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River Don and Colden Water fisheries surveys: final report

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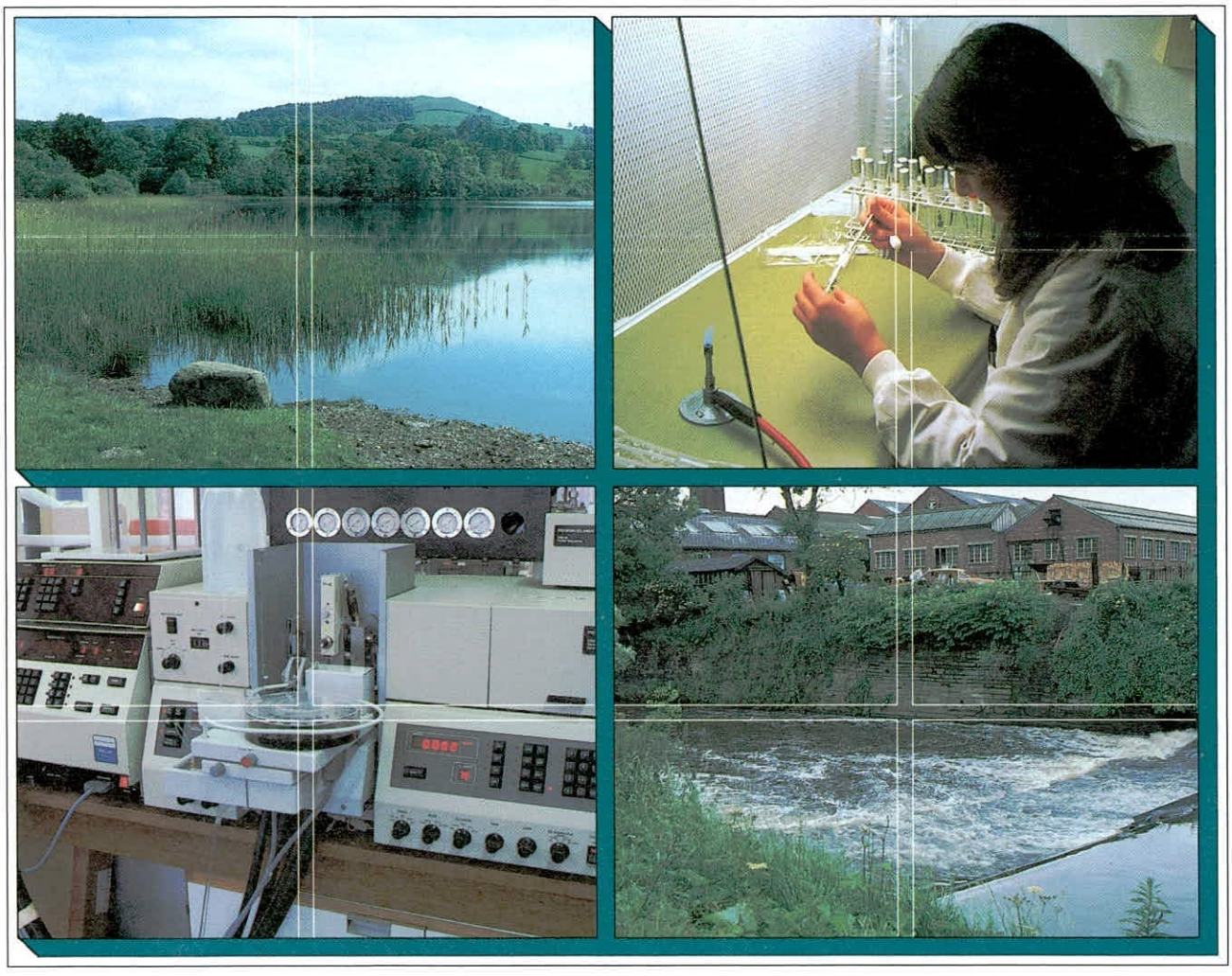

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River Don and Colden Water fisheries surveys: final report

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TABLE OF CONTENTS

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 October 1996 and March 1997.

2. Combining all three surveys a total of 13 species of fish were captured, but only brown trout was common to all sites.

3. There was no clear pattern of changes in brown trout density over all the sites between years. It is concluded that any impacts of the drought orders on brown trout density has been masked by stocking and angling practices.

4. Failures of recruitment of 0+ brown trout were observed in 1996 at two of the sites experiencing drought orders. These were the Little Don and River Rivelin. Recruitment was not observed to change significantly at the other two heavily impacted sites; Ewden Beck and Loxley.

5. Below Winscar reservoir a probable change in the temperature of the water released from this reservoir during 1996 resulted in increased growth rates of 0+ brown trout.

6. The only observed impacts of the drought orders in 1996 were a complete failure in the recruitment of 0+ brown trout during 1996 at the Little Don and River Rivelin, although other impacts may have been masked by stocking and angling activity.

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 March 1997. This report presents the results of the third survey carried out in March 1997, and compares the fish population found at each site in spring 1996 with those found in spring 1997.

3. GENERAL METHODS

3.1. Sampling procedures

Between 24 and 28 March 1997 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	25 March 1997	Unregulated Control	SK 327 823
River Don u/s Bullhouse Minewater	24 March 1997	Regulated Control	SE 213 032
River Don d/s Winscar Reservoir	28 March 1997	Regulated Control	SE 158 024
River Don at Oxspring	25 March 1997	Regulated Part-Affected	SE 278 016
Ewden Beck	26 March 1997	Regulated 50%	SK 293 955
Little Don d/s Underbank Reservoir	26 March 1997	Regulated 66%	SK 255 992
River Loxley at Storrs Lane Bridge	24 March 1997	Regulated 66%	SK 299 895
River Rivelin at Rivelin Mill	28 March 1997	Regulated 66%	SK 289 871
Colden Water at Hebden Bridge	27 March 1997		SD 983 277

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

3.2 Statistical analysis

Numbers or densities of all brown trout or 0+ brown trout between spring 1996 and spring 1997 were compared using the z test (5% level of significance). Since density estimates of single fished sections were calculated using the probability of capture from one other section the standard errors of each density estimate was estimated using Taylor's theorum approximation, treating the density for the whole site as a function of the one probability of capture estimate (Kendall & Stuart, 1977).

The t-test was used to compare differences in growth rates of 0+ trout between years.

4. RIVER SHEAF

4.1 River conditions

The dam above this site had been repaired between visits and the water was low and clear making for good electric fishing conditions.

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)	29	6	2	37	76.2

Table 4.2. Number of brown trout captured in each section of River Sheaf site, together with density and biomass, calculated from efficiencies in Table 4.5. (* = 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*	37	263	0.140	6.5
Section 2	22	290	0.1	4.6
Section 3	40	286	0.181	10.5
Section 4	14	274	0.069	4.1
Total	113	1113	0.123	6.5

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	- 1.48	2.66	98.8%

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	15	15	10.9	7.7 ± 0.75	7.7 ± 2.04
1995	61	78	51.8	13.8 ±1.57	6.4 ±10.6
1994	25	32	23.3	18.1± 6.9	75 ± 9.5
1993	12	12	14	23.2 ±3.88	152 ± 85

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	8/1/0	4	2	0	89.7	9 (0.034)	4 (0.0138)	2 (0.007)	0 (0)	69 (0.26)	31 (0.107)	15 (0.05)	0 (0)
Trout <20 cm older than 1	19/4/2	17	32	12	72.1	25 (0.095)	24 (0.083)	44 (0.154)	17 (0.062)	1191 (4.5)	1143 (3.94)	2096 (7.3)	810 (2.95)
Trout >20 cm	2/1/0	1	6	2	71.0	3 (0.011)	1 (0.0034)	6 (0.021)	2 (0.0073)	456 (1.73)	152 (0.52)	912 (3.18)	304 (1.1)

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)	8	9	3	29	31.8

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*	20	263	0.110	0.45
Section 2	13	290	0.141	0.26
Section 3	3	286	0.033	0.062
Section 4	4	274	0.046	0.086
Total	40	1113	0.113	0.212

