REPORT

to

DAVIDSON RADCLIFFE LTD., C. DAVIDSON & SONS,
Mugiemaoss Mills, Aberdeen
and
WIGGINS TEAPE (UK) PLC,
Stoneywood Mill, Aberdeen
on

CATCHES OF BROWN TROUT IN THE RIVER DON, ABERDEENSHIRE

by

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REPORT ON CATCHES OF BROWN TROUT IN THE RIVER DON, ABERDEENSHIRE

INTRODUCTION

A preliminary study has been made of the catches of brown trout (Salmo trutta) on rod and line in the River Don, Aberdeenshire, to determine whether any adverse effects are observable at Grandhome where the concentrations of dissolved oxygen (DO) have been close to their lowest values and growths of 'sewage fungus' have often been extensive.

A detailed study of brown trout fishing (Appendix 1) has already been carried out based upon the catches of individual members of the Angling Section of the Mugiemoss Social and Recreation Club fishing Mill Water and Caskieben during the period 1979-1982. This has established base-line data and highlighted the relevance of angler experience as well as certain environmental factors (water flow and temperature) in influencing catch efficiency.

DATA BASE

The present study is based mainly upon the returns of individual members of the Mugiemoss Angling Section when taking part in competitive trout fishing on single days in 1981. These took place in the R. Ythan (at Ellow and in the estuary) and at four sites on the R. Don, namely, Colguhonnie Hotel water at Strathdon and the fisheries at Kintore, Kinaldie, near Caskieben (all upstream of the Mills at Stonewood and Mugiemoss) and Grandhome (located downstream of the Mills). Altogether 85 angler-trips were involved, 36 on the R. Ythan and 49 on the R. Don.

The total number of fish was recorded, together with the total weight of the fish in pounds and ounces (avoirdupoids) and also occasionally, the weights of individual fish in an angler's catch.

METHODS

The catch per angler-trip and average weight of fish caught were

calculated for each site or groups of sites, and for groups of anglers. It was assumed that when the weight of a group of fish caught by a single angler was given, all fish in the group weighed the same.

The results have been calculated in three different ways to try to avoid undue bias caused by variability in angling efficiency and the fact that not all anglers fished all sites on all occasions. The first calculation includes the results for all (38) anglers taking part in the competitions, the second relates only to those (11) who fished once or more at Grandhome, while the third is confined to those (12) regular anglers who fished the Mugiemoss waters during all four seasons from 1979-1982, of whom 10 took part in the competitions and fished in at least one site in both the R. Don and R. Ythan.

RESULTS

The results are shown in Table 1. The efficiency of the anglers when fishing the R. Don at sites other than Grandhome was 0.97, 0.95 and 0.93 fish per angler-trip calculated by the three methods respectively. This is close to the value of 0.96 found for regular anglers fishing the Mugiemoss waters throughout the 1981 season. Catches for all sites on the R. Don were however somewhat higher as these include the relatively high catches at Grandhome. Values in the R. Ythan were markedly lower than elsewhere, even when catches of seatrout were included.

These results should not be taken on their face value because the detailed study of the Mugiemoss trout fishery (Appendix 1) revealed a relation between catch efficiency and the temperature and flow of the water (see Fig. 10 of Appendix 1). Taking this relationship into account, estimates have been made of the catches expected on the dates of the competitions. The averages are shown in Table 2, expressed as number of fish caught per hour, together with the average observed catches, expressed in number of fish per trip (since the duration of the competitions was unknown). Because of the disparate units of the predicted and observed

catches, the catches have also been expressed as proportions of the catch in the R. Don, excluding Grandhome.

TABLE 1. Angling efficiency (number of trout per angler-trip) of Mugiemoss Angling Section anglers fishing in Section competitions in 1981. Number of angler-trips shown in parenthesis; * indicates inclusion of seatrout caught in the estuary.

Anglers	R. Ythan (Ellow)	R. Don (4 sites)	R. Don (Grandhome)	R. Don (other than Grandhome)
All(38)	0.26(4)	1.12(49)	1.64(11)	0.97(38)
	0.33(36)*			
Grandhome (11)	0.00(5)	1.29(31)	1.91(11)	0.95(20)
	0.42(12)*			
Regular (10)	0.40(5)	1.29(21)	2.17(6)	0.93(15)
	0.55(11)*			

These show that relatively high catches are expected and found at Grandhome and relatively low ones at Ellow. However, while the expected catch at Grandhome is 1.2 times that elsewhere on the R. Don, the observed catch is actually rather higher, at 1.75 times. This suggests that the fishing at Grandhome is at least as good as upstream of the Mills, and possibly even slightly better.

Such a result is perhaps not unexpected because of the beneficial effect on fish production likely to accrue from the discharge of nutrients in the effluents from Stoneywood and Mugiemoss Mills and Persley Sewage Treatment Works, although no estimates are available of the standing crop of fish in the R. Don, and also other factors may be operative.

The results of the calculation of weights of fish at different sites is shown in Table 3.

