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OBSERVATIONS ON THE BROWN TROUT *(SALMO TRUTTA)* AND PERCH *(PERCA FLUVIATILIS)* OF MALHAM TARN, NORTH YORKSHIRE

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Introduction

ALTHOUGH the high quality of the trout fishing in Malham Tarn is well known (Anon, 1977) surprisingly little recent information is available about the biology of the fish themselves. Holmes (1960) provided some information on the growth, reproduction and feeding habits of the brown trout (*Salmo trutta*), and later, (1965), published notes on the biology of the other fish species. However, the specimens on which his observations were based had been captured over a period of several years. During this time no stocking of brown trout into the Tarn had taken place and so the trout population was virtually a native one. Furthermore, Holmes provided very few data on the biology, as opposed to the catches, of perch (*Perca fluviatilis*), the only other fish species in the lake large enough to be of interest to anglers.

Since the time of Holmes' survey management of the trout population has recommenced, and fish have been stocked into the lake at regular intervals. The inflow stream has also become less suitable for trout spawning, so that the trout population is now almost entirely composed of stocked fish. In order, therefore, to provide some basic information on the growth and other aspects of the biology of trout and perch populations at present, a survey of these two species was carried out in the summer of 1977. Additional aims of the survey were to compare the present stocked trout population with the native one studied by Holmes, and to evaluate the success of the present management policy. The results of the survey and the conclusions drawn from it are presented in this paper.

Materials and Methods

Fish were caught between the 20 and 27 July 1977, by gill netting. A small number were also captured by angling. Fleets of nets were generally set overnight off the north shore, in the region of the east boathouse, but sets were also made during the day in other parts of the Tarn. Altogether 115 perch and 57 trout were obtained.

The fork length (from the tip of the snout to the fork of the tail), and weight of the fish were measured. Samples of scales were taken from the shoulder region of the trout for the determination of age, whilst the opercular bones of the perch were removed and cleaned for the same purpose. Stomachs were removed and their contents identified as far as possible.

The trout scales were mounted dry and examined in a scale projector. Ageing of perch followed the method of Le Cren (1947), in which the annual marks were taken to be the leading edge of the opaque summer bands, and was carried out on a binocular microscope equipped with crossed polarizers.

Details of the stocking of trout into the lake, and of the catches made by the anglers, were provided from the records of Malham Tarn Field Centre.

Results and Discussion

Part 1: The Trout

(1) Growth

The trout could be divided into two distinct groups from their scales; those indicating an exceptionally good growth increment in the first year of life, and those with a rather poorer one. The size and age of introduced trout at the time of stocking is given in Table 1, and it was thus apparent that fish belonging to the first group were hatchery reared, whilst those of the second group, which contained only 3 fish, were naturally recruited.

Table 1. *Stockings of Brown Trout into Malham Tarn*

Year stocked	No. of fish	Size of fish
1967	1000	180–205 mm
1972	3000	205–230 mm
1973	2000	180 mm
1974	1000	205 mm
	1000	230 mm
1975	1000	205 mm
1977	1000	180–230 mm

All fish were stocked in March or April, and were 12–15 months old when introduced.

The length frequency distribution of the trout captured, together with mean lengths for age, are shown in Fig. 1. The mean length for age of the native fish is comparable with the data of Holmes (1960). The growth increments made by trout stocked into the Tarn are also comparable with Holmes' data. Thus fish stocked in 1975 at 1+* grew from *c.* 205 mm to a mean length of 388 mm in just over two years, by which time they were 3+. The growth curve given by Holmes also indicates a two-year period for the same growth increment, but his fish would have then reached an age of 4+. The difference can be attributed to the higher level of growth achieved by the stocked fish during their first year in the hatchery; native fish take two years to attain the same size.

(2) Food and feeding

It is not possible, in a short survey, to present a detailed picture of the diet of a fish population, but the following observations were made on the food of the trout in this instance.

