm	2	12.3cm.	15dr.
		1. 8. 74	14	"	"	12.4cm.	15dr.
		15. 8. 74		"	"	12.9cm.	18dr.

TABLE 9. (Cont.)

NUMBER	YEAR-CLASS	DATE	(DAYS) INTERVAL	METHOD	AREA	LENGTH	WEIGHT
203	2	31. 7. 74		Trap	2	12.5cm.	11dr.
		15. 8. 74	15	Maggot	"	13.0cm.	17dr.
186	2	19. 7. 74		Worm	2	12.1cm.	15dr.
		15. 8. 74	27	"	"	12.7cm.	16dr.
40	3	29. 5. 74		Maggot	6	17.0cm.	36dr.
		6. 6. 74	8	Trap	"	17.0cm.	36dr.
53	3	12. 6. 74		Maggot	1	17.0cm.	36dr.
		8. 7. 74	26	"	6	17.5cm.	42dr.
65	3	24. 6. 74		Trap	1	16.8cm.	40dr.
		15. 8. 74	52	Worm	"	18.0cm.	42dr.
68	3	24. 6. 74		Trap	1	16.3cm.	41dr.
		11. 7. 74	17	"	"	16.7cm.	34dr.
		15. 8. 74	35	Worm	"	17.9cm.	48dr.
87	3	26. 6. 74		Maggot	2	17.2cm.	38dr.
		9. 7. 74	13	"	"	19.4cm.	50dr.
141	3	9. 7. 74		Maggot	2	15.2cm.	25dr.
		31. 7. 74	22	Trap	"	15.5cm.	18dr.
157	3	14. 7. 74		Minnow	1	15.1cm.	24dr.
		15. 8. 74	31	Worm	"	16.2cm.	34dr.
161	3	14. 7. 74		Worm	2	16.2cm.	36dr.
		1. 8. 74	18	"	"	16.4cm.	38dr.
		15. 8. 74	14	"	"	16.7cm.	38dr.
171	3	15. 7. 74		Worm	2	19.5cm.	64dr.
		1. 8. 74	17	"	"	20.3cm.	67dr.
		15. 8. 74	14	"	"	20.3cm.	68dr.

TABLE 9. (Cont.)

NUMBER	YEAR-CLASS	DATE	(DAYS) INTERVAL	METHOD	AREA	LENGTH	WEIGHT
8	4	22. 5. 74		Maggot	6	20.5cm.	72dr.
		9. 7. 74	49	"	2	20.5cm.	74dr.
11	4	22. 5. 74		Maggot	6	19.0cm.	52dr.
		29. 5. 74	7	"	"	19.0cm.	52dr.
		11. 6. 74	13	Trap	"	19.5cm.	56dr.
		15. 8. 74	65	Worm	"	19.5cm.	56dr.
12	4	22. 5. 74		Maggot	6	20.5cm.	76dr.
		6. 6. 74	15	Trap	"	20.5cm.	68dr.
		15. 8. 74	70	Worm	"	21.0cm.	72dr.
17	4	22. 5. 74		Maggot	6	20.5cm.	72dr.
		6. 6. 74	15	Trap	"	20.5cm.	68dr.
		26. 6. 74	20	Maggot	2	20.5cm.	68dr.
75	4	24. 6. 74		Trap	2/8	20.5cm.	70dr.
		15. 8. 74	52	Worm	2	21.6cm.	79dr.
78	4	24. 6. 74		Trap	2/8	20.5cm.	68dr.
		15. 8. 74	52	Worm	2	21.7cm.	88dr.
83	4	26. 6. 74		Maggot	2	20.0cm.	65dr.
		9. 7. 74	14	"	"	20.0cm.	70dr.
		21. 7. 74	12	Worm	"	20.3cm.	72dr.
84	4	26. 6. 74		Maggot	2	21.0cm.	72dr.
		9. 7. 74	13	"	"	21.0cm.	82dr.
92	4	26. 6. 74		Maggot	2	21.5cm.	84dr.
		9. 7. 74	13	"	"	21.9cm.	92dr.
103	4	28. 6. 74		Trap	2/8	19.4cm.	58dr.
		15. 7. 74	17	Worm	2	19.5cm.	60dr.
113	4	4. 7. 74		Trap	5	20.5cm.	68dr.
		15. 8. 74	42	Worm	"	21.5cm.	86dr.

TABLE 9. (Cont.)