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	- 1.92	3.07	94.9 %

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	1	2	2	3.4	0.52
1995	39	90	98	7.0 ± 1.47	5.3 ± 3.2

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	3	19	24.1

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*	11	263	0.072	2.42
Section 2	0	290	0	0
Section 3	26	286	0.38	12.7
Section 4	0	274	0	0
Total	37	1113	0.114	3.8

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	-2.45	3.52	94.3%

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	31	106	84.2	11.2 ± 1.13	25.3±12.4
1994	6	20	15.8	17.2 ± 1.84	76 ± 9.2

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	n/a	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	2	286	0.007**	0.77**
Section 4	0	274	0	0
Total	2	1113	0.0018**	0.198**

** represents minimum densities 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	n/a	n/a	n/a

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	2	2	100	20.3 ± 0.71	0

4.2.5 Stoneloach

Table 4.22. Electric fishing efficiencies for stoneloach 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	n/a	n/d

Table 4.23. Number of stoneloach 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	1	290	0.0034**	0.043**
Section 3	0	286	0	0
Section 4	0	274	0	0
Total	1	1113	0.00089**	0.0113**

** represents minimum density and biomass

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

	a	b	R^2
Stoneloach	n/a	n/a	n/a

Table 4.25. Number of stoneloach 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	1	1	100	11.4	12.6

4.2.6 Tench

Table 4.26. Electric fishing efficiencies for tench 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	n/a	n/d

Table 4.27. Number of tench captured in each section of River Sheaf site, together with density and biomass, calculated from efficiencies in Table 4.26. (* = 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	263	0.042**	2.09**
Section 2	0	290	0.	0
Section 3	1	286	0.0035**	1.75**
Section 4	0	274	0	0
Total	2	1113	0.00180**	0.94**

** represents minimum density and biomass

Table 4.28. The length weight relationship for tench at the River Sheaf site. Relationship equates to $Log_{10} W (g) = a + b Log_{10} L (cm)$.

	a	b	R^2
Tench	n/a	n/a	n/a

Table 4.29. Number of tench 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	27.5 ± 2.12	530±32

4.3 Discussion

4.3.1 Brown trout

Section 3 had the most and largest of the trout *Salmo trutta* and most of the juveniles were captured in Section 1. Of the 12 brown trout over 20 cm captured three fish were identified as being 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 the other two surveys, species normally associated with lacustrine habitats were captured. These included both perch *Perca fluviatilis* and tench *Tinca tinca* on this occasion and were probably escapees from the reservoir upstream.

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

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)	17	6	2	26	65.4

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*	25	393	0.066	5.3
Section 2	20	299	0.117	6.0
Section 3	9	364	0.038	1.9
Section 4	19	298	0.104	6.4
Total	73	1354	0.078	4.5

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	- 1.93	2.99	98.9 %

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	11	17	16.0	7.8 ± 0.72	5.7 ± 1.51
1995	27	44	41.5	14.8 ± 1.84	38.6 ± 12.9
1994	12	19	18.0	18.8 ± 0.49	76 ± 5.9
1993	23	26	24.5	22.6 ± 2.45	136 ± 48

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	1/1/0	4	2	3	56.5	2 (0.0051)	7 (0.023)	3 (0.0082)	5 (0.0168)	11.5 (0.029)	40 (0.134)	0 (0)	0 (0)
Trout <20 cm older than 1	8/3/2	13	3	10	53.0	14 (0.036)	24 (0.080)	6 (0.0165)	19 (0.064)	702 (1.78)	1204 (4.0)	301 (0.83)	953 (3.19)
Trout >20 cm	8/2/0	3	4	6	82.1	10 (0.025)	4 (0.0134)	5 (0.0137)	7 (0.023)	1365 (3.47)	546 (1.82)	682 (1.87)	955 (3.20)

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	4	n/a	n/d

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*	11	393	0.028*	0.38*
Section 2	1	299	0.0033*	0.0254*
Section 3	0	364	0	0
Section 4	1	298	0.0033*	0.0255*
Total	13	1354	0.0096*	0.121*

* represents minimum density

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	-2.07	3.10	99.8%

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	12	12	92	8.8 ± 0.76	7.6 ± 2.17
1995	1	1	8	18.5	72

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)	27	26	13	106	27.6

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*	66	393	0.27	0.39
Section 2	8	299	0.097	0.062
Section 3	0	364	0	0
Section 4	0	298	0	0
Total	74	1354	0.198	0.127

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	-2.58	3.73	77.3 %

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	1	2	1.5	4.3	0
1995	58	106	78.5	5.7 ± 0.59	1.82 ±0.70
1994	15	27	20	7.3 ± 0.36	4.4 ±0.84

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)	0	3	1	n/a	n/d

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*	4	393	0.010*	0.02*
Section 2	0	299	0	0
Section 3	0	364	0	0
Section 4	0	298	0	0
Total	4	1354	0.003*	0.006*

* represents minimum density

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	-2.20	3.60	93.1

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	4	4	100	2.83 ± 0.46	0.205±0.11

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. The increase in the estimated number of trout at this site observed in October 1996 has carried forward to the spring 1997 survey. This is probably due to the large numbers of stocked fish present and seven such fish were identified by appearance and large numbers of replacement scales. 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.

5.3.2 Other species

As discussed in the initial report (Ibbotson *et al.*, 1996a) 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 and October 1996.

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)	15	9	1	26	61.8

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	25	100	0.41	6.5
Section 2*	25	90	0.29	4.4
Section 3	7	93	0.118	1.41
Section 4	11	122	0.139	1.6
Total	68	405	0.234	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	- 1.42	2.57	88.8 %

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	22	29	30.5	7.5 ± 0.74	6.9 ± 1.72
1995	36	52	54.8	10.8 ± 1.40	17.8± 6.0
1994	10	14	14.7	15.3 ± 1.26	43 ± 9.4

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	5	4/2/0	4	7	71.0	7 (0.07)	6 (0.066)	6 (0.064)	10 (0.082)	49 (0.49)	42 (0.46)	42 (0.45)	70 (0.57)
Trout <20 cm older than 1	20	11/7/1	3	4	58.9	34 (0.34)	20 (0.22)	5 (0.053)	7 (0.057)	605 (6.05)	356 (3.95)	89 (0.95)	124 (1.02)
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 two reports, 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 (Ibbotson *et al.*, 1996a & b).

The 1996 year class has 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, although this difference was not significant at the 5% level (z test). 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.

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)	16	1	0	17	94.3

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	3	392	0.0102	0.36
Section 2*	17	408	0.042	6.1
Section 3	4	430	0.0116	0.57
Section 4	7	439	0.018	2.0
Total	31	1669	0.0204	2.0

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	- 1.83	2.92	99.6 %

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	2	2	6.0	8.0 ± 1.13	6.6 ± 2.6
1995	11	12	35.0	14.6 ± 2.81	41 ± 19.4
1994	9	10	29.5	21.0 ± 1.02	109 ± 15.5
1993	9	10	29.5	27.2 ± 3.41	239 ± 92

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	1	0/0/0	1	0	n/d (94.3)*	1 (0.0102)	0 (0)	1 (0.0023)	0 (0)	6.5 (0.017)	0 (0)	6.5 (0.015)	0 (0)
Trout <20 cm older than 1	2	3/1/0	3	3	77.9	3 (0.0076)	4 (0.0098)	4 (0.0093)	4 (0.0091)	134 (0.328)	179 (0.438)	179 (0.4381)	179 (0.438)
Trout >20 cm	0	13/0/0	0	4	100	0 (0)	13 (0.03186)	0 (0)	4 (0.0091)	0 (0)	2323 (5.69)	0 (0)	715 (1.63)

* 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)	16	4	1	21	75.0

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	4	392	0.0136	0.91
Section 2*	21	408	0.069	4.6
Section 3	0	430	0	0
Section 4	10	439	0.0304	2.03
Total	35	1669	0.028	1.88