Molluscs, especially *Lymnaea peregra* and pea mussels, occurred frequently, particularly in the larger fish; Chironomid pupae also formed a major component of the diet. Other invertebrate foods encountered were beetle larvae, mayfly nymphs (mainly *Caenis* sp.), lesser water boatmen (*Corixidae*) and the larvae and adults of various caddis flies. Four trout contained fish remains, which were either young

* Fish in their first year of life are referred to as 0+, in their second year as 1+, and so on.

perch or bullheads (*Cottus gobio*), whilst the presence of the tapeworms *Eubothrium crassum* and *Diphyllobothrium dendriticum* provided evidence of the exploitation of planktonic crustaceans (Kennedy and Burrough, 1978).

(3) *The catches made by anglers in relation to the stocking of trout*

Details of the stocking of trout into the Tarn are given in Table 1, and Table 2 summarizes the information derived from the angling returns for the years 1972–1977. The number of angler visits made in the years 1972–1974 is unknown, and fewer details are available for that period. (An angler visit is used here to denote one day's fishing by one angler, but the time spent fishing by each person is unknown, and should not be regarded as constant.)

Table 2 shows that the number of fish caught in any one year correlates rather poorly with the density of stocking, although the catches for 1977 were rather higher than might have been expected. However, the ratio of natural to hatchery reared fish examined (3 : 54), emphasizes the importance of stocked trout to the maintenance of the fishery in the Tarn. The fact that it took Holmes (1960) nine years to accumulate data on only 70 specimens, at a time when no introductions were taking place, further substantiates this conclusion.

The seasons of 1976 and 1977 were particularly notable for their high ratios of takeable to undersized fish, compared to previous years. With the exception of the rather anomalous result for 1976 the average weight of takeable fish has tended to increase over the period for which records are available. By 1977 this was obviously reflected in the high aggregate weight of the takeable catch, and in the number of trout of over 2 lb caught. When this is coupled with the increase in the number of takeable fish per angler, which rose considerably from 1975 to 1977, then it is clear that the latter year was a rather more successful one than normal for the fisherman. The apparently low catch returns for 1976 must be at least partly due to the smaller number of angler visits, although it is likely that the gap in the stocking programme for that year also had an influence, if only on the number of undersized trout captured.

A total of 1,992 trout of all sizes were caught between 1972 and 1977. If it is assumed that the naturally recruited stock made no contribution to the catch, then this represents just over 22% of the number stocked (9,000), during the same period. However, if takeable fish only are considered, the return obtained is rather less, since only 971 trout were above the size limit of 330 mm. The return of takeable

Table 2. *Summary of Angling Returns for the years 1972–1977*

	1972	1973	1974	1975	1976	1977
Stocking density	3000	2000	2000	1000	0	1000
No. of takeable fish	241	120	206	74	94	236
No. of undersized fish	315	109	342	102	43	110
No. takeable/No. undersized	·76	1·10	·60	·73	2·19	2·13
Total No. caught	556	229	548	176	137	346
Total wt of takeable fish (lb)	324·0	157·4	287·4	109·1	134·8	357·2
Av wt of takeable fish (lb)	1·31	1·31	1·41	1·50	1·22	1·56
No of takeable fish over 2 lb.	22	9	16	13	16	71
Best fish (lb)	3·16	2·50	2·64	2·75	3·69	3·50
Takeable fish per angler visit	–	–	–	·31	·47	·97
No. of angler visits	–	–	–	240	198	242

fish, therefore, can be no more than about 11% of the number stocked over the 6-year period in question. The 1977 season produced the highest aggregate weight of takeable fish (357·2 lb), which is equivalent to a yield of 2·33 lb per acre.

The survey was conducted just over half way through the angling season, and three to four months after the time when stocking normally takes place. Fig. 1 shows that very few of the trout stocked in 1977 had by then reached the size at which they could be retained by anglers, and it is reasonable to assume that a good proportion of them would still be undersized when the season closed. It is likely that a similar pattern has been followed in previous years, especially as almost a third of the trout caught in 1976 were less than 330 mm, although none had been stocked in that year. There may be, therefore, a period of a year or more between introduction and the attainment of takeable size.

