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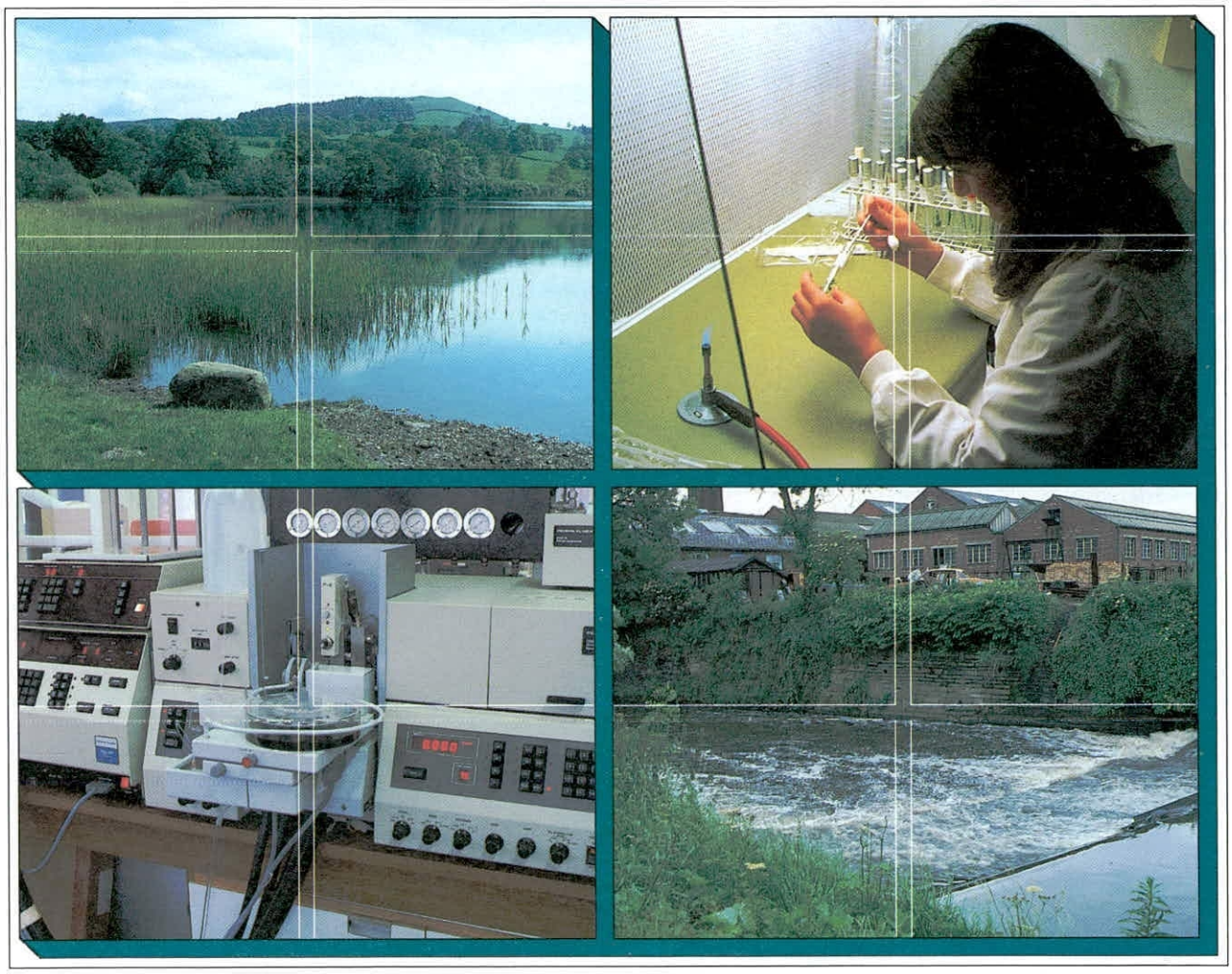

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1. EXECUTIVE SUMMARY

1. As a condition of drought orders imposed on several West Yorkshire rivers in 1996, eight sites on the River Don catchment and one on the Colden Water were surveyed once in April and once in October 1996. A further survey is planned for 1997.

2. Combining both surveys a total of 12 species of fish were captured, but only brown trout was common to all sites.

3. Major differences between the October and April surveys were declines in the numbers of 0+ brown trout in the 1996 year-class over the 1995 year-class, at all sites in the River Don catchment with the exception of Loxley.

4. The most serious decline was at the River Rivelin site, where a brief period of near no-flow in March 1996 appears to have caused a total failure in recruitment of the 1996 year-class.

2. INTRODUCTION

As a condition of drought orders being imposed on several West Yorkshire rivers, Yorkshire Water are obliged to carry out fishery surveys on the relevant watercourses. These surveys are intended to take place once in April 1996 and to be repeated in October 1996 and April 1997. This report presents the results of the second survey carried out in October 1996.

3. GENERAL METHODS

Between 24 and 29 October 1996 eight sites on the River Don Catchment and one on the Colden Water were surveyed for their fish populations (Table 3.1). Each site comprised a 200 m length of river divided into four equal 50 m sections. The location of each site had been predetermined.

Table 3.1 Dates and National Grid References of sites surveyed.

Site name	Date surveyed	Site Designation	National Grid Reference
River Sheaf	17 October 1996	Unregulated Control	SK 327 823
River Don u/s Bullhouse Minewater	17 October 1996	Regulated Control	SE 213 032
River Don d/s Winscar Reservoir	19 October 1996	Regulated Control	SE 158 024
River Don at Oxspring	20 October 1996	Regulated Part-Affected	SE 278 016
Ewden Beck	18 October 1996	Regulated 50%	SK 293 955
Little Don d/s Underbank Reservoir	20 October 1996	Regulated 66%	SK 255 992
River Loxley at Storrs Lane Bridge	21 October 1996	Regulated 66%	SK 299 895
River Rivelin at Rivelin Mill	18 October 1996	Regulated 66%	SK 289 871
Colden Water at Hebden Bridge	22 October 1996		SD 983 277

The sampling method, examination of fish captured and site descriptions are described in the initial report (Ibbotson *et al.*, 1996).

4. RIVER SHEAF

4.1 River conditions

The water at this site was low but quite turbid. This was surprising as there had been no significant recent rainfall and the river had been clear at the time of the previous sampling. The source of the turbidity was found to be an upstream reservoir which had been drained completely to the original river bed, whilst the dam was being repaired. The outflow from this reservoir joined the River Sheaf upstream of the sampling site. Upstream of the junction of the outflow and the main river the river was clear. It was considered that there would be no foreseeable improvement in the visibility at the site because the dam repair would take some time and the electric fishing was completed in conditions that would normally be considered unsuitable. It is felt that this will have had a serious impact on the results, particularly for the smaller species and size groups.

4.2 Results

4.2.1 Brown trout

Table 4.1. Electric fishing efficiencies for brown trout calculated from triple shocks of Section 1 of River Sheaf site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	42	8	13	70	52.9

Table 4.2. Number of brown trout captured in each section of River Sheaf site, together with density and biomass, calculated from efficiencies in Table4.5. (* = section fished for triple shock estimate of efficiency). Sections are ordered in an upstream direction. That is Section 1 is the section furthest downstream and Section 4 is the furthest upstream.

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	62	263	0.270	14.2
Section 2	40	290	0.283	12.4
Section 3	23	286	0.168	6.3
Section 4	42	274	0.255	20.8
Total	167	1113	0.243	13.3

Table 4.3. The length weight relationship for brown trout at the River Sheaf site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Brown Trout	- 1.84	2.93	99.2 %

Table 4.4. Number of brown trout captured in each year class, year class strengths and mean lengths and weights at the River Sheaf site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	17	29	10.7	6.6 ± 0.82	3.7 ± 1.32
1995	86	147	54.2	13.6 ± 1.80	31.5 ±12.2
1994	56	82	30.3	19.9 ± 1.79	94 ± 24.9
1993	10	12	4.4	25.1 ± 1.60	185 ± 36
1992	1	1	0.4	33.9	440

Table 4.5. Information for HABSCORE from the River Sheaf site. Section 1 provided estimate for triple shock estimate.

	No. of fish captured				Efficiency (%)	Estimated number in each section together with density (n m^{-2}) in brackets				Estimated total biomass in each section (g) together with g m^{-2} in brackets			
	Sect 1	Sect 2	Sect 3	Sect 4		Sect 1	Sect 2	Sect 3	Sect 4	Sect 1	Sect 2	Sect 3	Sect 4
0+ Trout	5/1/2	5	4	0	44.8	9 (0.034)	11 (0.038)	9 (0.031)	0 (0)	33 (0.125)	41 (0.141)	33 (0.115)	0 (0)
Trout <20 cm older than 1	28/7/ 10	31	18	21	47.2	52 (0.198)	66 (0.228)	38 (0.133)	44 (0.161)	2236 (8.5)	2838 (9.8)	1634 (5.7)	1892 (6.9)
Trout >20 cm	9/0/1	4	1	21	82.1	10 (0.038)	5 (0.017)	1 (0.0035)	26 (0.095)	1460 (5.6)	730 (2.5)	146 (0.51)	3796 (13.9)

4.2.2 Bullheads

Table 4.6. Electric fishing efficiencies for bullheads calculated from triple shocks of Section 1 of River Sheaf site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	2	0	1	3	40.6

Table 4.7. Number of bullheads captured in each section of River Sheaf site, together with density and biomass, calculated from efficiencies in Table 4.6. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	3	263	0.0114	0.060
Section 2	7	290	0.059	0.31
Section 3	2	286	0.0175	0.093
Section 4	0	274	0	0
Total	12	1113	0.0225	0.119

Table 4.8. The length weight relationship for bullheads at the River Sheaf site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Bullheads	- 2.41	3.57	97.4 %

Table 4.9. Number of bullheads captured in each year class, year class strengths and mean lengths and weights at the River Sheaf site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	12	25	100	7.3 ± 1.33	5.3 ± 3.3

4.2.3 Perch

Table 4.10. Electric fishing efficiencies for perch calculated from triple shocks of Section 1 of River Sheaf site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	5	3	6	n/a	n/d

Table 4.11. Number of perch captured in each section of River Sheaf site, together with density and biomass, calculated from efficiencies in Table 4.10. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density (n m^{-2})	Biomass (g m^{-2})
Section 1*	14	263	0.053**	4.1**
Section 2	0	290	0**	0**
Section 3	13	286	0.045**	3.5**
Section 4	44	274	0.161**	12.4**
Total	71	1113	0.064**	4.9**

** represents minimum density and biomass

Table 4.12. The length weight relationship for perch at the River Sheaf site. Relationship equates to $Log_{10} W (g) = a + b Log_{10} L (cm)$.

	a	b	R^2
Perch	- 1.87	3.03	99.4 %

Table 4.13. Number of perch captured in each year class, year class strengths and mean lengths and weights at the River Sheaf site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	11	11	15.5	12.0 ± 2.20	27.5 ±15.6
1994	60	60	84.5	18.0 ± 0.59	86 ± 8.4

4.2.4 Dace

Table 4.14. Electric fishing efficiencies for dace calculated from triple shocks of Section 1 of River Sheaf site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	0	0	0	0	n/d

Table 4.15. Number of dace captured in each section of River Sheaf site, together with density and biomass, calculated from efficiencies in Table 4.14. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	0	263	0	0
Section 2	0	290	0	0
Section 3	0	286	0	0
Section 4	5	274	0.0182**	2.61**
Total	5	1113	0.0045**	0.64**

** represents minimum density and biomass

Table 4.16. The length weight relationship for dace at the River Sheaf site. Relationship equates to $Log_{10}\ W\ (g) = a + b\ Log_{10}\ L\ (cm)$.

	a	b	R^2
Dace	-2.32	3.34	93.8%

Table 4.17. Number of dace captured in each year class, year class strengths and mean lengths and weights at the River Sheaf site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996					
1995					
1994					
1993					
1992					
1991	4	4	80	20.9 ± 0.25	122 ± 9.7
1990					
1989					
1988	1	1	20	25.2	228

4.2.5 Stickleback

Table 4.22. Electric fishing efficiencies for stickleback calculated from triple shocks of Section 1 of River Sheaf site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	0	0	0	0	n/d

Table 4.23. Number of stickleback captured in each section of River Sheaf site, together with density and biomass, calculated from efficiencies in Table 4.22. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density (n m^{-2})	Biomass (g m^{-2})
Section 1*	0	263	0	0
Section 2	0	290	0	0
Section 3	2	286	0.0070#	0.0043**#
Section 4	0	274	0	0
Total	2	1113	0.00180#	0.0011**#

** Estimates of biomass derived from stickleback length weight relationship for fish captured in upper Frome (Log_{10} W (g) = -1.93 + 3.14 Log_{10} L (cm).
# represents minimum density and biomass

Table 4.24. The length weight relationship for stickleback at the River Sheaf site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Stickleback	n/a	n/a	n/a

Table 4.25. Number of stickleback captured in each year class, year class strengths and mean lengths and weights at the River Sheaf site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d. *
1996	2	2	100	3.5 ± 0.283	0.61±0.153

* Estimates of biomass derived from stickleback length weight relationship for fish captured in upper Frome (Log_{10} W (g) = -1.93 + 3.14 Log_{10} L (cm)

4.3 Discussion

4.3.1 Brown trout

The turbidity of the water will have had a serious impact on the number of juvenile trout captured by the electric fishing team, because visibility was so poor. It may also have had a smaller impact on the capture of adult fish from deep water.