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	- 1.89	2.96	99.7 %

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	5	6	15.4	9.5 ± 1.4	10.7 ± 4.4
1995	15	17	43.6	18.0 ± 1.16	68 ± 12.3
1994	11	12	30.7	21.4 ± 0.46	112 ± 7.1
1993	3	3	7.7	25.6 ± 1.04	190 ± 23.3
1992	0	0	0		
1991	1	1	26	28.5	261

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)	3	4	0	8	49.9

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	16	392	0.082	0.175
Section 2*	7	408	0.0196	0.074
Section 3	6	430	0.0280	0.06
Section 4	1	439	0.0046	0.0098
Total	30	1669	0.036	0.077

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	- 1.48	2.54	98.1 %

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	1	2	3.7	5.0	1.97
1995	9	16	29.6	5.9 ± 0.116	3.0± 0.149
1994	20	36	66.7	7.2 ± 0.57	4.9 ± 1.04

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)	8	4	2	16	49.9

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	5	392	0.0256	0.095
Section 2*	14	408	0.039	0.145
Section 3	0	430	0	0
Section 4	2	439	0.0091	0.034
Total	21	1669	0.0180	0.067

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	- 2.39	3.51	87.3 %

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	21	30	100	6.9 ± 0.46	3.7 ± 0.84

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)	1	1	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	2	392	0.0076*	0.035*
Section 2*	5	408	0.012*	0.084*
Section 3	0	430	0	0
Section 4	1	439	0.0023*	0.0155*
Total	8	1669	0.0048*	0.033*

* 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	- 2.07	2.97	95.6 %

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	12.5	8.6	5.1
1994	7	7	87.5	9.6 ± 0.76	7.1 ± 1.70

7.3 Discussion

7.3.1 Brown trout

The greater number of trout were captured at this site in October has carried through to this spring but as suggested at the time this is the result of a larger number of stocked fish being present in the river this spring. It is not thought that the riparian owner at that site stocks himself, but neighbouring fisheries could.

7.3.2 Other species

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)	31	19	6	63	51.6

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	23	500	0.092	3.2
Section 2	41	345	0.223	11.5
Section 3	20	319	0.135	1.61
Section 4*	56	253	0.25	10.3
Total	140	1417	0.162	5.9

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	- 1.80	2.90	99.4 %

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	63	113	49.4	9.2 ± 1.23	10.2 ± 4.0
1995	54	81	35.4	14.7 ± 1.36	39 ± 10.6
1994	23	35	15.2	20.8 ± 5.7	134 ± 208

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	13	8	19	12/8/3	46.4	28 (0.056)	17 (0.049)	41 (0.013)	27 (0.107)	287 (0.574)	170 (0.493)	420 (1.316)	276 (1.09)
Trout <20 cm older than 1	9	28	1	16/10/3	51.8	17 (0.034)	54 (0.156)	2 (0.0063)	32 (0.126)	802 (1.60)	2547 (7.38)	94 (0.29)	1509 (5.96)
Trout >20 cm	1	5	0	3/1/0	77.9	1 (0.002)	6 (0.017)	0 (0)	4 (0.016)	205 (0.81)	1233 (3.57)	0 (0)	822 (3.25)

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)	1	1	1	n/a	n/d

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	2	500	0.004*	0.232*
Section 2	0	345	0	0
Section 3	0	319	0	0
Section 4*	3	253	0.0118*	0.69*
Total	5	1417	0.0035*	0.205*

* represents minimum density and biomass

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	-1.48	2.63	63.1%

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	5	5	100	17.3 ± 0.67	58 ± 5.6

Table 8.10. 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	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	2	0	0	1/1/1	n/d	2 (0.004)	0 (0)	0 (0)	3 (0.019)	116 (0232)	0 (0)	0 (0)	174 (0.69)
Trout >20 cm	0	0	0	0/0/0	n/d	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

* Minimum density values

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.*, 1996a) 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

Apart from one very large stocked brown trout the population structure for brown trout in this stream remained unusual with few 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.

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.

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)	0	0	0	n/a	n/d

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*	0	328	0	0
Section 2	0	416	0	0
Section 3	2	416	0.0048*	1.91*
Section 4	2	363	0.0055*	1.33*
Total	4	1523	0.00263*	0.84*

* represents minimum density and biomass

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	- 1.76	2.84	99.8 %

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	0	0	0		
1995	0	0	0		
1994	2	2	50	21.5 ± 2.97	109 ± 35
1993	2	2	50	36 ± 11.5	530 ± 440

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	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	1/0/0	1	1	1	100	0 (0)	0 (0)	2 (0.0048)	1 (0.0028)	0 (0)	0 (0)	0 (0)	84 (0.231)
Trout >20 cm	0/0/0	0	2	1	n/d	0 (0)	0 (0)	2 (0.0048)	1 (0.0028)	0 (0)	0 (0)	797 (1.92)	398 (1.09)

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)	8	11	11	n/a	n/d

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*	30	328	0.092**	0.43**
Section 2	10	416	0.024**	0.114**
Section 3	6	416	0.0144**	0.068**
Section 4	15	363	0.041**	0.196**
Total	61	1523	0.040**	0.190**

** 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	- 2.30	3.46	97.6 %

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	7	7	11.5	3.8 ± 0.34	0.52±0.15
1995	36	36	59	6.5 ± 0.55	3.4 ± 0.94
1994	18	18	29.5	8.7 ± 0.66	9.1 ± 2.60

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	n/a	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	5	363	0.0138**	0.88**
Total	5	1523	0.0033**	0.21**

** 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	-2.51	3.59	95.6%

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	3	3	60	11.4 ± 1.25	22.9 ± 6.9
1994	2	2	40	21.9 ± 2.05	126 ± 32

9.3 Discussion

9.3.1 Brown trout

As discussed in the initial report (Ibbotson *et al.*, 1996a) the population of brown trout captured at this site was heavily influenced by the presence of the weir pool in the top section. There were no brown trout from the 1996 year-class captured in this survey indicating very poor recruitment from that year.

9.3.2 Other species

The presence of perch is attributed to the reservoir upstream.

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

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)	26	19	4	55	51.9

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	42	340	0.215	9.5
Section 2*	49	319	0.17	6.1
Section 3	25	334	0.138	4.4
Section 4	14	369	0.065	2.20
Total	130	1362	0.145	5.5

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	- 2.00	3.05	97.3 %

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	44	68	34.5	7.3 ± 0.99	4.6 ± 1.85
1995	29	43	21.8	12.9 ± 1.16	22.1 ± 6.0
1994	50	75	38	17.9 ± 1.89	69 ± 22.4
1993	7	11	5.7	23.8 ± 1.00	161 ± 20.8

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	9	10/8/1	10	6	54.1	17 (0.05)	21 (0.06)	19 (0.057)	11 (0.03)	78 (0.229)	97 (0.304)	87 (0.26)	51 (0.138)
Trout <20 cm older than 1	26	15/8/3	13	6	53.0	42 (0.124)	52 (0.163)	55 (0.165)	20 (0.054)	2220 (6.5)	1314 (4.1)	1132 (3.4)	498 (1.35)
Trout >20 cm	7	1/3/0	2	2	n/d	7 (0.020)	4 (0.012)	2 (0.006)	2 (0.0054)	922 (2.7)	527 (1.65)	264 (0.79)	264(0.715)

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)	2	4	2	n/a	n/d

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	7	340	0.021**	0.128**
Section 2*	8	319	0.025**	0.156**
Section 3	5	334	0.015**	0.093**
Section 4	14	369	0.038**	0.236**
Total	34	1362	0.025**	0.155**

** represents minimum density and biomass

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	- 2.13	3.23	91.8 %

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	5.9	4.8	1.17
1995	30	30	88.2	7.8 ± 0.94	5.9 ± 2.1
1994	2	2	5.9	10.7	15.6

10.2.3 Grayling

Table 10.19. Electric fishing efficiencies for grayling 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	n/a	n/d