The fish stocked in 1975 apparently survived very well in the Tarn, since 19 out of the 57 trout examined belonged to this category (Fig. 1). The data obtained

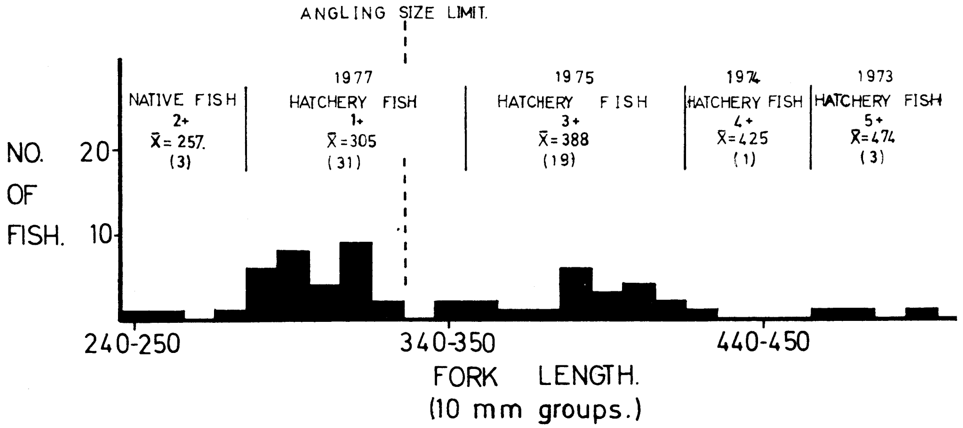

FIG. 1.

The length-frequency distribution of the trout sample. The number and mean size ($\bar{x}$), of the fish in each category are also indicated, together with their origin and age.

suggest that earlier introductions were less successful, since very few older fish were captured in spite of the fact that they had been stocked at greater densities. This may be the result of a substantially reduced survival rate at a higher density of stocking, or it may reflect a maximum life expectancy of about three years in the lake for the hatchery reared fish. The level of the angling returns shows that it is not because a much larger proportion of them had been fished out, and their absence must, therefore, be due to natural mortalities. The precise cause of such mortalities cannot be ascertained on the basis of the data available.

(4) *Evaluation of the success of the stocking programme to date*

The small numbers of naturally recruited fish present make it clear that the stocking programme has been successful in establishing a viable recreational fishery in the Tarn. Continued stocking will be necessary if the standard of the fishery is to be maintained or improved further. The limited amount of natural reproduction can be attributed to the fact that the Tarn is fed by only one rather small and short inflow stream, which forms the only possible spawning area. The substrates present in the Tarn itself (Holmes, 1960), are not of the type required if trout are to spawn in stillwaters, a habit which they may occasionally follow (Frost and Brown, 1967). The outflow is unlikely to be involved as a spawning area, since trout only normally migrate upstream for this purpose. In any case, the outflow disappears underground within about 500 m, a fact which prevents access to the lake by fish from other localities. Thus there is a physical limitation on the number and suitability of the spawning redds available (Holmes, 1960), and these are apparently inadequate to sustain a trout population approaching the size that the water can accommodate.

The present stocking policy has not resulted in the fishery operating strictly on a put-and-take basis. Many of the trout are evidently not caught and removed in the year in which they were stocked, as indicated by the number of 1975 fish found during the survey. Furthermore, the size limit in force at Malham is considerably greater than the size at which the trout are introduced, and this is inconsistent with the idea of a put-and-take fishery (Millichamp, 1974).

The returns obtained from the stocking programme do not compare very favourably with those from other localities. Frost and Brown (1967) indicated that many angling clubs in Britain expect a return of at least two-thirds of the number of fish stocked. In Graffam Water the ratio of brown trout stocked to takeable fish caught never dropped below about 35% between 1967 and 1974 (Fleming-Jones and Stent, 1975), whilst Lie (1974) considered returns of 20–30% unsatisfactory in a Dartmoor reservoir. All these figures are considerably greater than the 11% return from the Tarn.

