Institute of Freshwater Ecology

1995 SURVEY OF THE COARSE FISH OF THE RIVER TEES

Interim Report

**J S Welton; W R C Beaumont; A C Pinder;
M Ladle; D T Crisp; J E G Masters; I J Winfield; J M Fletcher**

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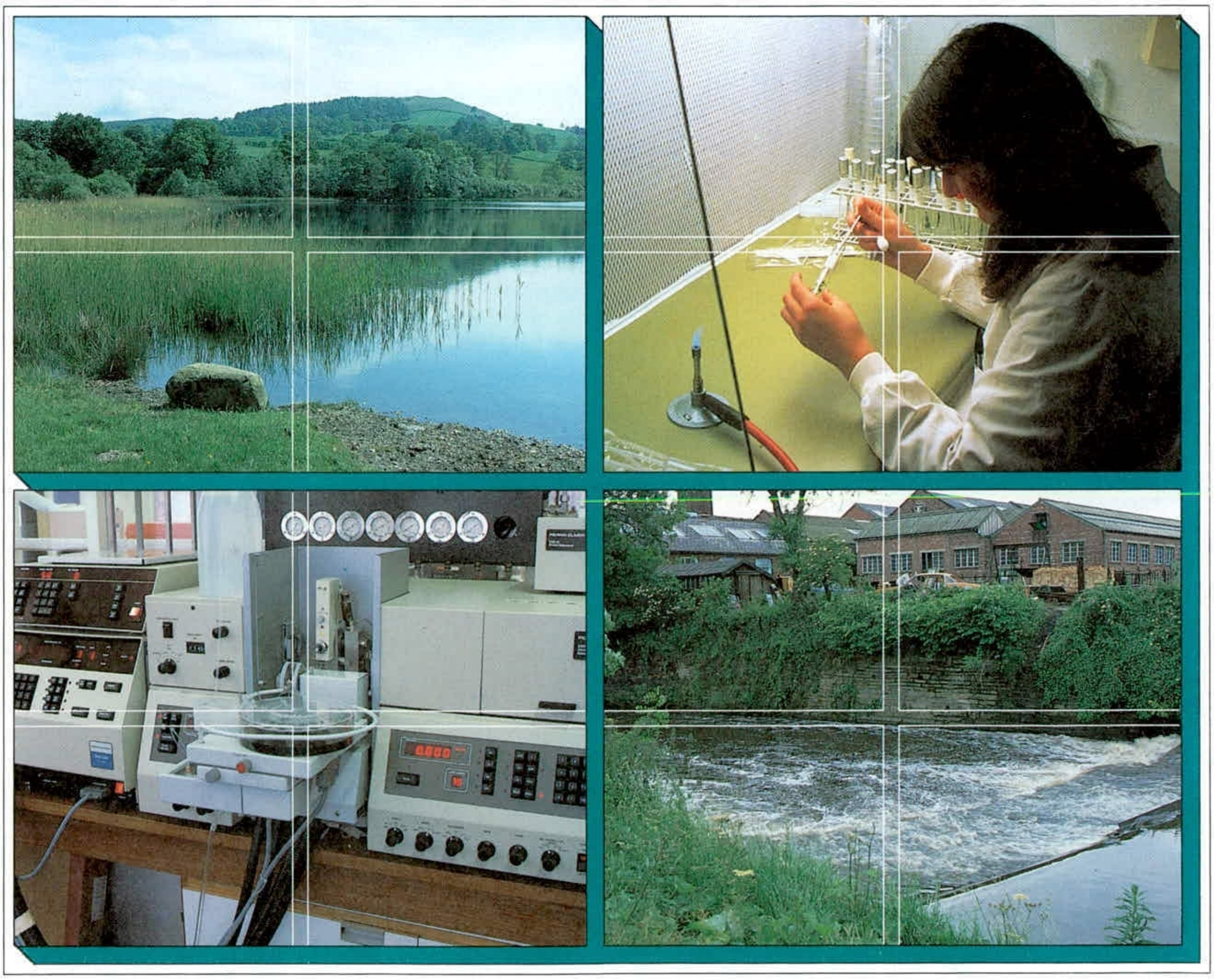

Natural Environment Research Council

Institute of Freshwater Ecology

River Laboratory
East Stoke
Wareham
Dorset BH20 6BB

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J S Welton, BSc, PhD, CBiol, MIBiol
W R C Beaumont, LMIFM
A C Pinder
M Ladle, BSc, PhD
D T Crisp, BSc, PhD, DSc, CBiol, FIBiol
J E G Masters, BSc
I J Winfield, BSc, PhD
J M Fletcher, BSc

Sub Project Leader:	J S Welton
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INTELLECTUAL PROPERTY RIGHTS

CONFIDENTIALITY STATEMENT

REVIEW OF PROGRESS

This progress report covers the period April 1995-January 1996.

The fry survey was successfully carried out in June and covered the sections of river previously inundated by salt water. Approximately 4000 fry were sampled and identified and a proportion of these were measured.

The main survey of adults was successfully carried out in early September. Despite the increased water levels due to the completion of the barrage, over 3700 fish were caught mainly by boom boat electrofishing and fish were found to be distributed through the lower sections which were previously saline at certain states of the tide.

Scales were taken from a proportion of fish of each species and each size group. These scales have been cleaned, mounted and aged. Approximately 200 fish scales were examined and aged.

Angling data was collected and the mean catch per angler was calculated for comparison with previous years..

Temperature loggers are still collecting data at Low Moor, Ingleby Barwick and in ORSU 1. The logger at Stockton marina has not been resited since the completion of the barrage due to the unavailability of a suitable site.

Data from all pre-barrage years was collated and compared.

1. SURVEY OF COARSE FISH FRY JUNE 1995

1.1 Introduction

The survey was designed to collect information on the fry of all species of angling importance. This is the first survey since the completion of the barrage. The timing of the survey has in the past been variable due to the conflict between assessing the spawning areas for dace and sampling all species of fry. Dace spawn earlier than most other coarse fish on the R. Tees and become large enough to leave the margins (typical fry habitat) before the eggs of some other species have finished hatching. This year, the survey was carried out early (June) and focused on dace fry to determine whether the dace had successfully spawned in the now deep slow flowing water at the previously recognised dace spawning sites. Roach and chub fry had also hatched and were sampled adequately enough to assess their distributions.

1.2 Methods

The survey was conducted in mid June and covered most of the length of the river affected by the barrage plus areas upstream of this for comparison. Sampling was conducted by point sampling from a boat and micromesh seine from the shore.

A description of sampling methods and sites is given in Appendix 1.

1.2.1 Electrofishing

Electrofishing apparatus designed for fry sampling was used. This is battery powered with the anode ring mounted on a telescopic pole so that it can be extended in front of the boat to sample fry with minimal disturbance. The shape and size of the anode allow point sampling, producing a high intensity field that stuns fry in a small area. At each sampling site, up to 10 point samples were taken over a 25 metre length of the river. The number of point samples depended on the number of fry caught. Point samples were either targeted at concentrations of fry or taken at random.

1.2.2 Micromesh seining

In addition to the electrofishing, a micromesh seine was used in areas where large congregations of fry were expected and where no snags were present. These were set and hauled in shallow marginal areas of the river, especially from beach gravel shoals. Fry were often observed to be in shallow water (<5 cm) and hand netting was often found to be a more effective sampling technique. With the increase in depth of the lower river as a result of the barrage, there were fewer suitable areas for micromesh seining.

1.3 Results

Over 3000 fry of species of angling importance were sampled this year compared with over 5000 in 1994 (Table 1). Much of this reduction was a result of fewer seine net samples. A minimum of 30 individuals of each species from each section were measured. Although effort varies between years gross changes in the population of various species can be recognised. Numbers of dace fry were very low compared with 1994 even though this year was considered likely to be a good year for growth and survival because of high temperatures. It is probable that the change is connected with the shift in physical parameters after the closure of the barrage. Known dace spawning grounds have been flooded out and it is likely that spawning at these sites was less successful. Roach and chub on the other hand were present in much larger numbers than in 1994. It is believed that these species are not as well adapted to fast flowing water as dace due to their later hatching and to their smaller size at hatching. This year, with flows negligible, survival appears to have been very good.

Numbers of both gudgeon fry and three-spined stickleback fry have increased markedly and numbers of stone loach have also increased (Table 2).

Table 1. Number of fry of each species of angling interest sampled in the R.Tees in June 1995.

Species	Total
Barbel *Barbus barbus* (L.)	6
Chub *Leuciscus cephalus* (L.)	1092
Dace *Leuciscus leuciscus* (L.)	526
Grayling *Thymallus thymallus* (L.)	5
Gudgeon *Gobio gobio* (L.)	91
Roach *Rutilus rutilus* (L.)	1641

Table 2. Number of fry of minor species sampled in the R.Tees in June 1995.

Species	Total
Minnow *Phoxinus phoxinus* (L.)	343
Stone loach *Barbatula barbatula* (L.)	146
Three spined stickleback *Gasterosteus aculeatus* L.	158

Table 3. Number of fry of each species found in each section in the R.Tees in June 1995.

Section	1	3	4	PP Orsu	5	6	7	8	9	10	11	12	13	14	15	16	17	Orsu I	18	19	20	21	22	25
Barbel																				1	3	2		
Chub		2	10	2	24		61	133	51	114	135	14	38	71	63	61	14	18	26	83	64	11	28	69
Dace			1	4	9		25	10	42	5	24	73	15	3	16	7	54	10	19	154	19	22	2	12
Gudgeon				1											1		58	1	2	6	5	14	25	4
Roach					5	113	50	2	73	56	67	41	232	145	302	232	59	42	16	75	61	15		30
Grayling																	5							
Salmon																								
Rudd																								
Stickleback	35	3	35	36	10	8	1		6	3	2	1			5	1								
Flounder																								
Minnow				28		1	2	3	1	1	5	3	1	12	24	52	79	20	30	39	21	8	5	35
Stone loach							2		1							3	47		10	30	12	16		22
Bullhead																								

1.3.1 Distribution of fry

The number of fry of each species in each section is given in Table 3 and length frequency histograms for dace, chub and roach for each section are given in Appendices 2-4.

The number of fry of the major species in Sections 3-5 were very low compared with the previous year. None was found in Sections 1 and 2. Fry are distributed mainly passively by the water current and with the lack of flow since the completion of the barrage, the fry have presumably not had time to reach these sections by active migration.

Gudgeon and barbel fry were found in the upper sections whereas stickleback fry were abundant in the lower sections only (Table 3). They were associated with the filamentous algae which has appeared this year for the first time.

High concentrations of roach fry were found in Sections 13-16 (Table 3). Dace concentrations in these sections were very low. High concentrations of chub fry occurred in Sections 8-12 (Yarm area).

Distribution of fry compared with known spawning sites for dace will be considered in the Interim Report.

1.3.2 Length frequency distribution

Length frequency histograms are shown for each species (Fig 1). Although the timing of the sampling was similar to last year (ie mid June), the modal size classes of the fry in 1995 are larger by 4-5 mm in the major species. The relationship with temperature will be reviewed in the Interim Report.

Dace fry show no length differences between sections except in ORSU 1 where fry are slightly bigger (Appendix 2). This difference was evident also in 1994. A difference between sections can be seen with chub fry (Appendix 3). Fry are generally smaller in the upper sections. There is a marked difference in Sections 18 and 21, with the modal length depressed by 3 mm compared to adjacent sections. There is no clear reason for this. These sections are above the influence of the barrage but similar differences are not apparent in Section 25 upstream.

Differential growth of roach fry is apparent between sections. They are bigger in the lower sections (Appendix 4). As with chub, small individuals were found in Section 18 but not in Section 21. The size of fish in ORSU 1 are more similar to those in downstream sections than the sections near the ORSU showing that growth in the ORSU is enhanced.

2. SURVEY OF ADULT COARSE FISH SEPTEMBER 1995

2.1 Introduction

Although this is the fifth year that the survey of adult coarse fish has taken place, it is the first survey since the completion of the barrage and the subsequent increase in water levels. The tidal effect has been eliminated and flows are negligible in most of the sections fished. Algae and macrophytes have appeared in most sections. *Polygonum* sp. (Amphibious bistort) is present in the margins and filamentous algae is becoming widespread. Sites 19 and 25 remain the same as prior to barrage closure, acting as controls above the influence of the barrage.

2.2 Methods

2.2.1 Electrofishing

Electrofishing was conducted in all sites except Section 1. Sites 19 and 25 were waded (twin anode 200 v, 1.9 KvA), the ORSU was electrofished from a dinghy with the same gear and all other sites were electrofished with the boom boat.

The boom boat used 200 v at 10 amps from a 7.5 KvA generator. Each section was fished twice, once along each bank. With the negligible flow there was no necessity to fish in any particular direction and fishing was conducted down one bank and up the other. Fish from both runs were retained in an oxygenated holding tank and processed as one catch. Fish were released at a distance sufficient to prevent their migration into the next study section before fishing commenced.

2.2.2 Gill netting

Gill nets were used in deep water in areas of Sections 1 and 2 where fish have not previously been able to survive due to the salinity. They were also used in Section 4 at Preston Park Pool where large bream had been caught by anglers. Two nets were used, with mesh sizes of 8 cm and 12 cm. Both nets were approximately 30 m in length and 2 m in height. Nets were set on the bottom and left for 30 minutes.

2.2.3 Processing

Length measurements were taken from each fish (fork length to the nearest 0.1 cm) and weight measurements (to the nearest gram) and scales for ageing were taken from a representative sample of these.

2.2.4 Echo-sounding

Echo sounding was carried out using a Simrad EY 200P portable echo sounder with a 200 kHz single beam transducer of beam angle 7 ° (Simrad Subsea A/S, Horten, Norway). Throughout the surveys, gain and attenuation settings were maintained at 3 and -15 dB respectively, pulse duration was set at 1.0 ms, and a 40 log R time-varied-gain employed. In addition to the real-time production of an echogram through a colour printer, data were also recorded to digital audio tape using a SONY Digital Audio Tape-corder TCD-D7. The system was deployed from the boom boat moving at a speed of approximately 2 m s^{-1} travelling in an upstream direction. The transducer was deployed in the vertical plane and positioned approximately 0.5 m below the surface of the water.

The above system was deployed on a series of transects along the River Tees during daylight on 4 September 1995. The transects generally followed the middle of the river channel, deviating only to examine known deep areas.

Echoes were recorded along 19 transects between the barrage at Stockton and Low Worsall (Section 16). In addition to these transects in the centre of the river, four sections were repeated where the transect was at the right hand margin (looking downstream) and the boat was travelling very slowly. The transect of Preston Park Pool covered both the margins, and the deep hole.

2.2.5 Echo-sounding data analysis

Data on the audio tapes were processed using version 4.02 of the hardware and software Hydro Acoustic Data Acquisition System (HADAS) (Lindem Data Acquisition Systems, University of Oslo, Norway). Using this system, analogue signals from the audio tape were digitised and transferred to an IBM-compatible personal computer where they were further processed to examine patterns of spatial distribution, abundance and target strength, the latter by the indirect statistical algorithm of Craig & Forbes (1969). Prior to such data processing, the system was calibrated using a sphere of target strength -39.2 dB.

Following exploratory data analysis, default software settings were used for all parameters with the exceptions of the following. The bottom level was set at 4000 mV, the bottom duration to 8 samples, the bottom backstep to 0 m to allow the recognition of fish echoes close to the bottom, and the single fish recognition to 14 samples. While in parts of some transects the bottom had to be redefined manually, close inspection of the HADAS echograms showed no evidence of any complications arising from false fish echoes near the bottom or sides of the river channel.

Estimates of target strengths produced by HADAS were converted to fish lengths using a rearrangement of the relationship recommended for physoclists by Foote (1987) of

$$TS = (20 \log L) - 67.4$$

where TS is target strength in dB and L is fish length in cm. Targets were then pooled into three length classes of small (4 to 10 cm), medium (10 to 25 cm) and large (greater than 25 cm) fish.

2.3 Results

The total number of fish caught in the September survey was 3756. Although this figure was lower than 1995 (5343), it was higher than the two previous years. It had been expected that numbers would be lower than last year as conditions had changed considerably since the closure of the barrage. The water depth was considerably greater over the whole length of the lower river, similar to the former high spring tide depth when electrofishing efficiency was known to be lower. In addition, the lack of saline water has increased the area available to the coarse fish and densities were expected to be lower as a result of redistribution of the populations. Water clarity, however, was better than before the completion of the barrage, and visibility of *c.* 2 m helped to increase efficiency of capture of stunned fish.

Although total numbers were lower than last year, the number of fish >8 cm was 1005 compared with 1180 for last year showing that the difference in numbers was mainly due to differences in the catch of young of the year.

Numbers of dace, roach and chub were remarkably consistent with last year (Table 4). Gudgeon numbers were over double the 1994 value whilst flounder numbers were only at a quarter of last year's level. Flounder numbers were expected to be low due to the increase in water depth and the effect of the barrage which is expected to interfere with the migration into freshwater. Salmon were expected to be similarly affected by the barrage even though there is a salmon pass incorporated. Only one adult salmon was seen. This individual was not caught but was estimated to be 8-10 lb.

Three perch were caught this year (first recorded in 1994) and it is expected that this species will do well under the new post-barrage conditions. Individuals are now being caught in angling matches. Three-spined sticklebacks are also expected to do well. Numbers sampled had trebled, with individuals mainly associated with filamentous algae which is appearing along the length of the study section.

One species new to the study was recorded. One 8.1 cm ide (*Leuciscus idus* L.) was caught in Section 2. Its identification was confirmed by examining the pharyngeal bones which had the dentition 5.3.3.5 on both sides. Anglers had indicated that this species was present having been introduced with roach from the River Kennet in Berkshire. This individual is smaller than the introduced specimens suggesting that the species is now breeding in the river.

Table 4. Species list for the R. Tees and number of each species caught - September 1995.

Species	Totals
Barbel *Barbus barbus* (L.)	23
Bullhead *Cottus gobio* L.	2
Chub *Leuciscus cephalus* (L.)	559
Dace *Leuciscus leuciscus* (L.)	1911
Eel *Anguilla anguilla* (L.)	>>100
Flounder *Platichthys flesus* (L.)	125
Grayling *Thymallus thymallus* (L.)	5
Gudgeon *Gobio gobio* (L.)	215
Ide *Leuciscus idus* L.	1
Minnow *Phoxinus phoxinus* (L.)	364
Perch *Perca fluviatilis* L.	3
Pike *Esox lucius* L.	1
River Lamprey *Lampetra fluviatilis* (L.)	0
Roach *Rutilus rutilus* (L.)	496
Salmon *Salmo salar* L.	0
Stone loach *Barbatula barbatula* (L.)	8
Three spined stickleback *Gasterosteus aculeatus* L.	26
Trout (brown) *Salmo trutta* L.	17
Trout (sea) *Salmo trutta* L.	0

2.3.1 Distribution of fish

Site descriptions, fishing methods, date, species and number of fish caught in each section are given in Appendix 5.

Species compositions at each site are summarised in Fig 2. Pie charts for each section are shown in Appendix 6.

Quasi-quantitative information expressed as number of fish per 100 m of river for each section is given in Table 5. Comparisons between sections and years may be made only after due regard to the different efficiencies with which each section is fished.

Sections are more comparable post- barrage as the variability of factors such as depth and state of tide has been substantially reduced or eliminated.

Table 5. Number of fish per 100 m found in each section in September 1995

Section	Dace	Roach	Chub
1	22.0	6.5	1.0
1/2	38.8	15.5	4.5
3	38.0	1.5	2.0
5	14.6	2.3	5.2
6	6.8	1.6	0.4
7	8.9	1.8	1.3
8	17.5	1.3	11.3
9	7.3	4.7	3.7
10	18.6	6.8	6.8
11	9.4	1.8	3.0
12	16.1	2.0	5.0
13	8.8	1.0	5.5
14	10.7	0.8	3.9
15	16.4	6.2	7.1
21	41.5	16.5	13.5
25	39.1	12.6	27.7

As in previous years, dace were present in all sections fished. In the upper sections unaffected by the barrage, densities were higher than in the previous year, especially in Section 25 (Low Dinsdale). Densities downstream, in most sections, were much lower than in the previous year. This could be due to fish having moved into Sections 1 and 2 thus reducing the density in the other sections.

A similar pattern is shown by roach. Densities in Sections 21 and 25 were high, 3-4 times the 1994 figures. Roach were spread out in Sections 3-15 ranging between 0.8 and 6.8 fish per 100 m although 8 out of the 12 sections had densities of 1-2 fish per 100 m. The previous year had shown more variable results suggesting that more of the habitat is now suitable for roach. Densities of roach in Sections 1 and 2 were high mainly from catches of young of the year although it should be noted that the largest roach caught (by gill net) were in this general area and thus the presence of large numbers of young of the year may be indicative of the good conditions for roach in general.

The pattern of chub distribution was more complex. Of the sections where data were available for both 1994 and 1995, six sites had lower densities in 1995, four sites had higher densities and three sites were similar. The overall density was approximately the same. Densities of chub in Sections 1 and 2 were low compared with roach and dace and compared with densities in other sections. Thus chub have not utilised the extra habitat available as effectively as the other two species. This might have been expected as chub generally prefer flowing water habitats as found in the upper reaches. Densities in the areas unaffected by the barrage were high, for example, in Section 21 the number of chub was similar to the high number last year, and four times the high density in Section 25 in 1994.

The new habitat available to fish in the lower river has been colonised by all the main species although only to a limited extent by chub. Chub favour strong flows and overhead cover, neither of which are present in these sections. Up river section populations have also increased in density possibly by upstream migration of some fish.

2.3.2 Length frequency distribution

The length frequency distribution of each of the major species is presented in Fig 3 and for dace, chub, roach and gudgeon this is also given by section fished (Appendices 7-10).

Young of the year have been excluded from Fig 3 as they occurred in such large numbers that, if included, the length frequency distribution of older fish could not readily be discerned. They are, however, included in the histograms in Appendices 7-9 where length frequencies for each section are shown.

In 1994, dace young of the year were found in very large numbers and it was postulated that this would be a good year class. This year, there were high numbers of 8-12 cm fish which correspond to the young of the year of 1994. In 1995, young of the year were again high in number but not as high as in the previous year.

Dace were found in all sections fished (Appendix 7). Concern had been expressed by anglers that all the dace would move upstream to areas of higher flow. It is true to say that numbers of older dace (>1+) are lower than in previous years in the electrofishing catches and were noticeably absent in the Yarm area (Sections 8-12). Although conditions for electrofishing had changed (deep water) which may have affected efficiency, angling results also suggest that larger dace are absent from these sections. Most dace catches comprise 1+ fish which are present in large numbers. These are the survivors of last year's strong year class and are conspicuous in the electrofishing catches. It should also be noted that the 1993 year class was poor and thus numbers of 2+ fish would be expected to be low even if conditions had not changed.

Sections 1 and 2 have been colonised by young of the year and 1+ dace. The large numbers of young of the year fish in the lower sections suggests that this species has successfully spawned in the area. It seems unlikely that so many fry would have drifted downstream from areas unaffected by the barrage especially as the flow has now been reduced considerably. It is likely the dace have spawned in the normal sites even though the flow is less than ideal for the species. Spawning gravels may not yet be silted up allowing good survival of eggs. In future years, as the silt component of the bed increases, survival of eggs is likely to diminish and the fish may eventually cease to spawn when silt levels are high.

The length frequency histogram for chub shows large numbers of young of the year suggesting a good year class in 1995 (Appendix 8). Numbers of 5-10 cm fish were also high corresponding to the good year class of 1994. there was a noticeable absence of 10-15 cm fish consistent with the poor year class of 1993 which also showed as a low number of 5-10 cm fish last year. Strong year classes can be seen at modal lengths of 18 cm and 31 cm which correspond to those of 12 cm and 27 cm respectively in 1995. Year class strengths are considered further in section 2.3.4.

In 1994, young of the year chub were found only in low numbers below Yarm. This year, numbers of these fish were higher in some of these sections particularly in Sections 2/1 and 5 (Appendix 8). Older fish were seldom found below Section 5 and were most common in the upper sections as is usually the case. Numbers of young of the year were low in ORSU 1 compared with 1994.

The length frequency histogram for roach shows a greater size range for young of the year than has occurred previously (Appendix 9). Large numbers of 5 and 6 cm fish were caught when previously few fish have attained this size range. These fish were found in the lower sections, particularly in Sections 1 and 2 which were previously too saline for coarse fish survival. This new slow flowing habitat appears to have produced good growth of roach fry and the size difference can be clearly seen between these sections and those higher up the river (Appendix 9). Only in Section 25, above the influence of the barrage, can roach fry of this size be found. This would suggest that it is not merely a temperature effect. The size of the young of the year in ORSU 1 substantiate this, where the fish are small compared with sections upstream and downstream but where the temperature was high, particularly in this hot dry year. It is always possible, however, that the larger young of the year may have left the ORSU and that only the smaller ones remain.

Last year's good survival of fry can be seen in terms of large numbers of 7-10 cm fish (Fig 3) although numbers of larger roach were very much reduced. The largest roach caught were in gill nets in Sections 1 and 2 and there could have been a general movement of adults into these areas where electrofishing efficiency is low.

Numbers of small barbel increased compared with previous years but there were less larger fish (Fig 3). Individuals presumably derived from the 1994 good year class were present.

Comparison between the length frequency distribution of flounder in 1995 and 1994 shows that the smallest individuals (5-10 cm) were not caught indicating a possible failure to negotiate the barrage (Fig 3).

Most gudgeon sampled were <5 cm in length and the number of these was much greater than in 1994. As usual, most gudgeon were found in the upper sections. Particularly high numbers were found in ORSU 1 as well as Sections 15, 21 and 25 (Appendix 10). Larger gudgeon were absent from many sections and present only in low numbers in others. Whilst the increase in depth may have contributed to the poor catch in the lower sections, a similar phenomenon was seen in those unaffected by the barrage.

2.3.3 Length weight relationship

Regression analysis of length on weight was carried out for each species occurring in large numbers. The regression equation is

$$\log W = a + b\log L$$

where W = weight (g), a = intercept constant, b = slope and L = length (cm). The values of a and b and r^2 (an indication of the goodness of fit) for each species are given in Table 6.

Table 6. Values of the length weight regressions for major species in the R. Tees, 1995.

Species	a	b	r^2(%)
Chub	-2.22	3.25	99.2
Dace	-2.36	3.38	96.5
Gudgeon	-1.87	2.92	96.6
Roach	-2.07	3.23	99.4

2.3.4 Year class strengths

The length frequency histograms for each age group of dace, chub, roach and gudgeon are shown in Figs 4-7. Although the same proportion of each age group was not necessarily aged, high numbers of a particular age group can be interpreted as an indication of a strong year class. There has been criticism that too many fish are being aged. If the sampling is changed to age a constant number of fish from each length class then it will not be possible to comment on year class strengths directly. It will be necessary to determine the relative year class strengths using a proportional method of assigning ages.

This is the first post barrage year and fish have had much more habitat available both in terms of length of river (downstream limit now the barrage at Stockton instead of the tidal limit) and depth. Added to this, there will almost certainly have been a decrease in the efficiency of capture due to this increased depth resulting in a lower number of fish being caught in certain areas. The relative number of each age class, which determines strong and weak years, may have been adversely affected by the changing efficiencies of capture in areas occupied by each age class. These factors have been born in mind when interpreting the current years results.

Young of the year dace were reasonably abundant and are expected to produce an average year class. The 1994 numbers were very high and have shown as good numbers of 1+ fish this year (Fig 4). The poor numbers of young of the year in 1993 showed as a poor year class of 1+ fish in 1994 and extremely low numbers of 2+ fish this year. The low numbers of 3+ and older dace make it difficult to interpret year class strengths having been more likely to have been affected by the above factors. No dace older than 6+ were caught this year.

As in previous years, chub up to age 15 were caught in the September fishings. Numbers of young of the year chub were slightly greater than last year. Corresponding numbers of 1+ fish are good compared with the 1993 year class which was seen as poor numbers of young of the year and low numbers of 1+ and 2+ chub in 1994 and 1995 respectively. There is a relatively large number of 6+ fish (Fig 5) which have been seen coming through the population as a strong year class in previous years. Numbers of fish >6+ were very low.

The length distribution of roach in September 1995 appears to be very different from previous years in the smaller length classes (Fig 6). The length of some young of the year is greater than found previously. Very large 0+ fish were present in the lower sections which were previously saline at certain states of the tide. 1+ fish are also bigger than found earlier in the study.

The length frequency distribution of gudgeon is different to last year in that few large fish were captured presumably because of the increased depth in most of the sampling sections. Large numbers of 0+ fish were present in the upper sections and in particular in ORSU 1. Although the numbers of large fish caught were very low, there is an indication that the 3+ age class was more common. This fits in with the good year class of 1992 which was seen as 2+ last year (Fig 7).

2.3.5 Echo-sounding results

Eleven of the 19 transects were subjected to quantitative analysis (Stockton to Ingleby Barwick (mouth of the R.Leven) and only 13 fish echoes were recorded, 11 being from small fish (<10 cm and 2 from large fish (>25 cm). These came from just four transects, two within Stockton itself and then nothing until Preston Park. This corresponds to an equivalent total of 188 in 1994, from a survey involving less sampling effort. The surveys carried out near the bank also showed no echoes. It is evident from the electrofishing survey that fish were present in many of theses sections and it is concluded that this vertical beam equipment is not suitable for this river although a horizontal beam may prove more successful. The comparison with the 1995 and 1994 samples shows a reduction in the number of echoes this year. This is probably a real phenomenon and is likely to be due to the change in the physical habitat. Fish are no longer associated with the deep holes as refuge from the flow as the water velocity has decreased substantially since the closure of the barrage. Individuals are spread over a much larger area thus decreasing the density and the likelihood of detection on a relatively narrow transect.

3. TEMPERATURE

3.1 Introduction

Logger problems caused the loss of some data at all sites. Massive floods resulted in the loggers at all sites becoming waterlogged, even in the NRA hut at Low Moor. They were removed and dried out, lab tested and replaced or sent for repair as necessary. The repaired logger was resited in ORSU 1 in July.

The logger at Stockton Quay was removed at the end of 1994. It is unclear when or where it will be moved to. It had been expected that the marina where it was sited would move before the barrage was closed but this has not been the case.

The concern expressed last year about the reliability of these machines is still extant and it is recommended that they are replaced with waterproof loggers at the earliest opportunity.

Daily means are calculated from 24 hourly readings taken between 9 am and 9 am to be in line with Met Office data. Monthly means are calculated as the average of the daily means. The range is calculated as the difference between the monthly means of the maxima and minima which are in turn calculated from the daily figures.

3.2 Results

Monthly means and monthly mean of daily ranges of water temperature are given in Table 7 with values from the R. Frome in Dorset for comparison.

March temperatures were very low, the monthly mean at Low Moor being 1.4 ° C compared with 5.4 ° C the previous year. Temperatures at Low Moor in June and July were very similar to 1994 but August 1995 was an average 3 ° C warmer than the previous year (Appendix 11). This site is above the influence of the barrage and differences in temperature reflect primarily changes in the air temperature. At Ingleby

Barwick, however, the river is now impounded due to the closure of the barrage and there is evidence from the May - July mean temperatures that the larger water body is taking longer to warm up than in pre-barrage years when this site was tidally influenced (Appendix 11).

As predicted in the 1994 report, the temperature range of ORSU 1 was much less than in previous years, being reduced to twice the range in the main river from four times the range. This is due to the increased depth and lack of tidal influence following the closure of the barrage.

Table 7. Monthly means (°C) and means of daily ranges in the River Tees at a) Low Moor, b) Ingleby Barwick, c) Stockton, d) ORSU 1.