NUMBER	YEAR-CLASS	DATE	(DAYS) INTERVAL	METHOD	AREA	LENGTH	WEIGHT
146	4	11. 7. 74	35	Trap	5	20.3cm.	68dr.
		15. 8. 74		Worm	4	20.7cm.	73dr.
156	4	12. 7. 74	34	Maggot	1	19.5cm.	68dr.
		15. 8. 74		Worm	"	20.8cm.	72dr.
237	4	6. 8. 74	7	Maggot	6	20.8cm.	76dr.
		15. 8. 74		Worm	"	21.3cm.	76dr.
48	5	6. 6. 74	14	Trap	6/7	22.5cm.	84dr.
		20. 6. 74		Maggot	6	22.6cm.	88dr.
61	5	20. 6. 74	25	Maggot	6	24.0cm.	113dr.
		15. 7. 74	4	Worm	2	24.5cm.	125dr.
		19. 7. 74	27	"	"	24.7cm.	121dr.
		15. 8. 74		"	"	24.7cm.	128dr.
81	5	24. 6. 74	52	Trap	2/8	23.0cm.	106dr.
		15. 8. 74		Worm	2	23.5cm.	108dr.
115	5	7. 7. 74	8	Maggot	2	21.0cm.	84dr.
		15. 7. 74	31	"	"	21.2cm.	86dr.
		15. 8. 74		Worm	"	21.9cm.	92dr.
145	5	11. 7. 74	35	Trap	5	22.7cm.	94dr.
		15. 8. 74		Worm	"	23.0cm.	100dr.
177	5	17. 7. 74	29	Trap	7	23.0cm.	108dr.
		15. 8. 74		Worm	"	23.0cm.	100dr.
9	6	22. 5. 74	15	Maggot	6	25.0cm.	158dr.
		6. 6. 74		Trap	"	25.0cm.	140dr.
16	6	22. 5. 74	15	Maggot	6	26.0cm.	168dr.
		6. 6. 74		Trap	"	26.0cm.	150dr.
89	6	26. 6. 74	19	Maggot	2	26.3cm.	160dr.
		15. 7. 74	31	Worm	"	26.5cm.	160dr.
		15. 8. 74		"	"	26.5cm.	162dr.

TABLE 9. (Cont.)

NUMBER	YEAR-CLASS	DATE	(DAYS) INTERVAL	METHOD	AREA	LENGTH	WEIGHT
140	6	9. 7. 74		Maggot	2	24.0cm.	132dr.
		15. 7. 74	6	Worm	"	24.1cm.	123dr.
		15. 8. 74	31	"	"	24.5cm.	135dr.
149	6	12. 7. 74		Minnow	2	23.0cm.	104dr.
		1. 8. 74	20	Worm	"	24.5cm.	108dr.
159	6	14. 7. 74		Minnow	2	25.0cm.	156dr.
		17. 7. 74	3	Trap	7	25.0cm.	144dr.
206	7	31. 7. 74		Trap	2	28.0cm.	158dr.
		15. 8. 74	15	Worm	"	28.0cm.	174dr.

TABLE 10. SUMMARY OF METHODS OF CAPTURE

YEAR-CLASS'		MAGGOT	WORM	MINNOW	TRAP
1		60	3	-	1
2		33	15	-	42
		2 M/M	3 W/W		1 T/T
	Including:	1 T/M/W	1 T/M/W		1 T/M/W
		1 M/W	1 M/W		
3		9	4	1	20
	Including:	2 M/M	2 W/W		1 T/T
		2 M/T			2 M/T
4		23	3	2	24
		3 M/M	1 T/W		1 M/T/M
		1 M/T/M	1 M/M/W		1 M/T
	Including:	1 M/T			1 M/M/T
		1 M/M/W			
		1 M/M/T			
5		12	4	4	19
		1 M/M	1 M/W/W		1 T/M
	Including:	1 M/W/W			
		1 T/M			
6		6	5	6	11
	Including:	2 M/T	1 F/W	1 F/T	2 M/T
		2 M/W	2 M/W	1 F/W	1 F/T
7			1		4

KEY: M - Maggot
W - Worm
F - Minnow
T - Trap
for recapture

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TABLE 11. RECAPTURE BY ANGLING - AUGUST 15TH, 1974

YEAR-CLASS 1:

LENGTH	WEIGHT	LENGTH	WEIGHT	LENGTH	WEIGHT
8.4cm.	5dr.	9.6cm.	7dr.	10.2cm.	8dr.
8.8cm.	6dr.	9.6cm.	7dr.	10.2cm.	9dr.
8.8cm.	6dr.	9.6cm.	7dr.	10.2cm.	9dr.
8.9cm.	7dr.	9.6cm.	8dr.	10.3cm.	9dr.
9.1cm.	7dr.	9.6cm.	8dr.	10.3cm.	9dr.
9.1cm.	7dr.	9.7cm.	7dr.	10.3cm.	9dr.
9.1cm.	8dr.	9.8cm.	8dr.	10.3cm.	9dr.
9.2cm.	7dr.	9.8cm.	8dr.	10.4cm.	8dr.
9.4cm.	7dr.	9.9cm.	8dr.	10.5cm.	7dr.
9.5cm.	6dr.	10.0cm.	7dr.	10.5cm.	8dr.
9.5cm.	6dr.	10.0cm.	8dr.	10.6cm.	10dr.
9.5cm.	7dr.	10.0cm.	8dr.	10.7cm.	8dr.
9.5cm.	7dr.	10.1cm.	8dr.	10.7cm.	8dr.
9.5cm.	8dr.	10.1cm.	8dr.	10.7cm.	10dr.
9.5cm.	8dr.	10.1cm.	9dr.	10.8cm.	9dr.