In the top section nearest to the reservoir outflow there were more large trout. These may have been escapees from the reservoir itself now that the dam is fully open. Two of these fish were identified as being potentially stocked fish by the presence of large numbers of replacement scales. The other trout examined all exhibited growth rates that are typical of naturally produced fish.

4.3.2 Other species

As in April there was a perch population which had probably come from the reservoir, but on this occasion there were no roach observed. No additional species were captured in October that had not been seen in April.

As discussed in the initial report (Ibbotson *et al.*, 1996) it is hard to attach any confidence to the efficiency of capture or the estimated population density and biomass for the small species, bullhead and stickleback, even where a catch depletion is obtained. This situation is exacerbated by the increased turbidity at this site.

5. RIVER DON U/S BULLHOUSE MINEWATER

5.1 River conditions

Conditions for electric fishing were good with the river low and clear.

5.2 Results

5.2.1 Brown trout

Table 5.1. Electric fishing efficiencies for brown trout calculated from triple shocks of Section 1 of River Don u/s Bullhouse Minewater site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	19	9	2	31	62.4

Table 5.2. Number of brown trout captured in each section of River Don u/s Bullhouse Minewater site, together with density and biomass, calculated from efficiencies in Table 5.1. (* = section fished for triple shock estimate of efficiency). Sections are ordered in an upstream direction. That is Section 1 is the section furthest downstream and Section 4 is the furthest upstream.

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	30	393	0.079	7.6
Section 2	11	299	0.060	3.0
Section 3	11	364	0.049	4.0
Section 4	23	298	0.124	11.7
Total	75	1354	0.077	6.5

Table 5.3. The length weight relationship for brown trout at the River Don u/s Bullhouse Minewater site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Brown Trout	- 1.79	2.91	98.4 %

Table 5.4. Number of brown trout captured in each year class, year class strengths and mean lengths and weights at the River Don u/s Bullhouse Minewater site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	5	8	7.7	8.0 ± 0.96	7.1 ± 2.32
1995	19	26	25.0	14.9 ± 0.83	43 ± 6.6
1994	47	64	61.5	19.7 ± 2.76	100 ± 44
1993	4	6	5.8	27.4 ± 0.52	247 ± 13.4

Table 5.5. Information for HABSCORE from the River Don u/s Bullhouse Minewater site. Section 1 provided estimate for triple shock estimate.

	No. of fish captured				Efficiency (%)	Estimated number in each section together with density (n m^{-2}) in brackets				Estimated total biomass in each section (g) together with g m^{-2} in brackets			
	Sect 1	Sect 2	Sect 3	Sect 4		Sect 1	Sect 2	Sect 3	Sect 4	Sect 1	Sect 2	Sect 3	Sect 4
0+ Trout	0/0/0	5	0	0	n/d (62.4)*	0 (0)	8 (0.0268)	0 (0)	0 (0)	0 (0)	57 (0.191)	0 (0)	0 (0)
Trout <20 cm older than 1	12/7/1	5	9	16	61.0	21 (0.053)	8 (0.0268)	15 (0.041)	26 (0.087)	1300 (3.3)	500 (1.67)	930 (2.55)	1610 (5.4)
Trout >20 cm	7/2/1	1	2	7	65.3	10 (0.0254)	2 (0.0067)	3 (0.0082)	11 (0.037)	1700 (4.3)	340 (1.14)	510 (1.40)	1870 (6.3)

* The numbers of trout captured were so low that individual efficiencies either could not be estimated or were unrealistic for each age and size class. Therefore the efficiencies estimated in Table 1 were used to estimate the numbers and biomass of brown trout in each section, as this was considered to give the most realistic values.

5.2.2 Grayling

Table 5.6. Electric fishing efficiencies for grayling calculated from triple shocks of Section 1 of River Don u/s Bullhouse Minewater site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	5	2	2	11	40.6

Table 5.7. Number of grayling captured in each section of River Don u/s Bullhouse Minewater site, together with density and biomass, calculated from efficiencies in Table 5.6. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	9	393	0.0229	1.47
Section 2	1	299	0.0067	0.43
Section 3	5	364	0.033	2.11
Section 4	1	298	0.0067	0.43
Total	16	1354	0.0185	1.18

Table 5.8. The length weight relationship for grayling at the River Don u/s Bullhouse Minewater site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Grayling	-2.42	3.36	97.7 %

Table 5.9. Number of grayling captured in each year class, year class strengths and mean lengths and weights at the River Don u/s Bullhouse Minewater site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	2	3	12.0	7.4 ± 0.35	3.1 ± 0.50
1995	13	20	80.0	17.3 ± 1.43	56 ± 15.7
1994	0	0	0		
1993	1	2	8.0	27.8	270

5.2.3 Minnow

Table 5.10. Electric fishing efficiencies for minnows calculated from triple shocks of Section 1 of River Don u/s Bullhouse Minewater site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	114	43	39	233	45.5

Table 5.11. Number of minnows captured in each section of River Don u/s Bullhouse Minewater site, together with density and biomass, calculated from efficiencies in Table 5.10. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density (n m^{-2})	Biomass (g m^{-2})
Section 1*	196	393	0.59	1.21
Section 2	11	299	0.080	0.164
Section 3	71	364	0.43	0.87
Section 4	3	298	0.0235	0.048
Total	281	1354	0.31	0.63

Table 5.12. The length weight relationship for minnows at the River Don u/s Bullhouse Minewater site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Minnows	-2.38	3.53	94.3 %

Table 5.13. Number of minnows captured in each year class, year class strengths and mean lengths and weights at the River Don u/s Bullhouse Minewater site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	4	6	1.4	3.0 ± 0.265	0.206±0.06
1995	255	381	90.7	5.5 ± 0.59	1.82 ±0.70
1994	22	33	7.9	7.4 ± 0.40	5.0 ±0.96

5.2.4 Stickleback

Table 5.14. Electric fishing efficiencies for stickleback calculated from triple shocks of Section 1 of River Don u/s Bullhouse Minewater site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	24	13	11	67	34.1

Table 5.15. Number of stickleback captured in each section of River Don u/s Bullhouse Minewater site, together with density and biomass, calculated from efficiencies in Table 5.14. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	48	393	0.170	0.060
Section 2	10	299	0.097	0.034
Section 3	4	364	0.033	0.0115
Section 4	1	298	0.0101	0.0035
Total	63	1354	0.082	0.0287

Table 5.16. The length weight relationship for stickleback at the River Don u/s Bullhouse Minewater site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Stickleback	-1.83	2.54	80.8

Table 5.17. Number of stickleback captured in each year class, year class strengths and mean lengths and weights at the River Don u/s Bullhouse Minewater site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	49	86	77.5	2.84 ± 0.45	0.22±0.086
1995	14	25	22.5	4.7 ± 0.55	0.78±0.228

5.3 Discussion

5.3.1 Brown trout

This site is a short distance above a large weir which creates a large stagnant pool immediately above it. Section 1 at this site is in that pool. There has been quite a significant increase in the estimated number of trout at this site, since April. This could potentially be due to the addition of stocked fish and three fish of lengths 16.4, 19.0 and 19.7 cm did have a large number of replacement scales, and another fish of 18.2 cm was large for a 1+ fish. However none of the other fish whose scales were examined showed any abnormal growth rates or other evidence of stocking. The stocking practices on this river are not known, but there is evidence that stocking of fish between 15 and 20 cm does take place. It is recommended that the local angling club is approached to obtain information on stocking history.

The other potential source of these additional fish is the large pool above the weir. In colder months, trout move to deep pools and shoal in areas of cover, in the summer they move into shallower water and defend territories. It is possible that the reason more trout were captured in October than April is that fish had moved from the extensive area of deep water, immediately below the surveyed area into the survey area itself.

5.3.2 Other species

A small number of grayling were captured. There is an apparent increase in the number of fish from the 1995 year class, but 0+ grayling are notoriously difficult to capture by electric fishing and this apparent increase may be a result of reduced efficiency to capture these at smaller sizes.

As discussed in the initial report (Ibbotson *et al.*, 1996) it is hard to attach any confidence to the efficiency of capture or the estimated population density and biomass for the small species, minnows and stickleback, even where a catch depletion is obtained.

6. RIVER DON D/S WINSCAR RESERVOIR

6.1 River conditions

River conditions were good for electric fishing with the river low and clear. The only difficulty in electric fishing was the area in Section 1 where dense tree growth covered the water and a great deal of rubbish had collected in that area making visibility poor. This was the same condition as found in April.

6.2 Results

6.2.1 Brown trout

Table 6.1. Electric fishing efficiencies for brown trout calculated from triple shocks of Section 2 of River Don d/s Winscar Reservoir site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	22	6	2	30	71.0

Table 6.2. Number of brown trout captured in each section of River Don d/s Winscar Reservoir site, together with density and biomass, calculated from efficiencies in Table 6.5. (* = section fished for triple shock estimate of efficiency). Sections are ordered in an upstream direction. That is Section 1 is the section furthest downstream and Section 4 is the furthest upstream.

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1	10	100	0.120	2.27
Section 2*	30	90	0.37	5.2
Section 3	19	93	0.30	4.3
Section 4	14	122	0.164	2.34
Total	73	405	0.230	3.4

Table 6.3. The length weight relationship for brown trout at the River Don d/s Winscar Reservoir site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Brown Trout	- 1.86	2.95	98.0 %

Table 6.4. Number of brown trout captured in each year class, year class strengths and mean lengths and weights at the River Don d/s Winscar Reservoir site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	13	26	28.0	7.0 ± 0.34	4.4 ± 0.62
1995	46	51	54.8	10.0 ± 1.29	13.0 ± 4.9
1994	14	16	17.2	14.6 ± 1.28	38 ± 10.8

Table 6.5. Information for HABSCORE from the River Don d/s Winscar Reservoir site. Section 2 provided estimate for triple shock estimate.

	No. of fish captured				Efficiency (%)	Estimated number in each section together with density (n m^{-2}) in brackets				Estimated total biomass in each section (g) together with g m^{-2} in brackets			
	Sect 1	Sect 2	Sect 3	Sect 4		Sect 1	Sect 2	Sect 3	Sect 4	Sect 1	Sect 2	Sect 3	Sect 4
0+ Trout	0	4/2/2	3	2	31.8	0 (0)	11 (0.20)	9 (0.194)	6 (0.098)	0 (0)	48 (0.88)	40 (0.85)	26 (0.43)
Trout <20 cm older than 1	10	18/4/0	16	12	83.6	12 (0.12)	22 (0.244)	19 (0.204)	14 (0.115)	227 (2.27)	420 (4.7)	360 (3.9)	260 (2.13)
Trout >20 cm	0	0/0/0	0	0	n/a								

6.3 Discussion

This was a very small outflow of a reservoir. The habitat comprised almost entirely of shallow water highly suitable for small brown trout, but unsuitable for larger individuals. Any large fish emerging from the reservoir would have to migrate further downstream or would quickly fall victim to predators. There was no evidence that any of the brown trout captured were of stocked origin.

As discussed in the last report, the efficiency of capture in this stream was impeded by the use of the large anode more suited to larger rivers, and this probably results in the inefficient capture of the 0+ fish.

The 1996 year class appears to have grown significantly faster then the 1995 year class in its first year. An increase of this size would normally be the result of an increase in density or an increase in the temperature of the water. Certainly, there appears to be less 0+ fish in the 1996 year-class than in 1995. However, with Winscar Reservoir stocks running low in 1996 (see Fig. 13.1c) the temperature of the outflow water may have risen as less cool bottom water is released. Confirmation of the increased growth rates and decreased density will be obtained at the next sampling date.

7. RIVER DON AT OXSPRING

7.1 River conditions

This site was fished in good conditions with the water clear and low. A previous attempt to sample it was abandoned on arrival at the site because rainfall had caused the level to rise and the water to become turbid.

7.2 Results

7.2.1 Brown trout

Table 7.1. Electric fishing efficiencies for brown trout calculated from triple shocks of Section 2 of River Don at Oxspring site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	24	3	2	29	78.6

Table 7.2. Number of brown trout captured in each section of River Don at Oxspring site, together with density and biomass, calculated from efficiencies in Table 7.5. (* = section fished for triple shock estimate of efficiency). Sections are ordered in an upstream direction. That is Section 1 is the section furthest downstream and Section 4 is the furthest upstream.