	Low Moor		Ingleby Barwick		Stockton		ORSU 1		Frome
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Dec 94	-	-	4.8	0.86	4.7	1.76	-	-	6.7
Jan 95	-	-	2.6	0.72	-	-	-	-	6.5
Feb	-	-	-	-	-	-	-	-	6.8
Mar	1.4	0.95	-	-	-	-	-	-	7.4
Apr	8.6	1.75	-	-	-	-	-	-	10.6
May	13.9	2.05	10.8	0.88	-	-	-	-	13.3
Jun	16.2	1.94	13.7	0.56	-	-	-	-	16.7
Jul	19.9	1.84	16.4	0.61	-	-	19.3	0.92	17.4
Aug	19.6	1.89	17.5	0.60	-	-	18.7	1.13	17.0
Sep	-	-	13.2	0.68	-	-	14.3	1.11	14.6
Oct	-	-	11.0	0.45	-	-	11.9	1.15	11.9
Nov	-	-	6.9	0.46	-	-	7.1	0.97	8.3

4. ANGLING DATA

4.1 Methods

The system set up for anglers to record data from matches has been reasonably successful this year. Data on individual angler's catches continues to be collected. The total weight of each catch is recorded along with the composition in terms of numbers of each species of fish. In the past, dace, roach and chub have been split into large and small fish, large dace and roach being >6 oz and large chub being >1 lb. This year, the match sheets have included gudgeon, perch and grayling. Also recorded are the position on the river (peg number), and a subjective assessments of the river and weather conditions.

Due to the fluctuations in numbers of anglers fishing each competition, and in particular due to the poor attendances in recent years, the anglers felt that the mean catch per angler was giving a result which was artificially high as the few anglers fishing were given what were expected to be the best pegs and comparisons with previous matches, where many anglers failed to catch anything, may not be valid. In order to address this, the top ten catches in each match were used to calculate the mean catch per angler.

4.2 Results

4.2.1 Mean catch per angler

The mean catch per angler was calculated and appended to those of previous years (Appendix 12). This weight is not significantly different from that of 1994 but has at least stopped the annual fall which has occurred since the 1991/92 season (Fig 8). This season's weight comprises matches which occurred both before and after the closure of the barrage. It was not thought valid to split the matches with reference to the closure as results differ with time of year.

The pattern of mean catch per angler using only the top ten weights in each match is slightly different with a similar pattern of annually falling weights although it is unlikely to be significant (Fig 9).

4.2.2 Distribution of catch weights along the river

The 'Alphabet' stretch just upstream of Yarm where large dace traditionally congregated in winter fished no better than any other stretch. Initial match results show that after closure of the barrage, most large fish disappeared from the Yarm AA water and catches were dominated, in terms of numbers, by small fish. For example, in one match in June 1995, an angler caught 51 roach and dace weighing a total of only 11.5 oz.

4.2.3 Introductions of fish

Detailed match sheets showed that bream were caught at Yarm in late 1995. This was surprising in that bream which were thought, by anglers, to be limited to Preston Park Pool had been caught at Stockton. It appeared that some fish had moved upstream as well. The following match sheet, however, commented that the "recently stocked bream were not seen". It will be much more difficult to assess the results of the barrage closure if angling clubs are allowed to introduce fish into the study stretch without our knowledge.

5. COMPARISONS BETWEEN YEARS PRIOR TO THE CLOSURE OF THE BARRAGE

5.1 Distribution of fry

5.1.1 Introduction

Comparisons of relative abundances of different species of fry between years are difficult due to the fact that surveys times were spread out over a two month period. There was a conflict of interests in that the surveys were expected to assess species composition and locate the main dace spawning sites in the tidal Tees. If the surveys were conducted later in the fry season to allow for the hatching of late spawning species then the dace (which spawn early) had reached such a size that they had moved away from the spawning sites and traditional fry sampling areas into deeper water and been carried by the currents, or swam, to other sections both upstream and downstream. In order to achieve both objectives, surveys were conducted in either June or July. A further complication arises over the timing of spawning which can be delayed by low water temperatures so that it is very difficult to plan this sampling programme. This year, sampling, in mid June, was early enough to catch both dace fry before they moved into deeper water and sample roach and chub which hatch later. Although these latter species were very small they were identifiable.

Another factor which must be taken into consideration is the change in the physical habitat and the associated change required in the sampling methodology. The river is now uniformly deep and there are very few sites where micromesh seining can be carried out. Thus the main sampling method is pond netting plus point sampling with battery pack electrofishing gear. Fry are consequently more likely to be caught when they are small and less mobile which favours a June rather than July sampling programme.

5.1.2 Results

The distribution and percentage contribution of dace fry, to the association of juvenile fishes, for the pre-barrage years 1992-1994 and the first post barrage year 1995 are shown in Fig 10. It can be clearly seen that the proportion of dace fry was much higher when sampled in June before they had moved from the shallow water. They constituted the major species of fry in most sections unlike the previous two years when their distribution was limited to relatively few sections. The fry in these years would have been large enough to move to the deeper water and to distribute themselves, in the river as a whole, into favourable areas for fry. A few sections were dominated by dace fry, in terms of numbers in these July fishings, and this will have reflected the favourability of the site and the ease of micromesh seining. In 1995, the relative proportion of dace fry was much lower than 1994 in all sections and as the fry were still small and had not moved into deeper water, this is interpreted as a real difference caused by the closure of the barrage and the resultant deep, slow flowing water.

The distribution of chub fry seems to be very variable. In July 1992 and 1993, chub fry were well represented in many of the sections in which they were found and they were particularly widespread in 1993 (Fig 11). In 1994, the chub fry were at the 'pinhead' stage and were considered to be still hatching which may account for their limited distribution. In 1995, chub fry were found in all but three sections which suggests that they spawned in almost all sections. As chub spawn on gravel and are expected to be affected in a similar way to dace, the result is perhaps surprising. The success of chub and dace spawning may well decrease as further siltation of spawning gravels occurs.

Samples taken in July 1992 and 1993 show downstream sections containing high relative abundances of roach fry but samples taken in June 1994 shows a different distribution with middle sections having higher proportions of roach. Given that the June value is more likely to indicate the proximity of spawning areas, it can be postulated that roach fry, which are poor swimmers in their early stages, were carried downstream by the flow and by July had aggregated in the lower sections (Fig 12). The first post-barrage year showed that roach fry occurred in most sections apart from the bottom 4. Whilst this region was affected by the tide, roach probably spawned on the bank vegetation at high tide due to the small amounts of aquatic vegetation, and eggs would have been left above the water level as the tide ebbed. Egg survival would have increased markedly without the influence of the tide. It is probable that the lack of roach fry in the lower reaches is due in part to the lack of vegetation. The banks are almost entirely composed of mud, unlike sections further upstream. A similar scenario is probably the cause of the lack of bream recruitment.

5.2 Densities

Density data (numbers of fish per 100m length of river) for sites electrofished in September in pre-barrage years 1992-1995 is graphically illustrated in Fig 13.

Analysis of Variance (two-factor without replication) has been performed on the density data at the 5% level of confidence. For pre-barrage dace no significant differences are found between the mean densities of fish at each site ($p=0.100$) but significant differences do occur between the means of fish density in each year (p=0.042). Dace densities in each year were further examined using one way ANOVA's at the 5% level of confidence. Densities in 1994, a year in which very high numbers of 0+ fish were sampled, were found to be significantly greater than those in 1993 (p=0.01), but not significantly different, at the 5% level, to the 1992 density data.

For pre-barrage roach, no significant differences have been detected between the mean densities of fish at each site (p=0.382) nor between the means of fish density in each year (p=0.727).

For pre-barrage chub, no significant differences, at the 5% level, were found between the mean densities of fish at each site (p=0.096). No significant differences occur between the means of fish density in each year (p=0.289).

In summary, the number of dace per 100m has been found to vary between years, high densities of dace in 1994 being due mainly to the large numbers of 0+ fish. No significant variation between sites has been detected. Neither roach nor chub densities vary significantly between years or between sites. Although densities of chub appear to be higher in the upstream sites than in the downstream sites, these differences are not statistically significant at the 5% level. With more year's data, a better picture of fish distributions in the Tees may have been obtained. More than three years data after closure of the barrage would be desirable, although any comparisons with pre-barrage data will still be affected by the low sample number of the latter surveys.

Site differences in population density of chub cannot be shown statistically although they can be seen graphically. Further years' data would probably have shown a significant difference. Thus three years' data is not enough for statistical comparisons and given the change in area available to the fish after closure of the barrage, density values are likely to take some years to stabilise before comparisons can begin, and then data from more than three years will be required for statistical comparisons. It should be noted that any comparisons between pre- and post- barrage data will always be affected by the low sample number of pre-barrage surveys. This problem has always been recognised and is the reason why high effort is spent looking at the biology of the species in order to detect changes rather than looking at densities.

5.3 Year Class Strength

5.3.1 Methods

Relative year-class strengths have been calculated using data collected in the September fish surveys. The length/age distribution for aged fish in each year was examined and, from these distributions, each fish caught was assigned an age, derived from its length. In order to assign ages, cut-off points between the various age groups needed to be determined, below which length a fish would be assigned to one year class, and above which the next age class would begin. This was achieved by adding or subtracting standard deviations to/from the mean length of each year-class (from aged fish) until the percentage of each sample which would be wrongly aged was minimised. This occurs when :

$$\text{mean }(x) + S(x) = \text{mean }(x+1) - S(x+1)$$

Where: mean(x) = the mean length of age-class x
S(x) = the standard deviation of age-class x
mean(x+1) = the mean length of the age-class above x
S(x+1) = the standard deviation of age-class x+1

These cut-off points were calculated, where possible, for each age class of dace, roach and chub, for all of the September surveys. When no 0+ group fish were aged, the cut off point between 0+ and 1+ group fish was assigned subjectively from examination of the relevant length/frequency distribution and the raw data.

After all dace, roach and chub had been aged, or had an age assigned to them, relative year-class strengths were calculated for these species [following the method in Mann R.H.K. (1973) J.Fish.Biol. : 5:707-736]. The percentage of fish in each age group in each year of capture was calculated. The mean percentage value of each age class was then calculated for use as a standard. This method assumes unbiased sampling for all age groups. As 0+, 1+ and 2+ fish are more easily caught than older age groups they are omitted from the calculations of relative year class strength. The method is not very sensitive but is designed to show major changes.

Relative year-class strength was assessed by summing the percentage occurrence of each year class through all years of capture, and comparing this value with the sum of the standards of the same period.

eg. for the 1991 year class of dace (which are aged 3 in 1994 etc see Table 8)
Relative Year Class Strength = 100(35.37+28.57)/(37.09+24.29).

Table 8 Numbers of dace in each age groups and their percentage composition of the catch in each year

Year of Capture		3	4	5	6	7	8	9	10	Total
1991	No.	11	7	18	24	8	0	0	0	68
	%age	16.17	10.29	26.47	35.29	11.76	0	0	0	100
1992	No.	134	39	23	17	14	9	0	0	236
	%age	56.78	16.53	9.75	7.20	5.93	3.81	0	0	100
1993	No.	44	72	14	5	3	2	0	0	140
	%age	31.43	51.43	10	3.57	2.14	1.43	0	0	100
1994	No.	29	12	26	8	6	1	0	0	82
	%age	35.37	14.63	31.71	9.76	7.32	1.22	0	0	100
1995	No.	16	10	5	4	0	0	0	0	35
	%ge	45.71	28.57	14.29	11.43	0	0	0	0	100
	mean%age	37.09	24.29	18.44	13.45	5.43	1.29	0	0	

5.3.2 Results

Data from back calculations indicate that he percentage of fish in each age group in each year of capture and the mean percentage value of each age class are shown in Tables 8, 9 and 10 for dace, roach and chub respectively and the relative year class strengths are given in Table 11. Each value is relative to 100 so that high values represent good year classes and low ones poor year classes.

The 1984, 1985 and 1989 year classes of dace are particularly strong and the 1988 year class is poor (Table 11). Strong chub year classes are 1977, 1980, 1982, 1984 and 1989, whereas poor year class strengths resulted from 1981, 1985-1988, 1990 and 1991 (Table 11). The Year class strength of roach is generally more variable than that of dace or chub with good year classes from 1983, 1984 and 1989 and poor year classes from 1985-1988, 1991 and 1992 (Table 11). Particular years are not necessarily good for all three species. For instance, 1985 was a particularly good year for dace but a very poor year for both roach and chub. Similarly, in 1992, roach had a poor year but chub and dace were better than average. 1984 and 1989 were good years for all three species (Table 11).

These good and poor year classes generally agree with the interpretation of the age frequency histograms given in this (Figs 4-6) and previous reports. In the cases of dace and roach, few of the identified strong and weak year classes still have representatives in the population. Some 6+ dace were found which relate to the good year class of 1989 and although numbers were not high, there were good numbers of 5+ fish in 1994. Similarly for roach, good numbers of 5+ fish were found in 1994 although no 6+ fish were found this year. This good year class of 1989 was seen in the case of chub both this year and last year. Results from previous years are broadly in agreement. The poor years of 1987, 1988, 1990 and 1991 for chub, identified from the calculations of relative year class strengths, are confirmed from age frequency data in 1995 for all years except 1991 where reasonable numbers of 4+ fish were found. Very few 5+ were seen (1990) and only two 7+ (1988) and one 8+ (1987) fish were found.

Because 0+, 1+ and 2+ fish are not included in the calculations of relative year class strength, the most recent relative year class data available in 1995 are from the 1992 year class. The value given for relative year class strength in this case is based on 1995 3+ fish only. Subsequent years' data will improve the accuracy of this relative year class strength value. Using this method, a value for the 1995 year class strength will become available in 1998. Values for the first three year classes after the closure of the barrage will become available in 2000. The relative year class strength values for 1995 would then be based on the capture of 3+, 4+ and 5+ fish in 1998, 1999 and 2000 respectively; the values of 1996 year class would be based on the capture of 3+ and 4+ fish in the 1999 and 2000 surveys with 1997 year class values being based on the capture of 3+ fish in 2000. Any surveys beyond this date will improve the accuracy of these values.

Table 9 Numbers of chub in each age groups and their percentage composition of the catch in the River Tees 1991-1995

Year of capture		3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1991	No.	9	5	3	5	11	8	7	1	8	1	0	2	0	60
	%age	15	8.33	5	8.33	18.33	13.33	11.67	1.67	13.33	1.67	0	3.33	0	100
1992	No.	88	13	1	3	3	3	1	1	2	2	1	2	0	120
	%age	73.33	10.83	0.83	2.5	2.5	2.5	0.83	0.83	1.67	1.67	0.83	1.67	0	100
1993	No.	43	187	25	7	2	0	7	3	3	2	0	0	1	280
	%age	15.36	66.79	8.93	2.5	0.71	0	2.5	1.07	1.07	0.71	0	0	0.36	100
1994	No.	19	22	102	15	2	2	2	7	3	4	1	2	2	183
	%age	10.38	12.02	55.74	8.20	1.09	1.09	1.09	3.82	1.64	2.19	0.55	1.09	1.09	100
1995	No.	31	10	4	29	2	1	4	0	2	1	1	0	1	86
	%age	36.05	11.63	4.65	33.72	2.33	1.16	4.65	0	2.33	1.16	1.16	0	1.16	100
mean	%age	30.02	21.92	15.03	11.05	4.99	3.62	4.15	1.48	4.01	1.48	0.51	1.22	0.52	

Table 10 Numbers of roach in each age groups and their percentage composition of the catch in the River Tees 1991-1995

Year of capture		3	4	5	6	7	8	9	10	Total
1991	No.	3	1	1	2	14	4	0	0	25
	%age	12	4	4	8	56	16	0	0	100
1992	No.	100	6	0	0	0	1	0	0	107
	%age	93.45	5.61	0	0	0	0.93	0	0	100
1993	No.	42	87	22	2	0	0	0	0	153
	%age	27.45	56.86	14.38	1.307	0	0	0	0	100
1994	No.	24	16	29	1	1	0	0	0	71
	%age	33.80	22.54	40.85	1.408	1.408	0	0	0	100
1995	No.	2	1	2	9	0	0	0	0	14
	%age	14.29	7.14	14.29	64.29	0	0	0	0	100
mean	%age	36.2	19.23	14.7	15	11.48	3.39	0	0	100

Table 11 Relative year class strengths of dace, roach and chub based on the capture of 3+ and older fish using ages as read from scales and also assigned ages. Base line = 100%

Year Class	Dace	Roach	Chub
1977			191.4
1978			90
1979			96.4
1980			223.1
1981			52.8
1982			145.6
1983		472.4	122.5
1984	231.7	382.9	161.6
1985	211.4	26.8	47.2
1986	95.9	9	35.9
1987	49.2	10.5	24.6
1988	53.1	34.6	54.5
1989	162.3	300.1	294.2
1990	75.6	91.6	47.8
1991	104.2	73.9	42.4
1992	123.2	39.5	120.1

5.4 Growth of fry

5.4.1 Methods

The mean length and CI of dace, chub and roach were calculated for both the fry and September fishings in each year. These data were used to calculate the mean growth increment of each species over that time period, along with a maximum and minimum estimate of the mean.

The number of dace, roach and chub caught on each day in each of the surveys was found and the number of days of potential growth between the summer and September surveys was calculated from these dates. The estimates of growth in length were divided by the number of days, as calculated above, to give a figure of growth per day.

Growth in length was then correlated with temperature in terms of mean summer temperatures and degree days above 12°C. Mean summer temperature was calculated as the average of the mean monthly temperatures for May to September inclusive and degree days above 12°C were calculated from mean daily temperatures. Whilst this is not absolutely correct, it was thought to provide a reasonable estimate for comparisons between years. The range was calculated as the difference between the minimum and maximum growth rates. These were estimated from the summer mean plus confidence limit length to the September mean minus confidence limit length and vice versa.

5.4.2 Results

The mean lengths and growth in length of dace, roach and chub fry are shown in Tables 12, 13 and 14 respectively.

Table 12 Growth in length of dace fry

	June/July Length (mm)	September Length (mm)	No of days between samples	Growth mm day^{-1}	Range mm day^{-1}
1992	36.2 ± 0.2	59.7 ± 0.4	61	0.38	0.02
1993	27.8 ± 0.2	51.4 ± 0.8	58	0.41	0.03
1994	13.6± 0.03	53.3 ± 0.3	89	0.44	<0.01

The growth estimates for dace show that the 1992 value was the lowest although the September mean length was the highest. In 1992, the initial size was 36.2 mm compared with only 27.8 mm in 1993. The initial length in 1994 was low because sampling was conducted in June unlike the other years when sampling occurred in

July. Comparisons of mean lengths in September show significant differences between all three years (non-overlapping confidence limits).

Table 13 Growth in length of roach fry

	June/July Length (mm)	September Length (mm)	No of days between samples	Growth mm day^{-1}	Range mm day^{-1}
1992	23.5 ± 0.6	41.6 ± 0.9	61	0.29	0.04
1993	13.2 ± 0.2	30.7 ± 0.8	58	0.30	0.04
1994	7.8± 0.1	36.7 ± 0.9	89	0.33	0.03

Table 14 Growth in length of chub fry

	June/July Length (mm)	September Length (mm)	No of days between samples	Growth mm day^{-1}	Range mm day^{-1}
1992	22.9 ± 0.5	42.8 ± 1.0	61	0.33	0.05
1993	13.3± 0.1	26.9 ± 1.5	58	0.23	0.06
1994	7.2± 0.1	35.1 ± 0.8	89	0.31	0.02

Table 15 Growth in length for dace, roach and chub for 1995

	June/July Length (mm)	September Length (mm)	No of days between samples	Growth mm day^{-1}	Range mm day^{-1}
Dace	18.4 ± 0.1	61.3 ± 0.6	83	0.52	0.02
Roach	10.6 ± 0.1	43.4 ± 1.3	83	0.39	0.03
Chub	11.1± 0.1	44.9 ± 1.1	83	0.41	0.03

A similar pattern over the years is seen for roach (Table 13) although growth in absolute terms is slower than that of dace over the same period. A comparison of mean lengths in September again shows significant differences between years. Similarly,chub growth in length is high than roach in 1992 but lower in 1993 and 1994 (Table 14).

The growth rates of dace, roach and chub in 1995 are all significantly greater than those of the previous pre-barrage years and as a consequence the mean lengths of 0+ fish of these species is also greater (Table 15). In future years it will be possible to relate growth per day to Relative Year Class strength, however at the moment the most recent value of Relative Year Class strength available is from 1992. In warmer years, spawning probably takes place earlier than in cooler years, allowing a longer growing season. However, growth per day as calculated above does not take temperature into account, as the calculation simply involves the number of days between surveys and not the number of degree days.

The mean September length of each of the three species was plotted against mean summer temperature (Fig 14). There is a clear relationship between fry length and mean summer temperature for each species. R^2 values for these relationships are 0.854, 0.998 and 0.994 for dace, roach and chub respectively. A similar relationship can be demonstrated using degree days above 12^0C (Fig 15). R^2 values for these relationships are 0.837, 0.998 and 0.992 for dace, roach and chub respectively.

An absolute measure of the relationship between growth and temperature can be found by plotting growth in terms of increase in length over a specific period against degree days above 12^0C for that period. In this case the period is between the fry survey and the September survey (Fig 16). R^2 values for these relationships are 0.95, 0.97 and 0.95 for dace, roach and chub respectively.

5.5 Growth of fish older than 0+

5.5.1 Methods

Scales from dace, roach and chub from each of the September surveys were examined under a Projectina (projecting microscope) and each fish was assigned an age. Distances from the scale origin to each of the annuli were measured and by comparison with the corresponding radius of the scale, the length of each fish at each age of its life was determined (back-calculation). Quadratic curves were fitted to the plots of fish length (mm)/100 against scale radius for each species in each year and corrections for allometric growth were made.

Relative growth rates for dace and roach were determined from back-calculated estimates of fish lengths, following the method of Mann 1973 (J.Fish.Biol., 5, 707-736) and Kempe 1962 (Rep. Inst. Freshwat. Res. Drottningholm, 44, 42-104). Data from fish which were I or II in the year of capture are excluded from the analysis (ie the 1992 year class is the latest for fish captured in 1995).

The back-calculated length data from all years, generated from an IFE program run in Minitab, were copied into Excel. The following explanation of the method uses the calculations performed on dace as an example. The data were then grouped into tables for each year class, showing the back-calculated lengths of all fish of that year class, for all years of the surveys (eg Table 16, showing the 1987 year class). For each year class, the median values of the length at each age were found and from these values the growth increment at each age was calculated (Table 16). From the growth increments thus determined for each year class, the median growth increment in each age class was established, for use as a standard in the following calculations (Table 17). The growth increment at each age for each year class was expressed as a percentage of the standard (eg for the 1992 year class at age II, the growth increment as a percentage of the standard is 43/42 = 102.381. The value for the relative growth rate in any one year is calculated by finding the mean of these percentages for that year, for example, the value of relative growth rate for Dace in 1992 is :- (98.53+95.24+112.94+120.31+92.96+77.42)/6 = 99.56 (Table 17 working diagonally from 1992 year class at age class I to 1991 year class at age class II etc to 1987 year class at age class VI).

Average relative growth in a year would give a value of 100. Values less than 100 indicate lower than average growth, values greater than 100 indicate better than average growth. Negative growth increments have been excluded from the calculations, as has an anomalously large growth increment resulting from a large VII group roach caught in 1994 (1987 year class).

The calculation of relative growth rate of roach and dace in different years was carried out using data from all ages of fish, and also for the I, II and III group fish only, as these are the years in which growth rate is greatest. In both cases, data from fish which were I or II in the year of capture were excluded.

5.5.2 Results

The equation of the quadratic curve of fish length against scale radius is:

$$y = a + bx + cx^2$$

where y = fish length/100
x = scale radius/100
a, b, and c are constants

The values of the constants for each species in each year are given in Table 18.

Table 16 Back-calculated lengths (mm) at each age of all dace caught from the 1987 year class

year of capture	I	II	III	IV	V	VI	VII
1991	63	104	129	159			
1991	63	85	138	192			
1991	62	96	138	193			
1991	90	137	191	214			
1991	70	127	187	218			
1991	81	135	196	220			
1991	93	153	206	228			
1992	63	101	133	165	201		
1992	59	91	115	172	204		
1992	67	115	161	195	212		
1992	66	106	150	196	216		
1992	78	111	161	193	218		
1992	81	118	151	196	222		
1993	77	127	171	198	214	218	
1993	83	124	158	197	211	218	
1993	56	113	173	205	216	219	
1994	69	127	149	165	183	199	206
1994	68	138	161	196	206	218	222
1994	65	84	128	180	212	218	223
1994	62	130	183	201	213	221	228
1994	77	107	136	161	192	220	231
median	68	115	158	196	212	218	223
growth inc.	68	47	43	38	16	6	5

Table 17 Growth increments between each age for each year class and standard (=mean) growth increments for dace

		GROWTH INCREMENT AT AGE							
YR.CLS.		I	II	III	IV	V	VI	VII	VIII
1984	mm	73	41	36	32	20	17	11	10
	%	107.3	97.62	84.71	100	112.68	219.3	220	111.1
1985	mm	74	36	43	32	19	16	5	
	%	108.8	85.71	101.18	100	107.04	206.4	100	0
1986	mm	71	46	40	32.5	22	7.5	0	9
	%	104.4	109.52	94.12	101.56	123.94	96.77	0	0
1987	mm	68	47	43	38	16	6	5	
	%	100	111.91	101.18	118.75	90.14	77.42	100	0
1988	mm	69	46.5	49	26.5	16.5			
	%	101.5	110.71	115.29	82.81	92.96	0	0	0
1989	mm	68	41	42	38.5	13	8		
	%	100	97.62	98.82	120.31	73.24	103.2	0	0
1990	mm	63	48	48	14	32			
	%	92.65	114.29	112.94	43.75	180.28	0	0	0
1991	mm	65	40	36	37				
	%	95.59	95.24	84.71	115.63	0	0	0	0
1992	mm	67	43	43					
	%	98.53	102.38	101.18	0	0	0	0	0
STANDARD		68	42	42.5	32	17.75	7.75	5	9

Table 18 Values of constants a, b and c of the quadratic curve of fish length against scale radius

Species	Year	a	b	c
Dace	1991	0.2812	1.7071	0.2644
Dace	1992	0.3976	1.622	0.2784
Dace	1993	0.2644	1.9203	0.4794
Dace	1994	0.3611	1.5726	0.2403
Roach	1991	0.2648	2.6338	0.6404
Roach	1992	0.4542	1.9949	0.2248
Roach	1993	0.6238	0.946	0.1317
Roach	1994	0.4675	1.0217	0.1397
Chub	1991	0.2704	2.2536	0.1822
Chub	1992	0.4924	1.8143	0.0536
Chub	1993	0.6047	1.8283	0.0252
Chub	1994	0.5586	1.8892	0.0078

Relative growth rates for dace and roach are shown in Figs 17 (all dace)and Fig 18 (I-III group only)and Fig 19 (all roach)and Fig 20 (I-III group only).

In the case of dace, the relative growth rates of the I-III group is less variable than for all ages. Most years show growth at or slightly above the long term average (ie 100%). Exceptionally poor years can be seen in the 1986 and 1993 years of growth from both sets of data and good years can be seen for 1984 (I-III group especially) and 1990. There is some consistency with year class strength data, 1984 produced a strong year class and the poor year of 1993 has resulted in a correspondingly weak year class. The high value for 1990 which is seen for all fish but not for the I-III groups suggests that some older fish may have been anomalous or aged incorrectly. The year class strength data show results consistent with the data from the I-III groups.

The relative growth rates of roach are more variable than those of dace. 1993 again is very poor and as with dace resulted in a weak year class. The poor relative growth rate of 1986 also corresponds with a weak year class but 1985 and 1988 were also poor year classes but the relative growth rates were above average.

Some of factors are common to years of good or bad relative growth rates and good or bad year class strengths but the lack of a complete match suggests that there are factors involved which operate on only one of these parameters.

The mean summer temperatures (May to September inclusive) have been plotted against the values of relative growth rate for the corresponding years, for all ages of dace and roach, and also for the I to III age groups only (Figs 21-24). There is a positive correlation between relative growth rate and mean summer temperature which can be particularly seen amongst the I to III age groups of dace and roach ($R^2 = 0.77$ in both cases).

5.6 Instantaneous growth rate

5.6.1 Methods

True (as opposed to population) instantaneous growth rates (G) have been calculated for dace, chub and roach for their first year (G0). These were determined by converting the back-calculated lengths of individual fish to their corresponding weight using length/weight equations for the relevant year of capture. Individual weights were then converted to instantaneous growth rates for each year of growth using the ratio of the final weight (w_2 - weight at first annulus formation) to the initial weight (w_1 - weight of egg) over time (one year) where;

$$G = \text{Log}_e\ w_2 - \text{Log}_e\ w_2\ /\ \Delta t.$$

Due regard was given to the possibility of errors resulting from using back-calculated data from older fish (lee's phenomenon). The length of the data set available for analysis was governed by the longevity of the various species.

Mood median and Kruskal-Wallis tests were carried out on all data and again for the 1991-1994 growing seasons) to test for between year variation in values of G0.

5.6.2 Results

There were significant ($p = <0.001$) long-term between year variations in G0 for all three species. Dace showed a general trend of decreasing G0 between the years 1984-1994 with all the top five ranking years occurring prior to 1990 (Appendix 13). In the absence of any corresponding trends in chub and roach, it is not considered that this could be attributed to Lee's phenomenon.

Between year differences in long-term (1977-1994) chub growth were also significant. Although there was no trend discernable over the whole period examined, the data from 1989 show a decline similar to that found for dace (Appendix 13).

Long-term (1983-1994) growth of roach showed an interesting pattern. Between 1983 and 1986, growth was fairly stable with mean G0 averaging 6.3. In 1987 and 1988 the growth rate rose dramatically (mean G0 averaging 7.4) before subsequently stabilising around a value of 7.0.

Only dace and chub showed significant (p= <0.001) variation in G0 in the 1991-1994 growing seasons. These years were ranked for values of G0 and compared between year groups and species (Table 19).

Table 19 Growing years 1991 - 1994 ranked by instantaneous growth rate for 0 group dace, chub and roach

RANK	1	2	3	4	
Dace	92	91	94	93	Sig diff
Chub	91	92	93	94	Sig diff
Roach	93	92	94	91	No sig diff
Overall	92	91	93	94	

Although there was no exact match of highest ranking years between species, 1992 ranked highest overall for all species combined.

5. COST OF WORK DURING THE REPORTING PERIOD (APRIL 1995 - FEBRUARY 1996)

In order to complete the contract to the IFE's satisfaction, the cost of the work is £34958 which is above the agreed contract price. The NRA is not contractually obliged to pay this figure.

6. ANTICIPATED COSTS OF THE WORK IN THE PERIOD UP TO FEBRUARY 1997

As in the current financial year, the costs are expected to be above that agreed in the contract. IFE has formally asked for a Variation Order to cover extra work being asked for.

7. PROGRAMME FOR THE NEXT REPORTING PERIOD

Sampling programmes for fry and adult fish will again take place in the summer and in September respectively. Post sampling laboratory work and analysis may need to be reduced in order to meet the agreed contract price. Temperature and angling data will continue to be collected.

8. FACTORS LIKELY TO AFFECT THE COMPLETION OF FUTURE WORK

It is possible that adverse weather conditions may delay the sampling programme in the short term but it is unlikely that the completion date of the project will be affected.

As in the previous year, section 9 was not fished effectively because of angler presence, even though notices were posted by the NRA warning of the sampling programme.