Frost and Brown (1967) thought that a very general idea of the productivity of a trout water could be gained from the yield taken by anglers in terms of lb per acre. They summarized such data as were available for the British Isles, and listed values ranging from 1 to 55 lb per acre. The maximum (1977) yield observed in the Tarn of 2·3 lb per acre was at the bottom of the range given by them, and they only identified one locality which gave a lower value. These figures can only give a very approximate idea of the standard of a fishery, since they do not take into account the fishing pressure involved, the density of the stock, or any size or bag limits in force. Nevertheless, they do support the suggestion of a low return.

The most usual causes of low returns from stocking policies are poor growth and/or survival of the stocked fish. The growth of the trout in the Tarn is fairly good (Holmes, 1960), and the survival rate would also appear to be reasonably high (see above), so these factors cannot be considered to apply. It seems probable that a substantial part of the reason for the low returns is the size at which the fish are considered to be takeable. Frost and Brown (1967) quote a value of 254 mm (10 in) as the usual size limit for brown trout in still waters, and this is 76 mm (3 in) below the limit for the Tarn. They point out that if the limit is set at too high a level much production of fish flesh will be lost via natural mortalities before the fish have reached takeable size; slower growth may also result from a limited amount of cropping and the anglers catches will be lower in size and weight.

It has been indicated above that there may be a considerable time lag between the introduction of trout to the Tarn and the attainment of takeable size. Frost and Brown (1967) showed that trout stocked into Wise Een Tarn needed to be caught in the year of introduction if a good return was to be obtained, and Lie (1974) also found this to be the case in Fernworthy reservoir. Although survival at Malham is apparently better than in these two localities, it is very probable that many of the fish die from natural causes without ever reaching 330 mm in length. A major reason for the imposition of a size limit is to give the fish a chance to spawn before they are caught and removed, but when natural reproduction is limited anyway (see p. 634/5), it is not really necessary to protect the stock in this way. Probably, therefore, the size limit in force has restricted the returns that might have been obtained, and has not been supported by any real justification.

Although it is not possible to determine empirically the correct density at which to stock a particular water, it is possible to introduce fish in numbers that are disproportionate to the amount of angling pressure they are intended to sustain. The optimum level of stocking can only be reliably ascertained over several seasons for which stock density and angling returns can be carefully related. Only a limited amount of information of this type is available for the Tarn, and no firm conclusions can be drawn regarding the suitability of the stocking densities employed. The absence of any clear connection between the number of fish introduced and the number caught suggests that it may prove difficult to determine how many fish should be introduced in order to sustain a desirable level of yield.

(5) *Suggestions for the future management of the trout fishery*

On the basis of the above evaluation it is possible to make certain recommendations for consideration in the future management of the trout. It has already been indicated that a continued stocking policy will be required if the fishery is to be maintained or improved, and annual introductions would be preferable, so as to avoid creating unnecessary gaps in the stock structure.

Apart from the above, the most obvious recommendation is that the size limit should be reduced to a more reasonable level of, e.g. 280 mm (11 in). This reduction would decrease the time taken for fish stocked within the size range employed so far to reach takeable size, which should result in less wastage due to premature mortalities, and a corresponding increase in the level of returns obtained. The present reservoir of larger and older trout in the lake could be maintained by stocking at a sufficient level to provide survivors into subsequent years.

A good sport fishery should ideally aim at a minimum average return of one takeable fish per angler per day. If the size limit suggested above had been in force then this level would easily have been exceeded in 1977, and probably reached in other years. The returns made in 1977 were based primarily on the stockings of 1,000 fish made in 1975 and 1977, since the survey had shown that few trout had survived from earlier introductions.