Table 10.20. Number of grayling 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**	0.153**
Section 2*	0	319	0	0
Section 3	1	334	0.00299**	0.132**
Section 4	0	369	0	0
Total	2	1362	0.00149**	0.070**

** represent minimum density and biomass estimates

Table 10.21. The length weight relationship for grayling 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
Grayling	n/a	n/a	n/a

Table 10.22. Number of grayling 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	2	2	100	16.1	48

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)	0	0	0	n/a	n/d

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*	0	319	0	0
Section 3	0	334	0	0
Section 4	2	369	0.0054**	0.0023**
Total	2	1362	0.00147**	0.00062**

** 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	2	2	100	3.6 ± 0.49	0.42±0.176

10.2.5 Pike

Table 10.23. Electric fishing efficiencies for pike 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	n/a	n/d

Table 10.24. Number of pike 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*	0	319	0	0
Section 3	0	334	0	0
Section 4	1	369	0.0027**	0.271**
Total	1	1362	0.0007**	0.073**

** represents minimum density and biomass

Table 10.25. The length weight relationship for pike 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 pike 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	1	1	100	20.2	100

10.3 Discussion

10.3.1 Brown trout

As found in previous surveys this site supports high numbers of brown trout, although there was a significant reduction in the total numbers from April 1996 to April 1997. These was evidence of low levels of stocking (< 10%).

10.3.2 Other species

The pike 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)	18	8	0	26	73.1

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*	26	300	0.086	3.7
Section 2	42	266	0.44	10.4
Section 3	5	218	0.032	0.78
Section 4	6	322	0.053	1.24
Total	79	1106	0.145	4.1

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	- 1.38	2.55	70.4 %

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	57	71	74.0	13.5 ± 1.48	33 ± 9.1
1994	13	16	16.6	18.3 ± 0.57	69 ± 5.5
1993	9	9	9.4	22.8 ± 2.41	124 ± 35

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	17/8/0	35	5	5	72.1	25 (0.083)	48 (0.180)	7 (0.050)	7 (0.050)	988 (3.3)	1897 (7.13)	277 (1.27)	277 (0.86)
Trout >20 cm	1/0/0	7	0	1	100	1 (0.0033)	7 (0.263)	7 (0)	1 (0.031)	124 (0.413)	870 (3.27)	0 (0)	124 (0.38)

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)	14	12	2	32	49.9

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*	28	300	0.187	4.0
Section 2	4	266	0.030	0.098
Section 3	10	218	0.092	0.299
Section 4	9	322	0.056	0.182
Total	51	1106	0.092	0.30

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	- 2.17	3.05	96.1 %

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	5	7	9.0	7.0 ± 0.260	2.6 ± 0.29
1994	45	68	87.2	9.5 ± 0.74	6.5 ± 1.48
1993	2	3	3.8	12.8 ± 0.28	16.1 ±1.08

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)	4	0	1	5	65.3

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*	5	300	0.025	0.0102
Section 2	2	266	0.011	0.0046
Section 3	2	218	0.007	0.0056
Section 4	0	322	0	0
Total	9	1106	0.011	0.0049

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	-1.83	2.71	63.7

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	0	0	0	0	0
1995	7	9	81.8	3.7 ± 0.198	0.56±0.135
1994	2	2	18.2	5.0 ± 0.71	0.8 ±0.077

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)	0	0	0	n/a	n/d

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*	0	300	0	0
Section 2	2	266	0.0075**	0.0301**
Section 3	0	218	0	0
Section 4	0	322	0	0
Total	2	1106	0.0018**	0.0072**

** represents minimum density and biomass

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	2	2	100	6.1	8.0

11.2.5. Grayling

Table 11.18. Electric fishing efficiencies for grayling 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 grayling 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	4	266	0.015**	0.83**
Section 3	0	218	0	0
Section 4	0	322	0	0
Total	4	1106	0.0036**	0.199**

** represents minimum density

Table 11.20. The length weight relationship for grayling 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
Grayling	n/a	n/a	n/a

Table 11.21. Number of grayling 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	4	4	100	14.9 ± 0.87	55 ± 7.4

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)	0	0	0	n/a	n/d

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*	0	300	0	0
Section 2	1	266	0.0037**	0.150**
Section 3	0	218	0	0
Section 4	0	322	0	0
Total	1	1106	0.009**	0.036**

** represents minimum density and biomass

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			

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	1	1	100	12.5	40

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.

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 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)	8	9	2	n/a	n/d

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	24	283	0.085**	2.16**
Section 2*	19	254	0.094**	0.77**
Section 3	17	324	0.052**	1.15**
Section 4	11	347	0.032**	1.49**
Total	71	1208	0.059**	1.28**

** represents minimum densities

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	- 1.64	2.79	98.1 %

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	50	50	70.4	9.3 ± 1.26	11.9 ± 4.4
1995	19	19	26.8	15.1 ± 0.94	45 ± 7.5
1994	1	1	1.4	17.8	71
1993	0	0	0	0	0
1992	1	1	1.4	31	320

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	14	5/9/2	12	8	n/a	14 (0.049)	16 (0.063)	12 (0.037)	8 (0.023)	167 (0.59)	191 (0.75)	143 (0.44)	95 (0.27)
Trout <20 cm older than 1	9	3/0/0	5	3	100	9 (0.032)	3 (0.0118)	5 (0.0154)	39 (0.0086)	414 (1.46)	138 (0.54)	230 (0.709)	138 (0.39)
Trout >20 cm	1	0/0/0	0	0	n/a	1 (0.0035)	0 (0)	0 (0)	0 (0)	30.5 (0.107)	0 (0)	0 (0)	0 (0)

12.3 Discussion

As in the previous surveys 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. IMPACTS OF THE DROUGHT ORDERS

Although over the period of the survey a total of 13 fish species were captured, most were found infrequently, in low numbers or the catch efficiency was unreliable (Ibbotson *et al.*, 1996 a & b). Brown trout were the only species captured at all eight sites on the River Don catchment with consistently acceptable and believable catch efficiencies. Thus the assessment of the impacts of the drought orders has only been completed utilising the data for this species.

13.1. All brown trout

The total density of brown trout altered significantly between spring 1996 and spring 1997 at all sites apart from Ewden Beck (Regulated 50%) and River Rivelin (Regulated 66%) (Fig. 13.3). However, where densities changed they increased at Bullhouse Minewater (Regulated control) and Oxspring (Regulated part affected) and decreased on the River Sheaf (Unregulated control), below Winscar Reservoir (Regulated part affected), Little Don (Regulated 66%) and Loxley (Regulated 66%) (Fig. 13.3).