FIGURES AND APPENDICES

Fig 1 Length frequency histograms for each species of fry in the R.Tees in June 1995

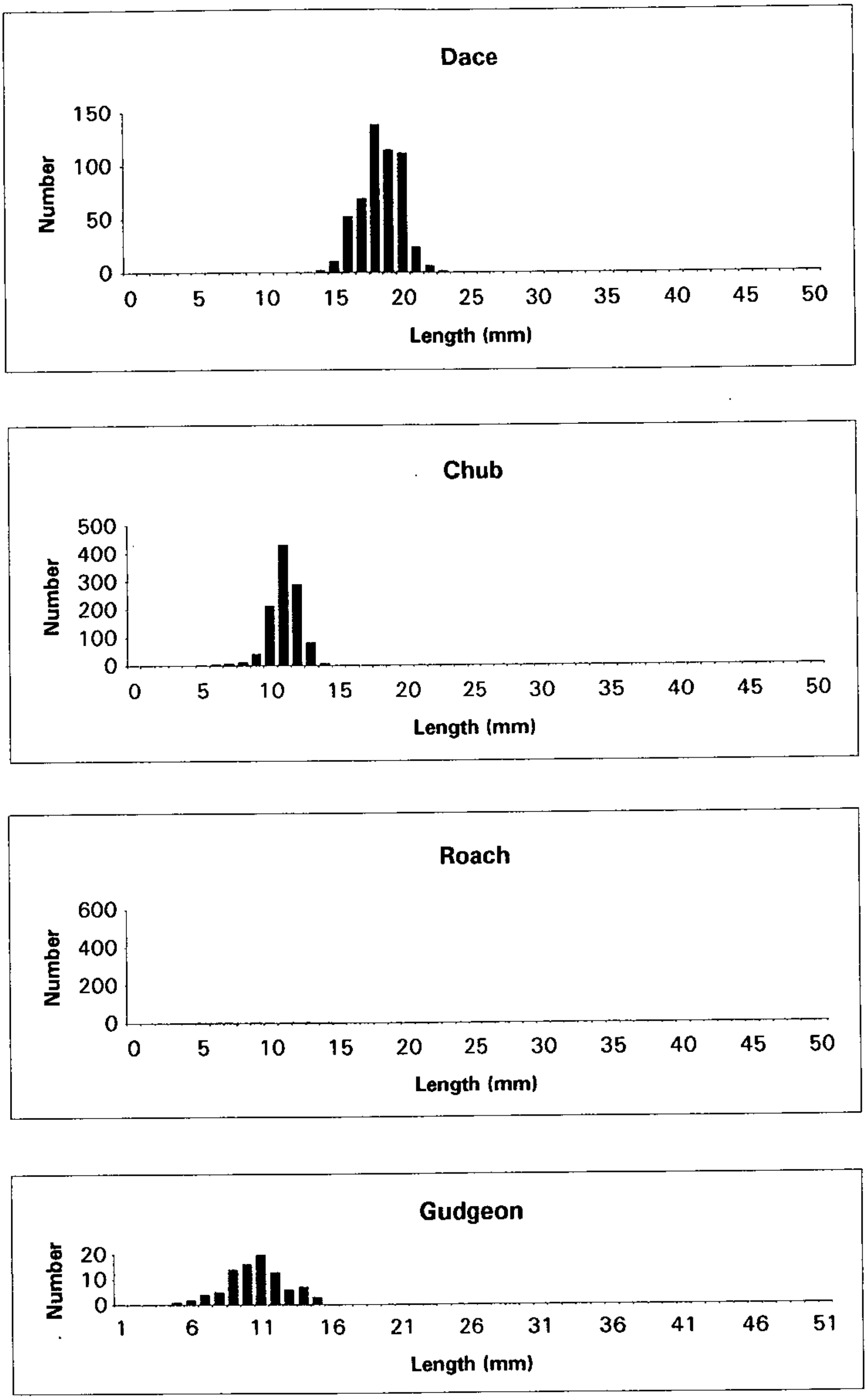


Fig 1 continued

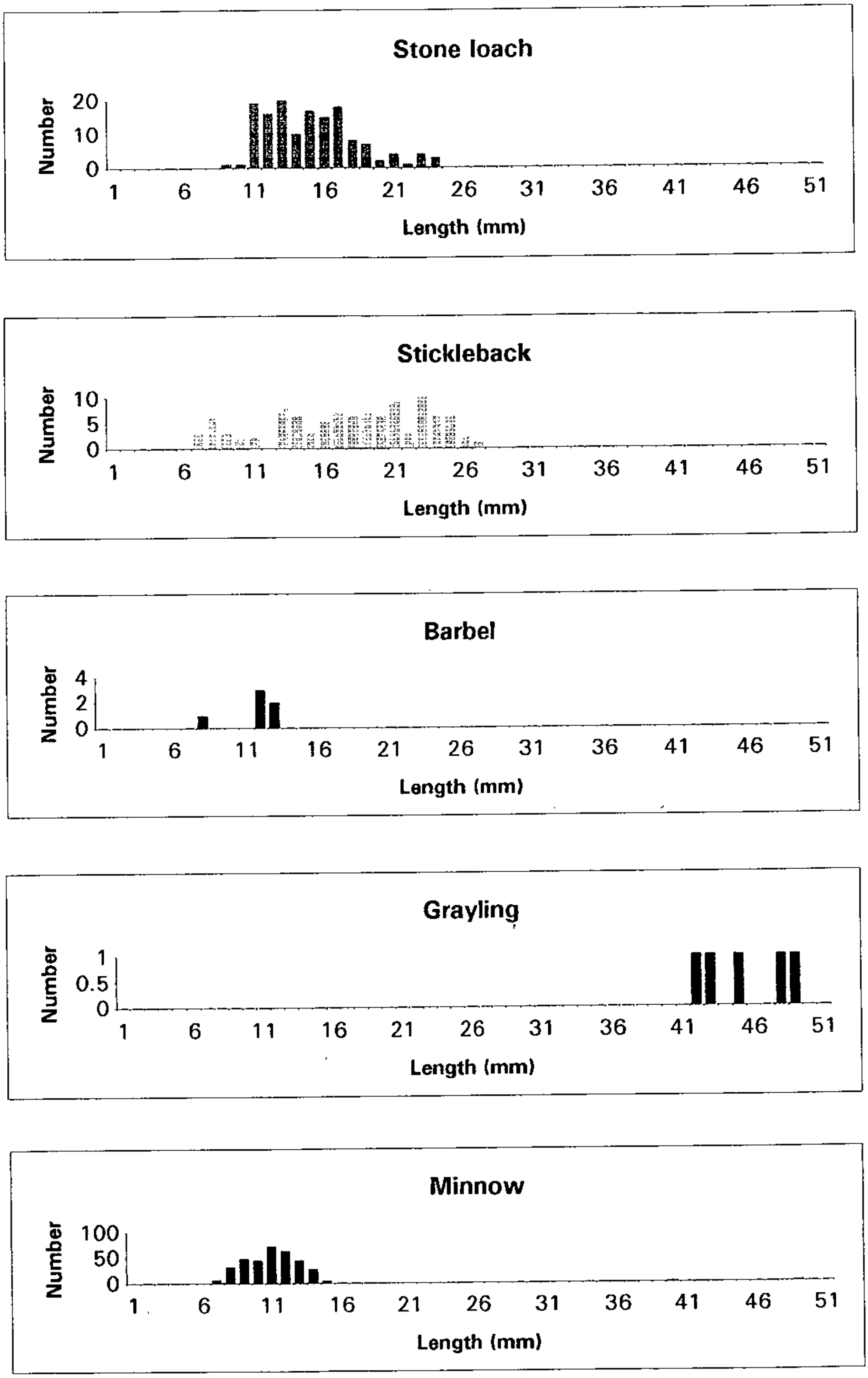


Fig 2 Species composition of fish in the R.Tees in September 1995 at various sites.

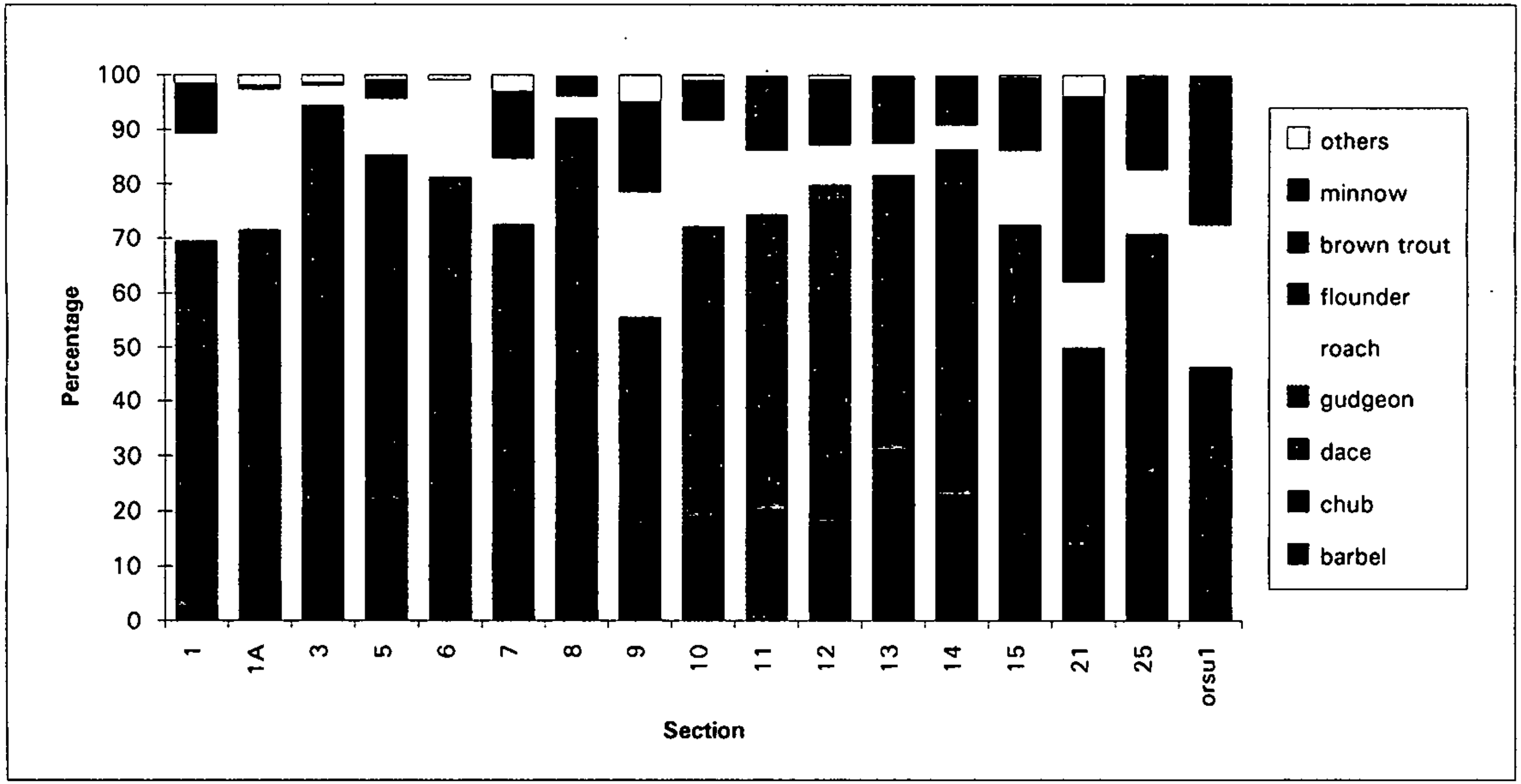
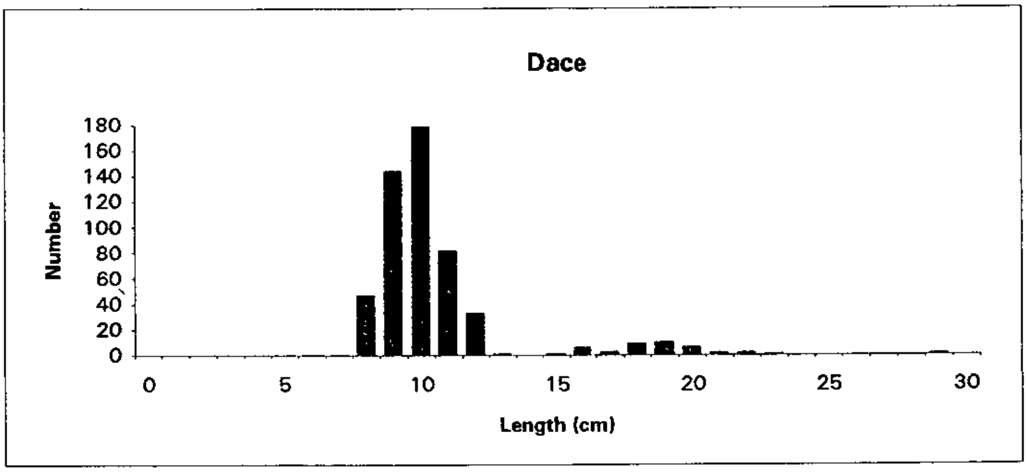
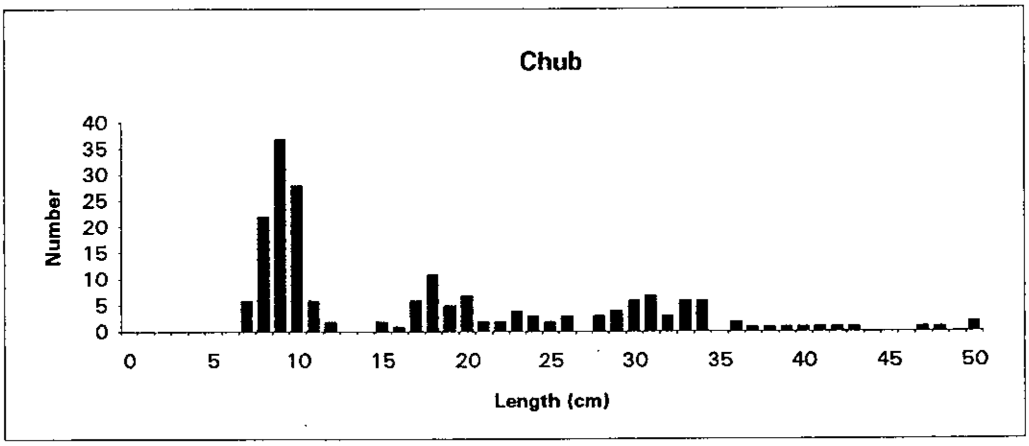


Fig 3 Length frequency histograms for each species of adult fish in the R.Tees in September 1995





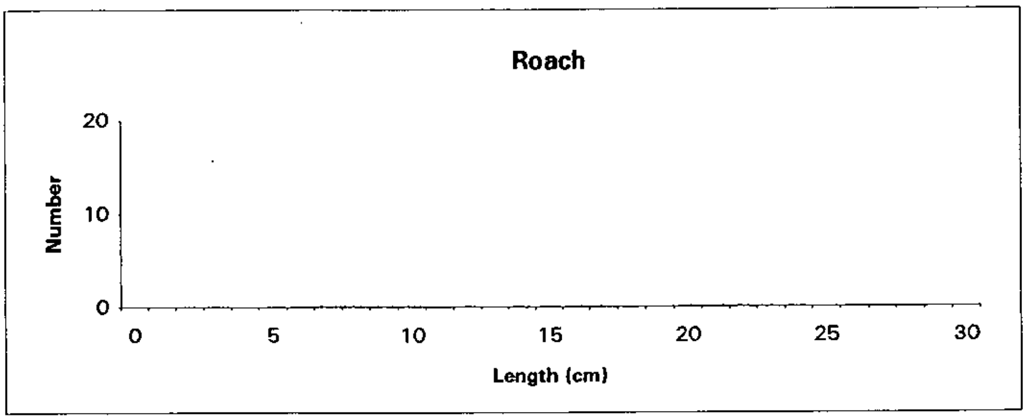
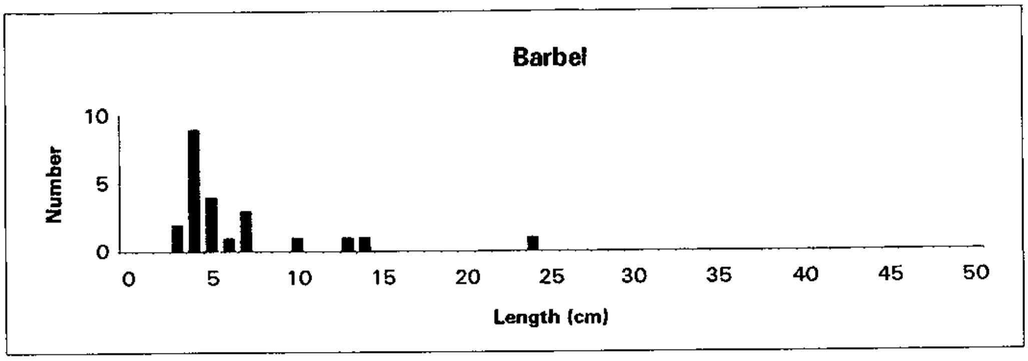
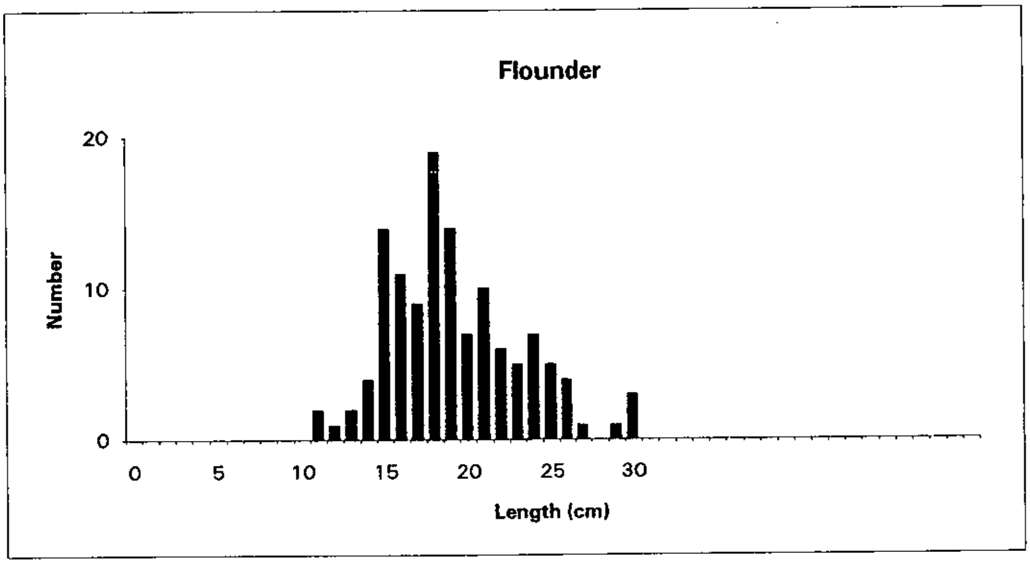


Fig 3 Continued





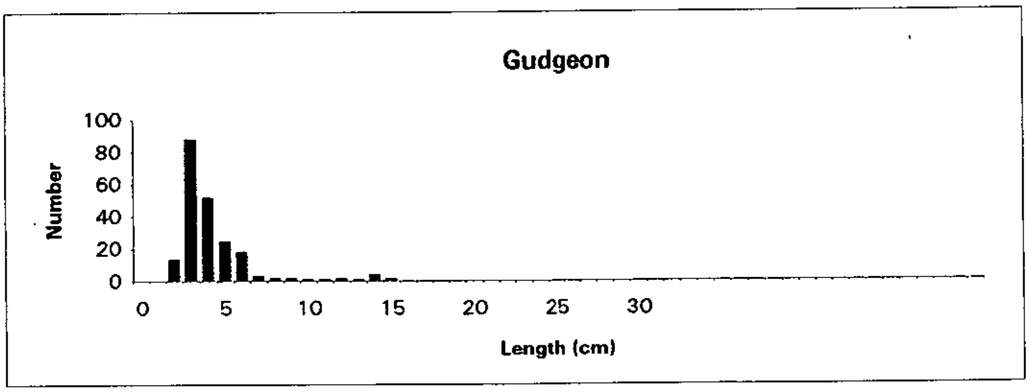


Fig 4 Length by age for dace in the R. Tees in September 1995.

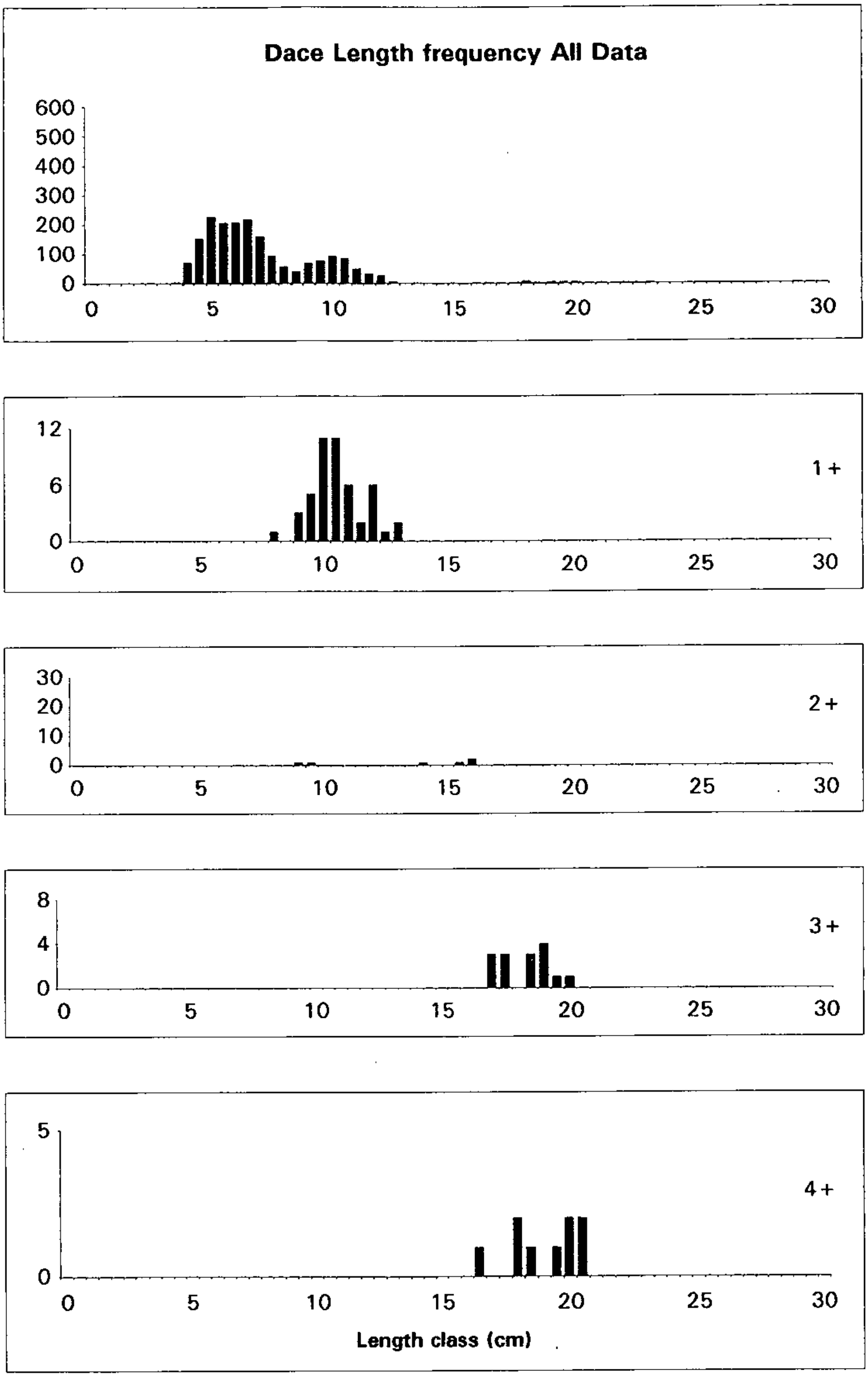


Fig 4 continued

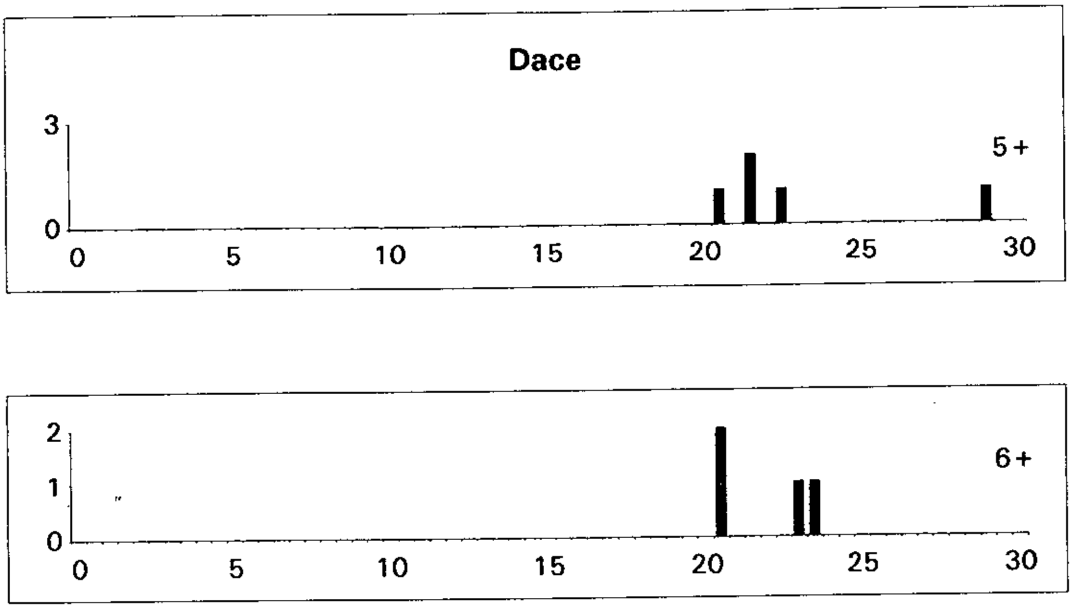


Fig 5 Length by age for chub in the R.Tees in September 1995.

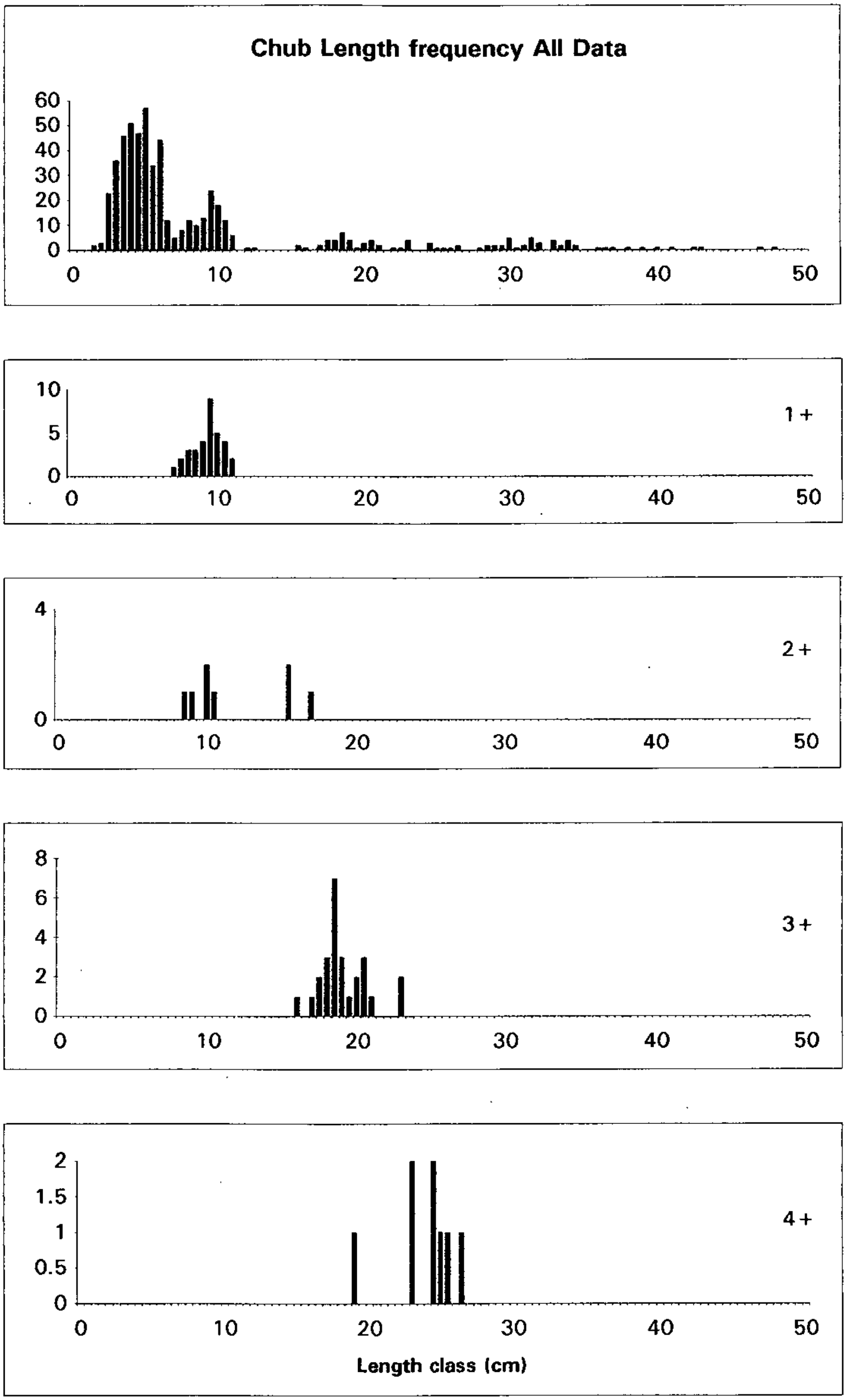
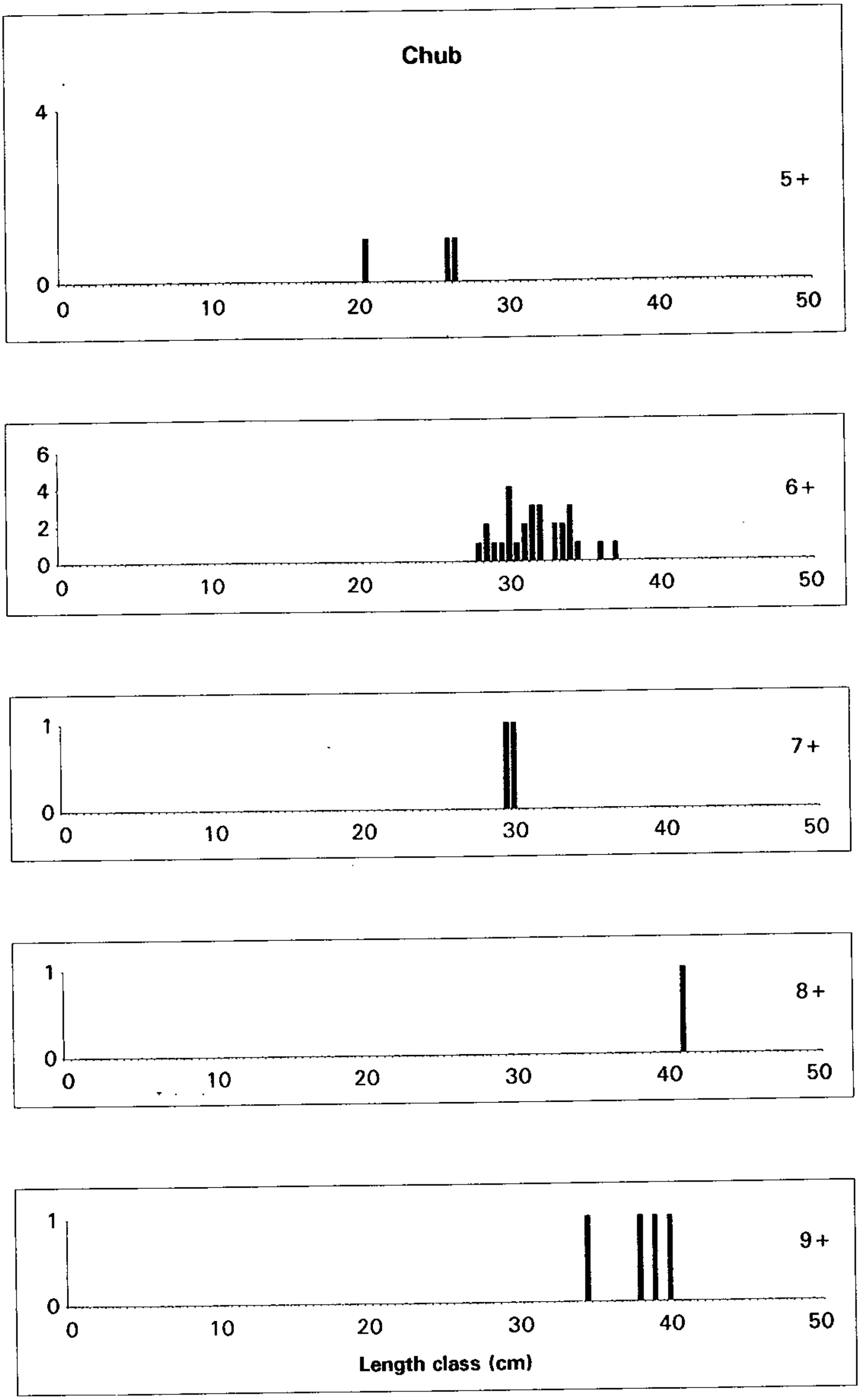