1977 was a reasonable season, and consequently it would seem that a stocking level of 1,000 a year may be able to provide a satisfactory return, especially if operated in conjunction with a reduced size limit. Although the total number of fish caught in 1977 was not as high as in 1972 or 1974, when stocking densities were much greater, there is no real indication that the higher levels of stocking would result in more recaptures. Possibly they would cause a continuation of the poor standard of return to date, even with a new size limit in force. When more angling returns are available from future seasons it should be possible to review further the suitability of the level of stocking, and to adjust it if necessary.

In considering the future of the trout fishing it is necessary to bear in mind that

Malham Tarn is managed primarily as a Nature Reserve, and not as a commercial fishery. Angling activities would not be allowed to jeopardize the reserve in any way (Disney, 1975), and it was for this reason that any bank fishery was banned some years ago. Any future management of the fishery will, therefore, be aimed solely at obtaining an optimum return from a stocking policy designed to support a limited angling pressure.

Part 2: The Perch

(1) *Age and Growth*

The opercular bones of young and old perch were very easy to read, but those of middle-sized fish (*c.* 180–240 mm), were more difficult, and the checks could not always be easily identified. This group consisted of the larger perch aged at 3+, and all those aged at 4+. In the case of these 3+ fish it was the second annual check, and in that of the 4+ specimens the second and third checks, which were difficult to detect. It seems probable that this difficulty is associated with the poor growth made by the 3+ and 4+ perch in the years preceding the formation of the checks in question. (The previous growth history of the perch in the Tarn has been described by Burrough and Kennedy (*in press*).)

The initial interpretation of the opercular bones was facilitated by the form of the length frequency distribution of the perch caught (Fig. 2). The distribution is clearly dominated by four peaks occurring at approximately 100, 140, 170 and

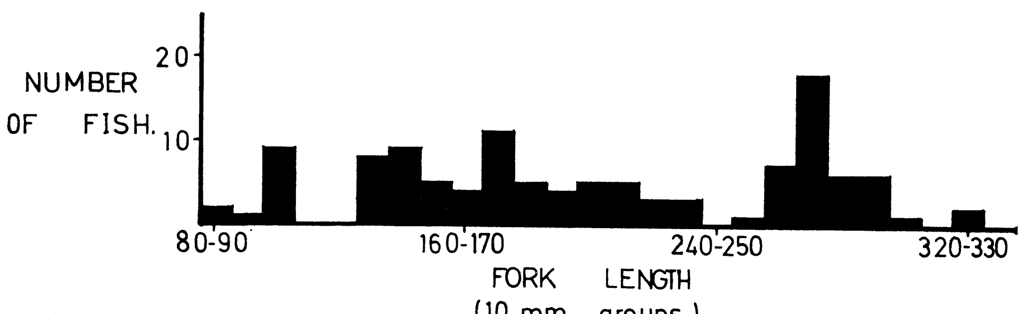

FIG. 2.

The length-frequency distribution of the perch sample.

270 mm. These correspond to fish aged at 1+, 2+, 3+ and 6 to 8+ respectively. There is also a suggestion of a fifth peak at *c.* 210 mm, which would correspond to the 4+ fish.

The age and year class distribution of the perch, together with mean lengths and length range for a given age, are given in Table 3. The length ranges of the 1 and 2+ fish do not overlap, which accounts for the gap in the length frequency distribution occurring at 110–130 mm. Thereafter the size range of fish of greater age overlaps to an increasing extent. No 5+ specimens were captured, which is the probable reason for the poor representation of fish of 240–260 mm. Fish of more than 300 mm were rarely encountered, and were not necessarily of the greatest age. Table 3 also shows that the year classes are of uneven strength, and that the Malham perch do not follow the theoretical pattern of a declining numerical

Table 3. *Age and Growth of Perch in Malham Tarn*

Age	Year-class	No. of fish	% of catch	Mean length (mm)	Range of length
0+	1977	0	0	–	–
1+	1976	12	10·4	98·7	83–104
2+	1975	21	18·3	142·0	130–156
3+	1974	25	21·9	178·5	159–214
4+	1973	16	13·9	216·3	194–252
5+	1972	0	0	–	–
6+	1971	13	11·3	270·9	238–286
7+	1970	20	17·4	279·3	261–301
8+	1969	6	5·2	291·8	264–326
9+	1968	1	0·9	322	–
10+	1967	0	0	–	–
11+	1966	0	0	–	–
12+	1965	1	0·9	295	–

representation with increasing age. Thus almost 50% of the population was of a large size and at least 6 years old. In this context the 1970 (7+) year class was particularly well represented.