TABLE 2. Comparison of observed catches of brown trout with those predicted from the relationship between catch and river temperature and flow found for regular Mugiemoss Angling Section anglers in 1981 (see Appendix 1). Catches are also expressed as a proportion of the corresponding values in all sites on the R. Don, excluding Grandhome.

Site	Predicted		Observed	
	No./h	Proportion	No./trip	Proportion
R. Ythan (Ellow)	0.15	0.4	0.25	0.2
R. Don (Grandhome)	0.45	1.2	2.17	1.75
R. Don (other than Grandhome)	0.38	1.0	1.24	1.0

TABLE 3. Weight of brown trout caught on rod and line by Mugiemoss Angling Section anglers during the Angling Section's competitions, 1981. (Standard deviation shown in parenthesis).

	R. Ythan (Ellow)	R. Don (Grandhome)	R. Don (other than Grandhome)
Average wt. (lbs)	0.59(0.17)	0.75(0.28)	0.72(0.31)
No. of fish	5	14	42

While the fish caught in the R. Ythan appear to be smaller than those caught in the R. Don, there is no significant difference in size between

fish caught at Grandhome and elswhere in the R. Don. This is also confirmed by the corresponding figures for all trout caught by Mugiemoss Angling Section anglers in 1981, namely averages of 0.69 lb for 39 trout caught at Caskieben and 0.72 lb for 175 trout caught at Mill Water.

CONCLUSIONS

The information available on brown trout fishing on rod and line at Grandhome is scant, but it suggests that catch efficiency there is at least as high, and the fish as large as at other sites on the R. Don.

More evidence should be collected however, both at Grandhome and elsewhere on the lower R. Don, where it may be alleged that fishing is poor, and also at control sites. This evidence should concentrate upon measurements of standing crop, age and size structure of the resident population and also the angling success of anglers of known high normal performance.

Appendix 1. Draft paper on Trout Angling in the River Don in preparation for submission to 'Fisheries Management' once the analysis of the replies to the questionnaire has been completed.

An analysis of angling for trout in the lower River Don, Aberdeenshire

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ABSTRACT

Analysis of four year's club records shows that, on average, the anglers fishing for brown trout in the lower River Don made 9 trips/y of 4 hours duration, caught 0.8 fish/trip at the rate of 0.2 fish/h, making a total of 7 fish/season, having an average weight of 350 g. There was, however, considerable variation in the results. Guests tended to fish for longer, and to catch less, than regular members. Most (95%) of the fish were caught by only 30% of the anglers, who accounted for 80% of the fishing effort. Angler efficiency increased with the number of seasons spent fishing the club waters during the period; it decreased with increase in water temperature and flow and, early in the season, tended to decrease slightly with increase in catch in the preceding month.

INTRODUCTION

While information has been published on the efficiency of angling in still waters for brown trout (Salmo trutta fario L.) (e.g. Crisp & Mann, 1977; Crisp & Robson, 1982; Steinmetz, 1982), the author is not

aware of comparable data on angling performance being produced for running waters, although somewhat relevant studies have been reported for brook trout (Salvelinus fontinalis Mitchill) in the United States (e.g. Tarzwell, 1936; Tarzwell, 1938; Hunt, 1966; Hunt, 1971) and for sea trout (Salmo trutta trutta L. (Fahy, 1978).

The present paper, therefore, analyses the records of an Angling Club fishing for brown trout in the lower R. Don, Aberdeenshire, and attempts to identify and evaluate some of the main factors affecting angling success.

DATA BASE AND METHODOLOGY

Fishing records

The Angling Club, which was established in 1979, fishes two stretches of water on the lower R. Don, the first known as Mill Water near Mugiemoss Mill, comprising a stretch of water immediately upstream of the mill together with Saugh Pool opposite the mill and Millionaires Pool immediately downstream (National Grid reference NJ 904 099) and the second known as Caskieben about 22 km immediately upstream (National Grid reference NJ 842 154). The club exercised strict control and required its anglers to log their catches; the present study is based on the original entries of each fishing trip made by individual anglers in the Club's log books at the Gatehouse during the 1979-1982 fishing seasons, which extended for between 26 and 28 weeks from the beginning of April. Entries included date, starting and finishing time, location, and the total (and sometimes individual) numbers and weights of fish caught. The weight of fish was usually recorded to the nearest quarter pound (avoirdupois) but, was occasionally given in pounds and ounces; for analysis, all were converted to decimal weight in pounds, to two decimal places.

Fishing was restricted to brown trout at Caskieben but included

salmon and seatrout at Mill water where it was a club rule to prohibit fishing on Sunday to avoid accidental catching of migratory fish when fishing for brown trout. A relatively small number of migratory trout was recorded as either 'finnock' or 'sea trout' but in the analysis of angling efficiency, finnock were combined with brown trout while seatrout were excluded.

The Club prohibited spinning and worming before dawn and after dusk, the use of floating devices, leaded lines, weighted fly casts and lures greater that 2 inches (51 mm) in length, including hooks. It also imposed a bag limit of 6 trout per rod per day and a size limit of 10 inches (25.4 cm).