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1	0	392	0	0
Section 2*	29	408	0.071	10.7
Section 3	5	430	0.0140	2.12
Section 4	8	439	0.251	1.77
Total	42	1669	0.0276	3.6

Table 7.3. The length weight relationship for brown trout at the River Don at Oxspring site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Brown Trout	- 1.82	2.92	98.7 %

Table 7.4. Number of brown trout captured in each year class, year class strengths and mean lengths and weights at the River Don at Oxspring site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	5	6	13.0	8.4 ± 1.57	8.1 ± 3.9
1995	11	14	30.4	18.0 ± 2.35	73 ± 26.4
1994	19	19	41.3	23.5 ± 1.30	154 ± 24
1993	5	5	10.9	27.5 ± 1.72	243 ± 23.3
1992	2	2	4.4	33 ± 0.21	410 ± 7.7

Table 7.5. Information for HABSCORE from the River Don at Oxspring site. Section 2 provided estimate for triple shock estimate.

	No. of fish captured				Efficiency (%)	Estimated number in each section together with density (n m^{-2}) in brackets				Estimated total biomass in each section (g) together with g m^{-2} in brackets			
	Sect 1	Sect 2	Sect 3	Sect 4		Sect 1	Sect 2	Sect 3	Sect 4	Sect 1	Sect 2	Sect 3	Sect 4
0+ Trout	0	0/1/1	0	3	n/d (78.6)*	0 (0)	2 (0.0049)	0 (0)	4 (0.0091)	0 (0)	16.2 (0.040)	0 (0)	32 (0.073)
Trout <20 cm older than 1	0	5/1/1	1	3	62.8	0 (0)	7 (0.0172)	2 (0.0047)	5 (0.0114)	0 (0)	511 (1.25)	146 (0.34)	365 (0.83)
Trout >20 cm	0	19/1/0	4	2	95.2	0 (0)	20 (0.049)	4 (0.0093)	2 (0.0046)	0 (0)	3820 (9.4)	764 (1.78)	382 (0.87)

* Not possible to calculate efficiency of capture for this size group so efficiency from Table 1 is used as the best estimate of density for 0+ fish in single shocked sections.

7.2.2 Grayling

Table 7.6. Electric fishing efficiencies for grayling calculated from triple shocks of Section 2 of River Don at Oxspring site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	20	6	3	30	64.1

Table 7.7. Number of grayling captured in each section of River Don at Oxspring site, together with density and biomass, calculated from efficiencies in Table 7.6. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1	0	392	0	0
Section 2*	29	408	0.074	0.61
Section 3	0	430	0	0
Section 4	1	439	0.0046	0.38
Total	30	1669	0.0192	1.59

Table 7.8. The length weight relationship for grayling at the River Don at Oxspring site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Grayling	- 2.15	3.16	99.1 %

Table 7.9. Number of grayling captured in each year class, year class strengths and mean lengths and weights at the River Don at Oxspring.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	4	4	12.5	9.8 ± 0.77	9.8 ± 2.41
1995	21	23	71.9	17.9 ± 1.64	67 ± 18.2
1994	3	3	9.4	23.4 ± 0.38	151 ± 7.6
1993	1	1	3.1	26.0	210
1992	0	0	0		
1991	1	1	3.1	31.5	380

7.2.3 Bullhead

Table 7.10. Electric fishing efficiencies for bullheads calculated from triple shocks of Section 2 of River Don at Oxspring site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	15	7	6	36	39.4

Table 7.11. Number of bullheads captured in each section of River Don at Oxspring site, together with density and biomass, calculated from efficiencies in Table 7.10. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density (n m^{-2})	Biomass (g m^{-2})
Section 1	21	392	0.135	0.46
Section 2*	28	408	0.088	0.30
Section 3	22	430	0.130	0.44
Section 4	14	439	0.082	0.279
Total	85	1669	0.051	0.173

Table 7.12. The length weight relationship for bullheads at the River Don at Oxspring site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Bullheads	- 1.94	3.07	90.7 %

Table 7.13. Number of bullheads captured in each year class, year class strengths and mean lengths and weights at the River Don at Oxspring.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	47	100	55.2	5.7 ± 0.35	2.39± 0.44
1994	38	81	44.8	7.0 ± 0.37	4.6 ± 0.73

7.2.4 Minnow

Table 7.14. Electric fishing efficiencies for minnows calculated from triple shocks of Section 2 of River Don at Oxspring site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	14	5	8	n/a	n/d

Table 7.15. Number of Minnows captured in each section of River Don at Oxspring site, together with density and biomass, calculated from efficiencies in Table 7.14. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density (n m^{-2})	Biomass (g m^{-2})
Section 1	1	392	0.00255**	0.0089**
Section 2*	27	408	0.066**	0.232**
Section 3	4	430	0.0093**	0.033**
Section 4	10	439	0.0228**	0.080**
Total	42	1669	0.0252**	0.088**

** represent minimum densities and biomass

Table 7.16. The length weight relationship for minnows at the River Don at Oxspring site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Minnows	- 2.16	3.27	94.2 %

Table 7.17. Number of minnows captured in each year class, year class strengths and mean lengths and weights at the River Don at Oxspring.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	39	39	92.9	6.4 ± 0.59	3.1 ± 0.90
1994	3	3	7.1	8.7 ± 0.212	8.0 ± 0.64

7.2.5 Stone loach

Table 7.18. Electric fishing efficiencies for stone loach calculated from triple shocks of Section 2 of River Don at Oxspring site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	0	5	3	n/a	n/d

Table 7.19. Number of stone loach captured in each section of River Don at Oxspring site, together with density and biomass, calculated from efficiencies in Table 7.18. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density (n m^{-2})	Biomass (g m^{-2})
Section 1	10	392	0.0255**	0.184**
Section 2*	8	408	0.0196**	0.141**
Section 3	13	430	0.030**	0.218**
Section 4	3	439	0.0068**	0.049**
Total	34	1669	0.0204**	0.147**

** represents minimum densities and biomass

Table 7.20. The length weight relationship for stone loach at the River Don at Oxspring site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Stone loach	- 2.01	2.91	93.4 %

Table 7.21. Number of stone loach captured in each year class, year class strengths and mean lengths and weights at the River Don at Oxspring.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996					
1995	1	1	2.9	7.0	2.81
1994	33	33	97.1	9.7 ± 0.79	7.4 ± 1.79

7.2.6 Stickleback

Table 7.22. Electric fishing efficiencies for stickleback calculated from triple shocks of Section 2 of River Don at Oxspring site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	5	1	0	6	84.9

Table 7.23. Number of stickleback captured in each section of River Don at Oxspring site, together with density and biomass, calculated from efficiencies in Table 7.22. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1	0	392	0	0
Section 2*	6	408	0.0147	0.0179#
Section 3	0	430	0	0
Section 4	1	439	0.00228	0.00278#
Total	7	1669	0.0042	0.0051#

Estimates of biomass derived from stickleback length weight relationship for fish captured in upper Frome (Log_{10} W (g) = -1.93 + 3.14 Log_{10} L (cm)

Table 7.24. The length weight relationship for stickleback at the River Don at Oxspring site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Stickleback	n/a	n/a	n/a

Table 7.25. Number of stickleback captured in each year class, year class strengths and mean lengths and weights at the River Don at Oxspring site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d. *
1996					
1995	7	7	100	4.4 ± 0.40	1.22± 0.33

* Estimates of biomass derived from stickleback length weight relationship for fish captured in upper Frome (Log_{10} W (g) = -1.93 + 3.14 Log_{10} L (cm)

7.3 Discussion

7.3.1 Brown trout

A greater number of trout were captured at this site than in April, but examination of the scales suggested that approximately 40% of the trout greater then 20 cm were of stocked origin. It is not thought that the riparian owner at that site stocks himself, but neighbouring fisheries could.

There was some evidence of increased growth rates after the first year in some of the older fish (Ibbotson *et al.*, 1996). This may be the result of downstream migration from upstream or out of feeder streams by juveniles after their first year. Thus numbers of trout in the 1996 year class may increase at this site when sampling is repeated in March/April 1997 as fish migrate downstream from small feeder streams upstream and real comparisons cannot be made until that sampling is completed.

7.3.2 Other species

A small number of grayling were captured. There is an apparent increase in the number of fish from the 1995 year class, but 0+ grayling are notoriously difficult to capture by electric fishing and this apparent increase will be the result of this. This 1995 year class appears to be strong.

As discussed in the initial report (Ibbotson *et al.*, 1996) it is hard to attach any confidence to the efficiency of capture or the estimated population density and biomass for the small species, bullhead, minnows, stone loach and stickleback, even where a catch depletion is obtained.

8. EWDEN BECK

8.1 River conditions

Conditions for electric fishing at this site were good with the river low and clear.

8.2 Results

8.2.1 Brown trout

Table 8.1. Electric fishing efficiencies for brown trout calculated from triple shocks of Section 4 of Ewden Beck site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	58	17	5	82	70.6

Table 8.2. Number of brown trout captured in each section of Ewden Beck site, together with density and biomass, calculated from efficiencies in Table 8.5. (* = section fished for triple shock estimate of efficiency). Sections are ordered in an upstream direction. That is Section 1 is the section furthest downstream and Section 4 is the furthest upstream.

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1	24	500	0.066	2.43
Section 2	50	345	0.188	8.2
Section 3	61	319	0.292	7.3
Section 4*	80	253	0.324	10.2
Total	215	1417	0.193	6.3

Table 8.3. The length weight relationship for brown trout at the Ewden Beck site. Relationship equates to $Log_{10} W (g) = a + b Log_{10} L (cm)$.

	a	b	R^2
Brown Trout	- 1.81	2.92	99.1 %

Table 8.4. Number of brown trout captured in each year class, year class strengths and mean lengths and weights at the Ewden Beck site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	78	112	41.0	8.0 ± 1.06	7.1 ± 2.61
1995	98	113	41.4	13.9 ± 1.47	35 ± 10.9
1994	39	48	17.6	19.1 ± 1.34	86 ± 18.0

Table 8.5. Information for HABSCORE from the Ewden Beck site. Section 4 provided estimate for triple shock estimate.

	No. of fish captured				Efficiency (%)	Estimated number in each section together with density (n m^{-2}) in brackets				Estimated total biomass in each section (g) together with g m^{-2} in brackets			
	Sect 1	Sect 2	Sect 3	Sect 4		Sect 1	Sect 2	Sect 3	Sect 4	Sect 1	Sect 2	Sect 3	Sect 4
0+ Trout	6	6	33	19/12/2	57.9	10 (0.02)	10 (0.0290)	57 (0.179)	35 (0.138)	71 (0.142)	71 (0.206)	405 (1.27)	249 (0.98)
Trout <20 cm older than 1	17	41	25	36/5/2	81.3	21 (0.042)	50 (0.145)	31 (0.097)	43 (0.170)	924 (1.85)	2200 (6.4)	1364 (4.3)	1892 (7.5)
Trout >20 cm	1	3	3	3/0/1	56.5	2 (0.004)	5 (0.0145)	5 (0.0157)	4 (0.0158)	220 (0.44)	550 (1.59)	550 (1.72)	440 (1.74)

8.2.2 Rainbow trout

Table 8.6. Electric fishing efficiencies for rainbow trout calculated from triple shocks of Section 4 of Ewden Beck site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	5	0	0	5	100

Table 8.7. Number of rainbow trout captured in each section of Ewden Beck site, together with density and biomass, calculated from efficiencies in Table 8.10. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1	4	500	0.008	0.4
Section 2	0	345	0	0
Section 3	0	319	0	0
Section 4*	5	253	0.0157	0.78
Total	9	1417	0.0064	0.32

Table 8.8. The length weight relationship for rainbow trout at the Ewden Beck site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Rainbow Trout	- 1.47	2.62	59.3 %

Table 8.9. Number of rainbow trout captured in each year class, year class strengths and mean lengths and weights at the Ewden Beck site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	9	9	100	16.1 ± 0.72	50 ± 7.3

Table 8.5. Information for HABSCORE from the Ewden Beck site. Section 4 provided estimate for triple shock estimate.