Fig 5 continued



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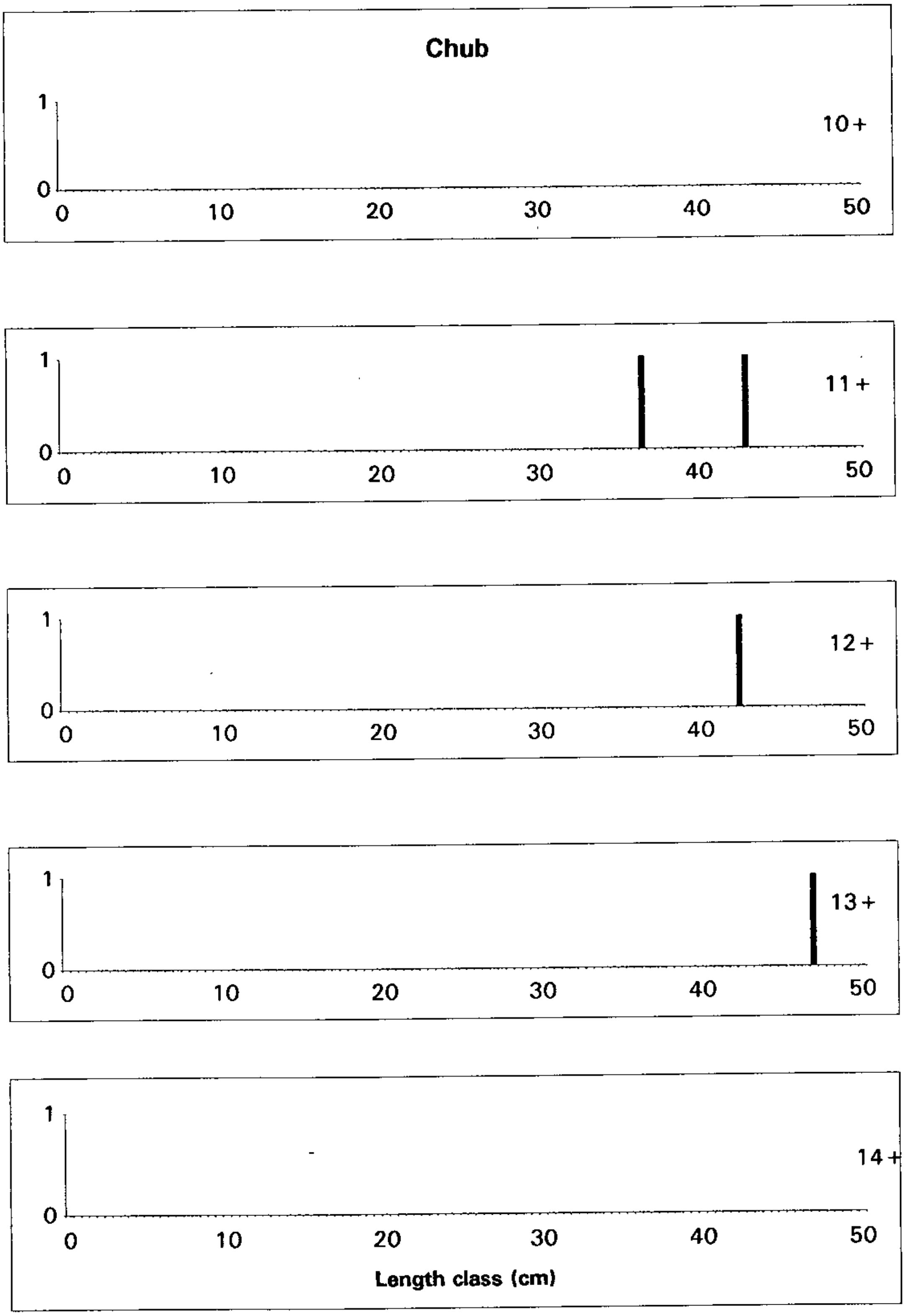

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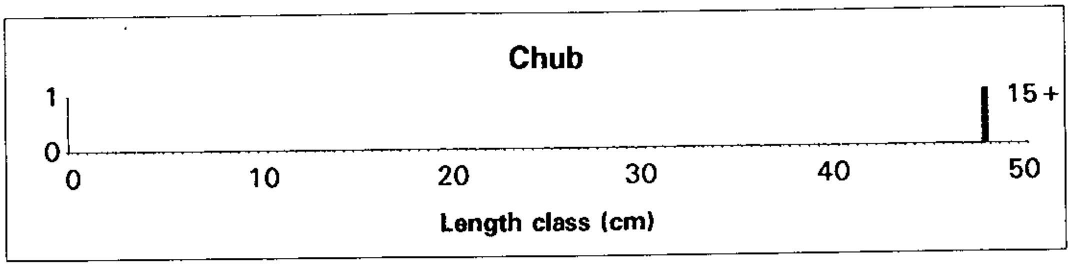


Fig 6 Length by age for roach in the R.Tees in September 1995

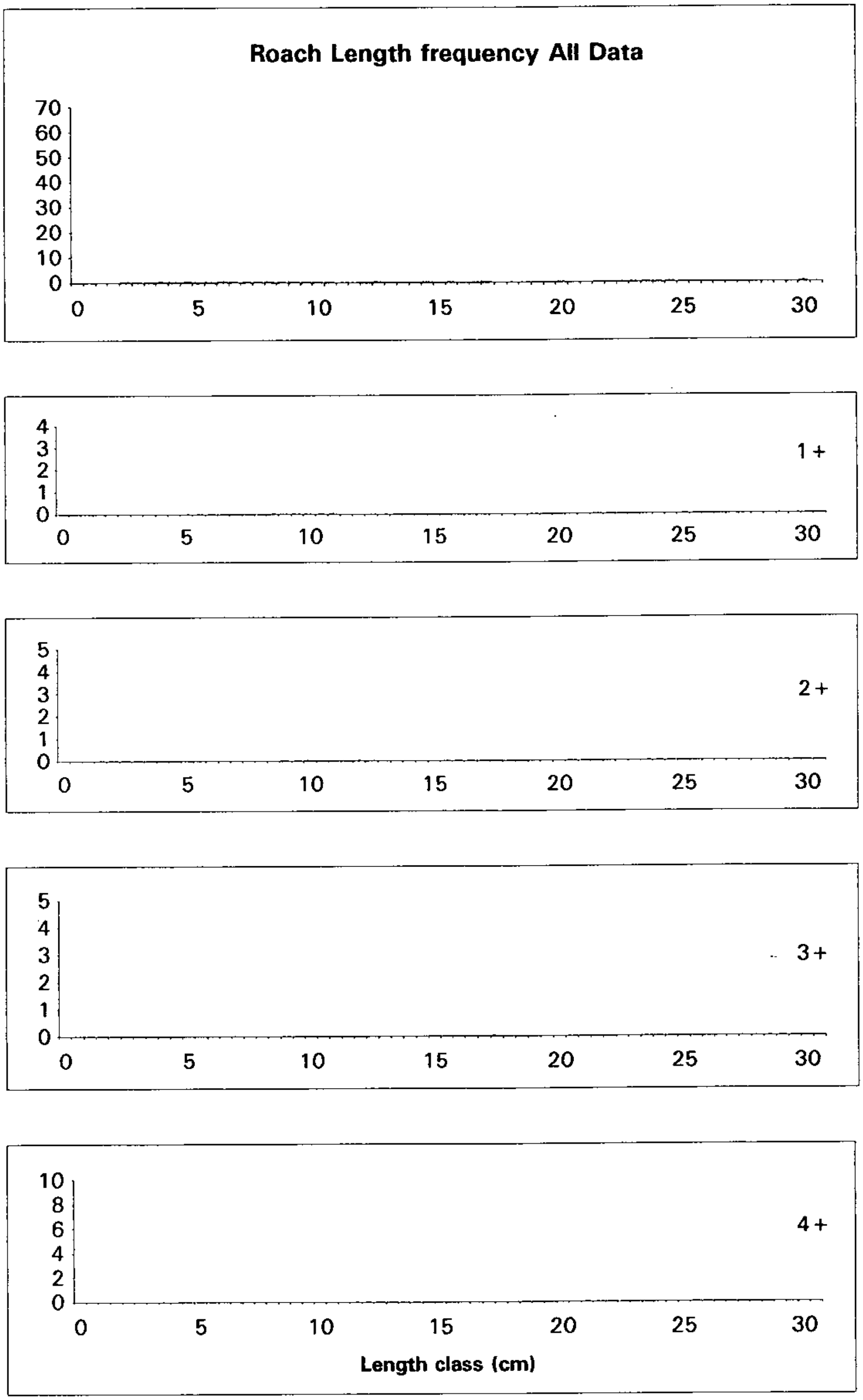


Fig 6 continued

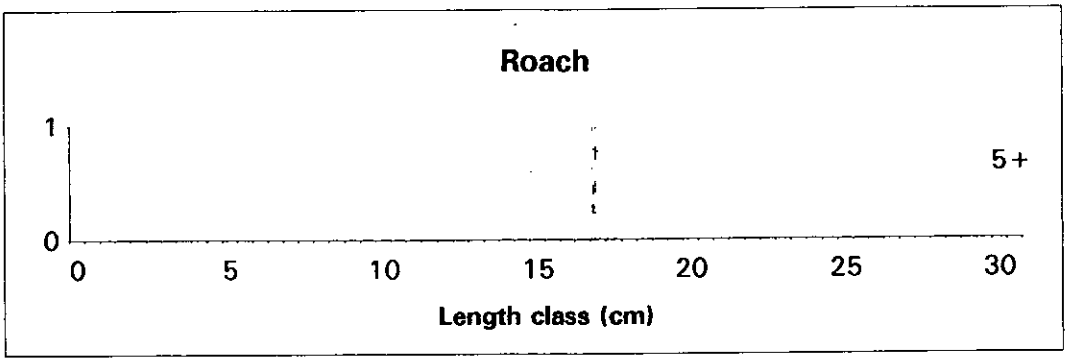


Fig 7 Length by age for gudgeon in the R. Tees in September 1995

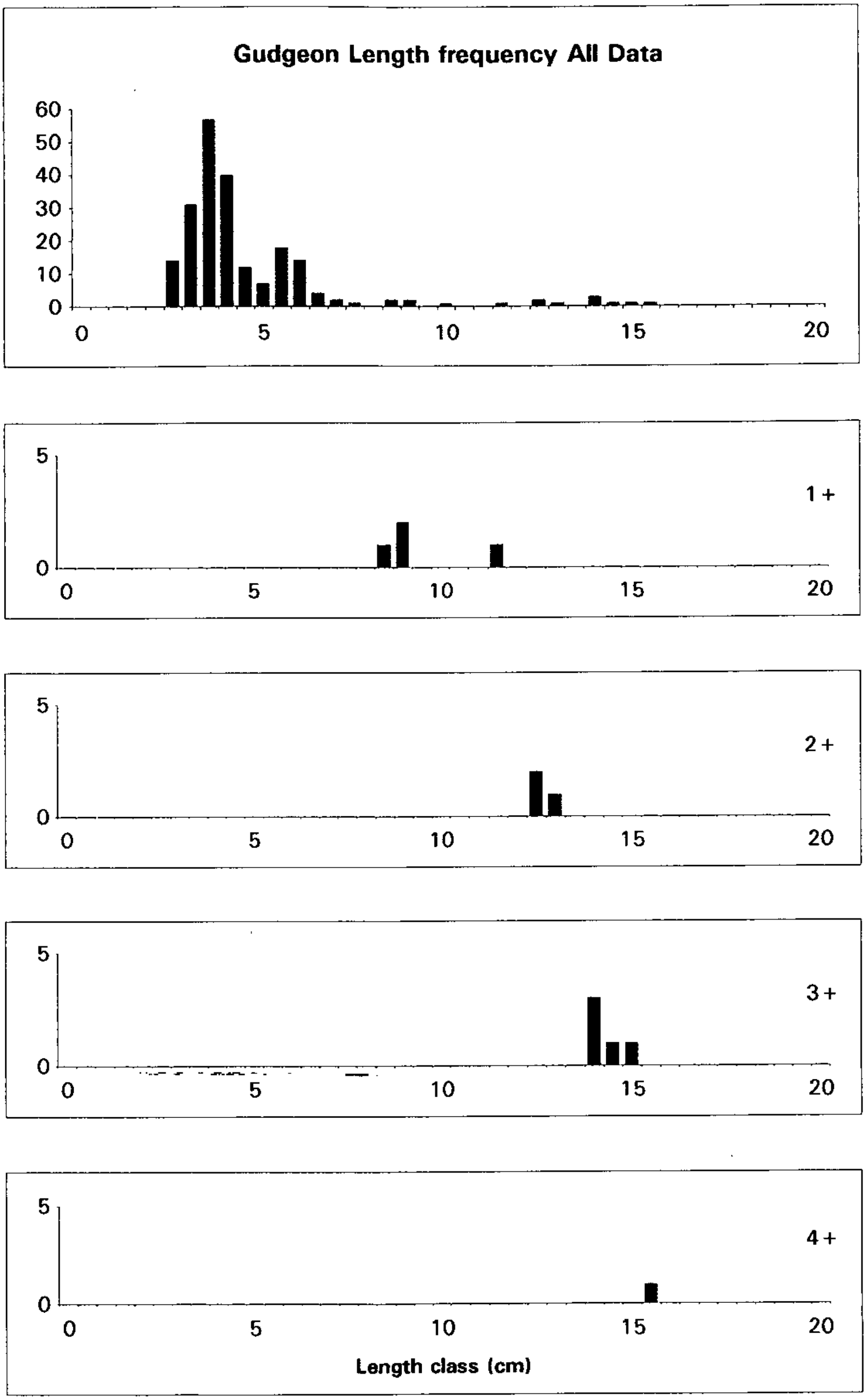


Fig 8 Mean (+ - 95 % CL) catch weight per angler per match for each season in the study period

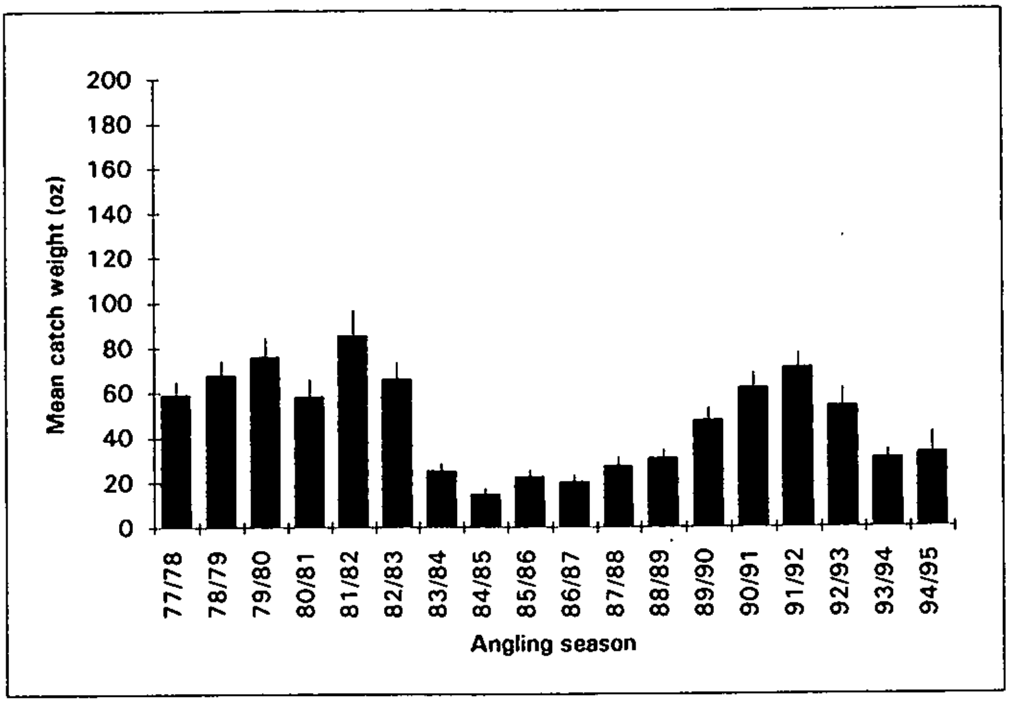


Fig 9 Mean (+/- 95% CL) catch weight per top ten angler per match for each season in the study period

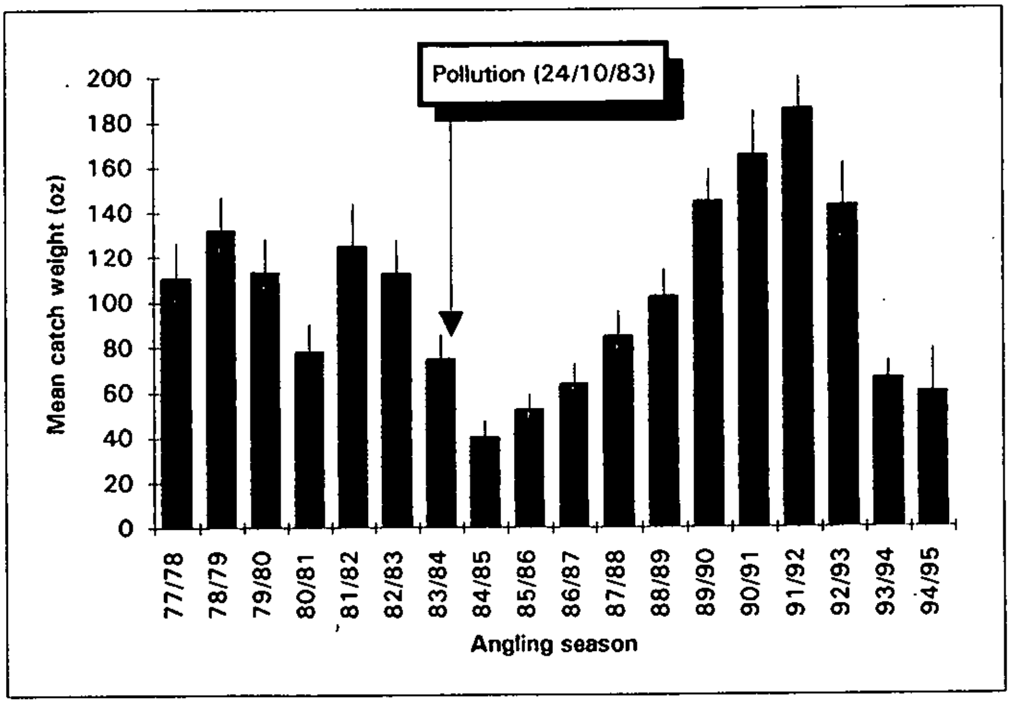


Fig 10 Percentage of dace fry in catch in each section in each year

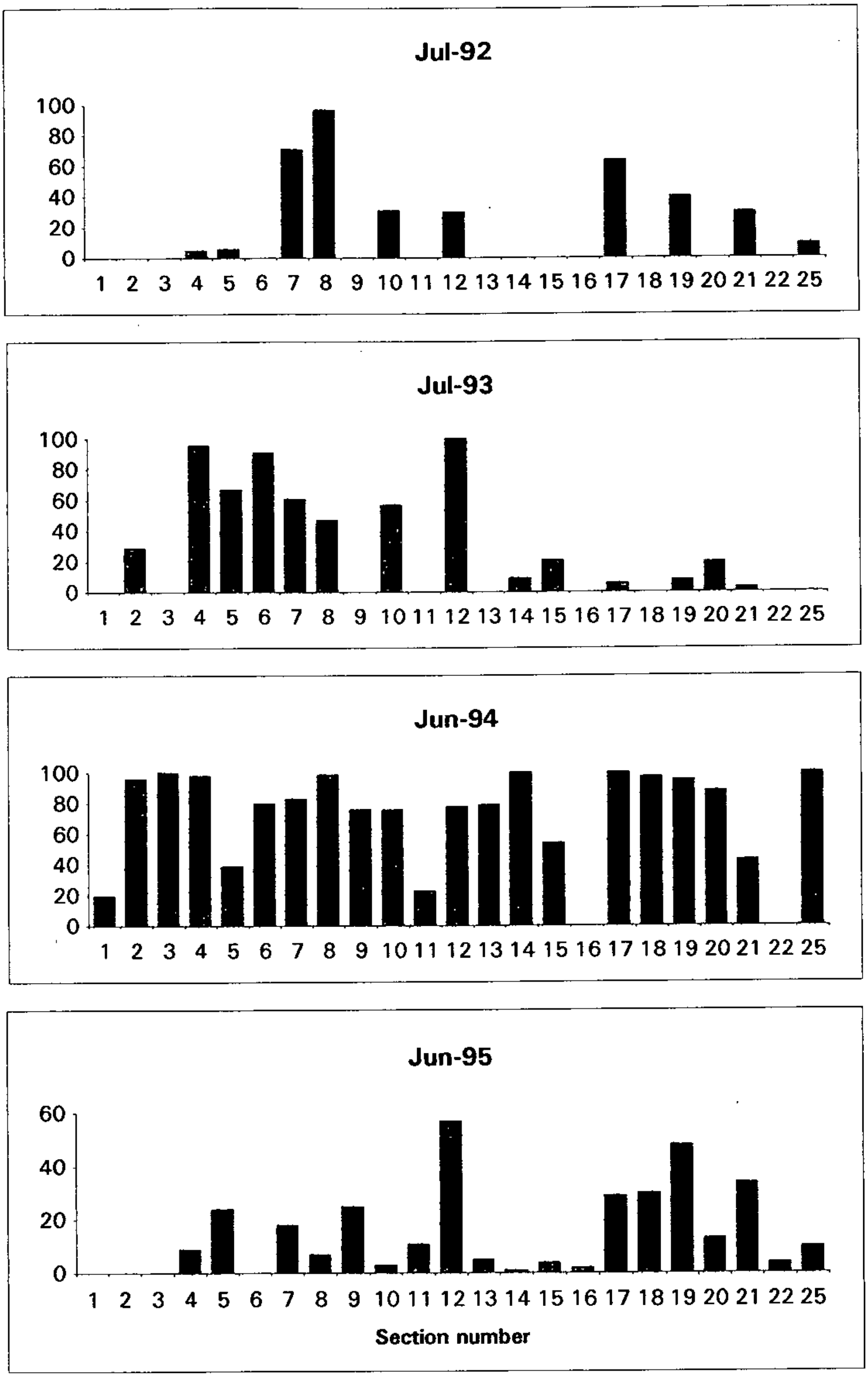


Fig 11 Percentage of chub fry in catch in each section in each year

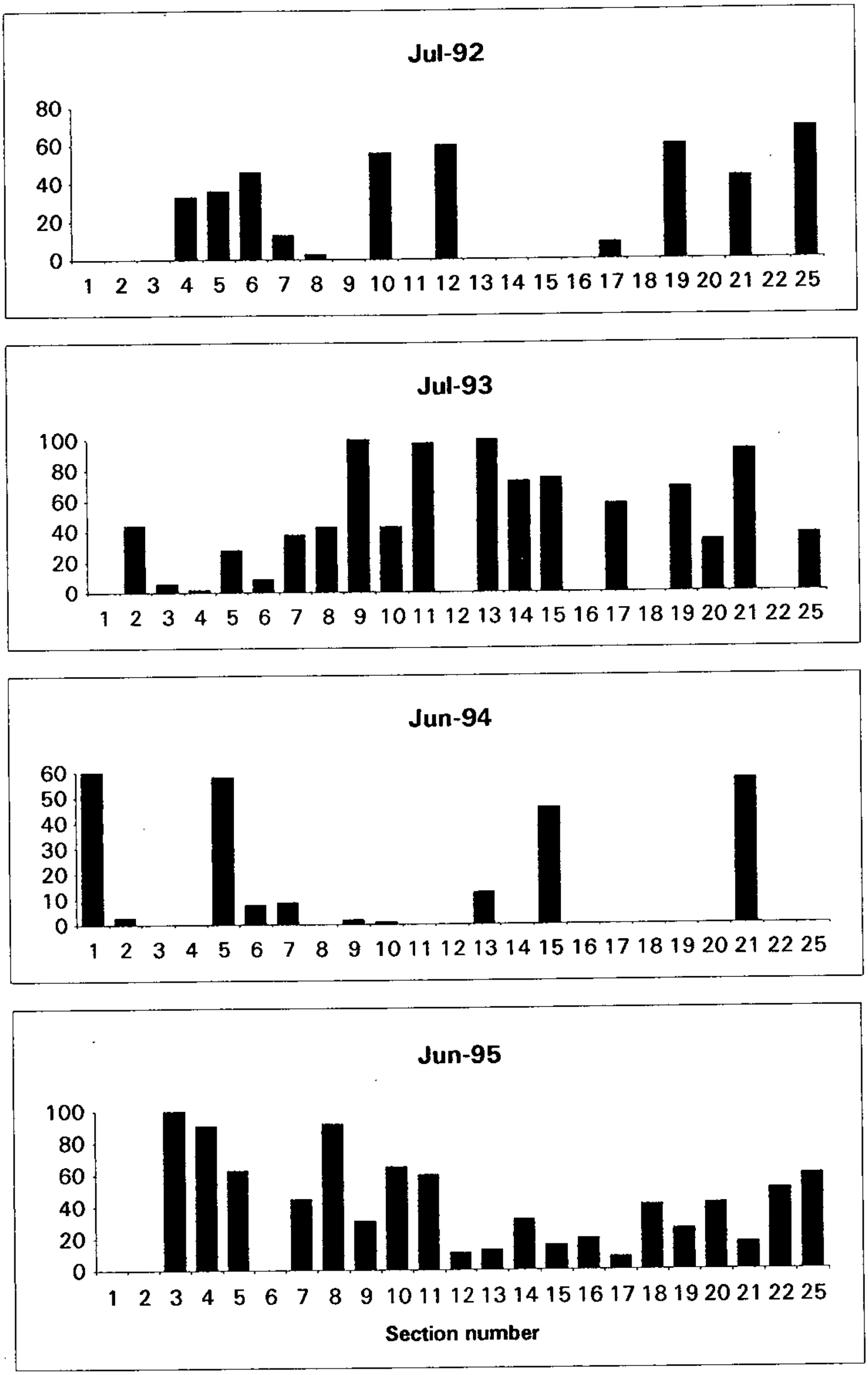


Fig 12 Percentage of roach fry in catch in each section in each year

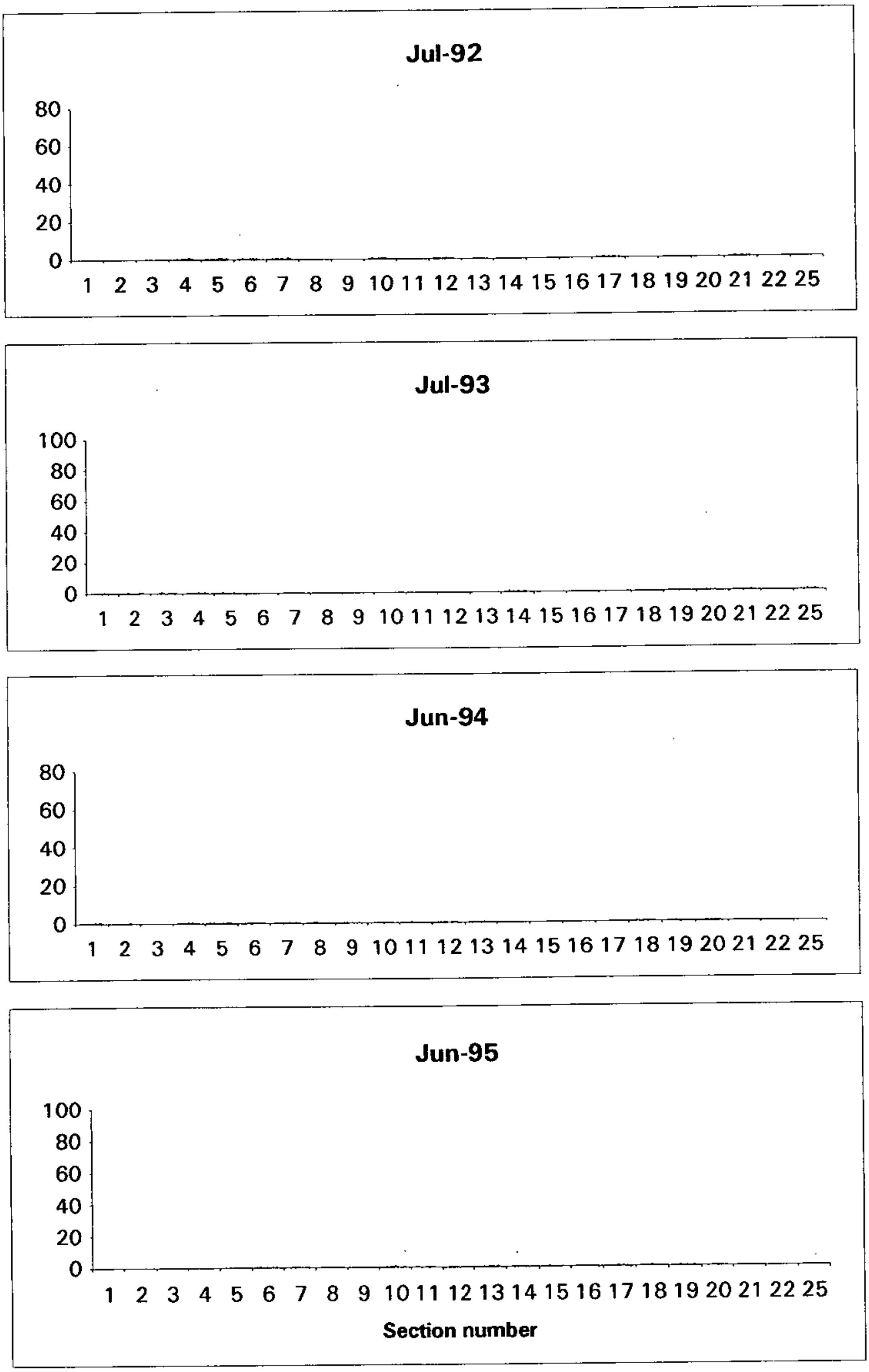
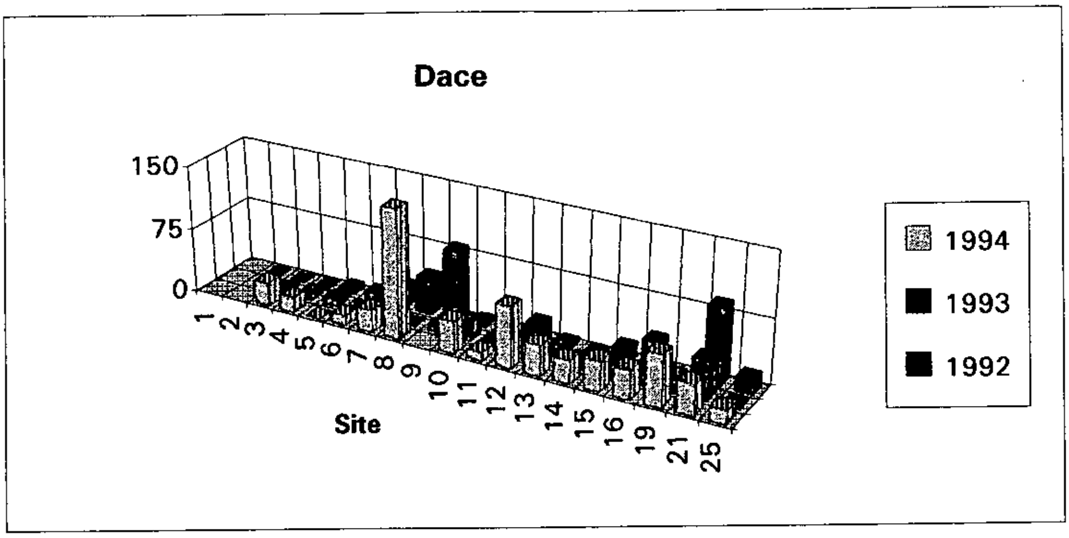
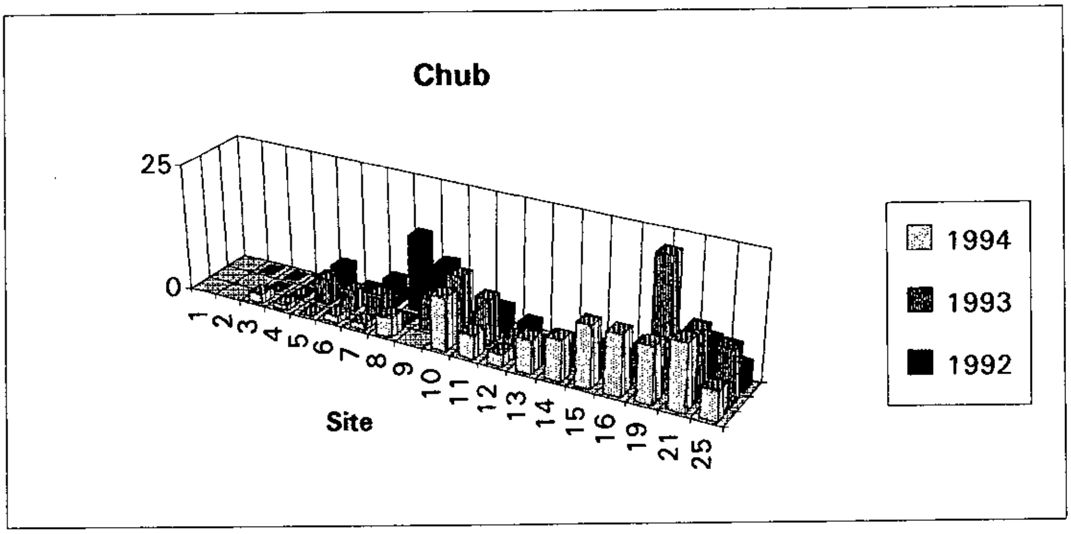