Members were identifiable by either name or club number or both. However, guests were seldom named, and although one or two identifiable guests fished consistently with a particular member, others, un-named, also occasionally accompanied that member. Since the majority of guests were neither obviously associated with a particular member, nor named, all were grouped together into a single category.

Occasionally (5.7% of all entries) the time of finishing was not recorded and this usually related to occasions when no fish were caught. About a third of such cases related to guests who were assumed to have finished at the same time as the member then accompanying them, as almost invariably happened when times were recorded and as required in any case by the club rules. In one or two cases the converse was true, the member's fishing period then being assumed to correspond to that recorded for his guest. For the remainder of occasions when the duration of the fishing trip was not given, it was assumed to equal the average time calculable for the angler in question during the whole of the fishing season concerned.

Since the exact time of capture of fish was not recorded, it was

assumed, in the analysis of the data, that there was a constant rate of capture over the whole period of a fishing trip.

Fishing by an individual was usually carried out at one site only; when, very occasionally, it was carried out at both sites on the same day it was then counted in the analysis as two separate fishing trips.

River Conditions

Data on instantaneous river flow and river temperature, collected during the morning on alternate dates during the fishing seasons, were obtained from the North East River Purification Board for the river at Parkhill (National Grid reference NJ 889 141) situated about 12 km upstream of Mill Water. Corresponding data for the alternate intervening dates were estimated by linear interpolation.

Angling efficiency

For the purpose of this paper angling efficiency is taken simply as the catch per unit effort, expressed either as fishing trips or as fishing time, there being no information available either on numbers of trout present in the river near the fishing sites, or on the fishing behaviour of anglers.

Questionnaire to the anglers

When the main analysis of the data had been completed, further background information was obtained from the anglers by means of a questionnaire administered through the Club. This was designed mainly to assess angling experience and preferences.

RESULTS

Catch

The total recorded catch of fish was 828 of which the majority were brown trout, there being only 13 finnock and only 19 seatrout. The finnock were reported only in April (11) and May (2), while the seatrout were recorded not only in April (3) and May (6) but also in

succeeding months, albeit in low numbers (successively, 4, 3, 2, and 1).

The weights of the brown trout and finnock were similar, averaging 345 g (0.76 lb) and 349±64 g (0.77±0.14 lb) respectively, while that of the seatrout was significantly higher at 953±680 g (2.1±1.5 lb). There were no significant differences in weight of trout between fishing sites or between months or years.

Fishing effort

Altogether, there were 53 separate anglers and an indeterminate number of guests who fished at one time or another during the four fishing seasons. Eleven anglers fished during all four seasons, 7 fished for only 3 seasons, 11 for 2 seasons and 21 anglers for only one, giving the totals shown in Table 1,

INSERT TABLE 1

which include guests grouped into one category. The table shows that over the 4-year period, there was a decline in both the number of anglers and in the number of fishing trips, but that the number of fishing trips per angler increased, although the duration of the trips was reduced.

The number of fishing trips was distributed fairly consistently over the years with respect to the month of the fishing season, the day of the week and the period during the day, as shown by the percentages in Table 2;

INSERT TABLE 2

trips were most frequent at Mill Water, and they tended to be concentrated early in the season and during the hours of daylight in the afternoon, whilst the least favoured days were Thursdays and Fridays. The distributions of duration of fishing, included in parentheses in Table 2, are somewhat similar and show that the greatest effort occurred at Mill Water, in April, on Saturdays and

during the 8 hours around mid-day, especially in the afternoon.

The average number of trips per angler (8.6) amounts to only one every 3.2 weeks, or 0.3 trips per week. There was, however, a considerable range over all anglers, the number of trips being distributed approximately log-normally, with a median of only 0.13/week (Fig. 1).

INSERT FIGURE 1

Guests, as a group (indicated in Fig. 1 by a cross), tended to fish more often than the majority of members; one or two anglers, such as Angler no.1 (indicated by a solid circle) who is discussed later, stood out as being among the most active.

Comparison of the distributions of fishing trips with those of the duration of fishing (Table 2) shows that there is some variation in the duration of fishing trips; Table 3 shows that trips lasted longest at Caskieben, in April and on Saturdays.

INSERT TABLE 3

There was a considerable variation of duration of trip between anglers, as depicted in Fig. 2.

INSERT FIGURE 2

Guests as a group fished for somewhat longer than average while Angler no. 1 was about average.

While the number of trips/angler averaged 8.6/season, the range was considerable (from 1-56); the distribution of anglers and of trips relating to frequency of visits/season is summarised in Table 4, together with corresponding data for trout fishing on Cow Green Reservoir (Crisp & Mann, 1977).

INSERT TABLE 4

It shows that while the percentage of anglers decreases as the number of visits/season increases, a high proportion (75%) of the angler

trips relate to a frequency in excess of 8/season.