	No. of fish captured				Efficiency (%)	Estimated number in each section together with density (n m^{-2}) in brackets				Estimated total biomass in each section (g) together with g m^{-2} in brackets			
	Sect 1	Sect 2	Sect 3	Sect 4		Sect 1	Sect 2	Sect 3	Sect 4	Sect 1	Sect 2	Sect 3	Sect 4
0+ Trout	6	6	33	19/12/2	57.9	10 (0.02)	10 (0.0290)	57 (0.179)	35 (0.138)	71 (0.142)	71 (0.206)	405 (1.27)	249 (0.98)
Trout <20 cm older than 1	17	41	25	36/5/2	81.3	21 (0.042)	50 (0.145)	31 (0.097)	43 (0.170)	924 (1.85)	2200 (6.4)	1364 (4.3)	1892 (7.5)
Trout >20 cm	1	3	3	3/0/1	56.5	2 (0.004)	5 (0.0145)	5 (0.0157)	4 (0.0158)	220 (0.44)	550 (1.59)	550 (1.72)	440 (1.74)

8.3 Discussion

8.3.1 Rainbow trout

A discussion of this population was given in the initial report (Ibbotosn *et al.*, 1996). It was concluded that their presence was either due to a natural spawning or were added either as escapees from farms or deliberately stocked. The complete absence of any fish from a 1996 year class supports the idea that these fish were introduced to the river during 1995. A few of these have survived and remained in the river and are now age 1+, although their mortality appears to much higher than for the brown trout.

As suggested in the initial report (Ibbotson *et al.*, 1996) it is recommended that past records of stocking held at the Environment Agency and within Yorkshire Water are checked to see if any fry were introduced in the spring of 1995. The presence of other potential sources such as a hatchery upstream should also be investigated.

8.3.2 Brown trout

Again the population structure for trout in this stream was unusual with no fish greater than 22 cm found. The reason for this is still unclear as the habitat at this site contained plenty of cover and deep water and was suitable to support larger trout. It is possible that angling pressure removes the larger fish, as fishery byelaws set a minimum size of 23 cm for brown trout.

Three trout between 14 and 17 cm showed evidence of being stocked with large numbers of replacement scales. It is possible that these were stocked along with the rainbow trout as fry in 1995.

The population structure of both the brown and rainbow trout suggest that there may have been some event that resulted in large or complete mortality of fish and that these were replaced with a large stocking of rainbow and brown trout fry in 1995.

9. LITTLE DON D/S UNDERBANK RESERVOIR

9.1 River conditions

Conditions for electric fishing were good with the water low and clear. A previous attempt to sample this site had been abandoned the day before, because a small amount of rain had increased water levels sufficiently to disturb the abundant ochrous substrate at this site.

9.2 Results

9.2.1 Brown trout

Table 9.1. Electric fishing efficiencies for brown trout calculated from triple shocks of Section 1 of Little Don d/s Underbank Reservoir site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	2	0	0	2	100

Table 9.2. Number of brown trout captured in each section of Little Don d/s Underbank Reservoir site, together with density and biomass, calculated from efficiencies in Table 9.1. (* = section fished for triple shock estimate of efficiency). Sections are ordered in an upstream direction. That is Section 1 is the section furthest downstream and Section 4 is the furthest upstream.

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	2	328	0.0061	0.139
Section 2	4	416	0.0096	0.145
Section 3	2	416	0.0048	0.109
Section 4	7	363	0.0193	3.1
Total	15	1523	0.0098	0.83

Table 9.3. The length weight relationship for brown trout at the Little Don d/s Underbank Reservoir site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Brown Trout	- 1.84	2.92	99.3 %

Table 9.4. Number of brown trout captured in each year class, year class strengths and mean lengths and weights at the Little Don d/s Underbank Reservoir site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	7	7	46.7	8.5 ± 0.45	7.5 ± 1.16
1995	4	4	26.7	14.8 ± 1.03	38 ± 8.0
1994	2	2	13.3	23.3 ± 4.31	148 ± 77
1993	2	2	13.3	32.5 ± 0.99	380 ± 33

Table 9.5. Information for HABSCORE from the Little Don d/s Underbank Reservoir site. Section 1 provided estimate for triple shock estimate.

	No. of fish captured				Efficiency (%)	Estimated number in each section together with density (n m^{-2}) in brackets				Estimated total biomass in each section (g) together with g m^{-2} in brackets			
	Sect 1	Sect 2	Sect 3	Sect 4		Sect 1	Sect 2	Sect 3	Sect 4	Sect 1	Sect 2	Sect 3	Sect 4
0+ Trout	1/0/0	3	1	2	100	1 (0.003)	3 (0.0072)	1 (0.0024)	2 (0.0055)	7.5 (0.0229)	22.5 (0.054)	7.5 (0.018)	15 (0.041)
Trout <20 cm older than 1	1/0/0	1	1	1	100	1 (0.003)	1 (0.0024)	1 (0.0024)	1 (0.0028)	38 (0.116)	38 (0.091)	38 (0.091)	38 (0.105)
Trout >20 cm	0/0/0	0	0	4	n/d	0 (0)	0 (0)	0 (0)	4 (0.0110)	0 (0)	0 (0)	0 (0)	1056 (2.91)

9.2.2 Bullhead

Table 9.6. Electric fishing efficiencies for bullheads calculated from triple shocks of Section 1 of Little Don d/s Underbank Reservoir site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	27	15	14	85	29.9

Table 9.7. Number of bullheads captured in each section of Little Don d/s Underbank Reservoir site, together with density and biomass, calculated from efficiencies in Table 9.6. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	56	328	0.259	1.19
Section 2	32	416	0.257	1.18
Section 3	48	416	0.39	1.78
Section 4	26	363	0.240	1.10
Total	162	1523	0.289	1.33

** represents minimum density and biomass

Table 9.8. The length weight relationship for bullheads at the Little Don d/s Underbank Reservoir site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Bullheads	- 2.24	3.38	98.3 %

Table 9.9. Number of bullheads captured in each year class, year class strengths and mean lengths and weights at the Little Don d/s Underbank Reservoir site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	12	33	7.5	3.6 ± 0.39	0.45±0.148
1995	95	258	58.6	6.3 ± 0.72	3.1 ± 1.06
1994	55	149	33.9	8.4 ± 0.77	8.0 ± 2.62

9.3.3 Perch

Table 9.10. Electric fishing efficiencies for perch calculated from triple shocks of Section 1 of Little Don d/s Underbank Reservoir site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	0	0	0	0	n/d

Table 9.11. Number of perch captured in each section of Little Don d/s Underbank Reservoir site, together with density and biomass, calculated from efficiencies in Table 9.10. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density (n m^{-2})	Biomass (g m^{-2})
Section 1*	0	328		
Section 2	0	416		
Section 3	0	416		
Section 4	58	363	0.160**	2.13**
Total	58	1523	0.038**	0.80**

** represents minimum density and biomass

Table 9.12. The length weight relationship for perch at the Little Don d/s Underbank Reservoir site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Perch	- 2.07	3.17	99.0 %

Table 9.13. Number of perch captured in each year class, year class strengths and mean lengths and weights at the Little Don d/s Underbank Reservoir site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	44	44	75.9	9.7 ± 0.56	11.4 ±2.20
1994	13	13	22.4	14.7 ± 2.13	45 ± 20.7
1993	1	1	1.7	20.2	117

9.2.4 Ruffe

Table 9.14. Electric fishing efficiencies for ruffe calculated from triple shocks of Section 1 of Little Don d/s Underbank Reservoir site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	0	1	0	n/a	n/d

Table 9.15. Number of ruffe captured in each section of Little Don d/s Underbank Reservoir site, together with density and biomass, calculated from efficiencies in Table 9.14. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	1	328	0.0030**	0.0226**
Section 2	0	416	0	0
Section 3	0	416	0	0
Section 4	1	363	0.028**	0.030**
Total	2	1523	0.00131**	0.0110**

** represents minimum density and biomass

Table 9.16. The length weight relationship for ruffe at the Little Don d/s Underbank Reservoir site. Relationship equates to $Log_{10} W (g) = a + b\ Log_{10} L (cm)$.

	a	b	R^2
Ruffe	n/a	n/a	n/a

Table 9.17. Number of ruffe captured in each year class, year class strengths and mean lengths and weights at the Little Don d/s Underbank Reservoir site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996					
1995	2	2	100	8.45 ± 1.48	8.35 ± 3.6

9.3 Discussion

9.3.1 Brown trout

As discussed in the initial report (Ibbotson *et al.*, 1996) the population of brown trout captured at this site was heavily influenced by the presence of the weir pool in the top section. All the trout greater than 20 cm were captured in this artificial habitat. The largest of the trout (33.2 cm) appeared to be stocked with a pre-dominance of replacement scales.

9.3.2 Other species

The presence of perch and ruffe is attributed to the reservoir upstream.

Again (Ibbotson *et al.*, 1996) it is hard to attach any confidence to the efficiency of capture or the estimated population density and biomass for bullheads even though a catch depletion is obtained.

10. RIVER LOXLEY AT STORRS LANE BRIDGE

10.1 Site description

Conditions for electric fishing were good with the river low and clear.

10.2 Results

10.2.1 Brown trout

Table 10.1. Electric fishing efficiencies for brown trout calculated from triple shocks of Section 2 of River Loxley at Storrs Lane Bridge site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	87	24	11	126	67.3

Table 10.2. Number of brown trout captured in each section of River Loxley at Storrs Lane Bridge site, together with density and biomass, calculated from efficiencies in Table 10.5. (* = section fished for triple shock estimate of efficiency). Sections are ordered in an upstream direction. That is Section 1 is the section furthest downstream and Section 4 is the furthest upstream.

	No. of fish captured	Area (m^2)	Density (n m^{-2})	Biomass (g m^{-2})
Section 1	55	340	0.215	15.0
Section 2*	122	319	0.40	12.2
Section 3	64	334	0.275	9.4
Section 4	40	369	0.165	6.2
Total	281	1362	0.259	10.6

Table 10.3. The length weight relationship for brown trout at the River Loxley at Storrs Lane Bridge site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Brown Trout	- 1.87	2.95	98.7 %

Table 10.4. Number of brown trout captured in each year class, year class strengths and mean lengths and weights at the River Loxley at Storrs Lane Bridge site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	101	138	39.1	6.6 ± 0.80	3.6 ± 1.27
1995	100	120	34.0	13.1 ± 2.31	29.3 ±14.3
1994	56	67	18.9	18.9 ± 1.49	80 ± 18.7
1993	22	26	7.4	23.8 ± 1.64	157 ± 34
1992	2	2	0.6	34	450

Table 10.5. Information for HABSCORE from the River Loxley at Storrs Lane Bridge site. Section 2 provided estimate for triple shock estimate.

	No. of fish captured				Efficiency (%)	Estimated number in each section together with density (n m^{-2}) in brackets				Estimated total biomass in each section (g) together with g m^{-2} in brackets			
	Sect 1	Sect 2	Sect 3	Sect 4		Sect 1	Sect 2	Sect 3	Sect 4	Sect 1	Sect 2	Sect 3	Sect 4
0+ Trout	5	38/14/8	18	18	56.5	9 (0.0265)	65 (0.204)	32 (0.096)	32 (0.087)	32 (0.094)	234 (0.73)	115 (0.34)	115 (0.31)
Trout <20 cm older than 1	32	41/8/3	42	15	76.3	42 (0.124)	52 (0.163)	55 (0.165)	20 (0.054)	1722 (5.1)	2132 (6.7)	2255 (6.8)	820 (2.22)
Trout >20 cm	18	8/2/0	4	7	82.1	22 (0.065)	10 (0.031)	5 (0.0150)	9 (0.0244)	3344 (9.8)	1520 (4.8)	760 (2.28)	1368 (3.7)

10.2.2 Bullhead

Table 10.11. Electric fishing efficiencies for bullheads calculated from triple shocks of Section 2 of River Loxley at Storrs Lane Bridge site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	15	4	0	19	81.2

Table 10.12. Number of bullheads captured in each section of River Loxley at Storrs Lane Bridge site, together with density and biomass, calculated from efficiencies in Table 10.11. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1	10	340	0.035	0.205
Section 2*	19	319	0.060	0.345
Section 3	4	334	0.0150	0.087
Section 4	9	369	0.0298	0.173
Total	42	1362	0.035	0.200

Table 10.13. The length weight relationship for bullheads at the River Loxley at Storrs Lane Bridge site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Bullheads	- 2.24	3.37	97.0 %

Table 10.14. Number of bullheads captured in each year class, year class strengths and mean lengths and weights at the River Loxley at Storrs Lane Bridge site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	2	2	4.3	3.7 ± 0.35	0.45±0.071
1995	39	44	93.6	7.7 ± 0.91	5.8 ± 2.46
1994	1	1	2.1	11.2	17.8

10.2.3 Perch

Table 10.19. Electric fishing efficiencies for perch calculated from triple shocks of Section 2 of River Loxley at Storrs Lane Bridge site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	0	0	0	0	n/d

Table 10.20. Number of perch captured in each section of River Loxley at Storrs Lane Bridge site, together with density and biomass, calculated from efficiencies in Table 1. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density (n m^{-2})	Biomass (g m^{-2})
Section 1	1	340	0.00294**	0.103**
Section 2*	0	319	0	0
Section 3	0	334	0	0
Section 4	0	369	0	0
Total	0	1362	0.00073**	0.0257**

** represent minimum density and biomass estimates

Table 10.21. The length weight relationship for perch at the River Loxley at Storrs Lane Bridge site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Pike	n/a	n/a	n/a

Table 10.22. Number of perch captured in each year class, year class strengths and mean lengths and weights at the River Loxley at Storrs Lane Bridge site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	1	1	100	13.8	35

10.2.4 Stickleback

Table 10.23. Electric fishing efficiencies for stickleback calculated from triple shocks of Section 2 of River Loxley at Storrs Lane Bridge site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	1	0	0	1	100

Table 10.24. Number of stickleback captured in each section of River Loxley at Storrs Lane Bridge site, together with density and biomass, calculated from efficiencies in Table 1. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1	0	340	0	0
Section 2*	1	319	0.0031**	0.00156**
Section 3	0	334	0	0
Section 4	0	369	0	0
Total	0	1362	0.00073**	0.00037

** Estimates of biomass derived from stickleback length weight relationship for fish captured in upper Frome ($Log_{10}W(g) = -1.93 + 3.14\ Log_{10}L(cm)$)

Table 10.25. The length weight relationship for stickleback at the River Loxley at Storrs Lane Bridge site. Relationship equates to $Log_{10}\ W\ (g) = a + b\ Log_{10}\ L\ (cm)$.

	a	b	R^2
Stickleback	n/a	n/a	n/a

Table 10.26. Number of stickleback captured in each year class, year class strengths and mean lengths and weights at the River Loxley at Storrs Lane Bridge site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	1	1	100	3.5	0.50

10.3 Discussion

10.3.1 Brown trout

As found in April (Ibbotson *et al.*, 1996) this site supports high numbers of brown trout. These was evidence of some stocking with a small proportion (10%) having a large number of replacement scales.