(2) *Comparison with growth in other waters*

The growth of the Malham perch is compared with that in other waters in Fig. 3. The curves for Malham represent fish of both sexes, whereas the others are for male or female fish alone. However, the data of many authors (e.g. Le Cren, 1958; McCormack, 1965; Shafi and Maitland, 1971; Craig, 1974) indicate that there is little difference in the growth of the sexes, although the females usually have a slightly higher growth rate. Such differences as do occur are not sufficiently significant to invalidate the comparison. A more serious problem is the inconsistent criteria by which various authors have determined the lengths of the fish. Le Cren (1958), and McCormack (1965), recorded the total length, whereas Shafi and Maitland (1971), Craig (1974) and the present study recorded the fork length. The growth curves shown in Fig. 3, which were derived from the data of Le Cren and McCormack, thus present a slightly exaggerated picture of length for age in comparison with the remainder. However, this deficiency in the comparison does not mask the fact that the Malham fish have an extremely good growth rate in relation to that achieved in other British Lakes.

(3) *Food and Feeding*

Little information on the diet of perch was obtained. Many of the stomachs examined were empty, or contained no identifiable food remains. The major food items detected were caddis larvae and molluscs, the latter being represented primarily by *Lymnaea peregra* and pea mussels. Three larger perch contained either small perch or bullheads, and parasitological evidence (Kennedy and Burrough, 1978) showed that perch of all sizes also consumed plankton.

(4) *Discussion of the perch results*

The perch population in the Tarn exhibited two major features of interest, namely, the apparently atypical population structure, and the very high rate of growth. Firstly, it is necessary to comment on the absence of certain year classes

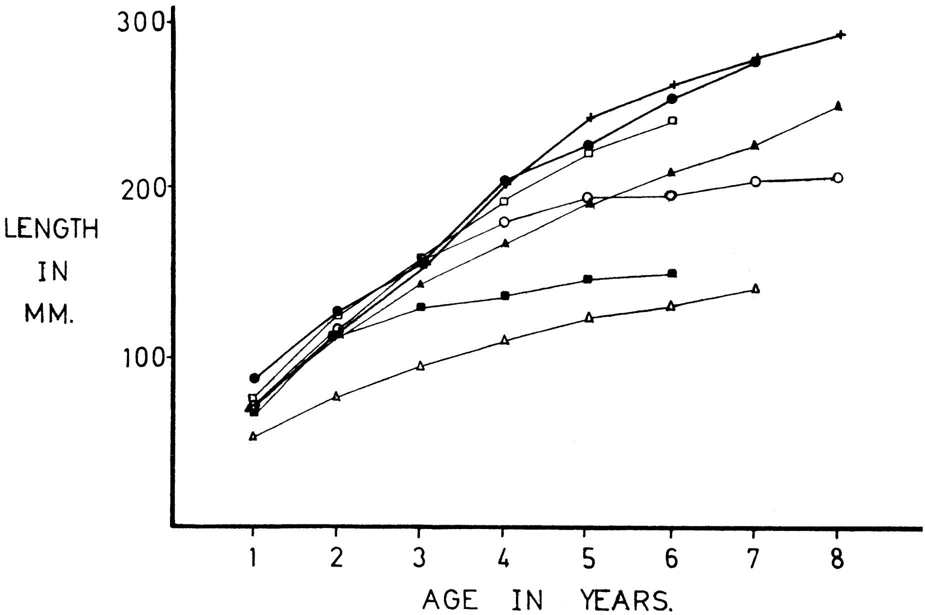

FIG. 3.