Efficiency of angling

The percentage of anglers catching some fish and the average numbers of fish/trip, of fish/angler and of fish/angler/h are shown in Table 5; all tend to increase slightly over the 4-year period, particularlt the latter figure between 1979 and 1980.

INSERT TABLE 5

Angling efficiency at the two sites and at different times is shown in Table 6;

INSERT TABLE 6

while more fish are caught per trip at Caskieben than at Mill Water, the numbers caught/angler/h is lower at Caskieben (more time per trip being spent there, as seen in Table 3). The results also indicate that efficiency is highest in April, on Saturdays and between 0800 and 1600 hours.

There is a considerable variation in efficiency between all anglers. This is illustrated in Fig. 3 in which the overall

INSERT FIGURE 3

cumulative percentage distributions of total catch and of corresponding effort are plotted against the cumulative percentage of all anglers. This shows (hatched line) that a small percentage of anglers accounts for a disproportionately large percentage of the catch; thus, for example, 30% of the anglers caught 95% of the fish, and 50% accounted for all the fish. The figure also shows (solid line) that the associated effort is disproportionately low; thus, for example, 95% of the fish resulted from only 80% of the effort. The solid line is irregular because of individual differences in angler efficiency, and shows, moreover, that the effort of anglers who failed to catch any fish at all amounted to about 10 per cent of the total.

The efficiency of individual anglers ranges from zero, after fishing for as much as 135 hours spread over three seasons, to 0.47 fish/h for a total fishing time of 500 hours spread over four (Angler no. 1). Guests were relatively inefficient, averaging 0.06, 0.09, 0.10 and 0.11 fish/h for the four successive years.

The number of fish/angler/h appears to be distributed approximately normally, but the overall values are different for anglers fishing for different numbers of seasons. This is illustrated if Fig. 4, which shows a higher efficiency for anglers with three or four season's experience than for those with only one or two.

INSERT FIGURE 4

For anglers fishing for 1, 2, 3 or 4 seasons the 75 percentile values are 0.03, 0.08, 0.26 and 0.3 fish/angler/h respectively, the averages are 0.09, 0.04, 0.13 and 0.24 fish/angler/h respectively and the percentage of anglers failing to catch anything at all are 0, 20, 50 and 73 respectively. Similar differences are still found when the relatively low catches for 1979 are neglected, the averages for those fishing for 1, 2, or 3 seasons then being 0.05, 0.17 and 0.3 fish/angler/h respectively. Corresponding figures, neglecting both 1979 and 1980, are and fish/angler/h for those fishing for 1 and 2 seasons respectively.

The distribution of bag number (Fig. 5) shows the generally high occurrence of zero and low catches and the comparatively rare return of five or six fish/trip; it also shows the difference between, on the one hand, the less efficent guests, who scarcely reached the bag limit and, on the other, the consistently good individual (e.g. Angler no. 1) who achieved it on more that 5% of his trips.

Water temperature and flow

The overall distributions of water temperature and flow, as

measured in the R. Don at Parkhill, are given in Table 7; this

INSERT TABLE 7

shows fairly marked differences between years and also indicates a broad correlation between the two characteristics, low temperature being associated with high flows, for example in 1979, and vice versa, for example in 1982.

Comparison of the annual means with those in Table 5 shows that in 1979 low angling efficiency over the year is associated with low temperature and high flow, and vice versa for the remaining years.

Further detailed examination of the data has been made utilising only the results obtained by anglers who fished during all four seasons at Mill Water, in which the relation between angling efficiency and temperature was examined for several different broad bands of flow (Fig. 6) and that between efficiency and flow for several broad temperature bands (Fig.7).

INSERT FIGURES 6 & 7

These two figures indicate fairly consistent negative correlations of efficiency with both temperature and flow. Multiple regression analysis yields the equation:

$$y = 0.82 - 0.03T - 0.01F$$

where y = number of fish/angler/h,

T = water temperature (°C) and

F = river flow (m^3/s).

The partial regression coefficients for the addition of T and F to the regression are each statistically highly significant ($P < 0.001$).

Temporal factors

Variations in angler efficiency between seasons and between months have been examined to allow for the correlation of efficiency with temperature and flow. For each month the efficiency of only regular anglers, fishing at Mill Water, was calculated from the

regression equation and subtracted from the corresponding observed efficiency, and the difference expressed as a percentage of the monthly mean for all months during the 4-year period. There was a considerable range of results and no clear relation observed between them and either month or year or total fishing effort in preceding months. However, there was a suggestion in the data that efficiency was lower than expected when catches in the preceding month had been relatively high. This is illustrated in Fig. 8 in which the catch in each preceding month has been expressed as a percentage of the catch for that month for the 4-year period, and then adjusted to allow for differences in average monthly catch between years. The correlation is not significant for data from all months together, but is just significant (P = 0.1-0.01) when considering only data for efficiency found in May, June and July (when most of the fish were caught).

DISCUSSION

Fishing effort

The reduction in number of anglers (Table 1) coincides with a 25 per cent redundancy occurring among mill employees. It may have been responsible for the increase in number of trips/angler and the reduction in number of hours/trip, although better angling results may also have been a factor.