10.3.2 Other species

The perch probably came from a local stillwater.

As discussed in the initial report (Ibbotson *et al.*, 1996) it is hard to attach any confidence to the efficiency of capture or the estimated population density and biomass for the small species, bullhead and stickleback, even where a catch depletion is obtained.

11. RIVELIN AT RIVELIN MILL

11.1 Site description

River conditions were good for electric fishing with the water low and clear.

11.2 Results

11.2.1 Brown trout

Table 11.1. Electric fishing efficiencies for brown trout calculated from triple shocks of Section 1 of River Rivelin at Rivelin Mill site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	29	16	4	53	57.4

Table 11.2. Number of brown trout captured in each section of River Rivelin at Rivelin Mill site, together with density and biomass, calculated from efficiencies in Table 11.5. (* = section fished for triple shock estimate of efficiency). Sections are ordered in an upstream direction. That is Section 1 is the section furthest downstream and Section 4 is the furthest upstream.

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	49	300	0.177	8.3
Section 2	57	266	0.36	22.9
Section 3	8	218	0.064	4.1
Section 4	9	322	0.050	2.04
Total	123	1106	0.162	9.2

Table 11.3. The length weight relationship for brown trout at the River Rivelin at Rivelin Mill site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Brown Trout	- 1.89	2.99	99.1 %

Table 11.4. Number of brown trout captured in each year class, year class strengths and mean lengths and weights at the River Rivelin at Rivelin Mill site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	77	113	63.1	13.1 ± 1.62	29.4 ±10.4
1994	27	40	22.4	18.0 ± 0.92	74 ± 11.4
1993	19	26	14.5	22.7 ± 2.06	149 ± 42

Table 11.5. Information for HABSCORE from the River Rivelin at Rivelin Mill site. Section 1 provided estimate for triple shock estimate.

	No. of fish captured				Efficiency (%)	Estimated number in each section together with density (n m^{-2}) in brackets				Estimated total biomass in each section (g) together with g m^{-2} in brackets			
	Sect 1	Sect 2	Sect 3	Sect 4		Sect 1	Sect 2	Sect 3	Sect 4	Sect 1	Sect 2	Sect 3	Sect 4
0+ Trout	0/0/0	0	0	0	n/d	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Trout <20 cm older than 1	27/15/ 4	43	6	9	56.5	50 (0167)	76 (0.286)	11 (0.050)	16 (0.050)	2050 (6.8)	3116 (11.7)	451 (2.07)	656 (2.04)
Trout >20 cm	2/1/0	14	2	0	71.0	3 (0.01)	20 (0.075)	3 (0.0138)	0 (0)	447 (1.49)	2980 (11.2)	447 (2.05)	0 (0)

11.2.2 Stone loach

Table 11.6. Electric fishing efficiencies for stone loach calculated from triple shocks of Section 1 of River Rivelin at Rivelin Mill site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	6	9	9	n/a	n/d

Table 11.7. Number of stone loach captured in each section of River Rivelin at Rivelin Mill site, together with density and biomass, calculated from efficiencies in Table 11.6. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	24	300	0.08**	0.57**
Section 2	6	266	0.0226**	0.160**
Section 3	12	218	0.055**	0.39**
Section 4	14	322	0.043**	0.31**
Total	56	1106	0.051**	0.36**

** represents minimum density and biomass

Table 11.8. The length weight relationship for stone loach at the River Rivelin at Rivelin Mill site. Relationship equates to $Log_{10}\ W\ (g) = a + b\ Log_{10}\ L\ (cm)$.

	a	b	R^2
Stone loach	- 2.01	2.91	93.4 %

Table 11.9. Number of stone loach captured in each year class, year class strengths and mean lengths and weights at the River Rivelin at Rivelin Mill site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	6	6	10.7	7.0 ± 0.235	2.53±0.54
1994	40	40	71.4	9.3 ± 0.75	6.4 ± 1.57
1993	10	10	17.9	11.6 ± 0.48	12.4 ±1.23

11.2.3 Stickleback

Table 11.10. Electric fishing efficiencies for stickleback calculated from triple shocks of Section 1 of River Rivelin at Rivelin Mill site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	3	3	2	18	17.1

Table 11.11. Number of stickleback captured in each section of River Rivelin at Rivelin Mill site, together with density and biomass, calculated from efficiencies in Table 1. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	8	300	0.06	0.044
Section 2	0	266	0	0
Section 3	2	218	0.055	0.040
Section 4	30	322	0.54	0.40
Total	40	1106	0.185	0.135

Table 11.12. The length weight relationship for stickleback at the River Rivelin at Rivelin Mill site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Stickleback	-1.60	2.46	88.1

Table 11.13. Number of stickleback captured in each year class, year class strengths and mean lengths and weights at the River Rivelin at Rivelin Mill site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d. *
1996	1	5	2.4	2.5	0.20
1995	36	185	90.2	3.8 ± 0.33	0.67±0.163
1994	3	15	7.3	5.4±0.27	1.53±0.189

11.2.4 Perch

Table 11.14. Electric fishing efficiencies for perch calculated from triple shocks of Section 1 of River Rivelin at Rivelin Mill site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	1	0	0	1	100

Table 11.15. Number of perch captured in each section of River Rivelin at Rivelin Mill site, together with density and biomass, calculated from efficiencies in Table 11.14. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	1	300	0.0033	0.054
Section 2	0	266	0	0
Section 3	0	218	0	0
Section 4	0	322	0	0
Total	1	1106	0.00090	0.0146

Table 11.16. The length weight relationship for perch at the River Rivelin at Rivelin Mill site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Perch	n/a	n/a	n/a

Table 11.17. Number of perch captured in each year class, year class strengths and mean lengths and weights at the River Rivelin at Rivelin Mill site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	0	0	0		
1995	0	0	0		
1994	1	1	100	16.2	80

11.2.5. Minnow

Table 11.18. Electric fishing efficiencies for minnows calculated from triple shocks of Section 1 of River Rivelin at Rivelin Mill site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	0	0	0	0	n/d

Table 11.19. Number of minnows captured in each section of River Rivelin at Rivelin Mill site, together with density and biomass, calculated from efficiencies in Table 11.18. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	0	300	0	0
Section 2	1	266	0.0038**	0.026**
Section 3	0	218	0	0
Section 4	0	322	0	0
Total	1	1106	0.00090**	0.0063**

** represents minimum density

Table 11.20. The length weight relationship for minnows at the River Rivelin at Rivelin Mill site. Relationship equates to Log_{10} W (g) = a + b Log_{10} L (cm).

	a	b	R^2
Minnows	n/a	n/a	n/a

Table 11.21. Number of minnows captured in each year class, year class strengths and mean lengths and weights at the River Rivelin at Rivelin Mill site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996					
1995	1	1	100	8.4	7.0

11.2.6 Roach

Table 11.22. Electric fishing efficiencies for roach calculated from triple shocks of Section 1 of River Rivelin at Rivelin Mill site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	2	1	1	5	31.8

Table 11.23. Number of roach captured in each section of River Rivelin at Rivelin Mill site, together with density and biomass, calculated from efficiencies in Table 11.18. (* = section fished for triple shock estimate of efficiency)

	No. of fish captured	Area (m^2)	Density ($n\ m^{-2}$)	Biomass ($g\ m^{-2}$)
Section 1*	4	300	0.0167	0.68
Section 2	4	266	0.049	2.0
Section 3	1	218	0.0138	0.56
Section 4	0	322	0	0
Total	9	1106	0.0190	0.78

Table 11.24. The length weight relationship for roach at the River Rivelin at Rivelin Mill site. Relationship equates to $Log_{10} W (g) = a + b Log_{10} L (cm)$.

	a	b	R^2
Roach	-1.20	2.48	90.3%

Table 11.25. Number of roach captured in each year class, year class strengths and mean lengths and weights at the River Rivelin at Rivelin Mill site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996					
1995					
1994					
1993	9	21	100	13.6 ± 0.95	41 ± 7.4

11.3 Discussion

11.3.1 Brown trout

The most notable aspect of this site was the apparent complete failure of brown trout recruitment in 1996, compared to the presence of high numbers from 1995. Confirmation of this failure to recruit will be obtained from the March/April 1997 survey.

All fish greater than 23 cm were of stocked origin as assessed from the high number of replacement scales.

11.3.2 Other species

The presence of perch and roach was attributed to the proximity of a number of ponds.

As discussed in the initial report (Ibbotson *et al.*, 1996) it is hard to attach any confidence to the efficiency of capture or the estimated population density and biomass for the small species, minnows, stone loach and stickleback, even where a catch depletion is obtained.

12. COLDEN WATER at HEBDEN BRIDGE

12.1 River conditions

The river was in good condition for electric fishing with the water slightly peat coloured but clear and low flowing.

12.2 Results

12.2.1 Brown trout

Table 12.1. Electric fishing efficiencies for brown trout calculated from triple shocks of Section 2 of Colden Water, Hebden Bridge site

	Shock 1	Shock 2	Shock 3	Estimated total	Efficiency (%)
Number (n)	29	15	9	63	45.0

Table 12.2. Number of brown trout captured in each section of Colden Water, Hebden Bridge site, together with density and biomass, calculated from efficiencies in Table 12.5. (* = section fished for triple shock estimate of efficiency). Sections are ordered in an upstream direction. That is Section 1 is the section furthest downstream and Section 4 is the furthest upstream.

	No. of fish captured	Area (m^2)	Density (n m^{-2})	Biomass (g m^{-2})
Section 1	17	283	0.120	4.2
Section 2*	53	254	0.248	5.0
Section 3	24	324	0.167	3.5
Section 4	29	347	0.170	6.3
Total	123	1208	0.174	4.8

Table 12.3. The length weight relationship for brown trout at the Colden Water, Hebden Bridge site. Relationship equates to $Log_{10} W (g) = a + b Log_{10} L (cm)$.

	a	b	R^2
Brown Trout	- 2.05	3.09	99.3 %

Table 12.4. Number of brown trout captured in each year class, year class strengths and mean lengths and weights at the Colden Water, Hebden Bridge site.

Yearclass	No. of fish captured	Estimated number in each year class	Year class strength (% of total fish captured	Mean length (cm) ± s.d.	Mean weight (g) ± s.d.
1996	66	117	55.7	7.8 ± 1.00	5.4 ± 2.02
1995	35	61	29.0	14.5 ± 1.28	35 ± 9.9
1994	20	30	14.3	19.2 ± 1.98	86 ± 30
1993	2	2	1.0	31 ± 2.76	360 ± 99

Table 12.5. Information for HABSCORE from the Colden Water, Hebden Bridge site. Section 2 provided estimate for triple shock estimate.