Fig 13 Densities (number per 100 m) of dace, chub and roach in each section in each year





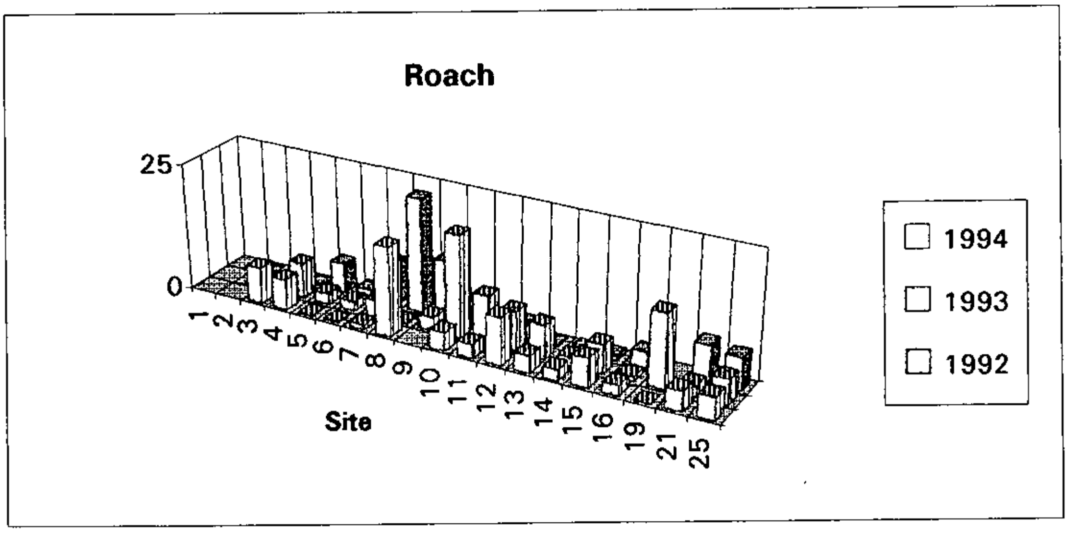
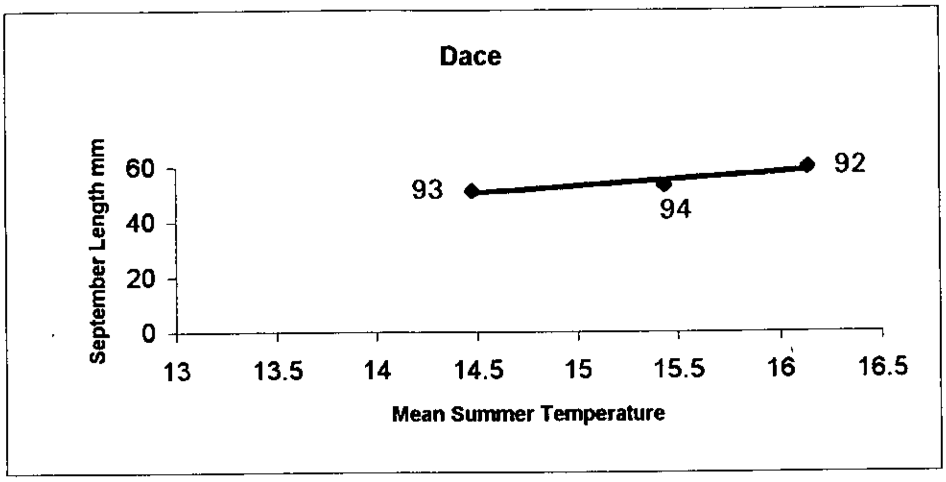
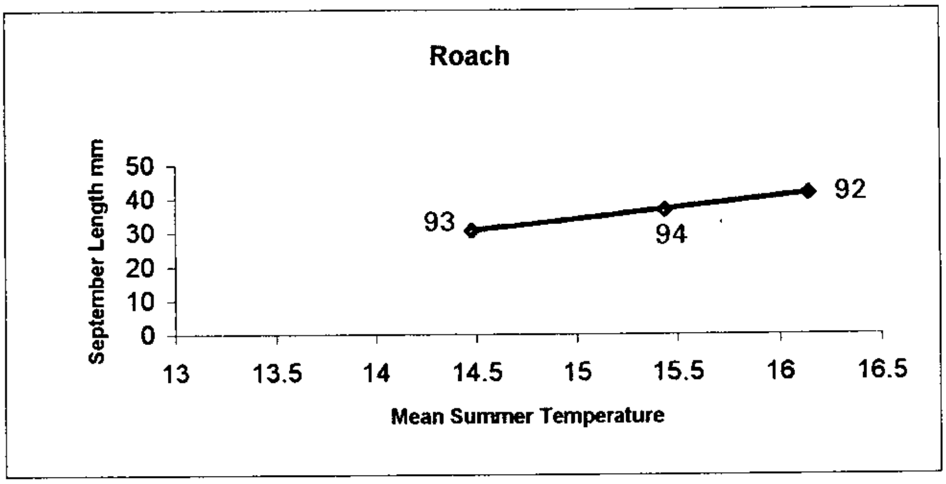


Fig 14 Relationship between September mean length of fry and mean summer water temperature





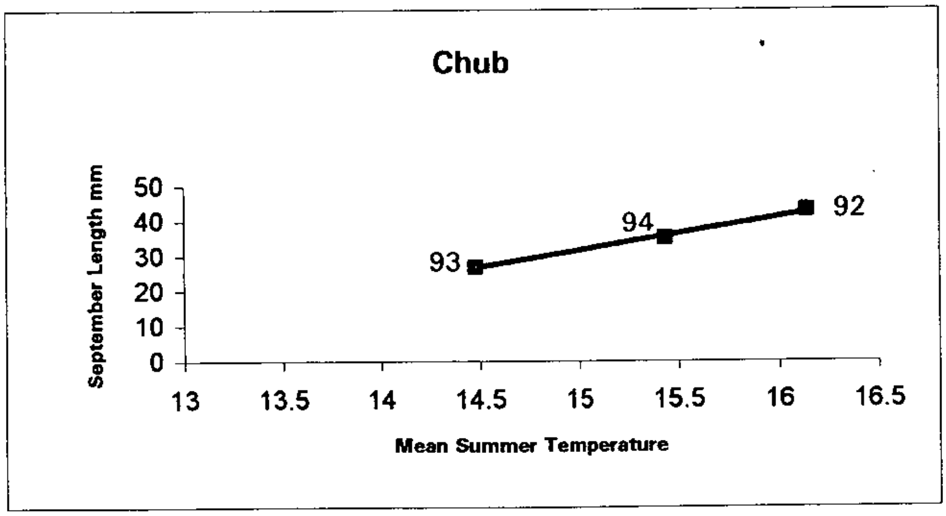
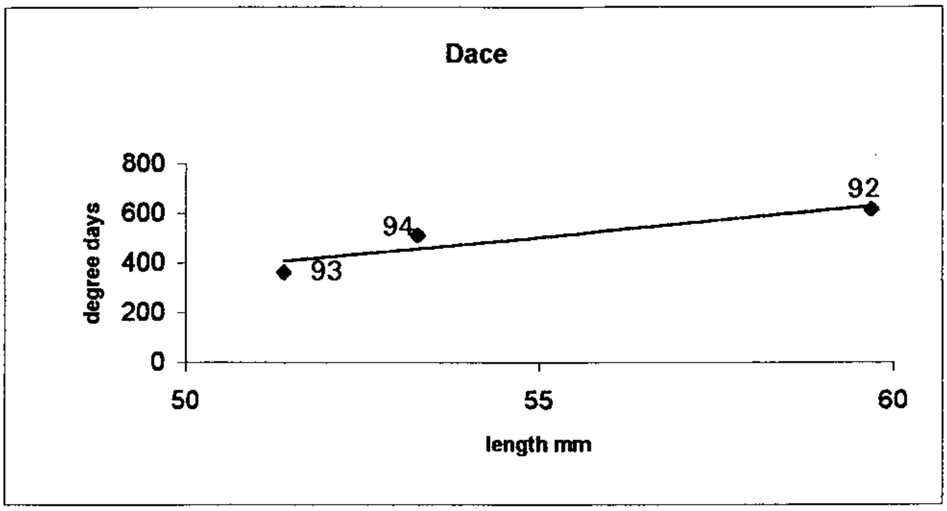
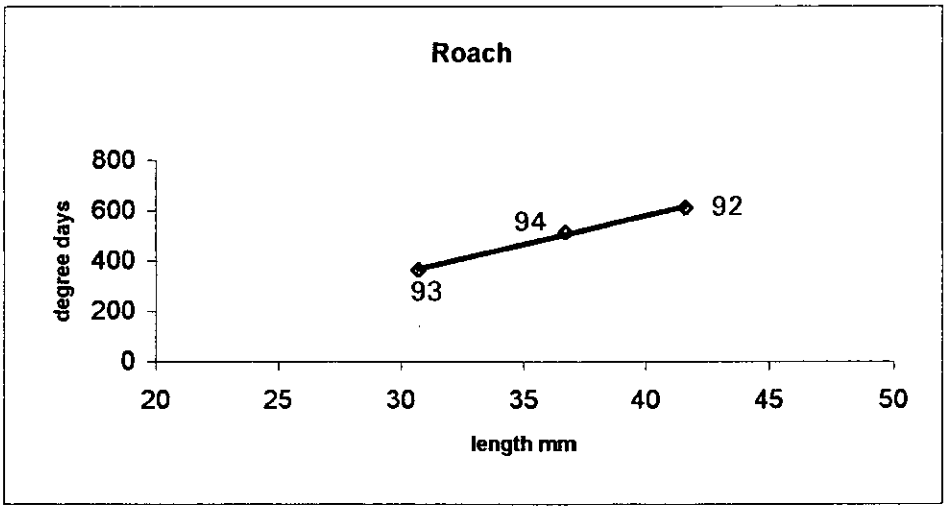


Fig 15 Relationship between September length of fry and summer temperatures (May - August degree days)





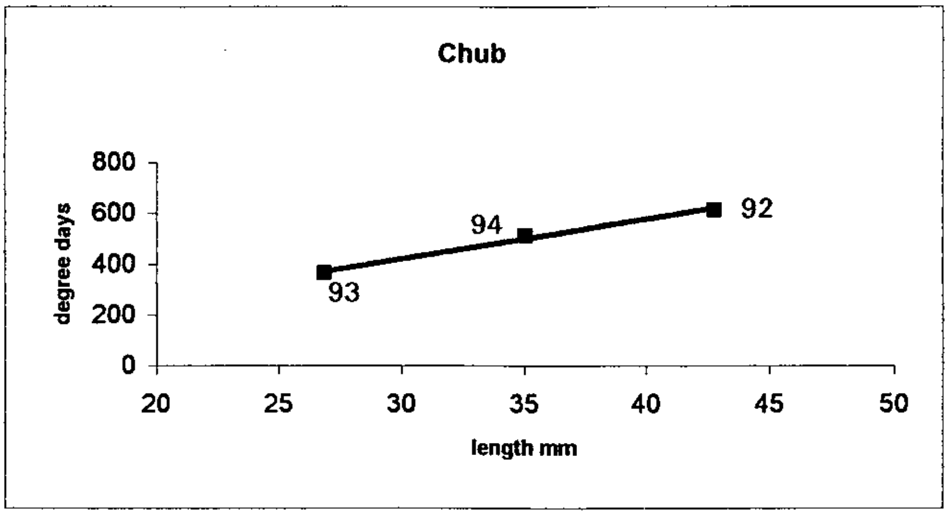


Fig 16 Relationship between growth of dace, roach and chub fry and temperature (degree days) between the summer fry survey and the September survey.

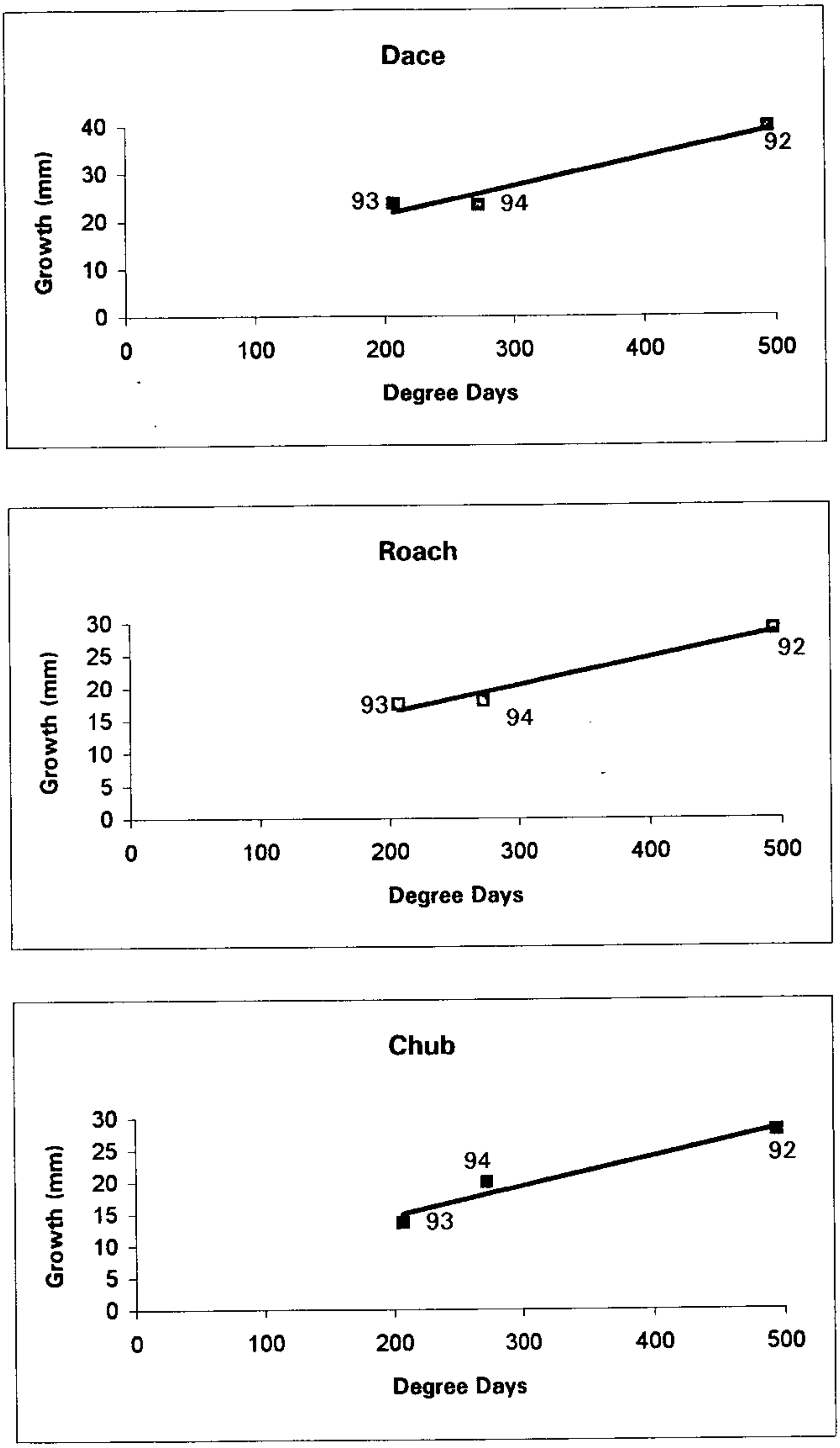


Fig 17 Relative growth rates of all dace for the years 1984 - 1994

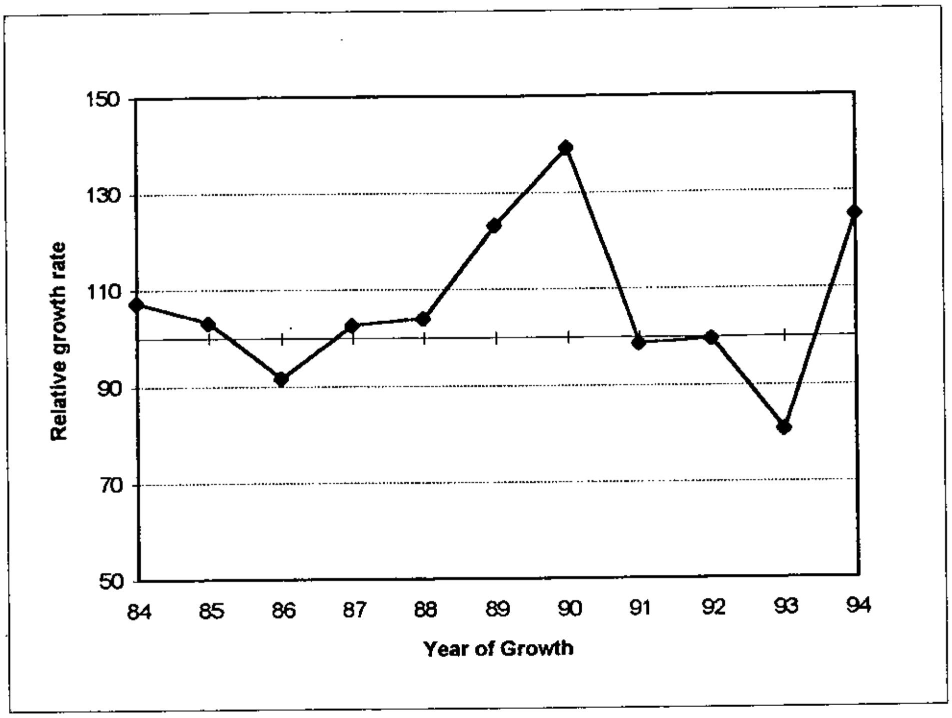


Fig 18 Relative growth rates of I -III group dace for the years 1984 - 1994

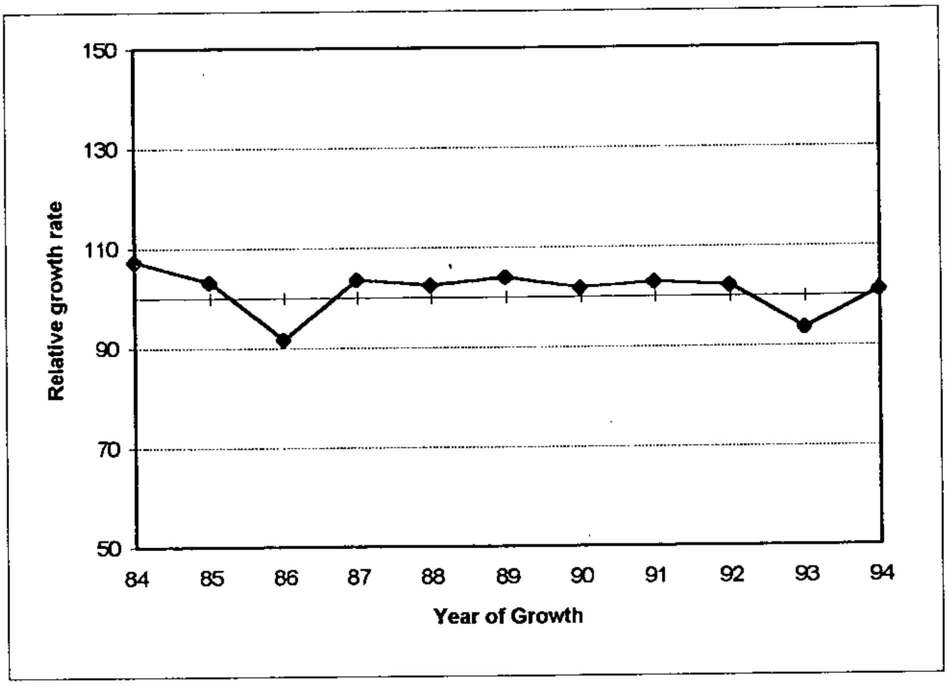


Fig 19 Relative growth rates of all dace for the years 1984 - 1994

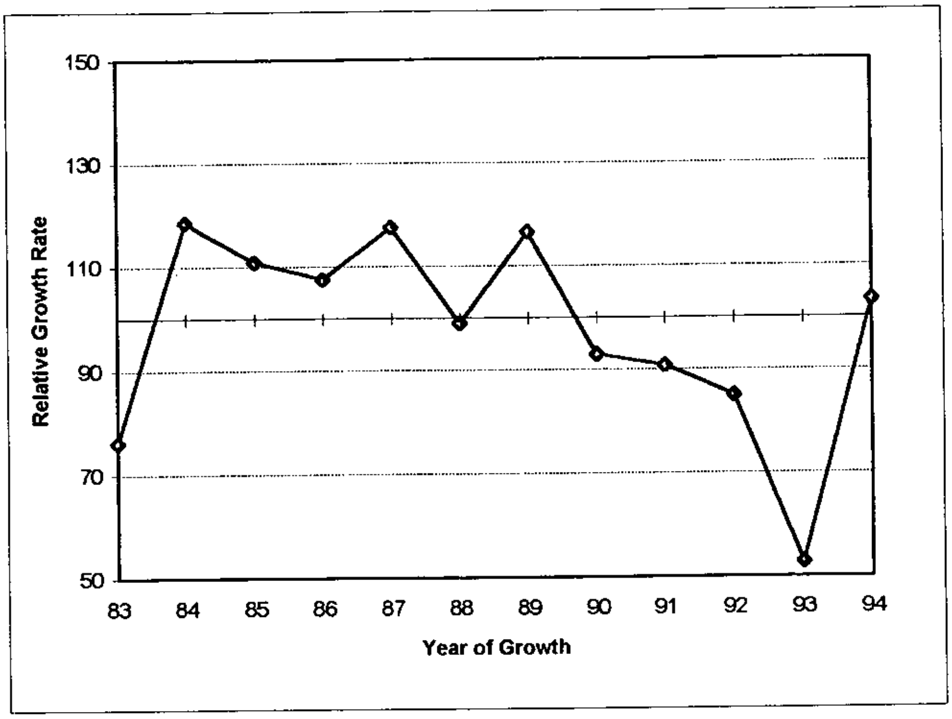


Fig 20 Relative growth rates of I -III group roach for the years 1984 - 1994

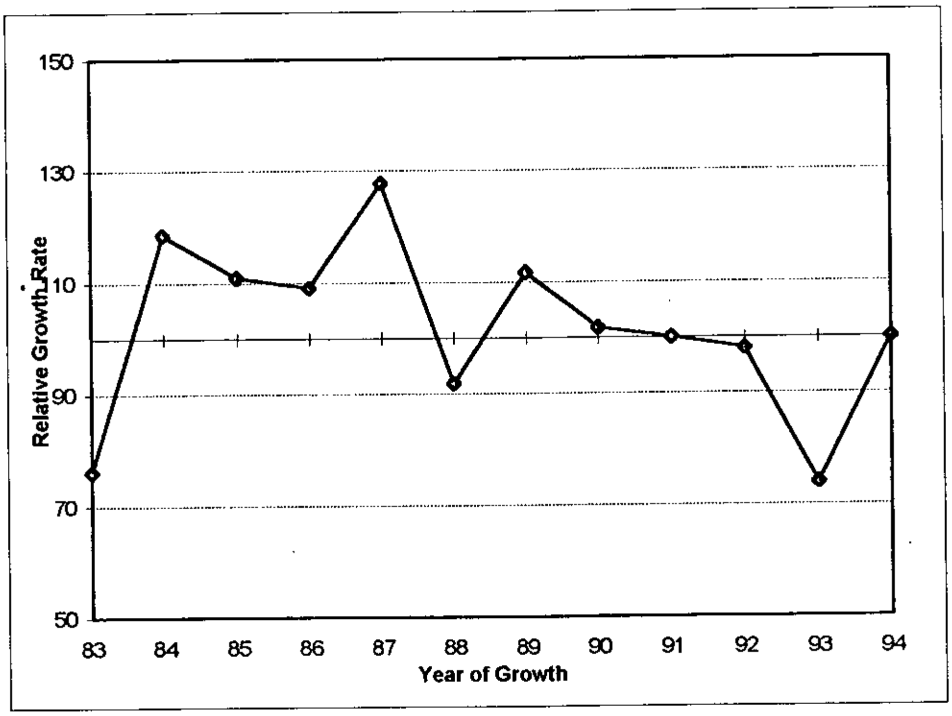


Fig 21 Relationship between relative growth rate and mean summer temperature (May - September) for all dace

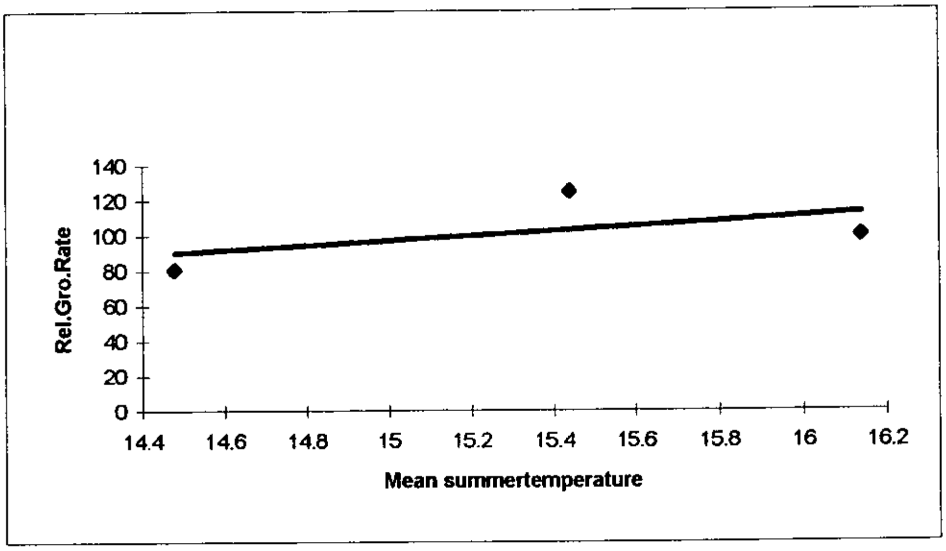


Fig 22 Relationship between relative growth rate and mean summer temperature (May - September) for I -III group dace

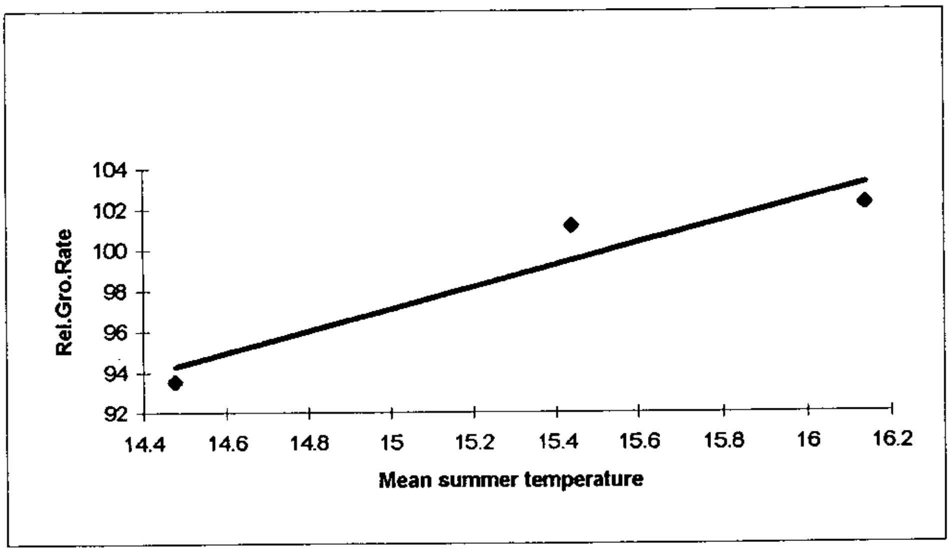


Fig 23 Relationship between relative growth rate and mean summer temperature (May - September) for all roach

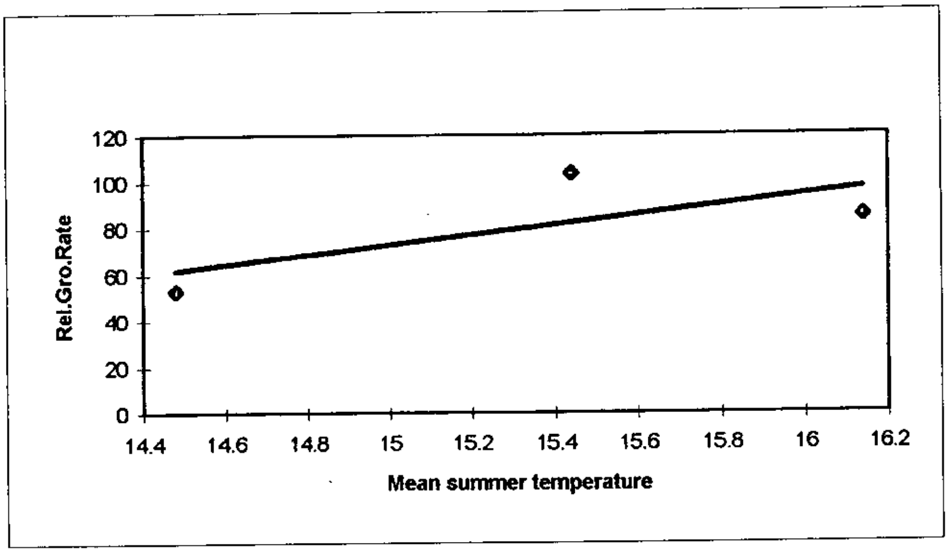
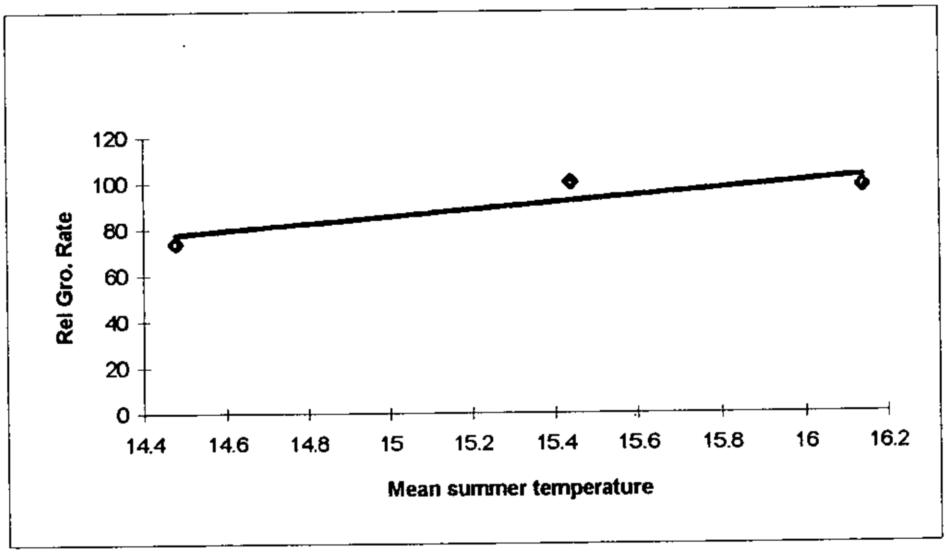


Fig 24 Relationship between relative growth rate and mean summer temperature (May - September) for I -III group roach



Appendix 1 Description of fry sampling sites: River Tees 13-15 June 1995.