The number of trips/week is certainly lower than the 0.4/week found in a national survey of all game anglers (National Opinion Poll, 1971) and the 0.5/week found in a survey of game anglers in Scotland (National Opinion Poll, 1980) (dashed line in Fig. 1). This is to be expected as it probably represents only a part of the club members' total fishing activity and is also unlikely to be overestimated since it is based, not on recall, as in the surveys, but on written records made at the time.

The popularity of Mill Water compared with Caskieben (Table 2)

is perhaps explained by its close proximity to the Mill as well as the higher angler efficiency at that site (Table 6).

The high popularity of April, May and June for angling (Table 2) coincides with relatively high angler efficiency during these months (Table 6), whilst the lower participation in July coincides with the annual holiday and low efficiency. However, the continuing decline in popularity as the season progresses is not consistent with the moderately high efficiency found in August and September. The results are certainly different from those reported for all game anglers (National Opinion Poll, 1971) for whom the greatest proportion of visits was made in June, July and August; the same is true of trout angling in Cow Green Reservoir for the periods 1971-1975, when also the minimum occurred in April (Crisp & Mann, 1971), and 1971-1980, when it occurred in April and September (Crisp & Robson, 1982). It is possible, therefore, that the seasonal pattern of fishing in rivers is quite different fron that of reservoirs.

The level of participation can also be expressed as the percentage frequency of months when anglers made any visits, as calculated for the national survey. Such calculations for anglers fishing the Don give chronological percentages of 59, 60, 53, 46, 22, and 27 for the months of April to September; these are higher than the corresponding figures given by National Opinion Poll (1971) for April, May and June and lower than the corresponding figures for the remaining months and may be a feature of trout fishing in running waters.

The Club policy of prohibiting fishing on Sunday and the relatively low activity on Thursdays (pay-day) and Fridays is in sharp contrast to the findings at Cow Green (Crisp & Mann, 1977; Crisp & Robson, 1982) where there were pronounced peaks on Sundays and also on Wednesdays, although the latter declined between 1976 and

1980. Saturdays were favoured at both Cow Green and on the Don which is to be expected of a daytime recreational activity.

Fishing was most active during the early afternoon, a feature that is probably site-specific, and in this case likely to have resulted from a concentration of activity in and around the lunch break and the timing of shift work during the working week. There are no other data available for trout fisheries but some studies have shown up differences in arrival and departure times between sites (e.g. Steinmetz, 1982).

The duration of the fishing trips in the present study averaged 4.1 hours (Table 1), but varied considerably (Table 3; Fig. 2). A longer duration was found by National Opinion Poll (1971) for all game anglers (about 5 hours) and by Crisp & Robson, (1982) for annual averages of trout anglers on Cow Green, which increased from 6.15 hours in 1972 to over 8 hours in 1980.

In the Don, visitors' trips tended to be rather longer than those of regular anglers, a phenomenon also recorded by Crisp & Robson (1982) for casual, compared with regular, visitors.

Although anglers averaged 8.6 trips/season, over three-quarters of the visits made over the 4-year period were derived from anglers who went on more that 8 trips/season and less than 3% were made by those making only one trip (Table 4). This again is markedly different from the situation at Cow Green, where only 28% of the trips were accounted for by anglers making more than 8 trips a season, and as much as 25% were derived from those visiting just once.

Angling success

Some anglers failed to catch any fish during a season; this was most marked in 1979 and 1980 (Table 5) and was probably caused by the high proportion fishing the water for the first time (Fig. 4), most

of whom, incidentally, did not fish in succeeding years. A somewhat lower proportion catching no fish (20%) was reported by National Opinion Poll (1971), although this is likely to represent a biassed sample weighted towards the more successful. It has been shown from a comparison of bailiff's notes of anglers' catches with returns made subsequently to dispersed collecting points that, in these circumstances, anglers are reluctant to admit zero and low catches (Cane, 1980); but the Don anglers made their returns promptly at the Gatehouse.

Angler visits which did not result in any fish being caught amounted to 64% of the total, a value similar to that (62%) found at Cow Green by Crisp & Mann, (1977); the figure for visitors was higher, being 76% on the Don and 69% on Cow Green (for casual, as against regular, visitors).

The average annual angling success of 0.8 fish/trip is close to those reported by Crisp & Robson (1982) for different reservoirs over a period of years (0.7-1.6 fish/trip). There is a similarity too in the relatively high values in April (1.2 fish/trip in the Don and 1.24 fish/trip in Cow Green), as well as in September (0.8 and 1.05 fish/trip respectively).

The concentration of most of the catch among relatively few anglers (Fig.3) has also been found by Crisp & Mann (1977) at Cow Green where, for example, 4.5% of anglers (accounting for 28.1% of angler visits, see Table 4) produced 36.7% of the catch, while 61% of anglers (accounting for 35.3% of visits) produced only 11.4%.