	No. of fish captured				Efficiency (%)	Estimated number in each section together with density (n m^{-2}) in brackets				Estimated total biomass in each section (g) together with g m^{-2} in brackets			
	Sect 1	Sect 2	Sect 3	Sect 4		Sect 1	Sect 2	Sect 3	Sect 4	Sect 1	Sect 2	Sect 3	Sect 4
0+ Trout	8	18/11/6	12	11	41.6	19 (0.067)	43 (0.169)	29 (0.090)	26 (0.075)	103 (0.36)	232 (0.91)	157 (0.48)	140 (0.40)
Trout <20 cm older than 1	6	10/4/3	12	14	48.4	12 (0.042)	19 (0.075)	25 (0.077)	29 (0.084)	540 (1.91)	855 (3.4)	1125 (3.5)	1305 (3.8)
Trout >20 cm	3	1/0/0	0	4	100	3 (0.0106)	1 (0.0039)	0 (0)	4 (0.0115)	543 (1.92)	181 (0.71)	0 (0)	724 (2.09)

12.3 Discussion

As in April (Ibbotson *et al.*, 1996) the population of brown trout looked natural although it is probable that some of the larger fish have been removed by angling. There was no evidence of any stocking with all the fish exhibiting natural growth rates.

13. COMPARISON BETWEEN APRIL AND OCTOBER SURVEYS

There are a number of problems in making direct comparisons between the data collected in April 1996 and the data collected in October 1996.

The estimates of abundance of many of the fish species should be regarded with a great deal of caution since it is not possible to attach any confidence to the efficiency of capture for bullhead, stickleback, minnow and stone loach.

Other species were captured in low numbers, sporadically or were not natural to rivers of this type and had probably come from neighbouring still-waters. Amongst these were perch, roach, pike and ruffe.

Of those species remaining, only brown trout were captured at all sites; rainbow trout and grayling have been observed in two and dace at one (Table 13.1 & 13.2).

Direct statistical comparisons between the catches in April and those in October, have not been completed since both surveys occurred at separate times of the year, and the influence of season cannot be separated from the influence of flow.

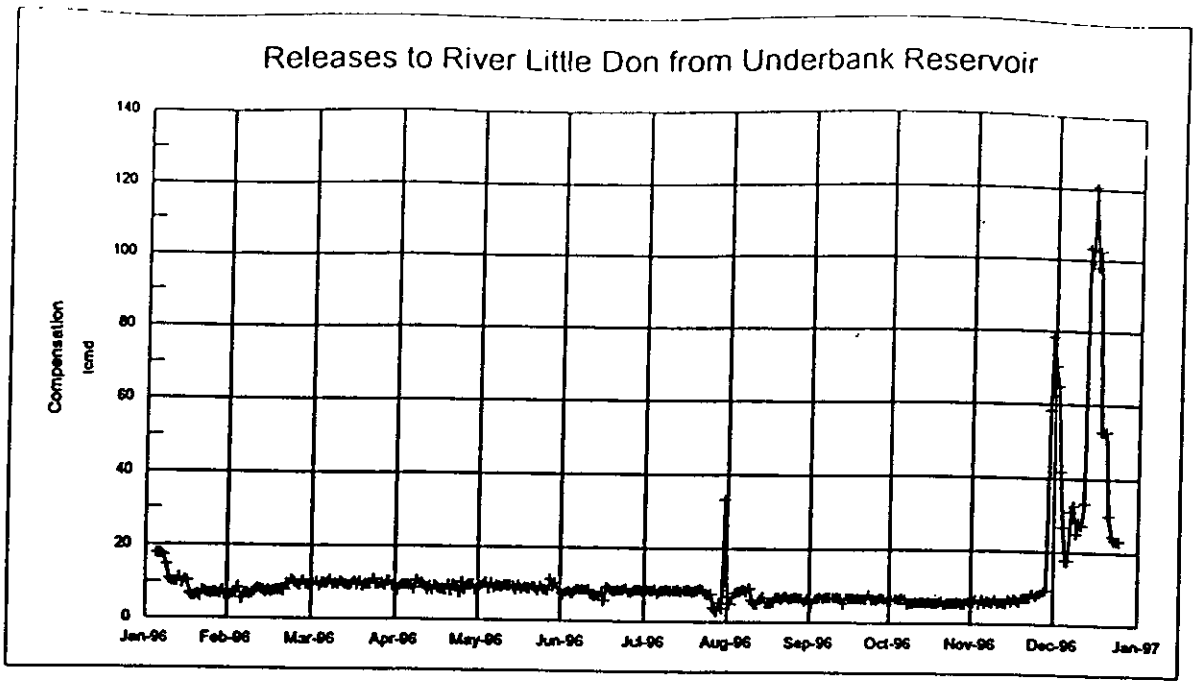
Thus, this part of the report considers brown trout populations only and in particular the 0+ trout, which are the group where the effects of reductions in flow are most likely to be observed.

13.1 River Don d/s Winscar Reservoir

There is a decline in the estimated density, biomass and number of 0+ fish at this site. However, the most noticeable difference at this site in 1996 over 1995 is that the growth rate of the 0+ fish has been substantially greater, the 0+ fish already being larger in October than the previous year-class were in April, one year after their birth (Table 13.3). It is not known whether the 1+ or two plus fish will also be larger in size by April, than their 1995 counterparts.

Increases in growth rate could occur for a number of reasons. Most likely is that they would result from a reduction in density or an increase in temperature. Density has apparently reduced between years at this site and this could be one contributor. The other potential contributor is a change in the temperature of the water released from the reservoir. In 1996 the reservoir stocks were at very low levels (Fig. 13.1c) and the water released may therefore have been warmer than in 1995 when cool bottom water would have been the primary release.

The differences in density, biomass and growth rates will be confirmed after the April survey.



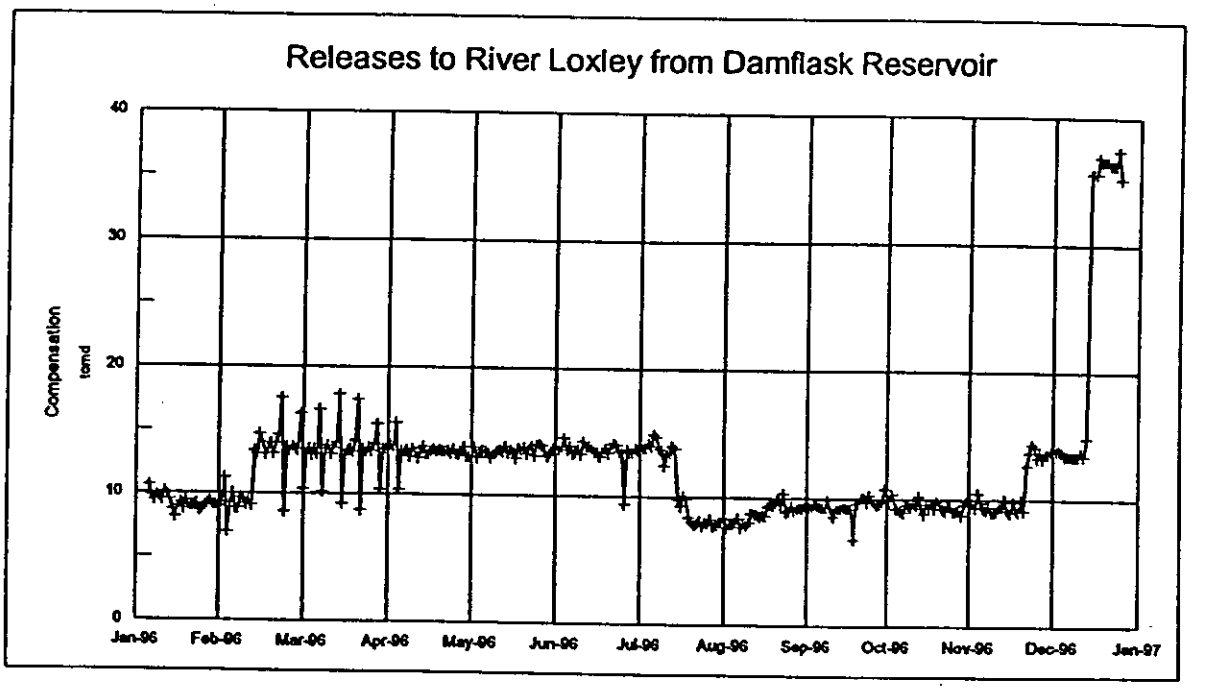
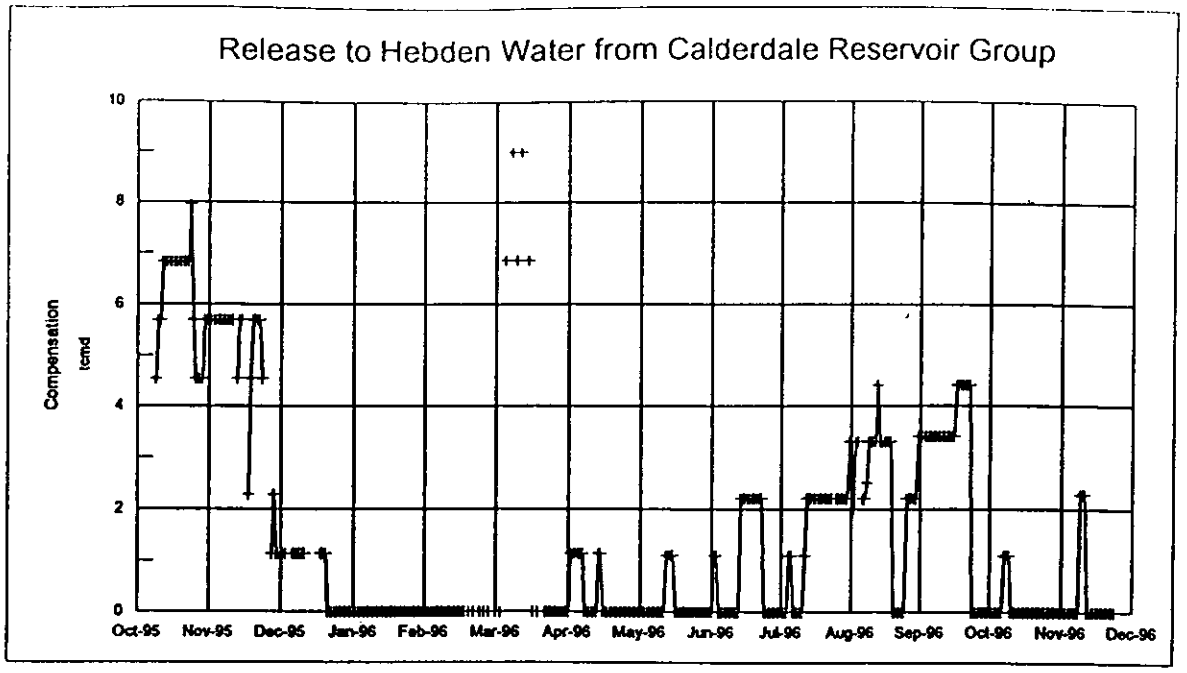


Figure 13.1a Hydrographs of releases from Under bank Reservoir and Damflask Reservoir in 1996.



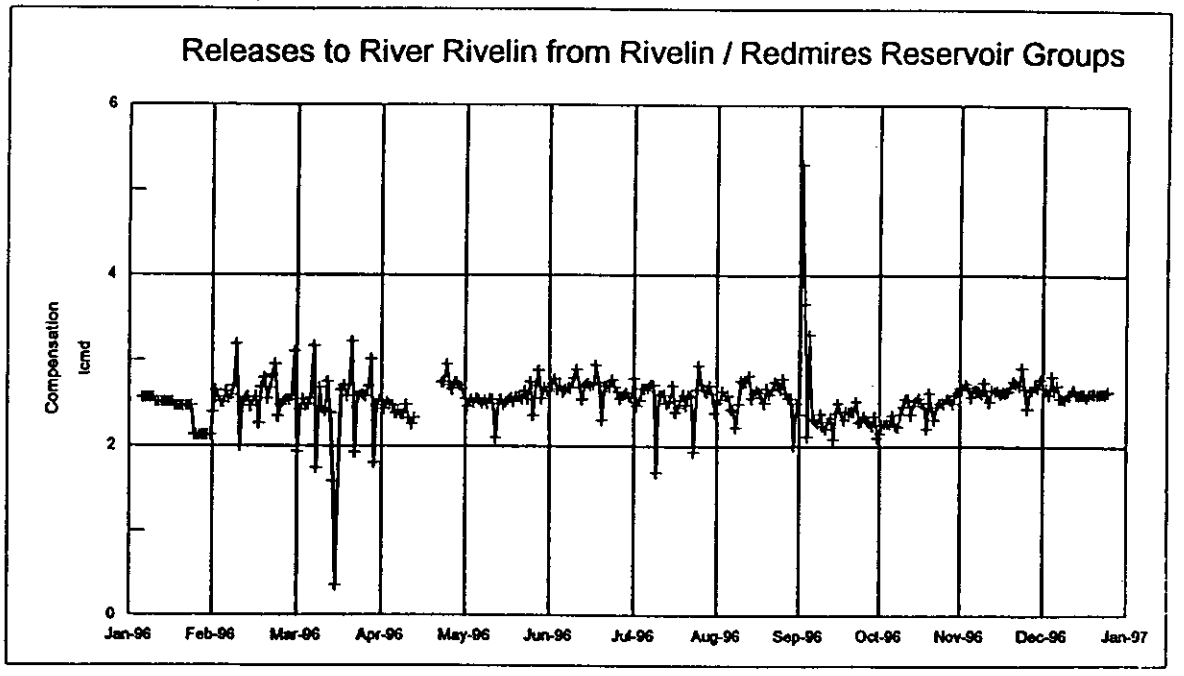


Figure 13.1b Hydrographs of releases from Calderdale Reservoir Group and Redmire Reservoir Group in 1996.