2 (Standard Error)

MEAN LENGTH = 9.8 ± 0.2 cm.

MEAN WEIGHT = 7.7 ± 0.3 dr.
=13.7 gr.

TABLE 11. (Cont.)

YEAR-CLASS 2:

LENGTH	WEIGHT	LENGTH	WEIGHT	LENGTH	WEIGHT
11.4cm.	12dr.	12.4cm.	16dr.	13.3cm.	18dr.
11.6cm.	11dr.	12.7cm.	16dr.	13.3cm.	18dr.
11.7cm.	10dr.	12.8cm.	16dr.	13.3cm.	20dr.
11.7cm.	12dr.	12.8cm.	17dr.	13.6cm.	18dr.
11.8cm.	11dr.	12.9cm.	13dr.	13.7cm.	22dr.
11.8cm.	13dr.	12.9cm.	16dr.	13.8cm.	20dr.
12.0cm.	12dr.	12.9cm.	18dr.	13.8cm.	21dr.
12.0cm.	12dr.	12.9cm.	18dr.	13.9cm.	21dr.
12.0cm.	13dr.	13.0cm.	17dr.	13.9cm.	21dr.
12.0cm.	14dr.	13.1cm.	16dr.	14.0cm.	20dr.
12.0cm.	16dr.	13.2cm.	16dr.	14.1cm.	21dr.
12.2cm.	14dr.	13.2cm.	16dr.	14.1cm.	21dr.
12.3cm.	14dr.	13.2cm.	16dr.		

2 (Standard Error)

MEAN LENGTH = 12.8 $\pm$ 0.3 cm.

MEAN WEIGHT = 16.2 $\pm$ 1.1 dr.
= 28.7 gr.

TABLE 11. (Cont.)

YEAR-CLASS 3:

LENGTH	WEIGHT	LENGTH	WEIGHT	LENGTH	WEIGHT
14.4cm.	20dr.	16.7cm.	38dr.	17.9cm.	48dr.
14.4cm.	22dr.	16.9cm.	39dr.	18.0cm.	42dr.
14.4cm.	22dr.	17.0cm.	42dr.	18.0cm.	45dr.
14.5cm.	25dr.	17.3cm.	45dr.	18.9cm.	53dr.
14.8cm.	24dr.	17.5cm.	40dr.	19.1cm.	53dr.
14.8cm.	24dr.	17.6cm.	42dr.	19.6cm.	54dr.
15.0cm.	24dr.	17.7cm.	38dr.	20.2cm.	68dr.
16.2cm.	34dr.				

2 (Standard Error)

MEAN LENGTH = 16.9 $\pm$ 0.8 cm.

MEAN WEIGHT = 38.3 $\pm$ 5.5 dr.
= 67.8 gr.

YEAR-CLASS 4:

LENGTH	WEIGHT	LENGTH	WEIGHT	LENGTH	WEIGHT
19.2cm.	56dr.	21.0cm.	72dr.	21.6cm.	79dr.
19.8cm.	70dr.	21.3cm.	76dr.	21.7cm.	98dr.
20.4cm.	69dr.	21.3cm.	78dr.	22.0cm.	91dr.
20.4cm.	69dr.	21.3cm.	78dr.	22.8cm.	104dr.
20.6cm.	74dr.	21.5cm.	76dr.	22.8cm.	106dr.
20.7cm.	73dr.	21.5cm.	86dr.	23.0cm.	103dr.
20.8cm.	72dr.				

2 (Standard Error)

MEAN LENGTH = 21.2 $\pm$ 0.5 cm.

MEAN WEIGHT = 80.5 $\pm$ 6.3 dr.
= 142.5 gr.

TABLE 11. (Cont.)

YEAR-CLASS 5:

LENGTH	WEIGHT	LENGTH	WEIGHT	LENGTH	WEIGHT
21.9cm.	102dr.	23.3cm.	86dr.	24.0cm.	123dr.
23.0cm.	96dr.	23.5cm.	108dr.	24.0cm.	124dr.
23.0cm.	100dr.	24.0cm.	122dr.		

			2 (Standard Error)	
MEAN LENGTH	=	23.3	± 0.5	cm.
MEAN WEIGHT	=	107.6	± 10.0	dr.
	=	190.0		gr.

YEAR-CLASS 6:

LENGTH	WEIGHT	LENGTH	WEIGHT	LENGTH	WEIGHT
23.0cm.	100dr.	24.5cm.	128dr.	25.5cm.	142dr.
24.5cm.	115dr.	24.7cm.	128dr.	26.5cm.	162dr.
24.5cm.	128dr.	25.2cm.	141dr.	27.0cm.	160dr.

			2 (Standard Error)	
MEAN LENGTH	=	25.0	± 0.8	cm.
MEAN WEIGHT	=	133.8	± 13.3	dr.
	=	236.8		gr.

YEAR-CLASS 7:

LENGTH	WEIGHT
28.0cm.	174dr.
28.0cm.	198dr.

MEAN LENGTH	=	28.0	cm.
MEAN WEIGHT	=	186.0	dr.
	=	329.2	gr.

C H A P T E R   S I X

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