Angler efficiency in the Don averaged 0.2 fish/h. Data for brook trout in the United States work out at 1.3 fish/h in the Black river, where the imposed size limit was only 8 inches (10.5 cm) (Tarzwell, 1936), 0.31 fish/h in Lawrence Creek in 1961-1964 (Hunt, 1966) and 0.37 fish/h in 1961-1967 (Hunt, 1971), for a size limit of 9 inches (22.9 cm) and 0.38 fish/h in a Wisconsin creek (White, 1975). Efficiency expressed in terms of weight of fish was, for brown trout, 68 g/h (0.15 lb/h) in the Don, for brook trout, 113 g/h (0.25 lb/h) in the Black River (Tarzwell, 1936) and 32 g/h (0.07 lb/h) in Lawrence Creek (Hunt, 1964) and, for rainbow trout (Salmo gairdneri Richardson), it was 118 g/h (0.26 lb/h) in Tonto and Horton Creeks (Tarzwell, 1938). Thus angler efficiency in the lower Don is of the same order as for other salmonids in running waters. It is also similar to that found (0.1-0.13 fish/h) in Cow Green reservoir (Crisp & Mann, 1977; Crisp & Robson, 1982).

The wide range in efficiency of anglers (Fig. 4) is largley explained in terms of number of season's experience of the Mugiemoss waters but there remain wide differences between anglers of apparently the same experience. This is largely explicable in terms of angler's general experience of game angling.....

Guests' performance tends to be intermediate between those of anglers with one or two seasons experience and those of anglers having three or four. The data of Crisp & Robson (1982) show that at Cow Green the mean catch of regular visitors was about 1.3 fish/h while that of casual visitors was 0.8 fish/h.

The overall catch amounts to about 160 fish/km of river bank per year which, allowing for the width of the river, is equivalent to about 14 kg fish/ha/y and compares favourably the figure of 7.5 kg/ha/y reported by Timmermans (1966).

Temperature and flow of the water

Calculations based on only regular anglers on the Don, chosen in order to reduce variability due to lack of angling experience, still show considerable variation in angling efficiency, much of which is inversly related to both water temperature and flow (Figs. 6 & 7). Several other studies report qualitatively similar results. The data of Taylor (1978) show that the number of brown trout caught per angler visit at Eyebrook reservoir was higher at temperatures lower than 13°C than at higher temperatures. North (1980) found reduced angling success for coarse fish in the River Severn at temperature above an optimum and at relativley high rates of flow. And in the R. Coquet, where counts were made of the annual stocks of salmon (Salmo salar L.) and seatrout entering the non-tidal part of the river from the sea, it was found that that the total angler catch, expressed as a percentage of the run, fell proportionately with increase in river flow, expressed as average daily flow during the fishing season (Alabaster, 1970), although in this case the precise angling effort involved was not known.

Although several accounts indicate effects of relatively high temperature in reducing angler efficiency, the underlying reasons are unclear. At temperatures between 13.3 and 21.6°C the appetite of brown trout is actually higher, not lower, than at other temperatures. Possibly the avoidance of artificial lures is enhanced at high temperatures. The intensity of natural feeding is related to the availability of food organisms, as shown by Neill (1938) for brown trout in the R. Don just upstream of Parkhill where it reached

a peak in May and was very low in both April and July. But in the present study, when water temperatures were similar to those recorded by Neill (1938), angler efficiency was generally high, falling off only in July (Table 6).

High river flow is associated with increased water depth and increased turbidity which could reduce the visibility of the fish to the angler, and the ease of wading, respectively. High water velocity has been shown to affect the territorial behaviour of brown trout under experimental conditions (Kallenberg, 1958; Hartman, 1963), the fish becoming more territorial and aggressive. Also high water velocity is likely to carry more drift food organisms to the fish, as suggested by Giger(1973), and thus affect feeding behaviour. It is not known, however, whether any of these possible effects could account for the results found on the Don.

White (1975) showed that over a period of 9 years the biomass of trout (in April) in a small Wisconsin stream increased almost directly with increase in flow (mean of January and February). He also gave a few figures for angler catch for years of comparable flow in managed and unmanaged stretches of stream in which the biomass of trout can be calculated; examination of his data shows that an increase of 37% in angler catch in managed as compared with unmanaged streams is related to a corresponding increase in biomass of 43% - remarkably close agreement. Thus, if, as is likely, a similar phenomenon operated in the Don, there may have been residual adverse affects on trout stocks from the drought year of 1976 and the relatively low flow in February 1979 which could account in part for the catches in 1979 being relatively low.