Sampling technique:
S = micro-mesh seine net sample:
P(n) = point sample.
TP(n) = targetted point sample ie fish seen and activly caught using point sample electrofishing gear.
N(n) = hand net sample.
Where (n) = number of samples combined into one sample.

Flow: Unless stated all flows were neglible as from section 18 downstream the river was backed up from the barrage.

Section 1 Below Thornaby 15 June 1995.

P1(1)	Upstream entrance to ORSU. Deep water - mud substrate. Fry caught = 1 - 0+ Stickleback Non-fry caught = 5 - 1+ Dace, 4 - 1+ Chub & 1 - 0+ Stickleback
P2(-)	North bank of ORSU, 15 m of bank fished. No fish seen.
P3(1)	Downstream entrance to ORSU. Deep water with large boulders Fry caught = 4 - 0+ Sticklebacks Non fry caught = 5 - 1+ Dace, 4 - 1+ Chub & 2 - 1+ Roach
P4(1)	Eastern end of downstream ORSU. Bottom shallow shelving mud. Fry caught = 30+ - 0+ Sticklebacks. No other fish seen.
S1	Micromesh seine on public slipway at Stockton. Bottom shelving concrete. Non-fry caught = 100+ - 1+ Dace, 1 - 1+ Roach & 100++ Sticklebacks.

Section 2 Bassleton Wood 15 June 1995.

P1(5)	Mouth of Basaleton Beck. Emergent reeds Depth >1m. Non fry caught = 15 - 1+ Roach & 2 - >0+ Minnows.
P2(5)	North bank, shelving area of mud (cattle drink) 10 cm deep. No fish seen.

Section 3 Pipe Bridge 15 June 1995.

P1(5)	North bank. Emergent reeds Depth >1m.
P2(5)	South bank just downstream of pipe bridge. Emergent reeds Depth >1 m.
P3(5)	South bank. Shallow shelving sand (10-20 cm)plus some emergent vegetation. Fry caught = 1 - 0+ Stickleback.

Section 4 Preston Park 15 June 1995.

TP1(10)	North bank. Shelving sand with emergent reeds
TP2(5)	South bank. Mud / sand, steep drop-off.
P1(15)	Western end of Preston Park ORSU. Steeply shelving mud slope. Non fry caught = 7 - 1+ Dace & 2 - >0+ Sticklebacks.
P2(20)	Eastern end of Preston Park ORSU. In shallow margins substrate mud.
P3(10)	South bank. Emergent reeds in 30 - 50 cm water
P4(5)	South bank. Floating grass, depth 40 cm. Fry caught = 1 - 0+ Stickleback.

Section 5 Barwick Farm 15 June 1995 am

P1(5)	South bank. Depth = 30 - 50cm. Emergent reeds.
P2(5)	North bank. Depth >1m. Emergent reeds.
P3(10)	South bank. Mud / algae & emergent reeds. Shelving bottom (1m to 30 cm)
TP4(3)	South bank. Smal bay in bank, mud substrate
P5(10)	North bank. Emergent vegetation. Depth >1 m. Non fry caught = 1 - 1+ Dace, 3 - 1+ Roach, 1 - 1+ Minnow & 1 - 2+ Chub.

Section 6 15 June 1995 am

P1(10)	North bank. Mud substreate 50 - 10 cm deep.
P2(5)	North bank. Substrate mud and emergent reeds 50 cm deep.
P3(6)	In mouth of R. Leven. Mud and emergent reeds, >1 m deep.
P4(5)	In R. Leven Emergent glyceria on mud substrate, >1 m deep.

Section 7 Below Yarm 14 June 1995 pm

TP1(2)	North bank. Shelving mud approximately 20 cm deep
P2(5)	North bank. Mud with emergent reeds. Depth 30 - 60 cm.
P3(5)	South bank. Depth >2 m. Mud substrate with emergent reeds.
P4(10)	North bank. Shelving mud bank with emergent reeds. Depth 1 - 2 m.

Section 8 Between Bridges 14 June 1995 pm

P1(10) South bank between bridges. Substrate sandy-mud with floating vegetation.

N1(1) North bank by small drainage stream.

Section 9 14 June 1995 pm

P1(5) North bank by inlet pipe from water works. Substrate mud with emergent reeds.

P2(6) South bank. Substrate mud with some emergent reeds and vegetation. Depth 30 cm to 1 m.

N1(1) North bank. Emergent reeds with mud substrate. Depth 30 cm +.

Section 10 14 June 1995 pm

P1(5) South bank. Steeply shelving bank with emergent vegetation and felled tree.

P2(5) South bank by fishing platform. Bare mud substrate.

P3(5) In Nelly's Beck. Deep with branches.

Section 11 The Cabins 14 June 1995 pm

N1(3) North bank just upstream of Holme House slipway. Emergent veg. present.

TP2(7) South bank. Mud and emergent / floating vegetation. Depth = 30 cm.

P3(5) South bank. Steep mud bank with emergent reeds.

Section 12 14 June 1995 am

TP1(2) North bank. Steep mud bank with some emergent vegetation.

P2(5) South bank. Depth 20 cm Substrate mud with emergent glyceria.

Section 13 14 June 1995 am

P1(5) South bank. Steep mud bank with emergent vegetation and tree stump.
Non fry caught. 1 - >0+ Bullhead

P2(5) North bank. Substrate mud with emergent glyceria. Depth 20 cm.

Section 14 14 June 1995 am

P1(5)	North bank. Steep bank with mud substrate and tree stump
P2(5)	South bank. Steep mud bank with emergent Phragmites.
TP3(5)	North bank. Steep mud bank with emergent reeds.

Section 15 14 June 1995 am

P1(10)	North bank. Mud substrate with emergent reeds.
P2(6)	Backwater on south bank. Substrate mud with emergent vegetation.
N3(3)	Backwater on south bank. Substrate mud & tree branches.

Section 16 Low Worsall 14 June 1995 am

P1(6)	South bank. Steep mud bank.
P2(8)	North bank. Emergent Phragmites

Section 17 14 June 1995 am

S1	South bank. Shelving gravel (1 m to 0 m) Non fry caught. 100+ - 1+ dace
P1(5)	Worsall ORSU. Depth = 60 cm. Soft mud substrate with emergent reeds. Non fry caught. 1- 2+ Chub.
P2(5)	Worsall ORSU. Depth = 40 cm. Soft mud substrate with emergent phragmites.
P3(5)	North bank. Backwater area. Sand substrate depth = 30 cm.
P4(8)	North bank. Between main river and backwater area. Mud substrate with some emergent phragmites. Depth = 30 cm.

Section 18 14 June 1995 am

P1(15)	South bank. Sand / gravel area with emergent reed. Depth 40 cm.

Section 19 Fardeanside. 13 June 1995 pm

TP1(2)	South bank. Substrate silt & roots, depth 30 cm.
S1	In lee of island in mid-river. Deep bay shelving from 0 - 50 cm. Substrate sand & silt.

Section 20 13 June 1995 am

S1	South bank. In shear zone between slight and no flow. Depth shelving from 10 cm to 1 m. Substrate silty gravel. Non fry caught. 1 - 1+ Dace.
P1(8)	South bank. Flow slight/nil. Substrate sand/silt & ranunculus. Depth 10-30 cm.
S2	North bank. In shear zone between slight and no flow. Substrate cobbles/gravel. Depth shelving from 5 - 75 cm.

Section 21 Below Low Moor weir 13 June 1995 am

S1	South bank in backwater downstream of ford. Silt substrate flow nil.
TP1(5)	North bank in amongst weed beds. Slight flow depth 5 cm.
P1(5)	North bank. Slight flow. Depth 10 - 30 cm. in amongst ranunculus beds.
P2(8)	North bank. No flow. Depth 30 cm. in ranunculus beds.

Section 22 Above Low Moor weir 13 June 1995 am

P1(5)	North bank. In marginal vegetation, depth 50 - 75 cm Flow nil
P1(2)	North bank. In marginal vegetation, depth 30 - 40 cm Flow nil

Section 23

Not Sampled

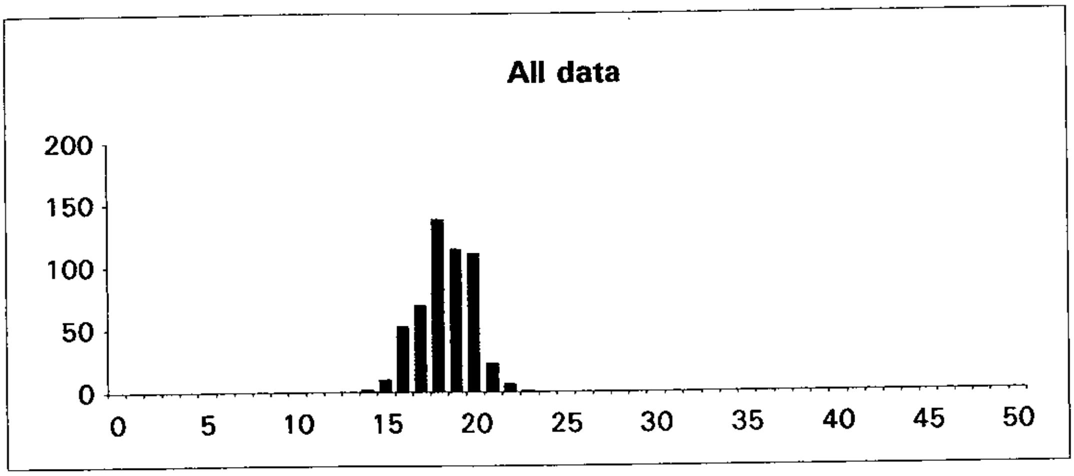
Section 24

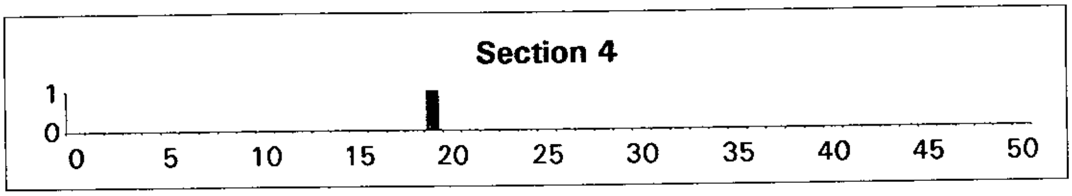
Not Sampled

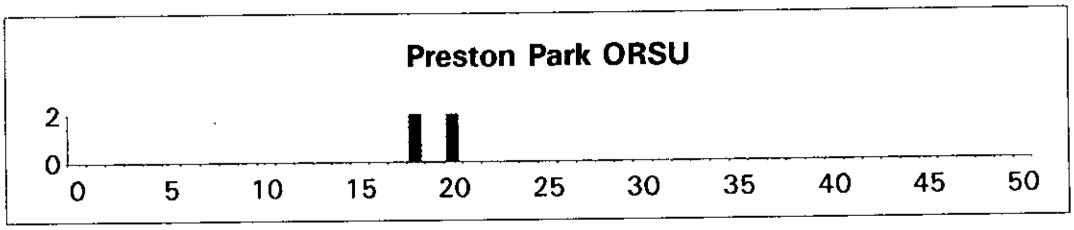
Section 25 Low Dinsdale 13 June 1995 am

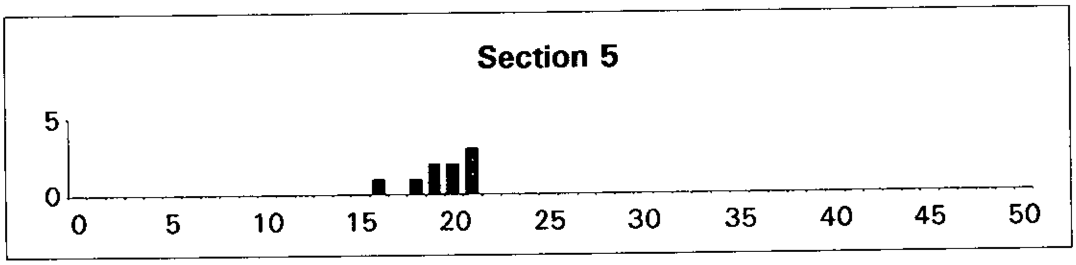
S1	Area 11 m * 5 m in 20 cm deep backwater. Substrate gravel / sand.
S2	Area 11 m * 5 m in 30 cm deep backwater. Substrate gravel / sand.

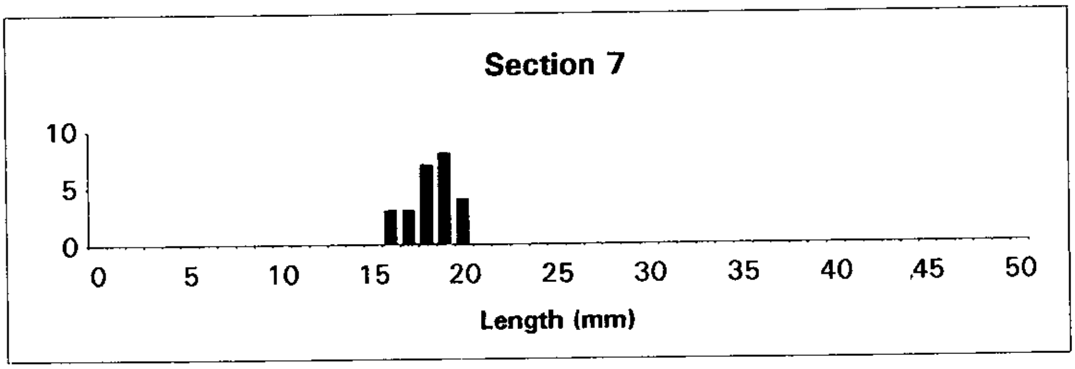
Appendix 2 Length frequency distribution of dace fry in each section of the R.Tees in June 1995.











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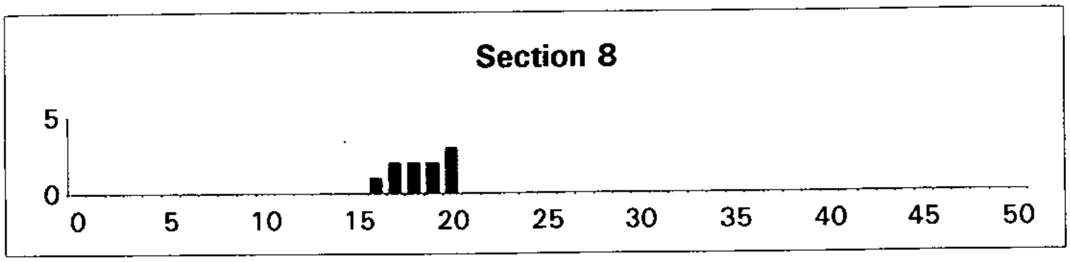

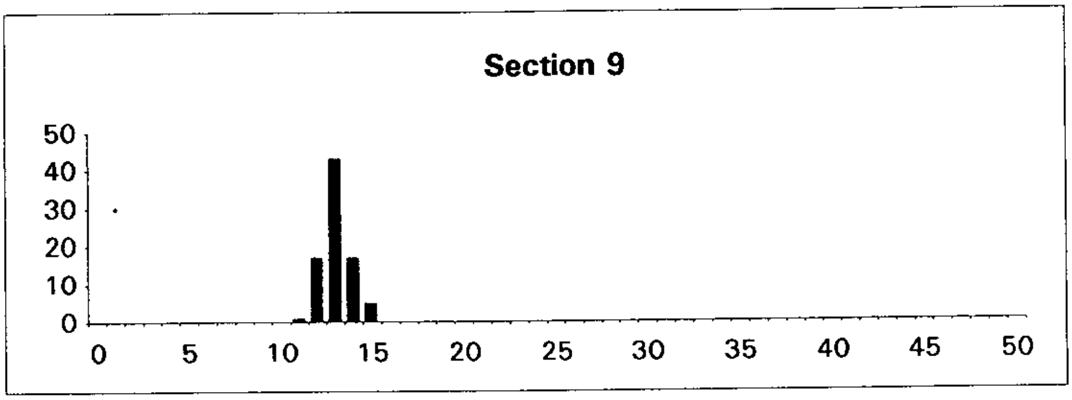

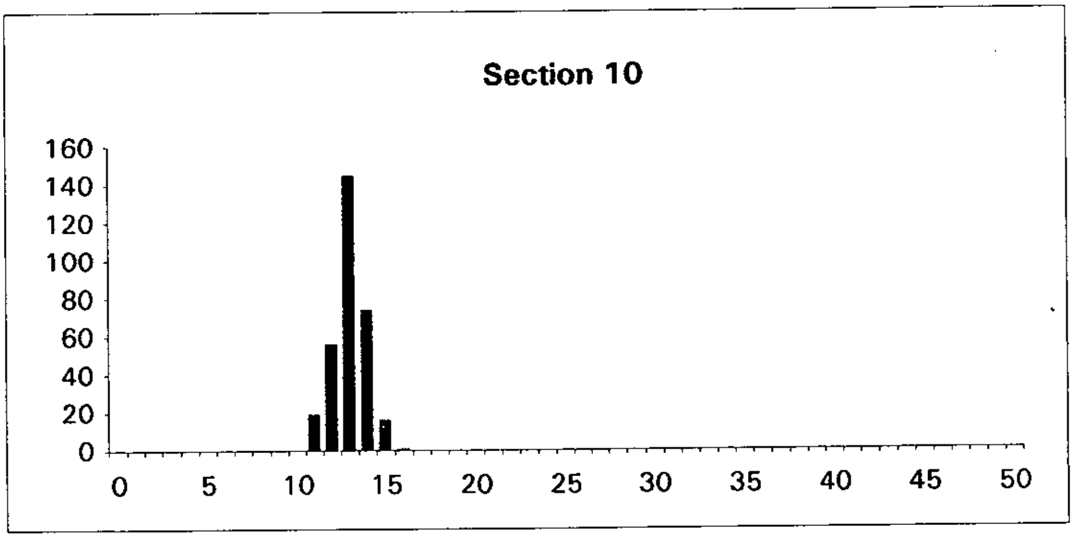

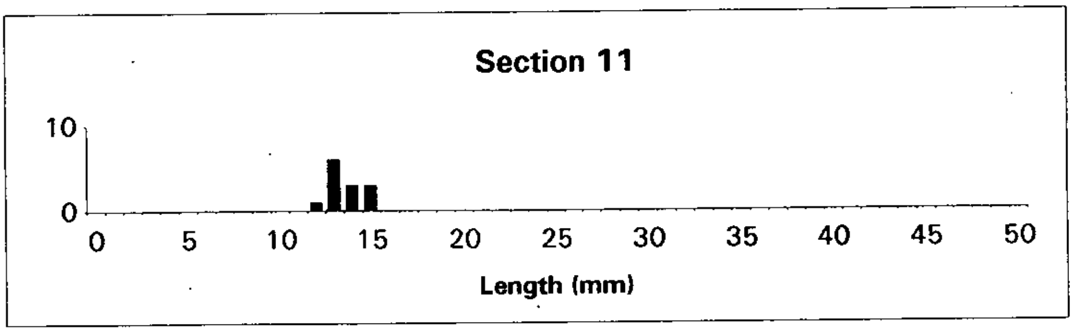

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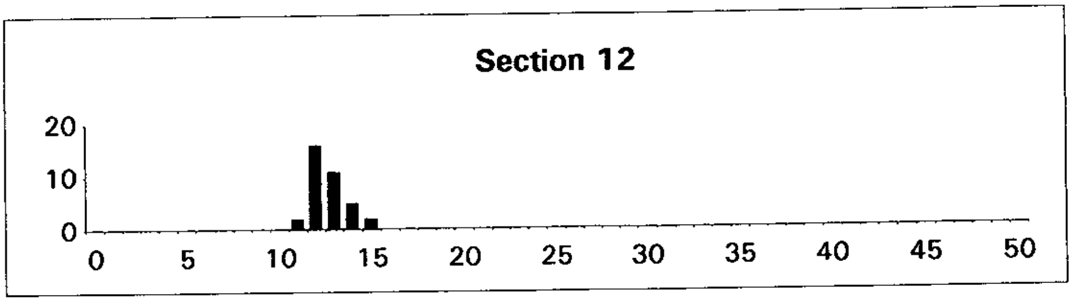

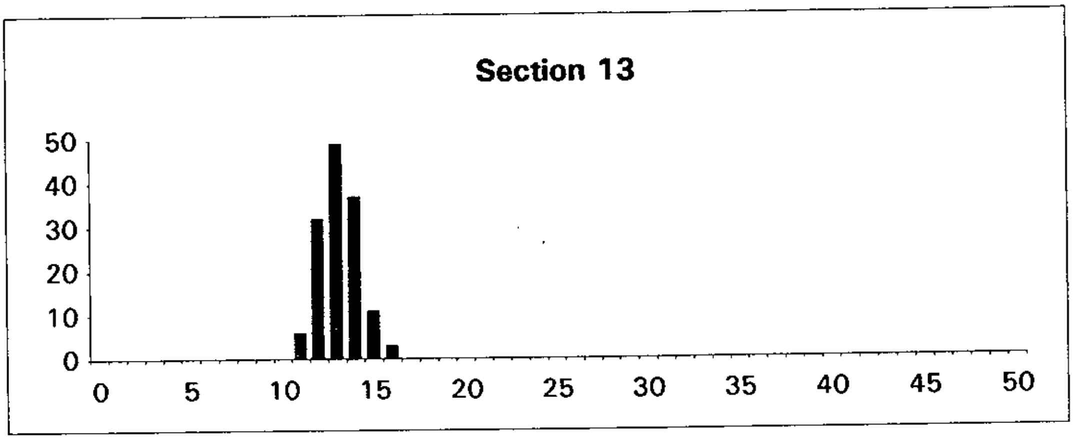

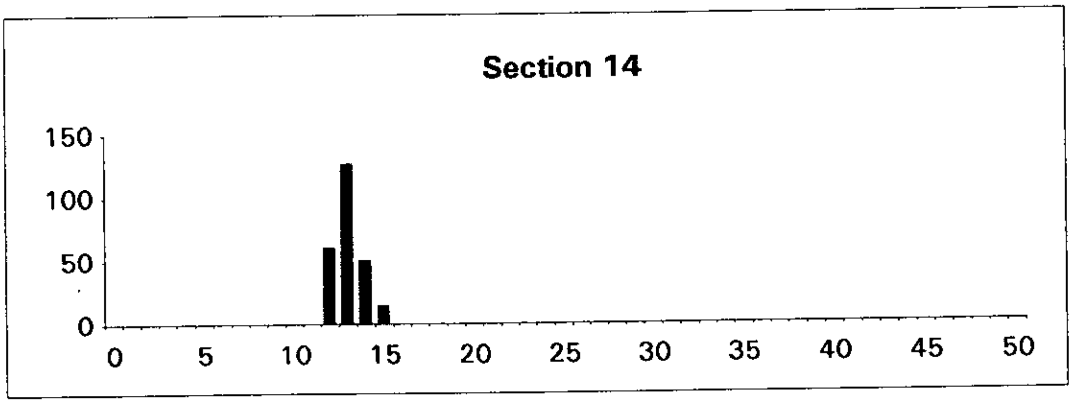

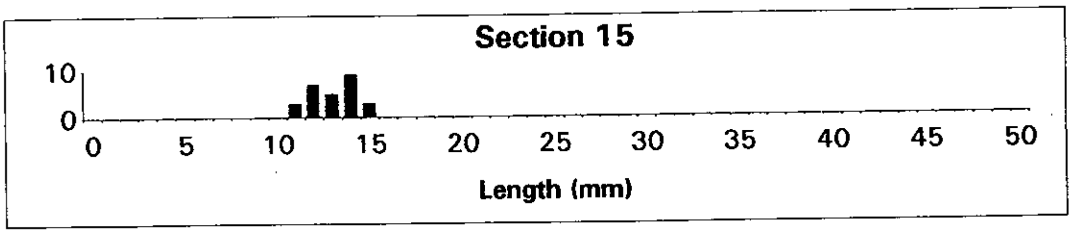

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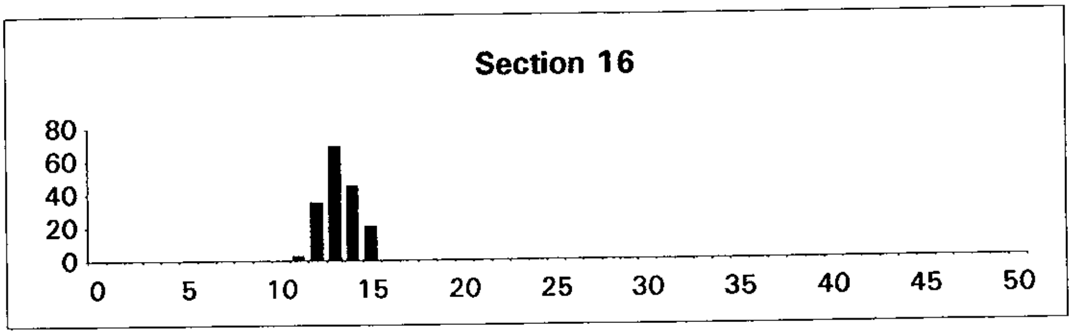

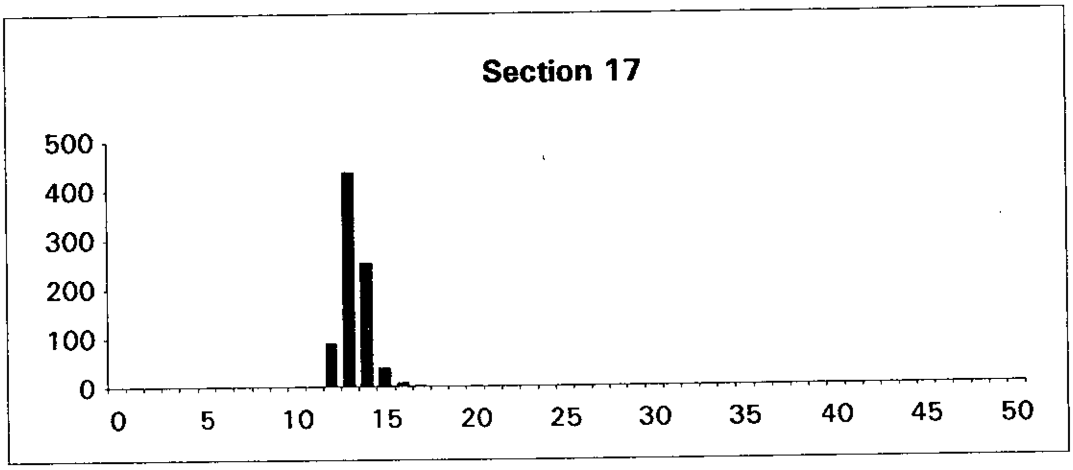

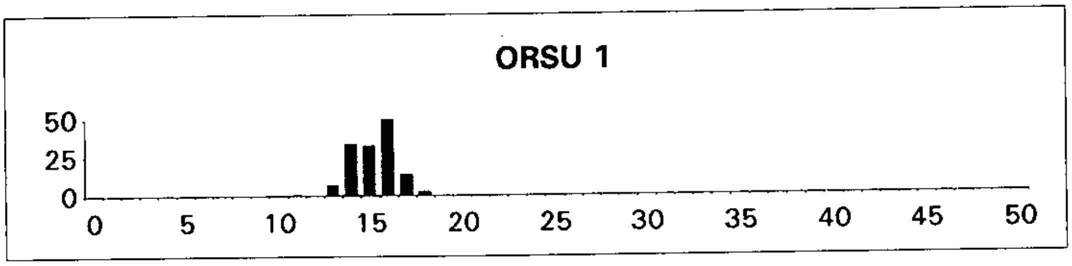

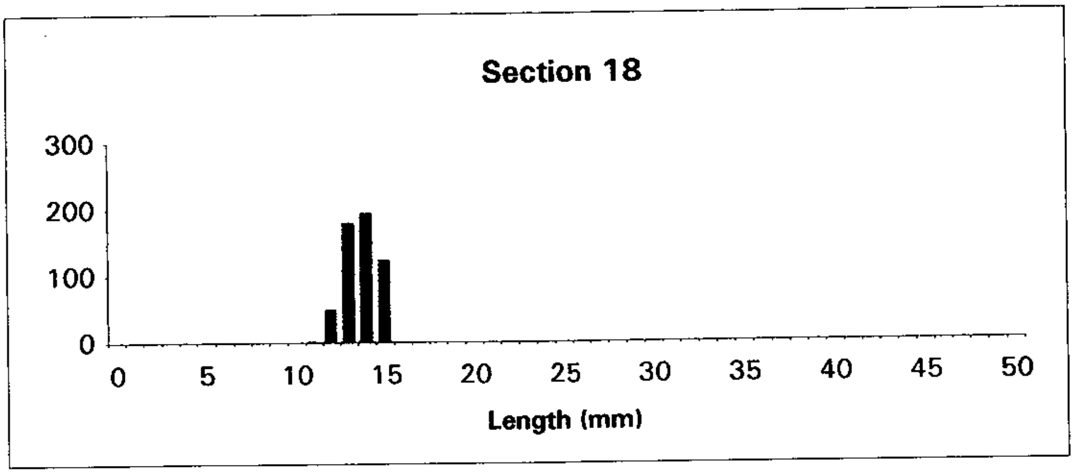

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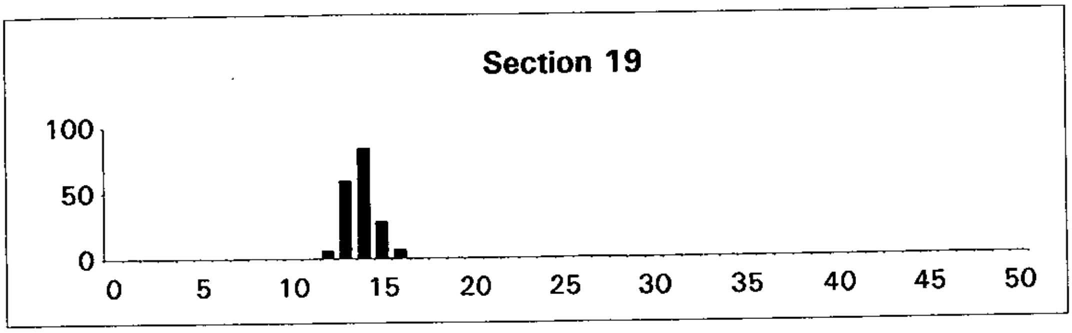