Comparison of the growth of perch in Malham Tarn with that observed in other British Lakes.
● The 1970 year class of Malham Perch.
+ Mean curve for all year classes of Malham perch.
□ Slapton Ley ♀'s (Craig, 1974).
▲ Loch Lomond ♀'s (Shafi and Maitland, 1971).
△ Dubh Lochan ♀'s (Shafi and Maitland, 1971).
○ Ullswater ♀'s (McCormack, 1965).
■ Windermere, ♂'s (Le Cren, 1958).

of perch in the sample examined. The 1977 fish would have been no more than 3 or 4 months old at the time, and their absence can be attributed to their being too small to sample with the gill nets used. It is unlikely that the 1966 and 1967 year classes (10+ and 11+), would be any more than poorly represented by 1977, on account of their age. It is not, therefore, very remarkable that none were recovered.

The most interesting omission is that of the 1972 (5+) year class. Many older fish were captured, and so age cannot be the answer; the most probable explanation concerns the conditions in the lake at the time when these fish should have been introduced to the population. Repairs to the spillway of the Tarn outflow, which took place in 1972, necessitated the lowering of the water level by approximately 1 m for about 3 months during the spring and early summer (Disney, 1973, 1975 and pers. comm.). This period would probably have included the perch spawning season. It would certainly have covered the early stages of life of any perch born in that year, and this alteration in conditions is the most likely reason for spawning failure. This could have been caused by the exposure of the spawning sites or fry nursery areas before or after the eggs had been laid, and may also have had a marked influence on the availability of food to very young fish. Menshutkin *et al.* (1968) have shown that food availability is a crucial factor in the survival rate of young perch. Whatever the precise reason or reasons may be, it seems reasonable to propose that few, if any, perch of the 1972 year class were able to survive, which would account for their absence in subsequent years. Holčík (1970) found that a similar depression in water level in the Klíčava reservoir resulted in the destruction of perch spawn for the season in question.

The marked fluctuations in the strengths of the year classes which were present is a characteristic of perch populations. For instance, Alm (1952), Le Cren (1955), McCormack (1965), Sumari (1971), Thorpe (1974) and Neuman (1976) have all reported similar variations. Le Cren and Alm both indicated that they were unlikely to be due to actual spawning success, and attributed the fluctuations they observed to the differences in post-spawning survival rates of the fry. Le Cren (1955) observed that strong year classes were synchronous in certain lakes, and on this basis suggested that climatic factors may be the causative agent. Neuman (1976) found a positive correlation between year class strength and the July/August temperatures. He suggested that this might be linked to growth rate, since faster growing fry would be able to avoid predation and exploit a wider range of prey more rapidly, thus enhancing their chances of survival.

Temperature, however, cannot be the answer in every case, since Sumari (1971) found that lakes in Finland with comparable climatic regimes did not necessarily exhibit the same pattern of year-class strengths. As an alternative he proposed that a predation cycle was involved, with successive generations of fry being suppressed by a dominant age-group, until that group had declined sufficiently to allow the development of a new one. Alm (1952) also thought that this was the most likely explanation, but Le Cren (1955) had found no evidence for it in Windermere. Possibly a balance between these two contrasting factors is the real explanation for the fluctuations, with the emphasis shifting from one to the other in a manner dependent on the precise conditions under which they are operating. In certain dystrophic* Swedish lakes one year-class of perch may dominate for many years, to the virtual exclusion of all other generations, but in more productive waters the dominance may be less marked, and several strong year-classes may follow each other (Alm, 1952). Malham clearly falls into the second grouping since the 1969–1971 year-classes were all well represented for their age, when considered in relation to those of 1973–1977. The 1976 year-class would appear to be particularly weak, and may have been a victim of the cycle of predation outlined above.