Fishing pressure and stock density

The data for the lower Don suggest that relatively high angling exploitation early in the season, especially in 1979, had adverse

repercussions on catches and efficiency in subsequent months. But it is not known whether this would be related to the incidence of relatively adverse temperatures and flows, which was high in 1979, or to differences in the abundance of fish. Enquiries of neighbouring riparian owners fishing the Don from its mouth to 50 km upstream of the fishing sites indicate a virtual absence of artificial restocking since 1975, except for 300 7-8" fish introduced in May 1982 at Parkhill. Most of these are unlikely to have been caught as far afield as Caskieben and Mill Water, judging from results elsewhere; Templeton (1970) found over 88 per cent recaptured within a mile downstream of the point of stocking, but it is still possible that natural annual recruitment and survival have varied from year to year. It seems likely, in any event, that the supply of fish from upstream would have been limited and that the quality of the fishing might therefore be improved by reducing fishing effort in April and May or by increasing the population of fish through artificial stocking.

~~The fishing sites are approximately 0.? ha in area and the yield therefore amounted to about ?kg/ha/y which is...?~~

Management implications

It is not known to what extent the relationships found in the present study would be applicable elsewhere, but it seems likely that there would be marked site-specific differences. For a river like the Don, artificially reducing the flow by a reduction in the size of the floods, and artifcial releases of relatively cool water, could well benefit trout angling.

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Table 1. Average fishing effort of all anglers (guests are included collectively as a single angler-group)

No.	1979	1980	1981	1982	All years
Anglers	37	38	27	16	30
fishing trips	319	274	251	184	257
trips/angler	8.6	7.2	9.3	11.5	8.6
hours/trip	4.3	4.2	3.9	3.6	4.1

Table 2. Percentage distribution of all fishing trips and (in parenthesis) total duration of fishing for the whole period, 1979-1982

Site	Caskieben	17	(31)
	Mill Water	83	(69)
Month	April	23	(28)
	May	24	(24)
	June	22	(20)
	July	16	(14)
	August	6	(5)
	September	8	(8)
	October	1	(1)
Day	Monday	18	(17)
	Tuesday	17	(16)
	Wednesday	17	(16)
	Thursday	12	(12)
	Friday	14	(14)
	Saturday	21	(24)
Time (h)	0-4	1	(2)
	4-8	8	(6)
	8-12	21	(23)
	12-16	30	(37)
	16-20	27	(21)
	20-24	13	(11)

Table 3. Average and range of duration of all fishing trips (h) for the whole period, 1979-1982, excluding October and Sundays

		Mean	Range
Site	Caskieben	7.1	5.9 - 8.1
	Mill Water	3.4	3.0 - 4.0
Month	April	4.9	4.2 - 6.3
	May	4.1	3.5 - 4.5
	June	3.7	2.9 - 4.0
	July	3.6	3.0 - 3.9
	August	3.4	3.0 - 4.1
	September	3.7	3.3 - 3.9
Day	Monday	3.8	3.1 - 4.5
	Tuesday	3.7	3.2 - 4.4
	Wednesday	3.7	3.1 - 4.2
	Thursday	3.8	2.2 - 5.2
	Friday	3.9	3.6 - 4.6
	Saturday	4.5	3.5 - 5.9

Table 4 Distribution of anglers and trips corresponding to different frequencies of visits/season for the whole period and, in parenthesis, similar data from Crisp & Mann (1977).

Visits/season	% anglers		% angler visits	
1	23.0	(61.0)	2.7	(35.3)
2	14.2	(15.7	3.3	(13.1)
3	10.6	(7.6)	3.7	(9.4)
4	8.8	(4.2)	4.1	(6.9)
5	5.3	(2.3)	3.1	(4.8)
6	4.4	(2.0)	3.1	(4.6)
7	2.7	(1.7)	2.2	(4.6)
8	2.7	(1.0)	2.3	(3.3)
>8	28.3	(4.5)	75.5	(28.1)

Table 5 Percentage of anglers catching some fish and average efficiency of all anglers in different years