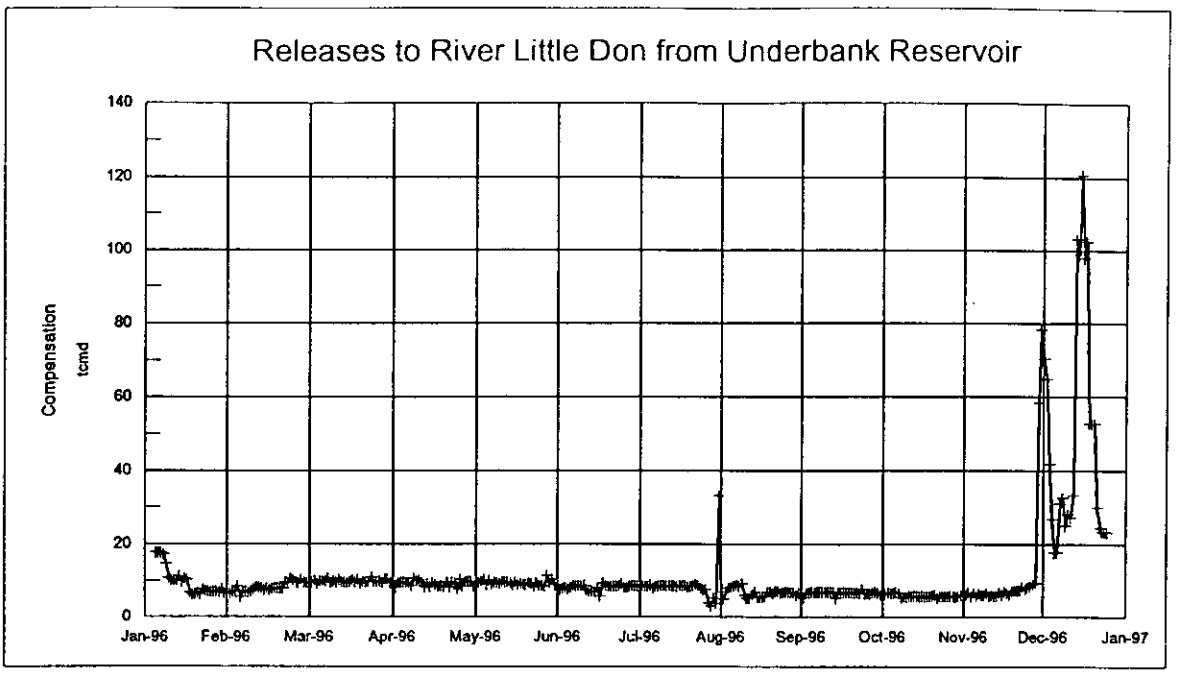
Thus there was no clear pattern of effects between the controls and the impacted sites. One cannot be certain of the reasons for this but it is likely that stocking of fish and angling had major impacts on the density of brown trout at most sites.

13.2. 0+ brown trout recruitment

Since it is probable that most of the angling and stocking impacts on brown trout density will be observed in the older age classes and larger sizes, it was decided to try and detect any impacts of the drought orders by comparing the recruitment of juveniles between years.

Here too, it was difficult to find clear patterns emerging between control and impacted sites. There were significant reductions in the recruitment of 0+ brown trout at three sites; these being the River Sheaf (Unregulated control), Little Don (Regulated 66%) and River Rivelin (Regulated 66%). Failure to recruit appeared to be complete at the latter two sites. However recruitment seemed to be unaffected at Ewden Beck (Regulated 50%) and Loxley (Regulated 66%). The releases of water into the Little Don and Rivelin are shown at Figure 13.1 a & b. A period of dramatic reduction in March 1996 is identified on the River Rivelin (Fig. 13.1b) which, if real, may be responsible alone for the failure to recruit at this site.

The reason for the decline on the River Sheaf is not known, but it appears to be severe and may be the result of some factor other than drought, which may negate its value as a control. The October survey revealed that the dam of the small reservoir upstream was under repair and during this period the river had a very high sediment load. It is possible that if this situation had prevailed for a long time it could have had some impact on the 0+ trout. In addition it is not known over what period the water from the reservoir was released when the dam was fully opened. If it had been rapidly this may have caused displacement of the 0+ trout. It is likely that the cause of this reduction will remain unknown.



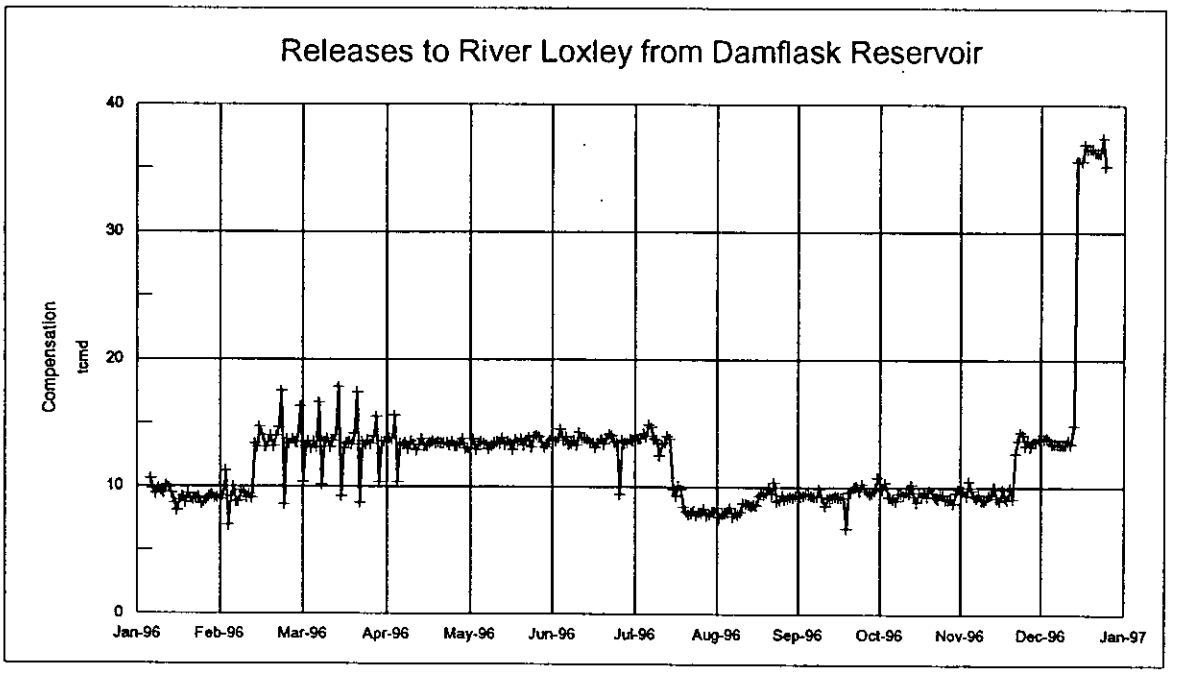
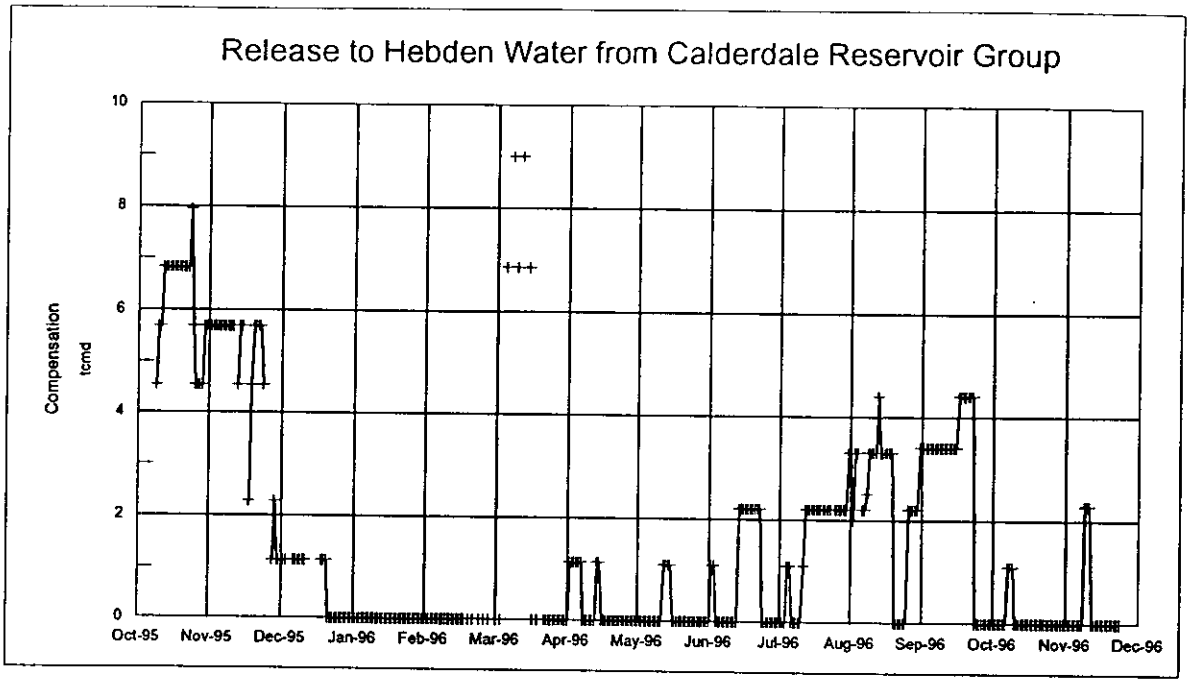


Figure 13.1a Hydrographs of releases from Under bank Reservoir and Damflask Reservoir in 1996.