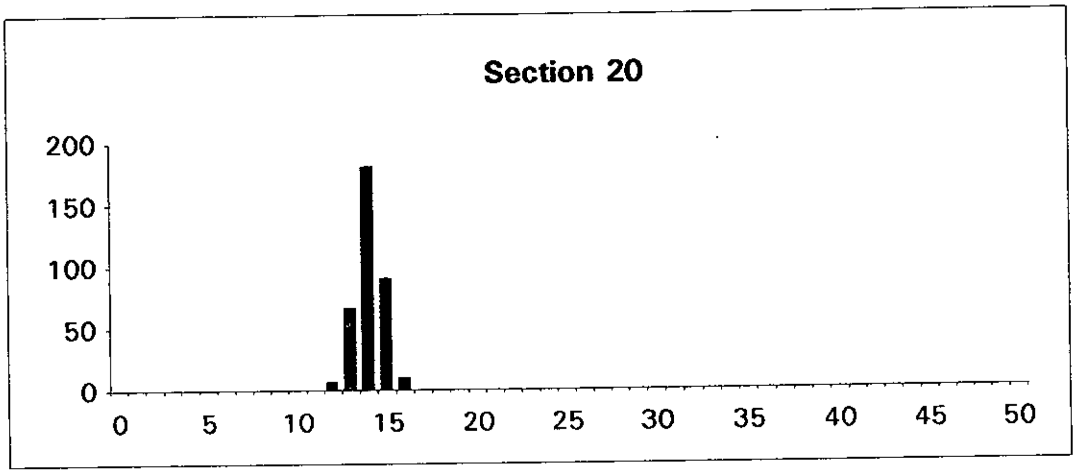

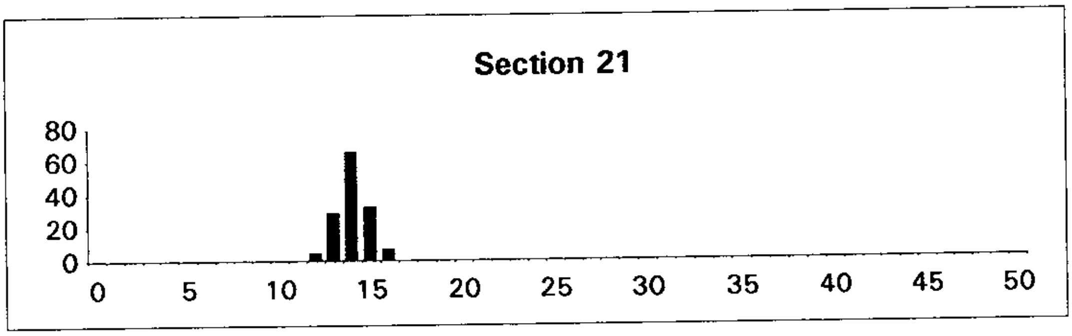

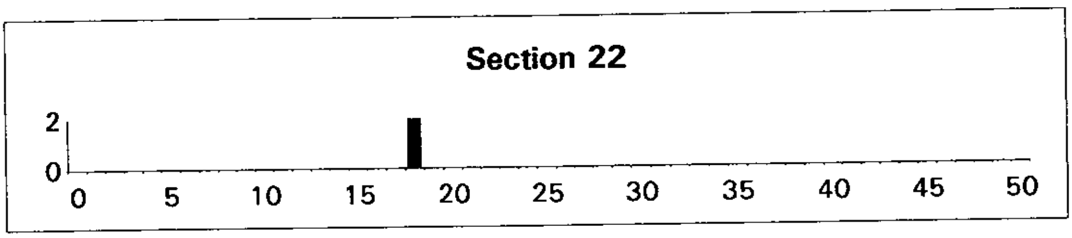

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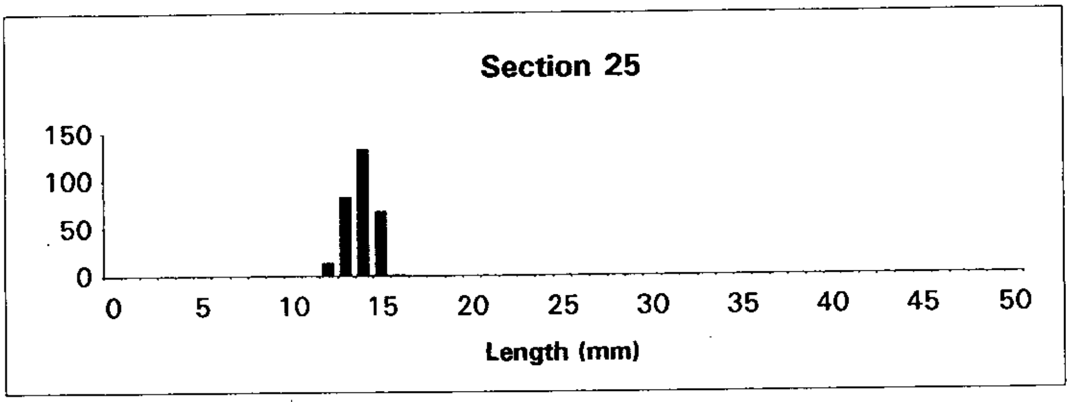
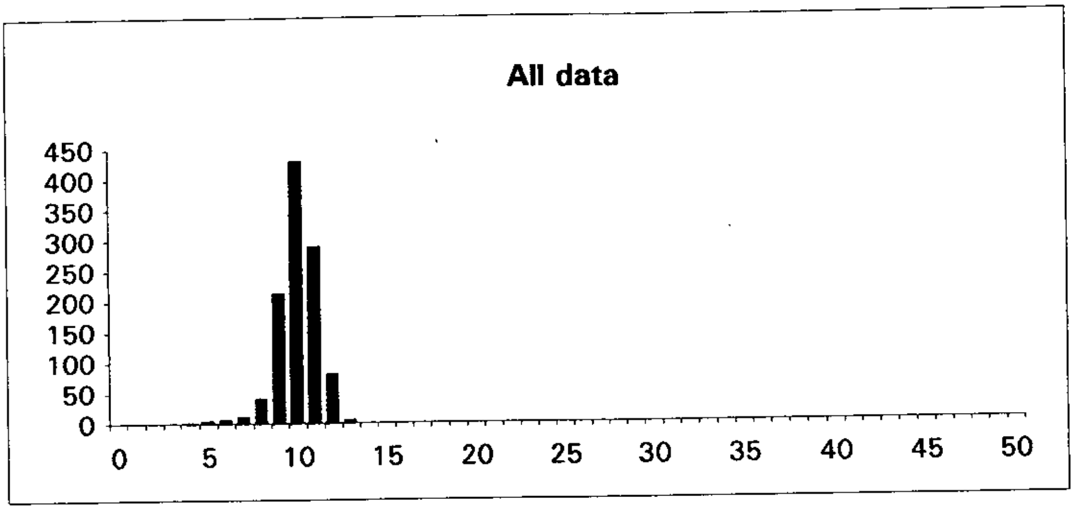
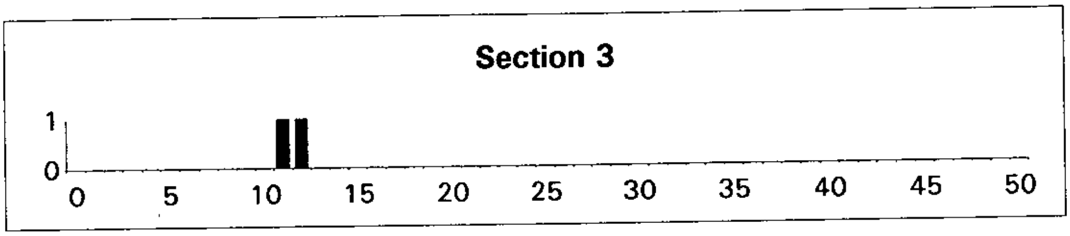
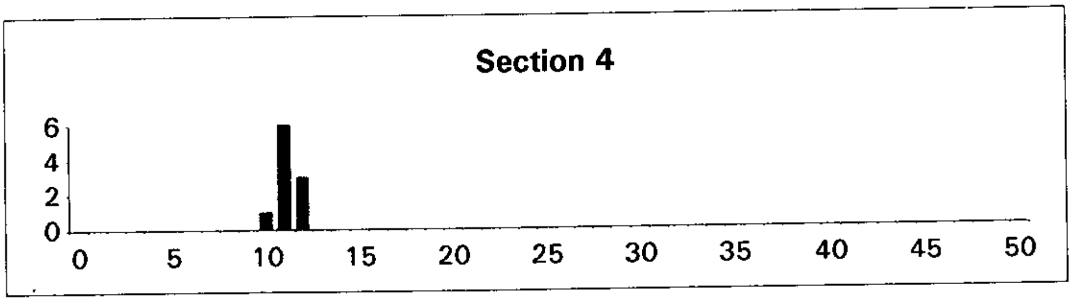
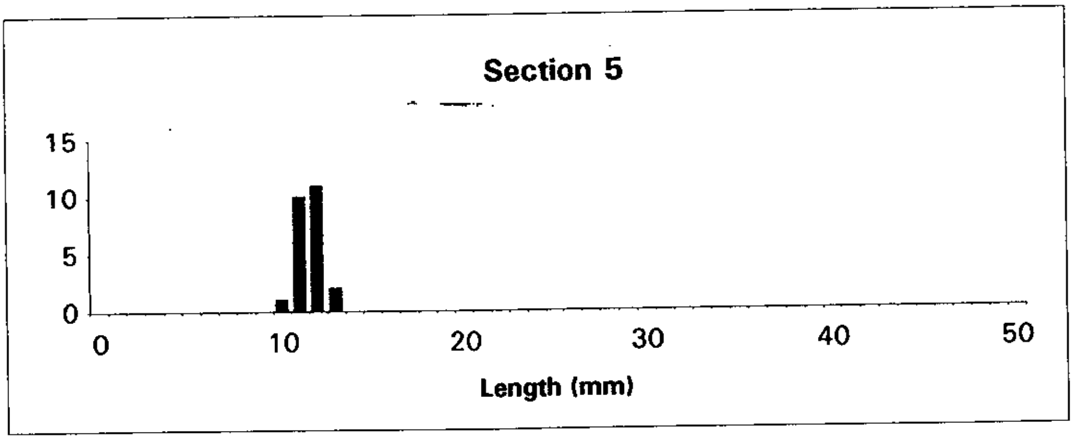


Appendix 3 Length frequency distribution of chub fry in each section of the R. Tees in June 1995.









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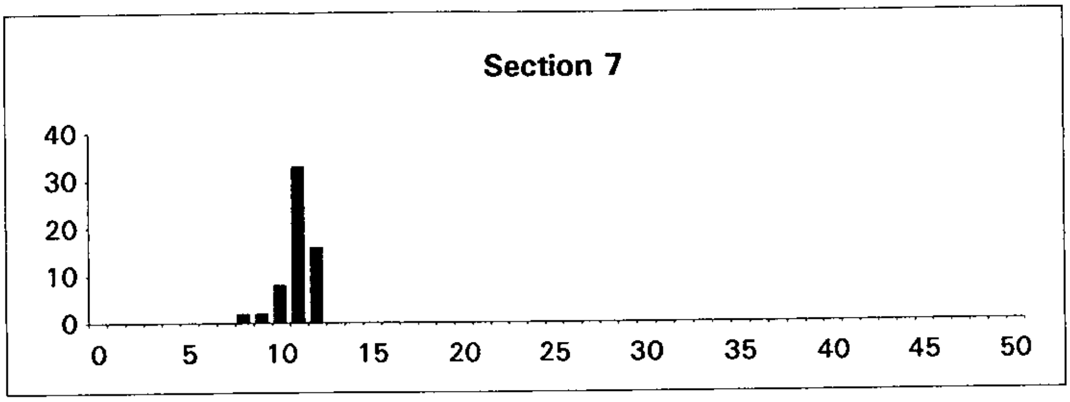

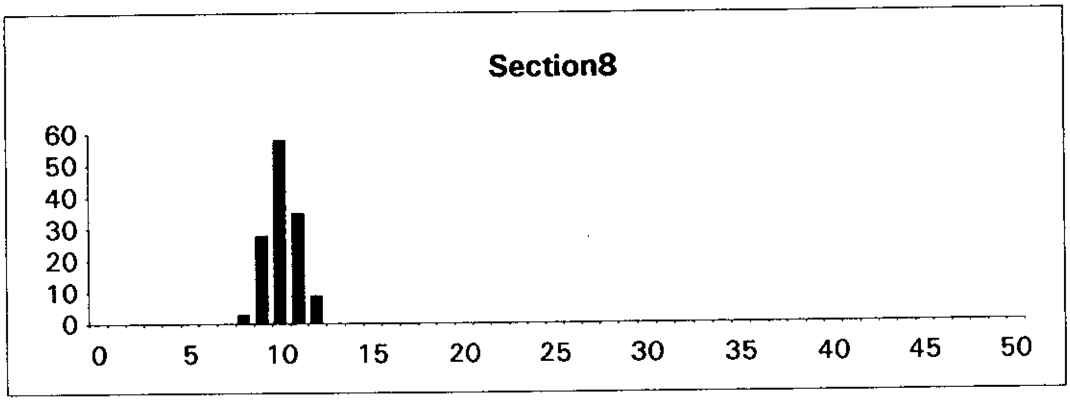

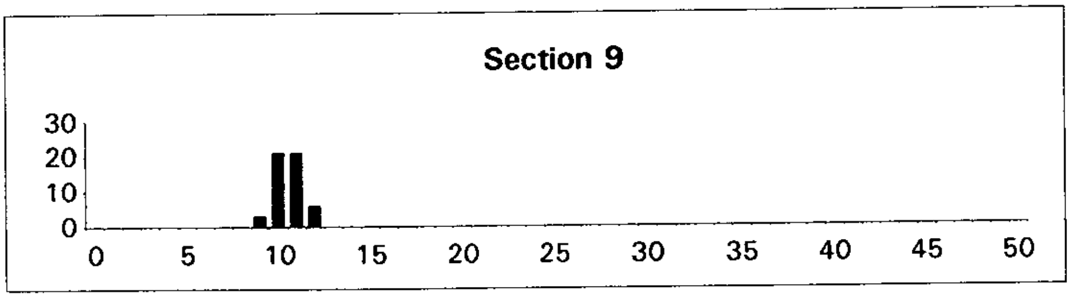

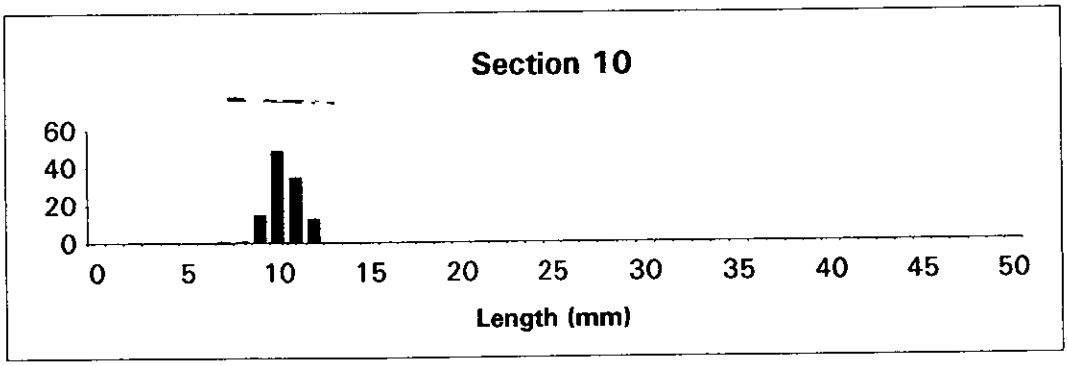

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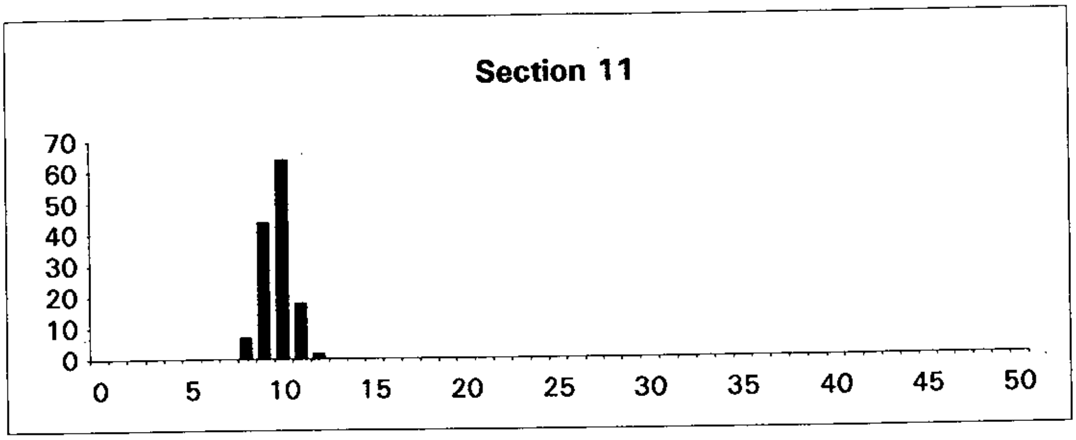

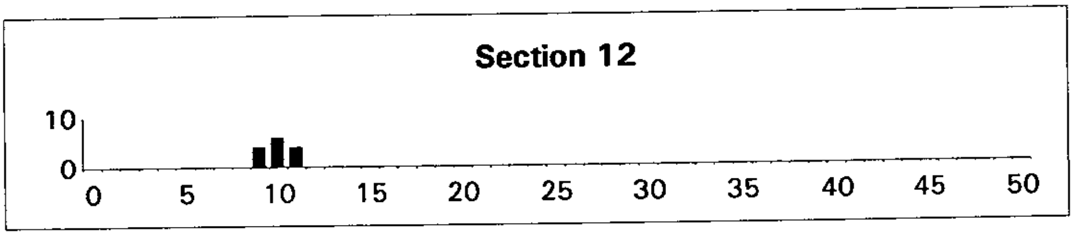

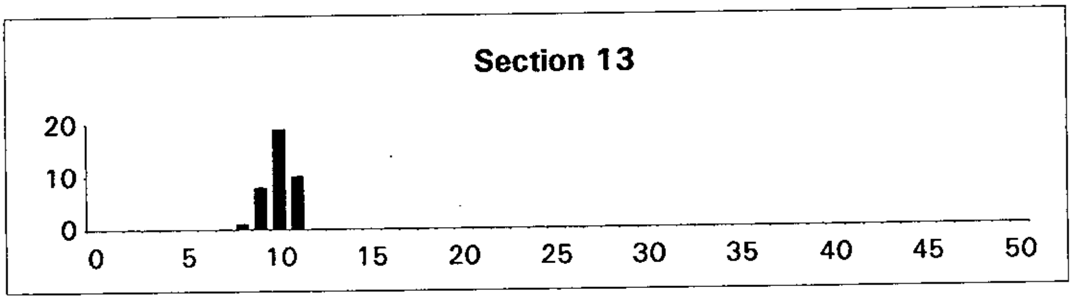

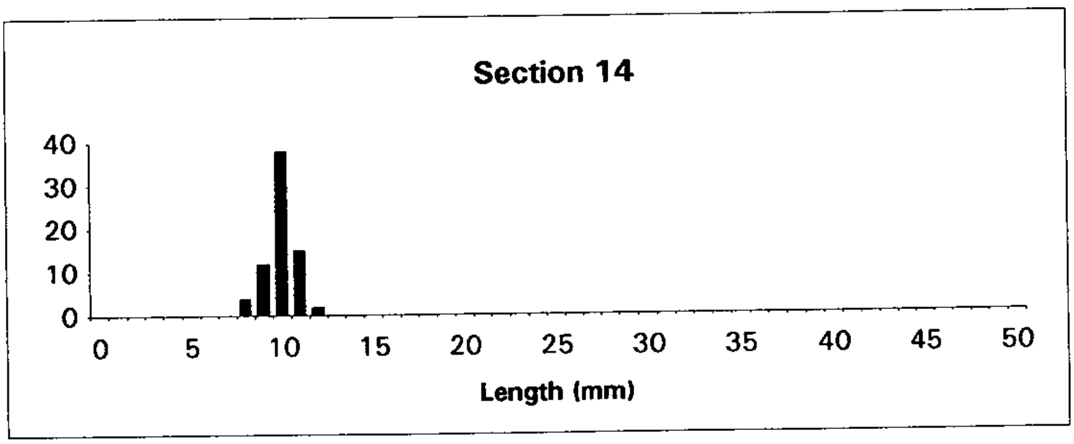

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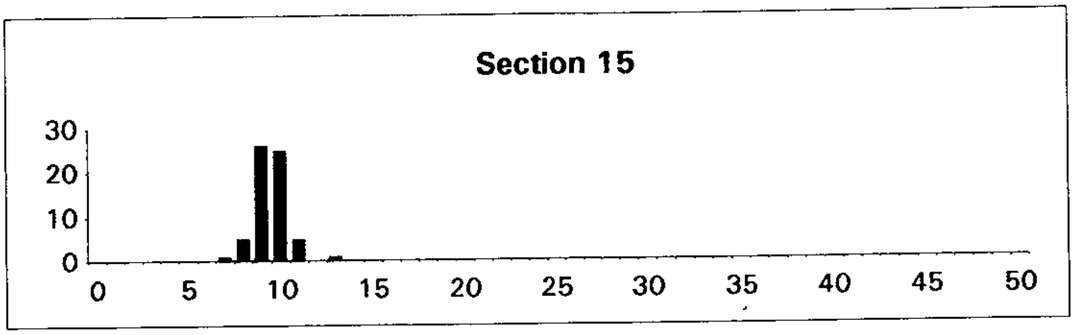

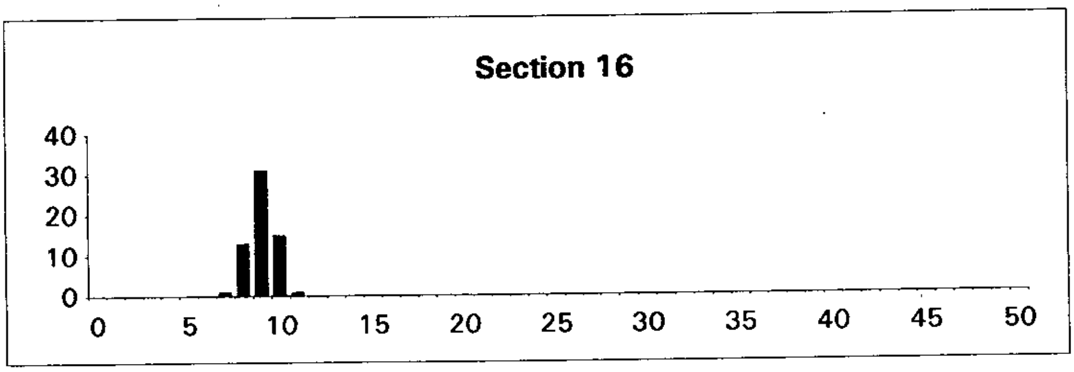

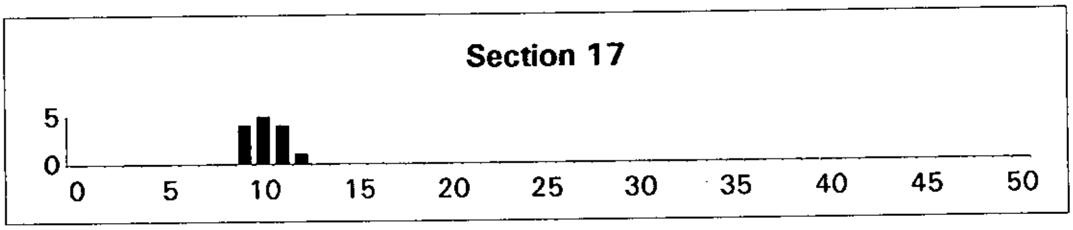

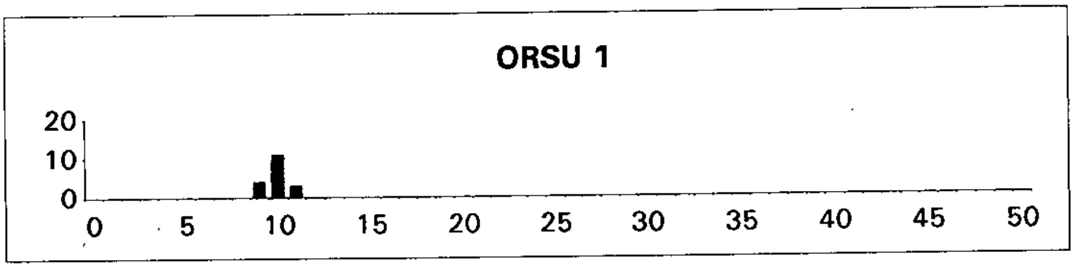

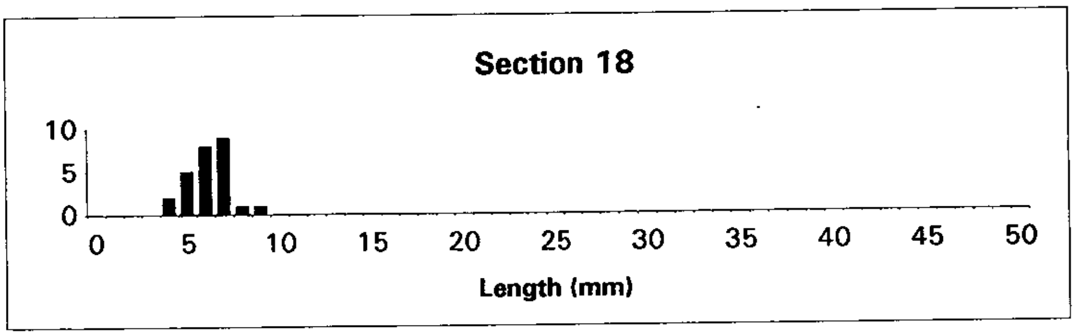

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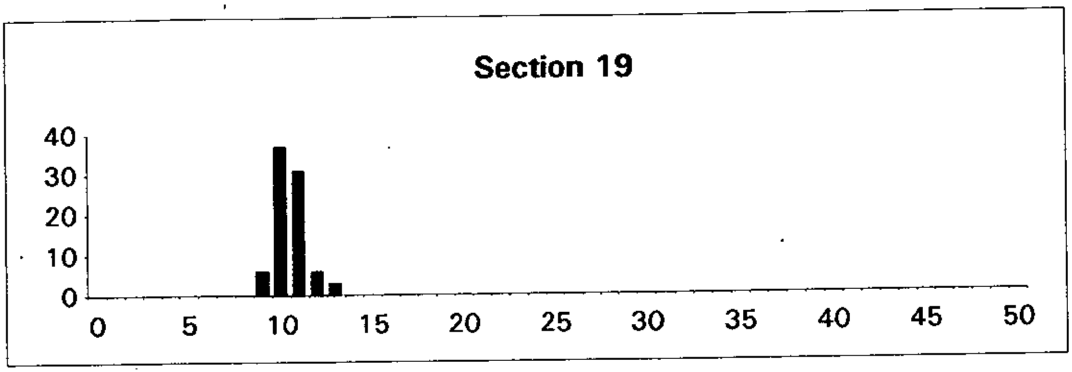