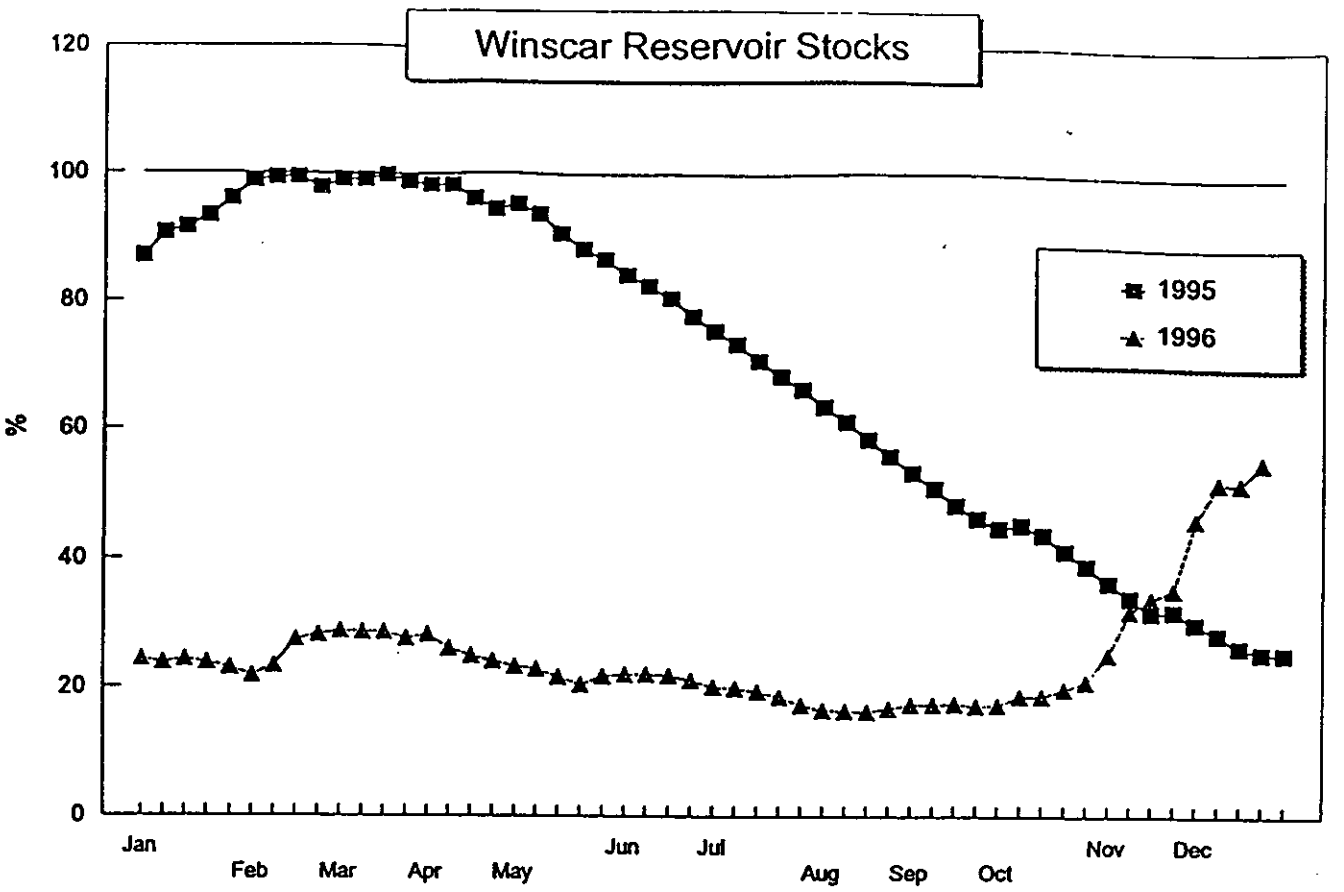
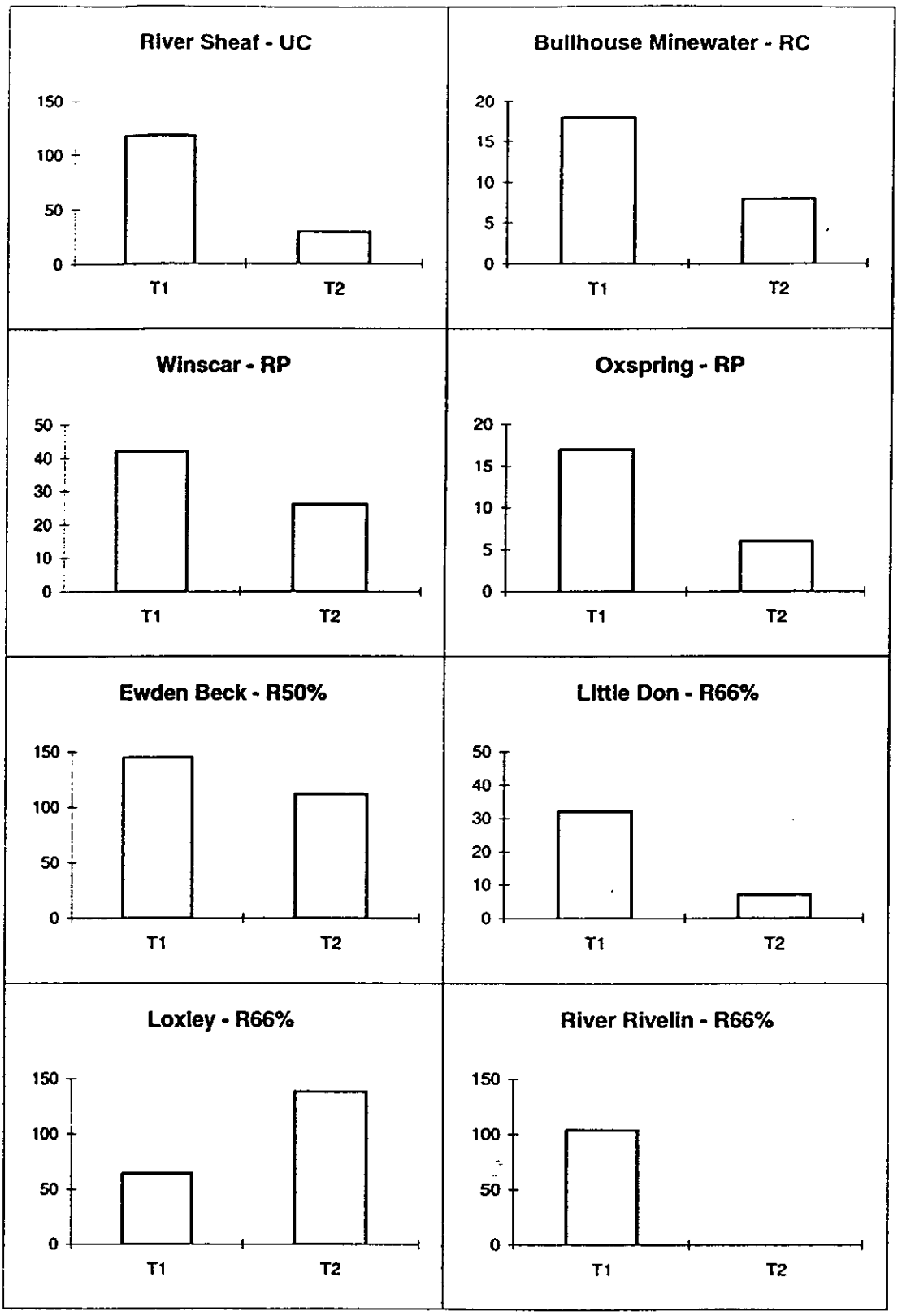
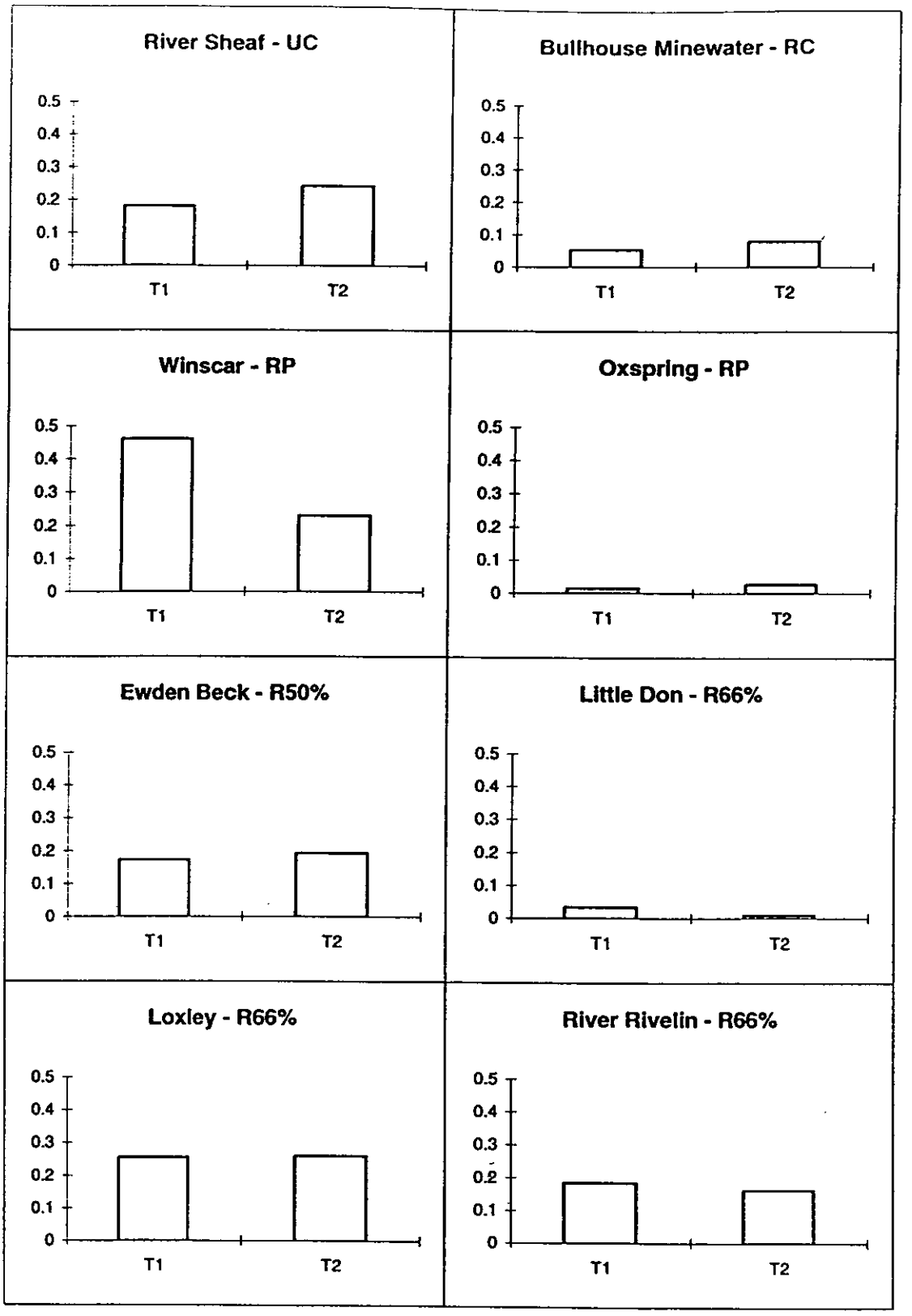


Figure 13.1c Winscar Reservoir stocks in 1995 and 1996.