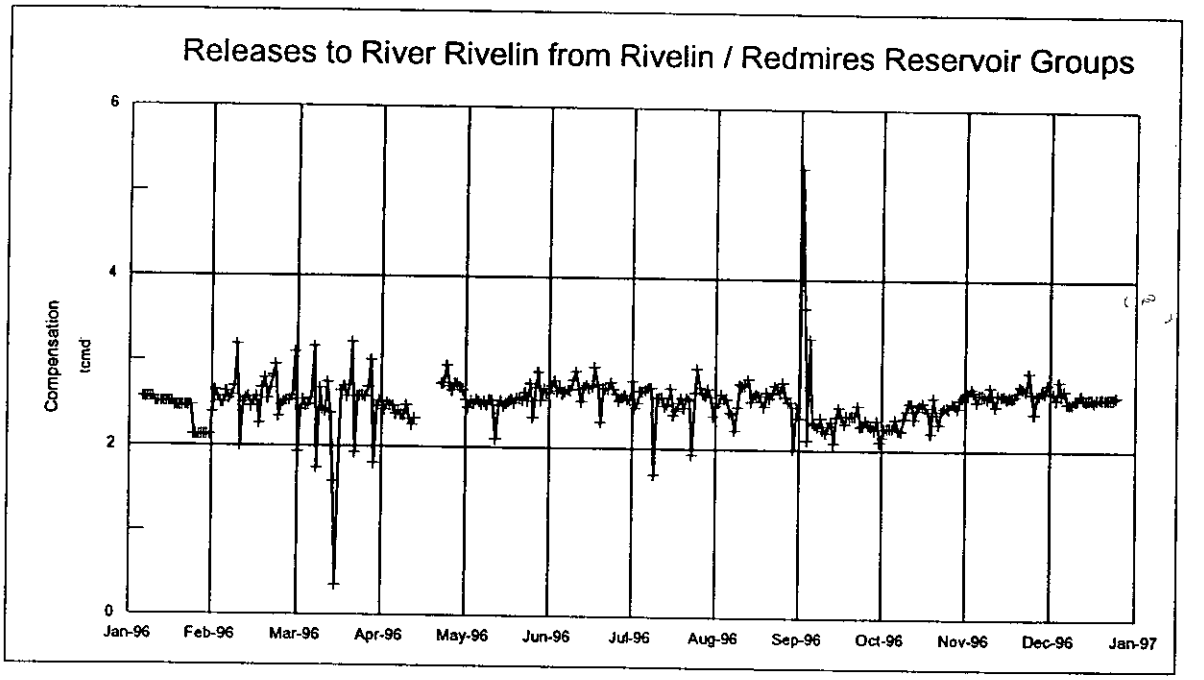


Figure 13.1b Hydrographs of releases from Calderdale Reservoir Group and Redmire Reservoir Group in 1996.

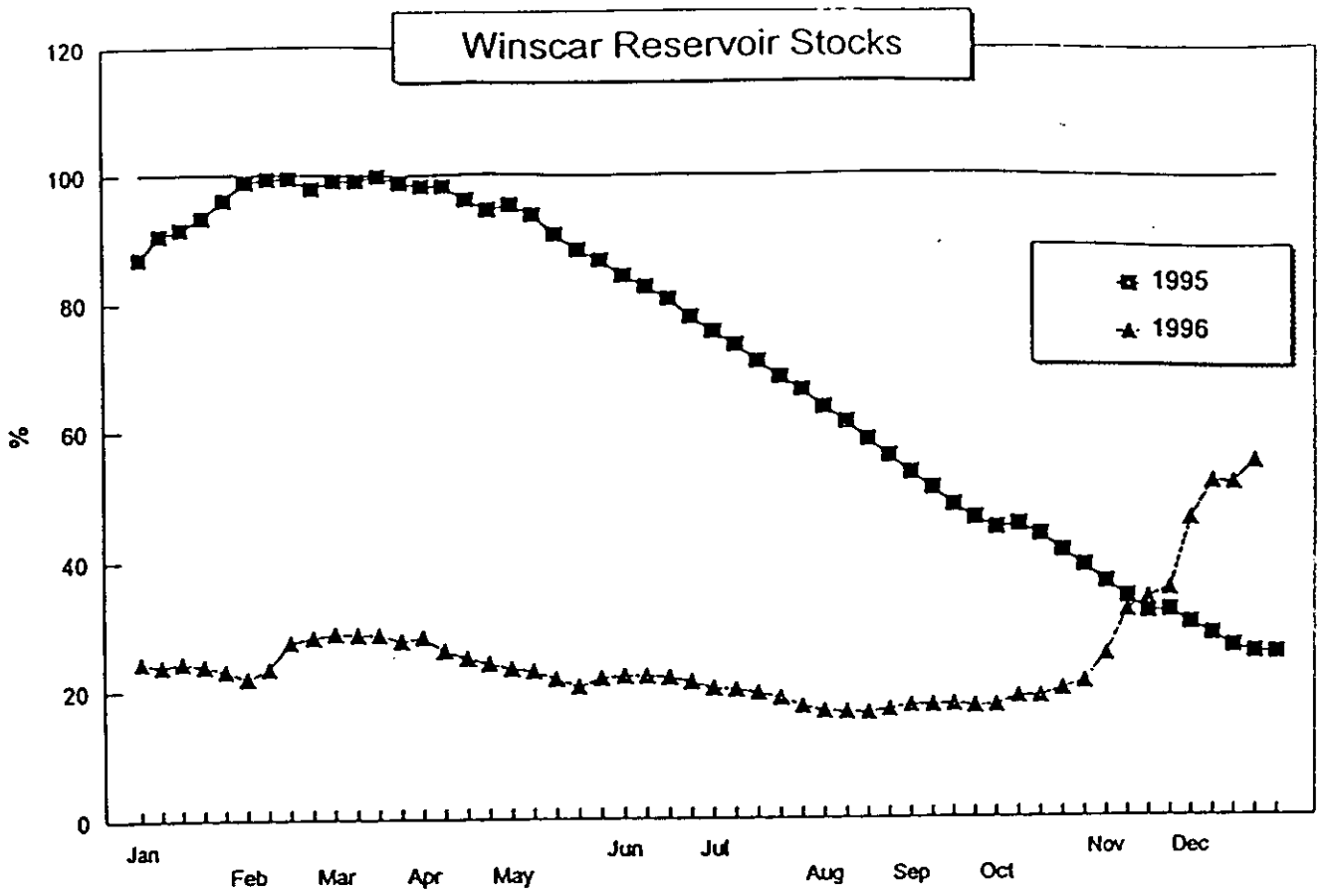
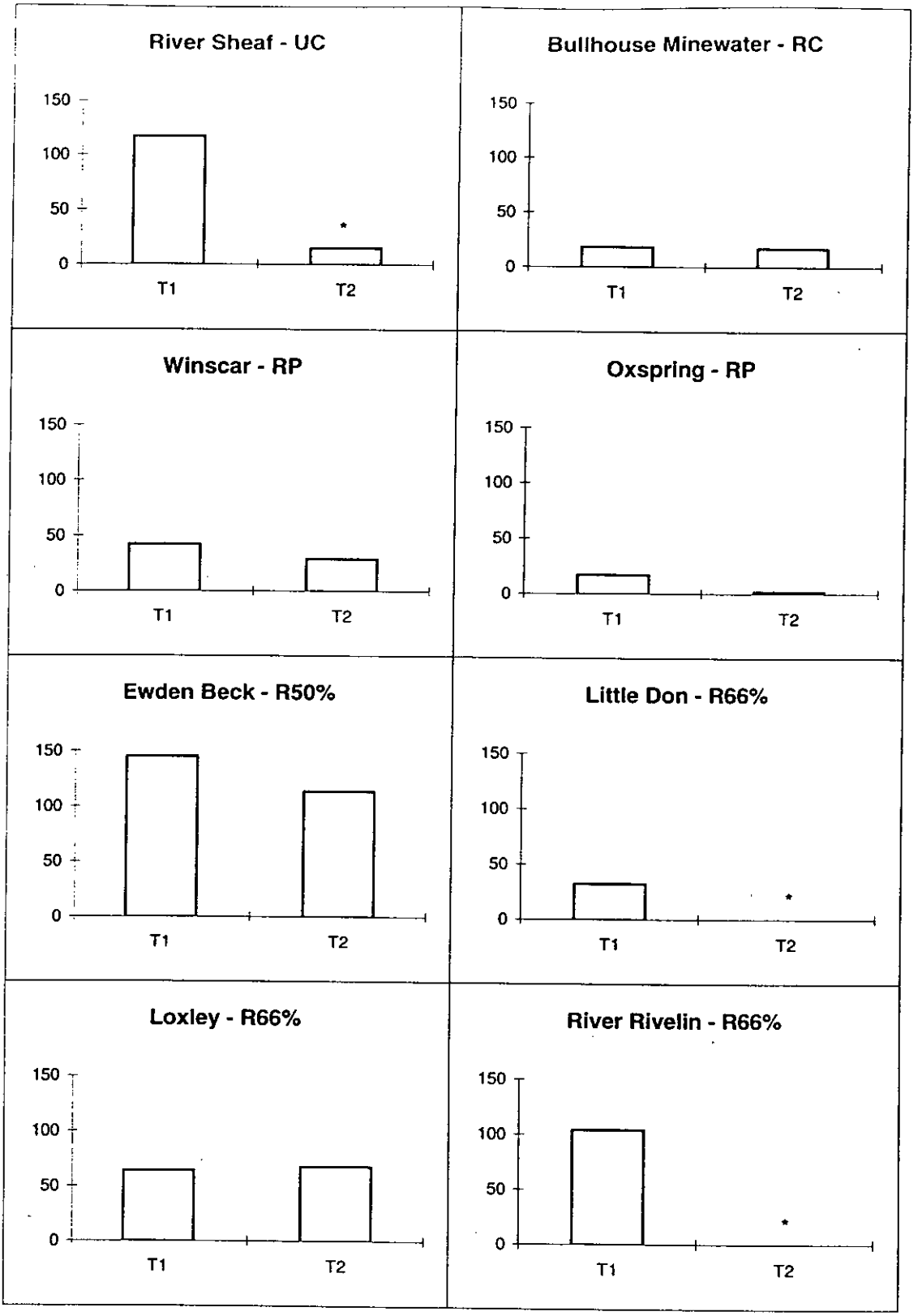