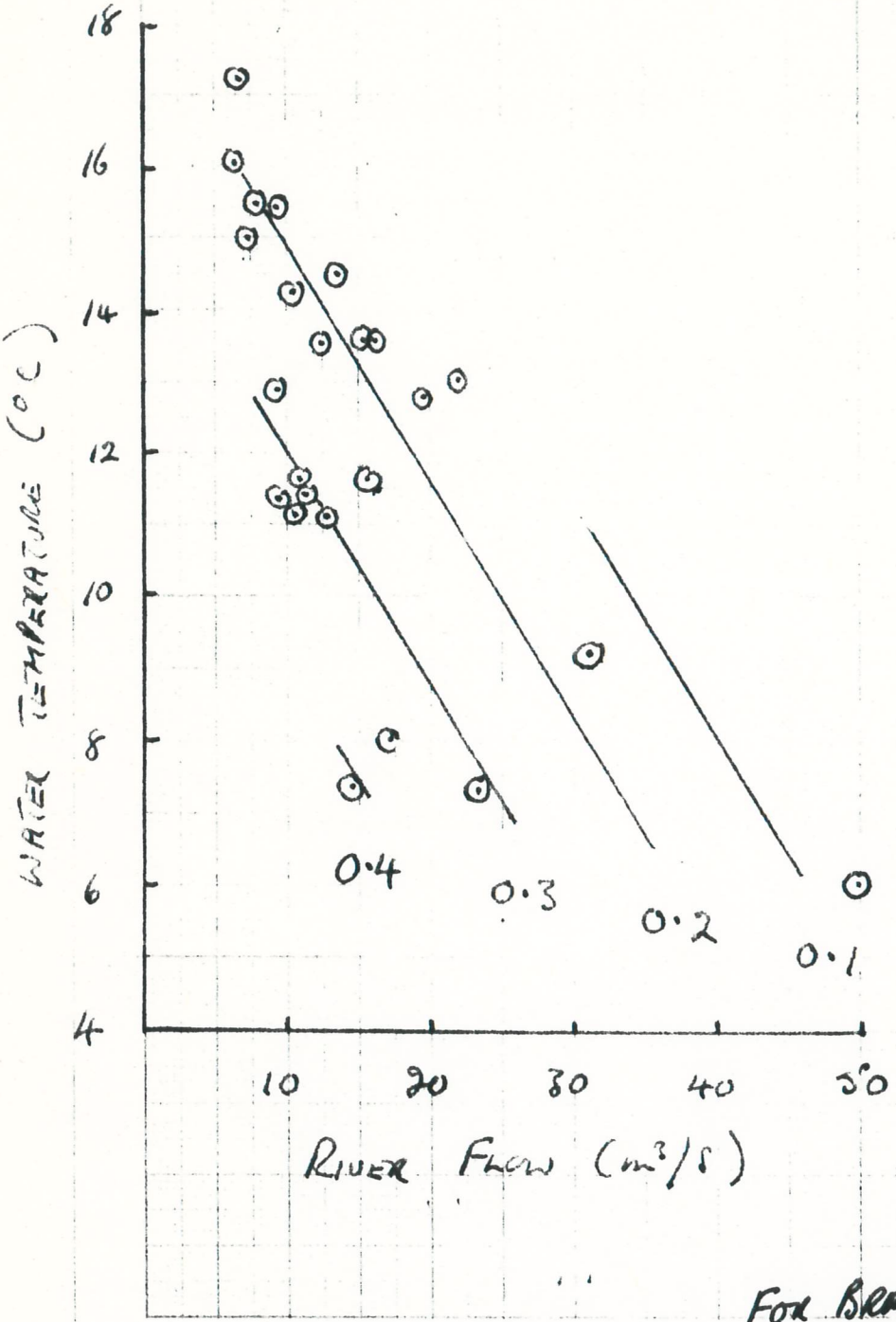
	1979	1980	1981	1982	All years
% anglers	54.1	55.3	66.7	75.0	79.8
Fish/trip	0.4	1.0	0.9	1.0	0.8
Fish/angler	3.6	7.0	7.9	10.9	6.7
Fish/angler/hour	0.10	0.24	0.22	0.26	0.19

Table 6. Efficency of all anglers at different sites and times for the whole period, 1979-1980, excluding October and Sundays

		No. fish/trip	No. fish/angler/h
Site	Caskieben	1.1	0.15
	Mill Water	0.7	0.21
Month	April	1.2	0.24
	May	0.9	0.21
	June	0.5	0.23
	July	0.5	0.14
	August	0.8	0.22
	September	0.8	0.21
Day	Monday	0.7	0.17
	Tuesday	0.7	0.22
	Wednesday	0.8	0.20
	Thursday	0.8	0.20
	Friday	0.7	0.18
	Saturday	0.9	0.19
Time (h)	0-4	0.4	0.10
	4-8	0.2	0.15
	8-12	0.5	0.22
	12-16	0.5	0.21
	16-20	0.2	0.17
	20-24	0.3	0.16

Table 7 Average monthly water temperature and flow in the R. Don at Parkhill

	1979	1980	1981	1982	All years
			Temperature (°C)		
April	6.0	7.3	7.3	8.0	7.2
May	9.2	11.1	11.3	11.3	10.7
June	13.0	13.5	14.2	15.0	13.9
July	14.5	13.0	15.3	17.3	15.0
August	12.8	13.6	16.0	15.4	14.5
September	11.1	11.6	12.9.	11.6	11.8
April-Sept.	11.1	11.7	12.8	13.1	12.2
			Flow (m^3/s)		
April	50.1	23.5	14.6	17.5	26.4
May	31.2	10.9	9.8	13.0	16.2
June	20.4	12.3	10.3	7.4	12.6
July	13.5	15.3	9.3	6.8	11.2
August	19.8	15.7	6.5	8.3	12.2
September	12.9	15.4	9.1	11.2	12.2
April-Sept.	24.7	15.5	9.9	10.7	15.2



FOR BROWN TROUT

EFFICIENCY OF ANGLING ~~RE~~/ ~~[illegible]~~ IN

FIG. 10 RELATION ~~REFERRED~~ TO WATER TEMPERATURE AND FLOW (MONTHLY MEAN VALUES)
POINTS INDICATE OBSERVATIONS; NUMBERS INDICATE EFFICIENCY (NO./HOUR) ~~FOR~~ CONDITIONS;