Many of the trout and perch in the Tarn were large enough to include a piscivorous component in their diet, but fish remains were found in very few stomachs. The data of Holmes (1965) are in agreement with these observations. This suggests that the resource may be in short supply, particularly as Thorpe (1974) estimated that in Loch Leven perch fry constituted 29·9% by weight of the diet of trout and 13·5% of the diet of adult perch, during the period June–September. In this connection it is interesting to note that the strong year classes of perch mentioned above would have been recruited to the population at a time when no trout were being introduced into the Tarn. If predation plays an important part in determining the strength of different age groups of Malham perch, then it could be predicted that no further dominant group or groups will emerge if trout stocking continues, and whilst strong perch year classes are still present. This may not prove to be the case, but the possibility clearly merits further attention in the future.

The exact reasons for the high growth rate in Malham Tarn cannot be readily

* Bog lakes with a high content of humic organic material and generally, a low pH.

ascertained, as many complex and inter-related factors may influence the growth of a fish population. The flora and fauna of the Tarn are richer than its altitude and location might suggest, and Kennedy and Burrough (1978) noted that the parasitological evidence they were considering pointed to a rather more productive body of water than they had expected. The invertebrate fauna seems to be both abundant and varied, and apparently capable of withstanding considerable predation by the fish populations. Certainly there is no suggestion that food supply may limit growth, unless it was in terms of available fish prey. The climate of the Tarn is rather severe for England, but in spite of this the perch growth is comparable to that reported in Slapton Ley by Craig (1974). Slapton Ley is a highly eutrophic lake situated in the extreme south of Devon, and enjoys very mild weather in relation to the rest of the British Isles. It is highly unlikely, therefore, that the climate of the Tarn is in any way responsible for the growth rates achieved. The trout also grow fairly well and possibly the good fish growth is no more than a reflection of the generally productive nature of the Tarn, although this in itself is a rather unusual feature.

Interactions between the Trout and Perch

The presence of potentially competing fish species in a trout water is almost universally frowned upon by anglers, but not always with adequate justification. Judging by comments attached to the angling returns this attitude has considerable support at Malham, and it is clear that many fishermen would like to see the perch population substantially reduced, if not entirely removed. It is, therefore, pertinent to consider whether the presence of perch in the Tarn has an adverse influence on the trout population.

In certain localities the removal of pike (*Esox lucius*) and perch has resulted in an improvement in the trout fishing (Frost and Brown, 1967) but the extent to which this can be attributed to the removal of perch is unknown. Holmes (1960) considering the register of trout caught at Malham over many years, found that there were considerable year-to-year fluctuations, but that these did not correlate with the very marked peaks and troughs in the numbers of perch. (The changes in the perch numbers are fully described by Holmes, 1965.) Such evidence as exists for interaction between these fish species in the Tarn suggests that it is the perch which are most affected, since their growth rate is depressed when many trout are present (Burrough and Kennedy, *in press*).

The most obvious source of potential competition between these species is in terms of food supply. The diets of the two fish can certainly overlap to a considerable extent (Frost, 1946; Moriarty, 1963; Thorpe, 1974), and there is some indication that this is also true in the Tarn (Holmes, 1965, present study). Moriarty (1963) thought that an abundance of perch may have prevented the trout from obtaining a full supply of the necessary foods, but he did not report any influence on the trout population resulting from this supposed shortage. Open competition for food was avoided in Loch Leven by complementary feeding periods; although all the principal items in the diet of perch also occurred in that of trout, only restricted periods of simultaneous demand were observed (Thorpe, 1974). Burrough and Kennedy (*in press*) considered an interactive relationship based on the food supply as a possible reason for the depression in perch growth mentioned above. In absolute terms the effects of any such relationship are unknown, and the position may be rather more complex than it appears on the surface, and involve other unidentified factors. McCormack (1970) suggested that stress may play a part in the inter-relationships of different fish species, since the food available to trout and perch in Windermere did not seem to be a fully exploited resource.

Overall, therefore, there are no good grounds for arguing that the perch population in the Tarn is likely to be adversely affecting the trout, or that their removal would benefit them. Possibly future work will show that perch are an undesirable presence in a trout fishery, but until and unless that is done the removal of some of all of the perch from the Tarn would be unjustifiable, especially in view of the time and effort that would be necessarily involved.

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