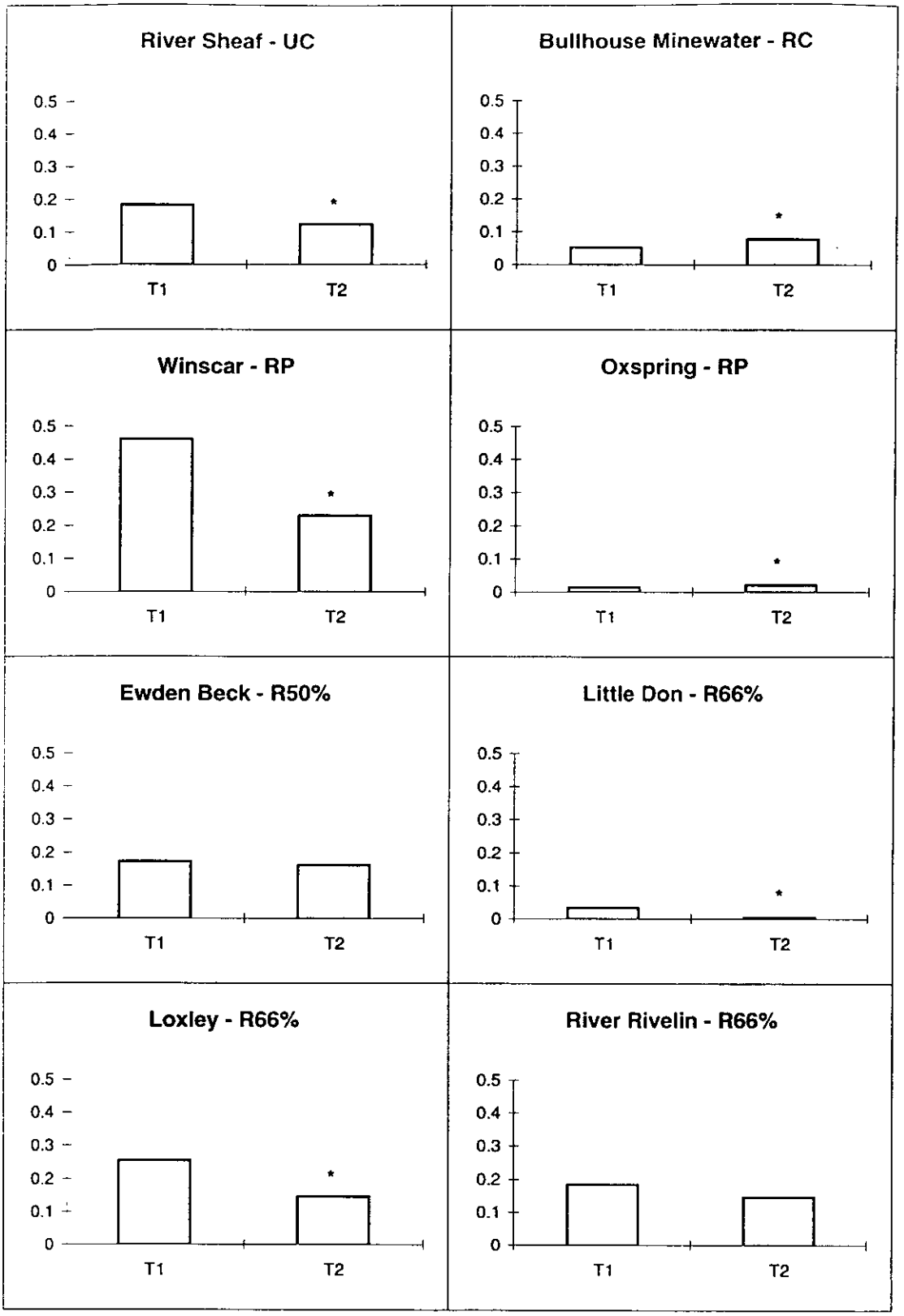
Figure 13.1c Winscar Reservoir stocks in 1995 and 1996.



Key:- UC = Unregulated Control. RC = Regulated Control. 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 March 1997 (T2).