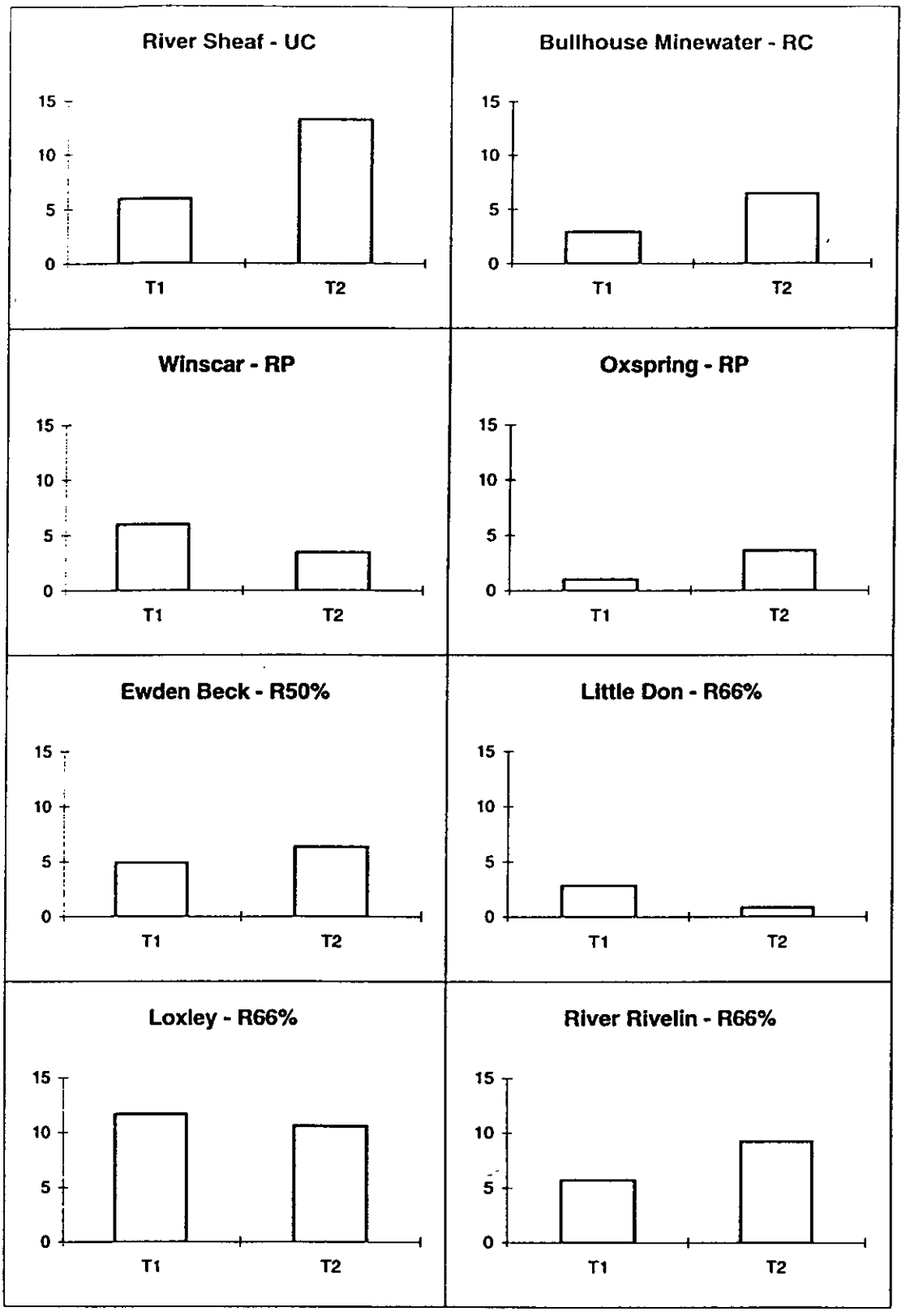
Key:- UC = Unregulated Control. RC = Regulated Control. FR = Fish Rich. FP = Fish Poor. RP = Partly Reduced Regulated. R50% = Reduced 50%. R66% = Reduced 66%

Figure 13.2 Estimated number of 0+ trout from 1995 and 1996 year-classes per 200 m section of river at eight sites on the River Don catchment in April 1996 (T1) and October 1996 (T2).



Key:- UC = Unregulated Control. RC = Regulated Control. FR = Fish Rich. FP = Fich Poor. RP = Partly Reduced Regulated. R50% = Reduced 50%. R66% = Reduced 66%.

Figure 13.3 Estimated density of brown trout (n m^{-2}) in a 200 m section of river at eight sites on the River Don catchment in April 1996 (T1) and October 1996 (T2).



Key:- UC = Unregulated Control. RC = Regulated Control. FR = Fish Rich. FP = Fish Poor. RP = Partly Reduced Regulated. R50% = Reduced 50%. R66% = Reduced 66%.

Figure 13.4 Estimated biomass of brown trout (g m^{-2}) in a 200 m section of river at eight sites on the River Don in April 1996 (T1) and October (T2)

Table 13.1. The density (n m^{-2}) of each fish species at each of eight sites surveyed in April and October 1996

Site Name	Designation	Sample Date	Species										
			Brown Trout	Rainbow Trout	Bullhead	Stickle-back	Minnow	Perch	Grayling	Roach	Stone Loach	Dace	Pike	Ruffe
Sheaf	UC	04/96 10/96	0.181 0.243		0.108 0.0225	0.00090* 0.00180*		0.114 0.064*		0.00090* 0		0.0036* 0.0045*		
Bullhse Mnwtr	RC FR	04/96 10/96	0.052 0.077			0.0170 0.082	0.140 0.31		0.0037 0.0185					
Winscar	RC FR	04/96 10/96	0.46 0.230											
Oxspring	RP	04/96 10/96	0.0150 0.0276		0.118 0.051	0.00060* 0.0042	0.059* 0.0252*		0.0108 0.0192		0.0102* 0.0204*			
Ewden Beck	R50%	04/96 10/96	0.172 0.193	0.030 0.0064						0.00071* 0				
Little Don	R66%	04/96 10/96	0.034 0.0098		0.056* 0.289			0.0072* 0.038*						0.00066* 0.00131*
Loxley	R66%	04/96 10/96	0.254 0.259	0.00073 0	0.048 0.035	0 0.00073*		0 0.00073*					0.00073* 0	
Rivelin	R66%	04/96 10/96	0.183 0.162			0.0127* 0.185	0.00090* 0.00090*	0.0036* 0.00090		0 0.0190	0.074* 0.051*			

* represents minimum density

Key:- UC = Unregulated Control. RC = Regulated Control. FR = Fish Rich. FP = Fish Poor. RP = Partly Reduced Regulated. R50% = Reduced 50%. R66 = Reduced 66%.

Table 13.2. The biomass (g m^{-2}) of each fish species at each of eight sites surveyed in April and October 1996

Site Name	Designation	Sample Date	Species										
			Brown Trout	Rainbow Trout	Bullhead	Stickle-back	Minnow	Perch	Grayling	Roach	Stone Loach	Dace	Pike	Ruffe
Sheaf	UC	04/96 10/96	5.9 13.3		0.77 0.119	0.00090* 0.00180*		0.77 0.064*		0.192* 0		0.47* 0.0045*		
Bullhse Mnwtr	RC	04/96 10/96	2.92 6.5			0.084* 0.0287	0.47 0.31		0.40 1.18					
Winscar	RC	04/96 10/96	6.0 3.4											
Oxspring	RP	04/96 10/96	0.99 3.6		0.35 0.173	0.0006* 0.0051	0.0178* 0.088*		0.52 1.59		0.088* 0.147*			
Ewden Beck	R50%	04/96 10/96	4.9 6.3	0.52 0.32						0.034* 0				
Little Don	R66%	04/96 10/96	2.82 0.83		0.42* 1.33			0.51* 0.80*						0.0053* 0.0110*
Loxley	R66%	04/96 10/96	11.7 10.6	0.106 0	0.34 0.20	0 0.00037		0 0.0257*					0.294* 0	
Rivelin	R66%	04/96 10/96	5.7 9.2			0.036* 0.135	0.0044* 0.0063*	0.210* 0.0146		0 0.78	0.46* 0.36*			

* represents minimum biomass

Key:- UC = Unregulated Control. RC = Regulated Control. FR = Fish Rich. FP = Fish Poor. RP = Partly Reduced Regulated. R50% = Reduced 50%. R66 = Reduced 66%.

Table 13.3 The numbers and mean length of 0+ trout from two year classes captured at 8 sites on the River Don, together with estimates of abundance and year class strength at each site calculated from electric fishing efficiencies.

Site Name	Designation	Number captured		Number estimated, from electric fishing efficiencies to be present at each site		Year class strength (% of total fish captured in that year		Mean lengths (cm) ±	
		1995	1996	1995	1996	1995	1996	1995	1996
Sheaf	UC	45	17	117	29	57.9	10.7	8.0 ± 1.12	6.6 ± 0.82
Bulhouse Mwt	RC	14	5	18	8	24.7	7.7	9.3 ± 0.90	8.0 ± 0.96
Winscar	RC	28	13	42	26	22.5	28.0	5.6 ± 0.95	7.0 ± 0.34
Oxspring	RP	12	5	17	6	68.0	13.0	10.7 ± 1.78	8.4 ± 1.57
Ewden Beck	R50%	107	78	145	112	59.4	41.0	9.1 ± 0.81	8.0 ± 1.06
Little Don	R66%	16	7	32	7	61.5	46.7	9.6 ± 1.39	8.5 ± 0.45
Loxley	R66%	32	101	64	138	17.0	39.1	7.9 ± 1.22	6.6 ± 0.80
Rivelin	R66%	40	0	104	0	51.5	0	8.2 ± 0.95	--

Key:- UC = Unregulated Control. RC = Regulated Control. FR = Fish Rich. FP = Fish Poor. RP = Partly Reduced Regulated. R50% = Reduced 50%. R66 = Reduced 66%.

13.2 Little Don d/s Underbank Reservoir

The density and biomass of brown trout at this site was very low at both April and October (Fig. 13.3; 13.4), and there was a decline in density, biomass and numbers of 0+ fish between surveys, most noticeably in the numbers of 0+ trout (Fig. 13.2). However, the 0+ trout do not appear to have increased their growth rate in response to the reduction in density as they have at the site below Winscar Reservoir.

Reductions in density, biomass and numbers of 0+ trout will be confirmed in the April survey.

13.3 River Rivelin at Rivelin Mill

This is the one site where an obvious impact has occurred which can reasonably be ascribed to a reduction in flow. There appears to have been a total failure of the 1996 brown trout year-class at this site (Fig. 13.2), whereas in 1995 quite high numbers of 0+ trout were found. Examination of the hydrographs for the release into the Rivelin (Fig. 13.1b) show that the release from the reservoir dropped almost to zero for a short period in March 1996. If this correctly reflects the release, then it would be expected that the flow at this site would virtually cease. At this time of year the 1996 year-class would still be in the gravel interstices as eggs or alevins and with no flow they would quickly become de-oxygenated and die.

The survival of the older age groups would have been facilitated by the presence of extensive ponded areas at the site.

Confirmation of the failure of the 1996 year-class will be obtained in the April survey.

13.4 Other sites

In general, density and biomass does not appear to change dramatically at each site, between sampling although biomass is often higher (Sheaf, Bullhouse Minewater, Oxspring and Rivelin) (Fig. 13.4) probably as a result of the increased number of stocked fish found at this time of year.

With the exception of Loxley all sites exhibit a decline in the number of 0+ trout, but it is not always easy to ascribe these observations to changes in flow. In the case of the River Sheaf the sampling was seriously affected by the turbidity of the water in October. At Bullhouse Minewater and Oxspring the number of 0+ brown trout may increase in April as they migrate downstream from upstream nursery areas. There is some evidence that this may have occurred with the 1995 year-class (Ibbotson *et al.*, 1996).

It is still not clear, what the source of the 1995 year-class was in the Ewden Beck and until that is known there is little value in trying to compare the 1995 and 1996 year-classes at this site.

13.5 Impacts of drought orders

The impacts of the drought orders are difficult to determine at this stage of the monitoring programme. Comparisons can only really be made between sites using brown trout because these were the only species captured at every site and there was little confidence that could be attached to the electric fishing of the smaller species. It is further considered that comparisons can only really be made for density and growth rates of 0+ brown trout, since the larger size groups are impacted so much by stocking and angling.

13.5.1 Density of 0+ trout

A fundamental problem of comparing impacted and non-impacted sites was encountered because the unregulated control site on the River Sheaf could not be electric fished reliably due to the turbidity of the water (see Section 4). Additionally, the estimates of abundance of 0+ trout at the regulated control site at Bullhouse Minewater site had to be based on adult efficiency rates at both sampling times because no 0+ trout were captured in the section that was triple shocked.

There were estimated reductions in the numbers of 0+ trout between 1995 and 1996 year-classes at both the regulated controls (Bullhouse Minewater and Winscar). This observation was repeated at all the impacted sites with the exception of Loxley where there was an estimated increase. However, there were very serious declines in the abundance of 0+ brown trout at the Little Don site and the Rivelin site, in the latter case a total failure of recruitment (Fig. 13.2 and Table 13.3).

Because of the seasonal differences affecting mortality and distribution of these fish more detailed comparisons should await the outcome of the final survey in April 1997.

13.5.2 Growth of 0+ trout

Direct comparisons of the growth rate of 0+ trout between the initial survey and this one are not appropriate since season will have a big impact. The only observation of note is the already increased size of the 1996 year-class at Winscar, which is probably due to the change in temperature of the water released from the reservoir in 1996.

Proper comparisons in growth rates can be made after the final survey in April 1997.

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