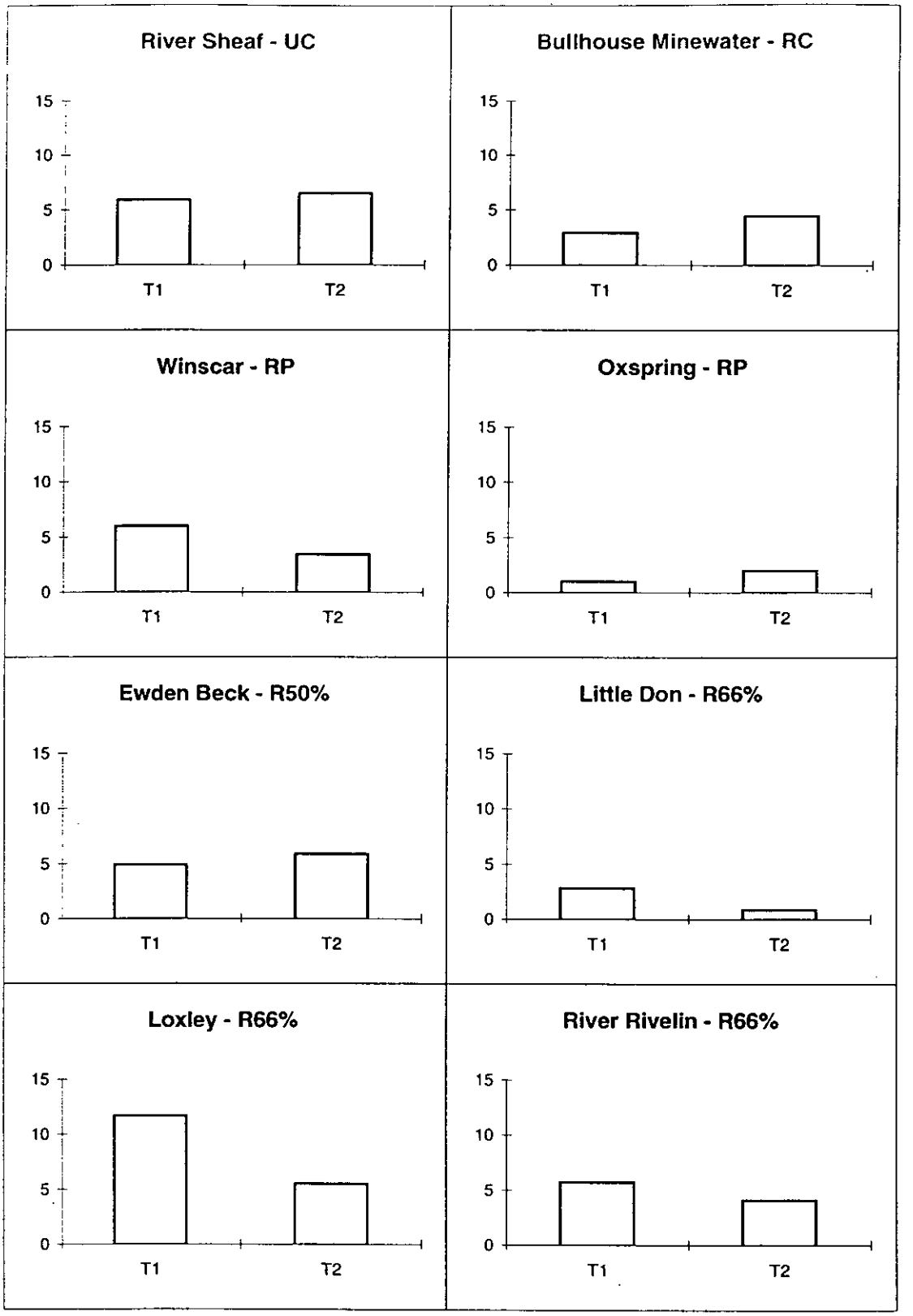
* Significant differences between years ($p < 0.05$)



Key:- UC = Unregulated Control. RC = Regulated Control. 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 March 1997 (T2).

* Significant differences between years ($p < 0.05$)



Key:- UC = Unregulated Control. RC = Regulated Control. 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 March 1997 (T2)

Table 13.1. The density (n m^{-2}) of each fish species at each of eight sites surveyed in April and March 1997

Site Name	Designation	Sample Date	Species											
			Brown Trout	Rainbow Trout	Bullhead	Stickle-back	Minnow	Perch	Grayling	Roach	Stone Loach	Dace	Pike	Ruffe	Tench
Sheaf	UC	04/96 03/97	0.181 0.123		0.108 0.113	0.0009* 0		0.114 0.114		0.0009* 0	0 0.0009*	0.0036* 0.0018*			0 0.0018*
Bullhse Mnwtr	RC	04/96 03/97	0.052 0.078			0.017 0.003*	0.140 0.198		0.0037 0.0096						
Winscar	RC	04/96 03/97	0.46 0.234												
Oxspring	RP	04/96 03/97	0.0150 0.0204		0.118 0.036	0.0006* 0	0.059* 0.0180		0.0108 0.028		0.0102* 0.0048*				
Ewden Beck	R50%	04/96 03/97	0.172 0.162	0.030 0.0035						0.0007* 0					
Little Don	R66%	04/96 03/97	0.034 0.0026		0.056* 0.040*			0.0072* 0.0032*						0.0007* 0	
Loxley	R66%	04/96 03/97	0.254 0.145	0.0007 0	0.048 0.025*	0 0.0015*			0 0.0015*				0.0007* 0		
Rivelin	R66%	04/96 03/97	0.183 0.145			0.0127* 0.011	0.0009* 0	0.0036* 0.0018*	0 0.0036*	0 0.009*	0.074* 0.092				

* represents minimum density

Key:- UC = Unregulated Control. RC = Regulated Control. 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 March 1997

Site Name	Designation	Sample Date	Species											
			Brown Trout	Rainbow Trout	Bullhead	Stickle-back	Minnow	Perch	Grayling	Roach	Stone Loach	Dace	Pike	Ruffe	Tench
Sheaf	UC	04/96 10/96	5.9 6.5		0.77 0.212	0.0009* 0		0.77 3.8		0.192* 0	0 0.0113*	0.47* 0.0018*			0 0.94*
Bullhse Mnwtr	RC	04/96 10/96	2.92 4.5			0.084* 0.006*	0.47 0.127		0.40 0.121*						
Winscar	RC	04/96 10/96	6.0 3.4												
Oxspring	RP	04/96 10/96	0.99 2.0		0.35 0.077	0.0006* 0	0.0178* 0.067		0.52 1.88		0.088* 0.033*				
Ewden Beck	R50%	04/96 10/96	4.9 5.9	0.52 0.205						0.034* 0					
Little Don	R66%	04/96 10/96	2.82 0.84		0.42* 0.190*			0.51* 0.21*						0.0053* 0	
Loxley	R66%	04/96 10/96	11.7 5.5	0.106 0	0.34 0.155*	0 0.0006			0 0.07*				0.294* 0.073*		
Rivelin	R66%	04/96 10/96	5.7 4.1			0.036* 0.0049	0.0044* 0	0.210* 0.0072*	0 0.199*	0 0.036*	0.46* 0.30				

* represents minimum biomass

Key:- UC = Unregulated Control. RC = Regulated Control. 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	15	117	15	57.9	10.9	8.0 ± 1.12	7.7 ± 2.04
Bulhouse Mwt	RC	14	11	18	17	24.7	16.0	9.3 ± 0.90	7.8 ± 0.72*
Winscar	RC	28	22	42	29	22.5	30.5	5.6 ± 0.95	7.5 ± 0.74*
Oxspring	RP	12	2	17	2	68.0	6.0	10.7 ± 1.78	8.0 ± 1.13
Ewden Beck	R50%	107	63	145	113	49.4	41.0	9.1 ± 0.81	9.2 ± 1.21
Little Don	R66%	16	0	32	0	61.5	0	9.6 ± 1.39	--
Loxley	R66%	32	44	64	68	17.0	34.5	7.9 ± 1.22	7.3 ± 0.99*
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%.

* Significantly different between years ($p < 0.05$).

13.3. Growth of 0+ brown trout

In general, the size of the 0+ brown trout from the 1996 year-class were smaller after one summer's growth than from the 1995 year-class (Table 13.3). This reduction in size was significant at Bullhouse Minewater and Loxley, and may reflect a universal environmental difference between the two years.

The one exception to this was at Winscar, where there was a significant increase in growth rate during 1996 (Table 13.3). This is probably the result of the reduction in water stocks held in Winscar Reservoir and an associated increase in the temperature of the water released (Ibbotson *et al.*, 1996a).

14. REFERENCES

Ibbotson A. T. *et al.* (1996) a. River Don and Colden Water surveys: initial survey. Report to Yorkshire Water Services Ltd.

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Kendall M G and Stuart A. (1977) The Advanced Theory of Statistics. 4th Edn, Vol 1. Griffin, London.

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