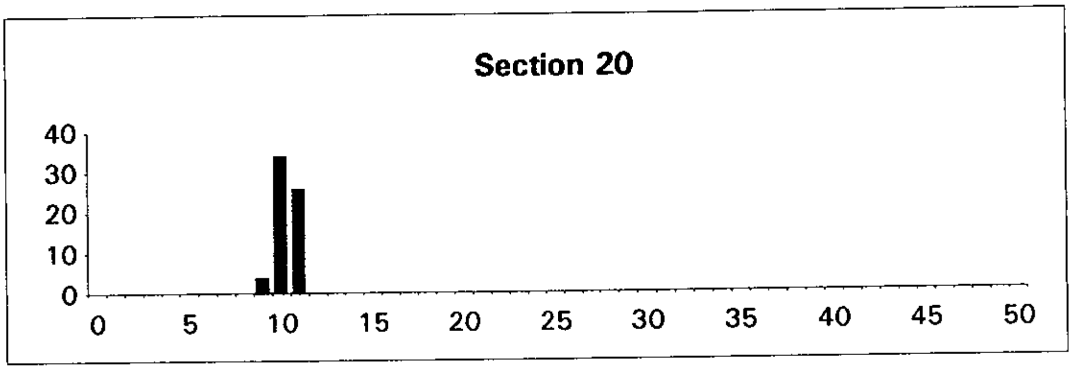

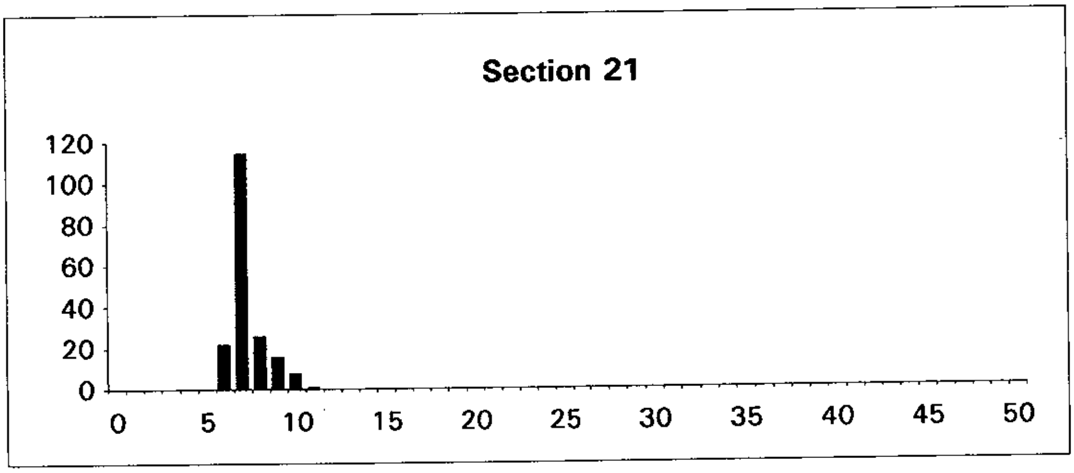

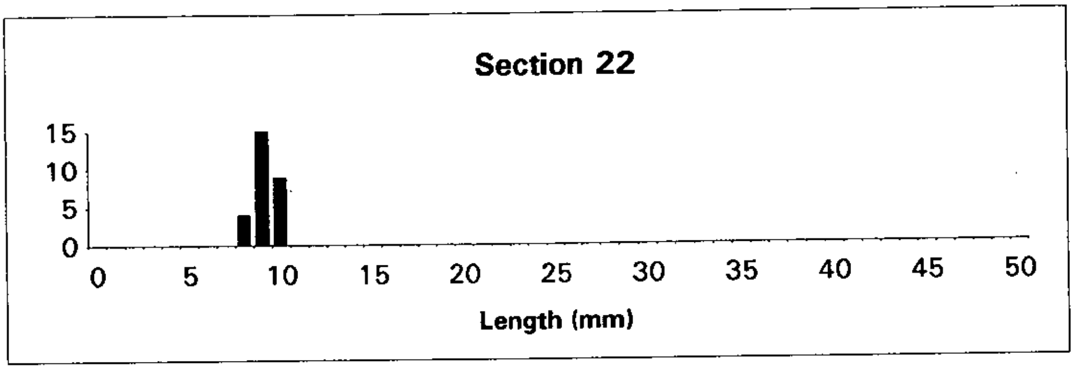

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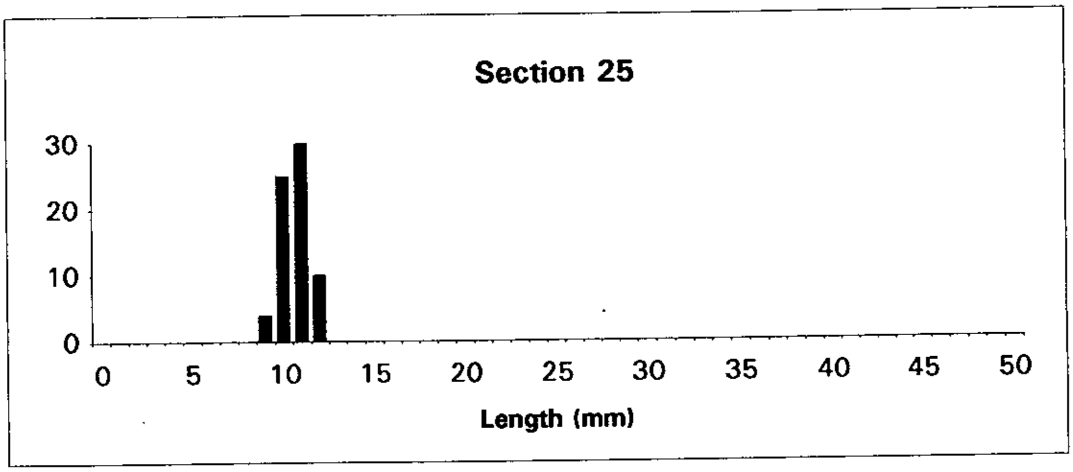
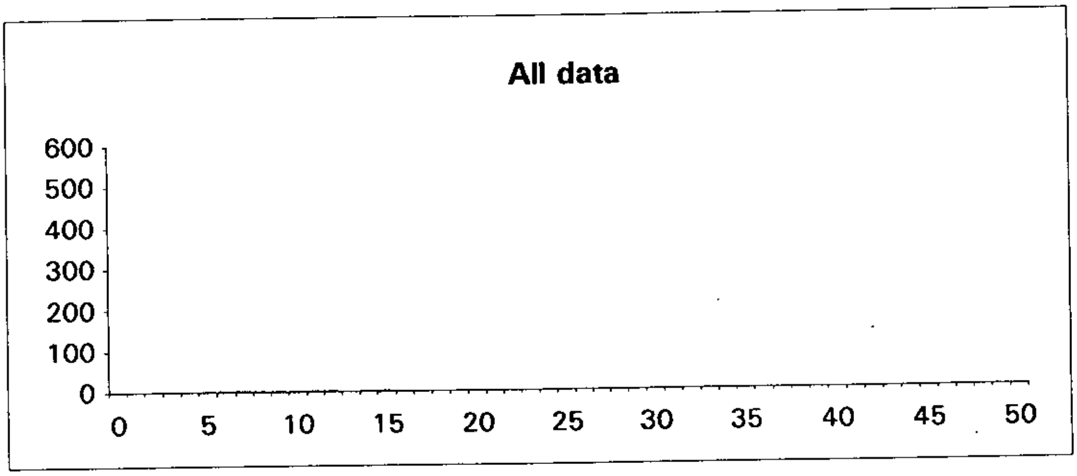
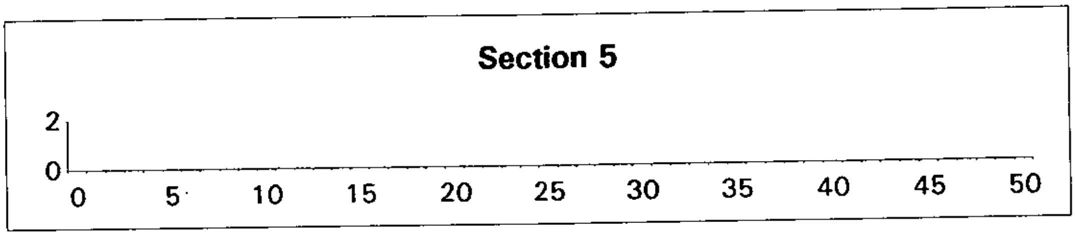
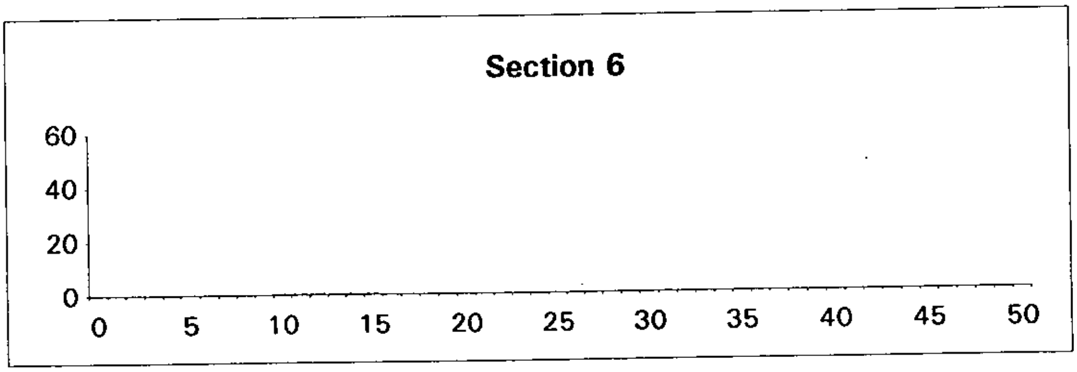
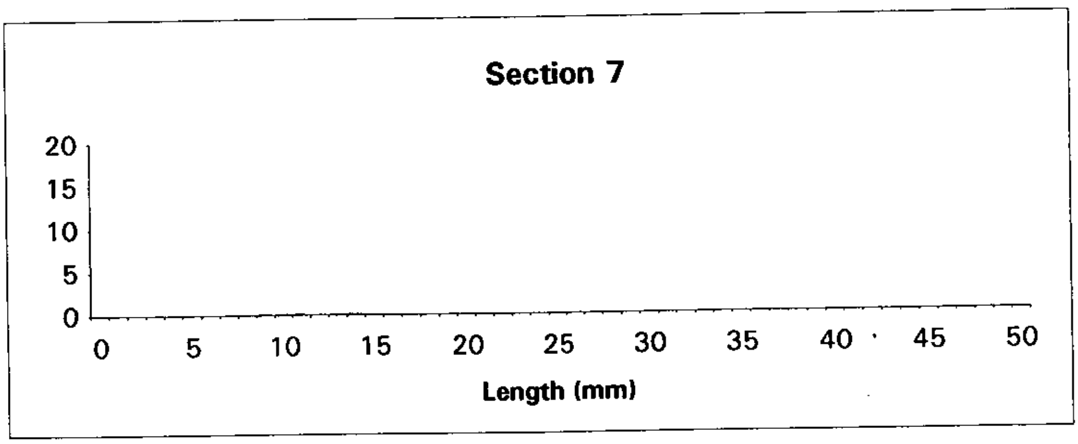


Appendix 4 Length frequency distribution of roach fry in each section of the R. Tees in June 1995.









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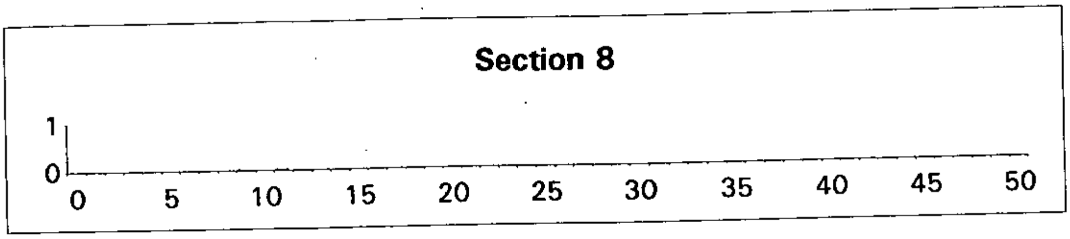

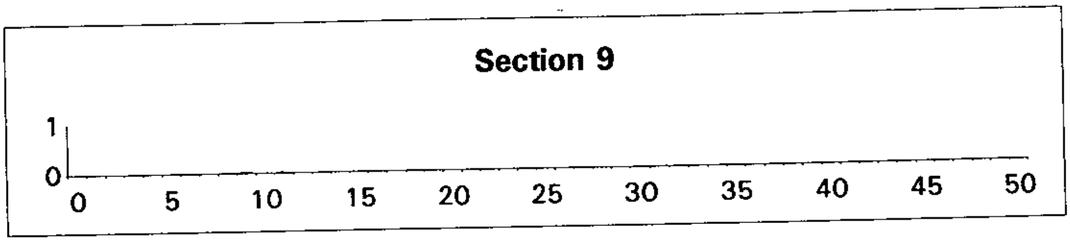

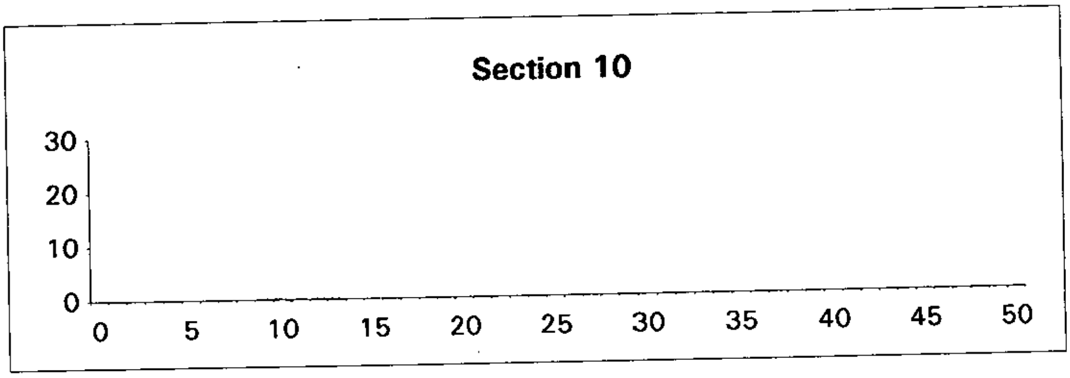

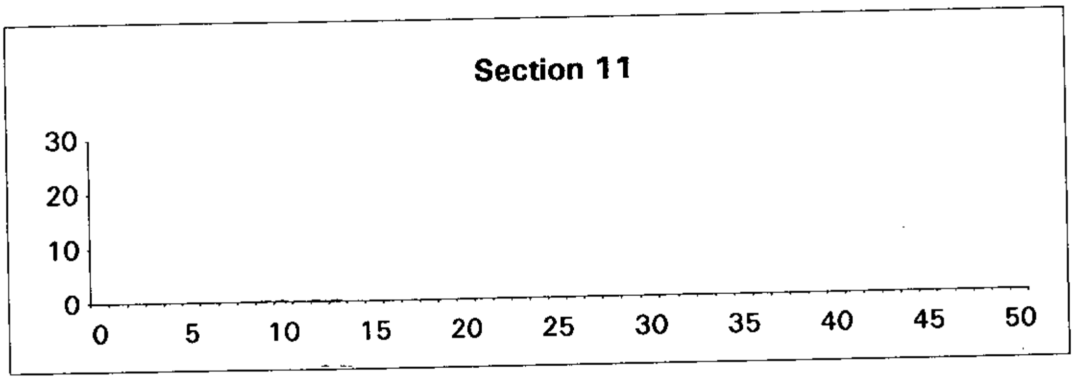

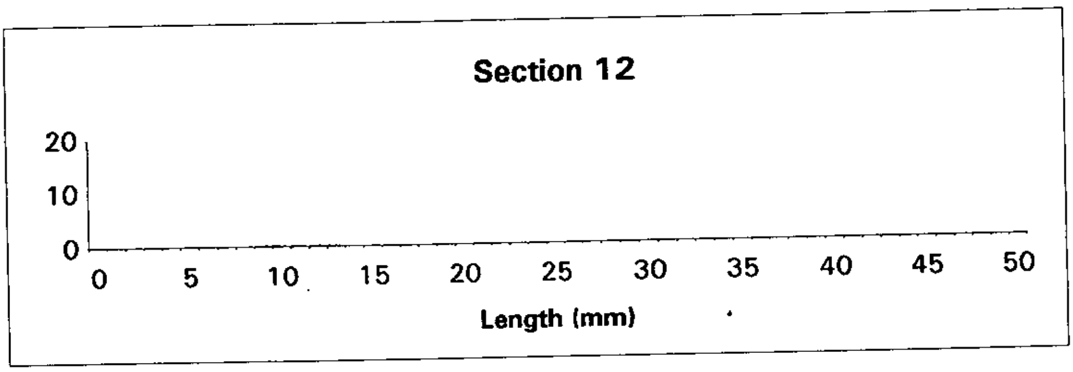

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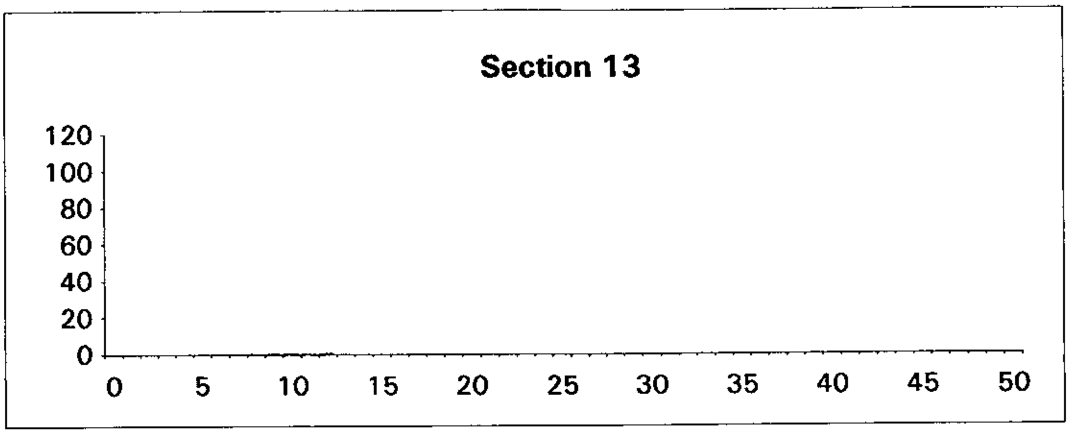

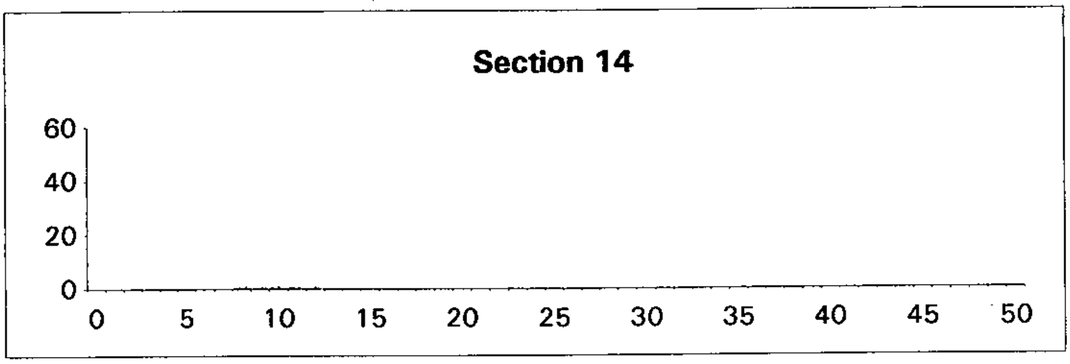

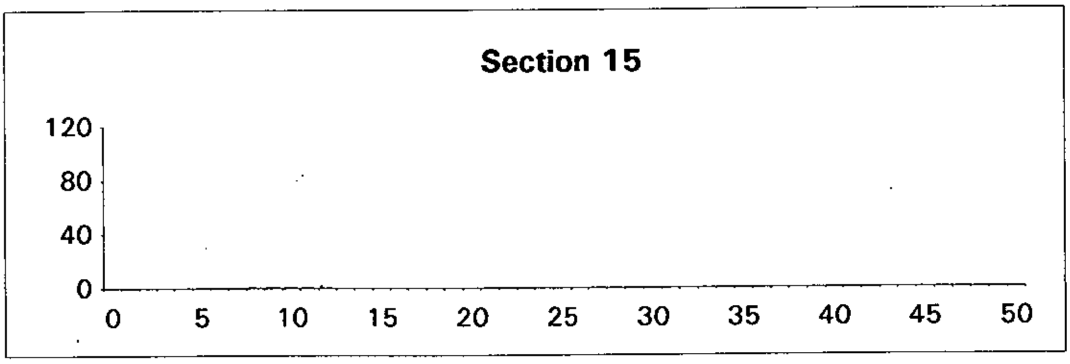

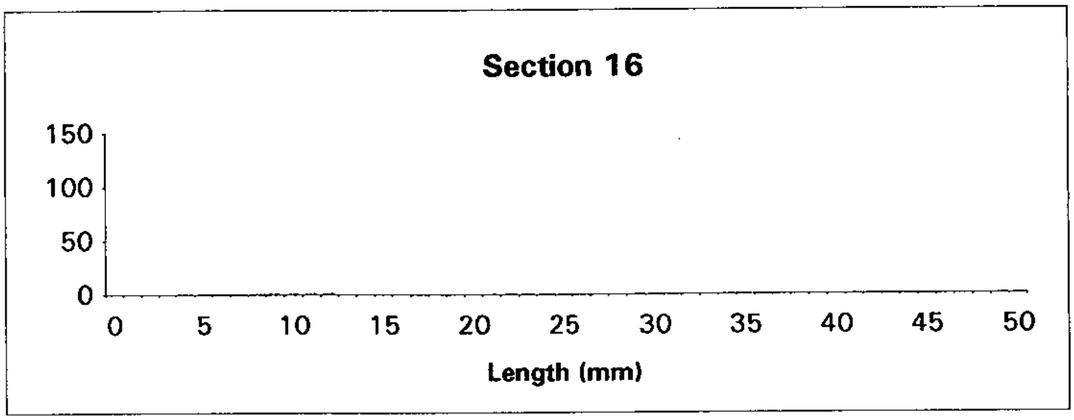

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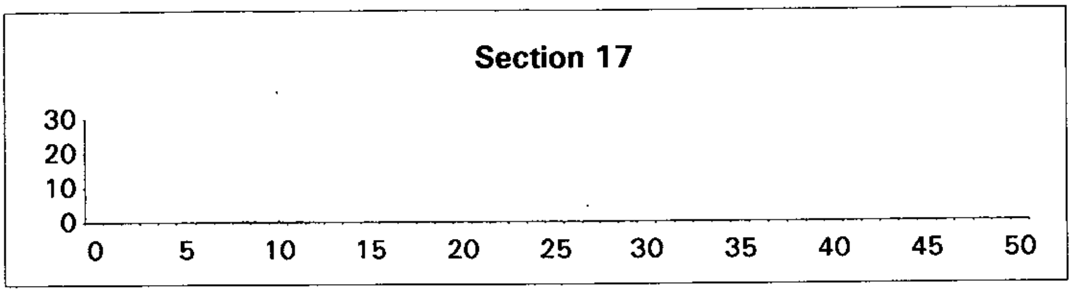

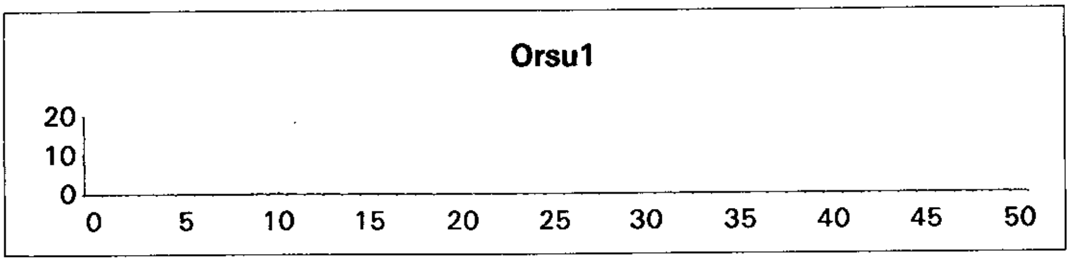

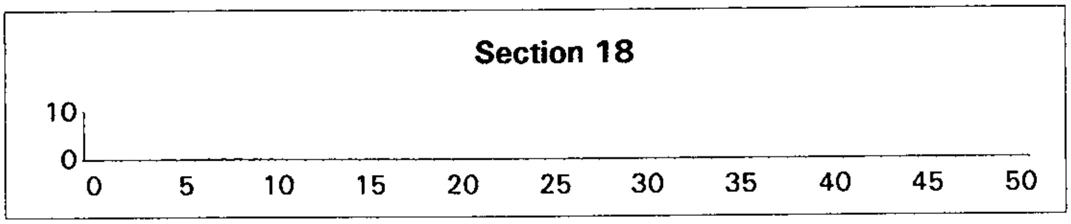

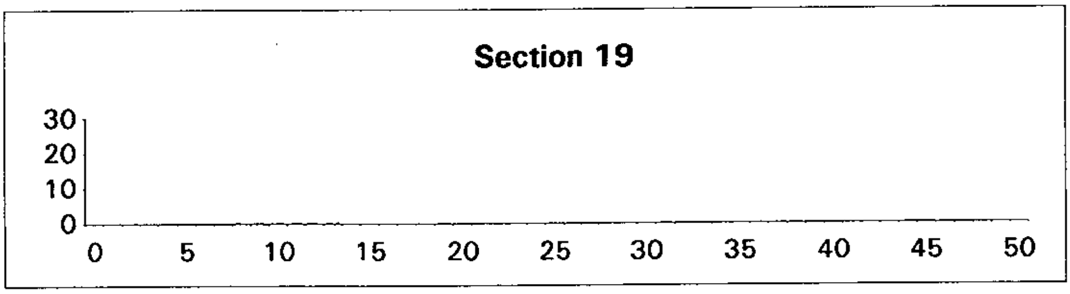

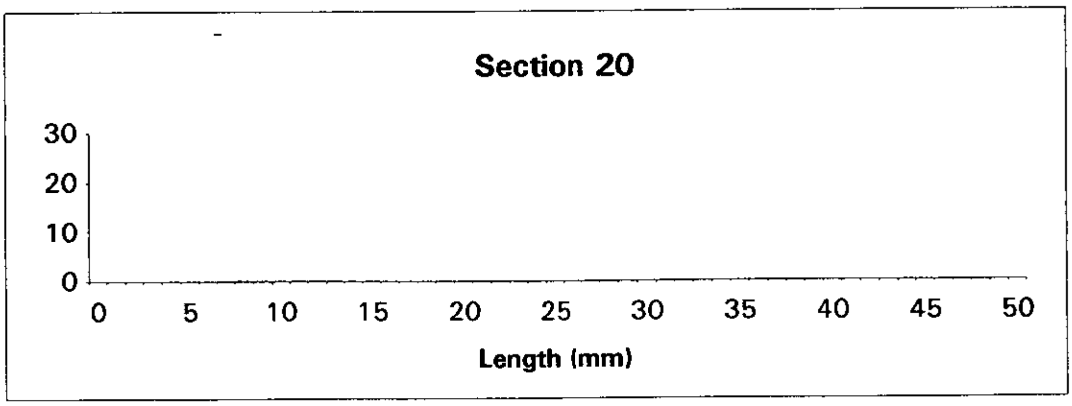

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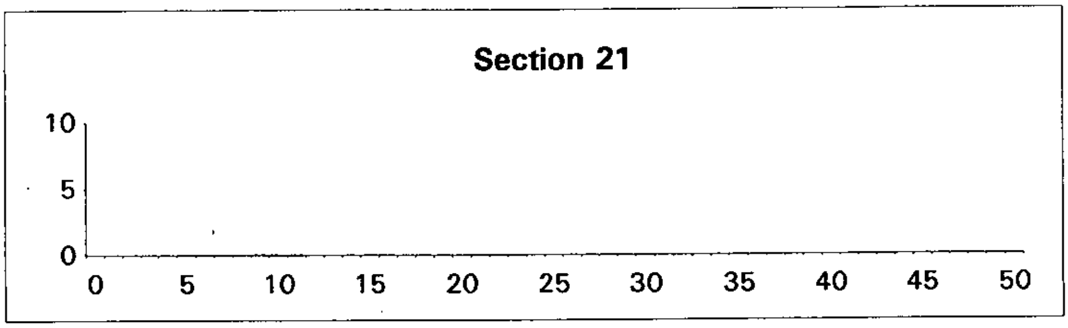
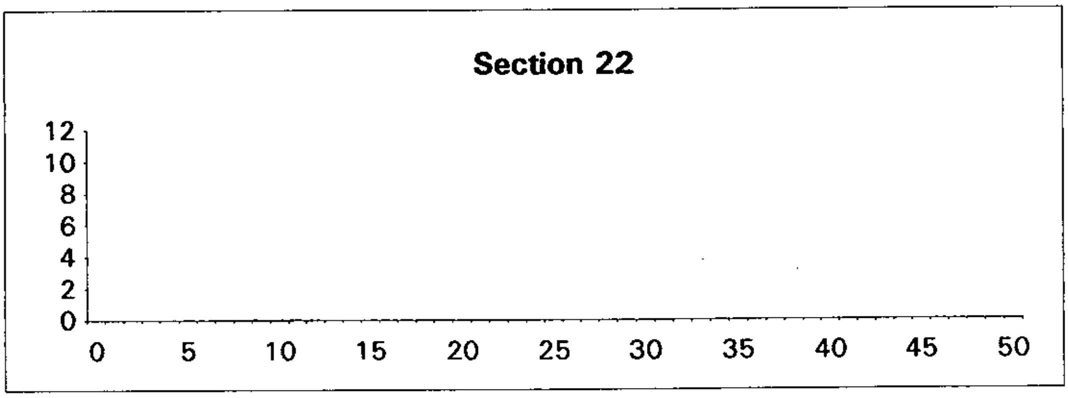
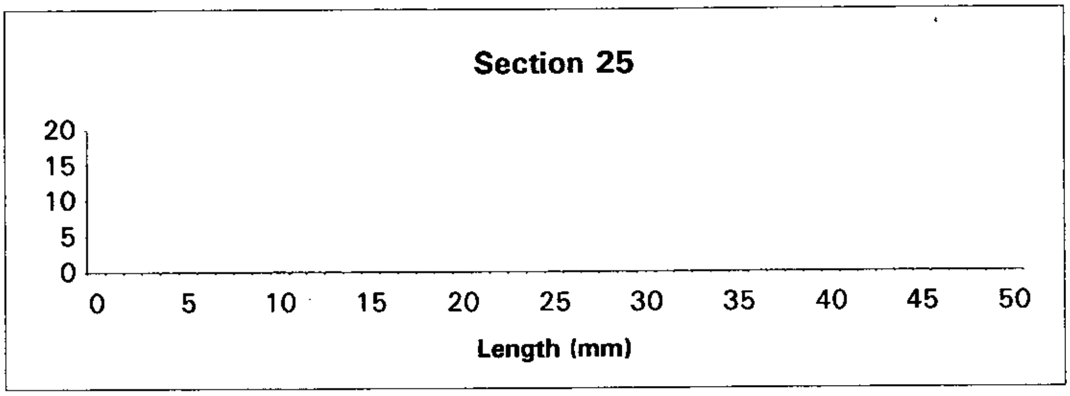






Appendix 5. Site descriptions and details of fish caught.

SECTION 1

Date fished	8 September 1995
Area	5MPH sign-ORSU
Length	400 m Right hand bank only looking downstream
NGR	NZ449163 - NZ446166
Time	14.30-15.30
Fishing method	Boom boat
Site description	River lined with reeds. Meadows, few trees.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	2	6.4-10.2
Dace *Leuciscus leuciscus* (L.)	44	5.7-11.4
Flounder *Platichthys flesus* (L.)	5	18.6-20.4
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)		
Minnow *Phoxinus phoxinus* (L.)		
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	13	5.3-24.6
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.	1	28.0
Eel *Anguilla anguilla* L.		
Perch *Perca fluviatilis* L.	1	13.0

SECTION 2/1 (1A)

Date fished	9 September 1995
Area	Bassleton Beck-upstrem mouth of ORSU Left hand bank only
Length	1200 m
NGR	NZ442155 - NZ440160
Time	13.30-14.00
Fishing method	Boom boat
Site description	River lined with reeds. Meadows, no trees.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	27	5.5-9.9
Dace *Leuciscus leuciscus* (L.)	233	5.9-11.7
Flounder *Platichthys flesus* (L.)	2	15.2-19.5
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)		
Minnow *Phoxinus phoxinus* (L.)		
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	93	4.5-8.2
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.	7	5.4-19.5
Trout (brown) *Salmo trutta* L.		
Eel *Anguilla anguilla* L.		
Sea trout *Salmo trutta* L.		

SECTION 3

Date fished	8 September 1995
Area	Bend below Great Holme to bend below pipe bridge
Length	800 m
NGR	NZ434154 - NZ441157
Time	17.00-18.30
Fishing method	Boom boat
Site description	River lined with reeds. Meadows, few trees.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	16	5.5-24.5
Dace *Leuciscus leuciscus* (L.)	304	5.2-19.0
Flounder *Platichthys flesus* (L.)		
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)		
Minnow *Phoxinus phoxinus* (L.)		
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	12	4.7-12.0
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.	5	4.0-5.7
Trout (brown) *Salmo trutta* L.	1	15.0
Eel *Anguilla anguilla* L.		
Sea trout *Salmo trutta* L.		

SECTION 4

Date fished	Not fished
Area	The Rings and Great Holmes
Length	2280 m
NGR	NZ431147 - NZ434154
Time	
Fishing method	Boom boat
Site description	High banks with meadows and few trees. River lined with reeds.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)		
Dace *Leuciscus leuciscus* (L.)		
Flounder *Platichthys flesus* (L.)		
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)		
Minnow *Phoxinus phoxinus* (L.)		
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)		
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.		
Eel *Anguilla anguilla* L.		

SECTION 5

Date fished	8 September 1995
Area	Downstream of R. Leven - start of The Rings
Length	1840 m
NGR	NZ365105 - NZ431147
Time	09.30-12.30
Fishing method	Boom boat
Site description	High banks with meadows. Some trees and shrubs on the banks, very few overhanging the water. High wooded banks at the bottom of the section.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	95	4.7-34.0
Dace *Leuciscus leuciscus* (L.)	269	4.3-23.3
Flounder *Platichthys flesus* (L.)	7	14.4-27.1
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)		
Minnow *Phoxinus phoxinus* (L.)	4	5.1-6.7
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	43	2.4-22.7
Salmon *Salmo salar* L.	1 seen	
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.	4	3.7-4.5
Trout (brown) *Salmo trutta* L.	3	14.0-24.9
Eel *Anguilla anguilla* L.	8 <30 cm	35 >30 cm

SECTION 6

Date fished	6 September 1995
Area	River Leven - large bend upstream
Length	1240 m
NGR	NZ423122 - NZ430130
Time	15.45-17.05
Fishing method	Boom boat
Site description	High banks. Overhanging trees on south bank. Open land on north bank.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	5	3.6-30.4
Dace *Leuciscus leuciscus* (L.)	84	4.5-22.8
Flounder *Platichthys flesus* (L.)		
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)	3	5.8-15.9
Minnow *Phoxinus phoxinus* (L.)		
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	20	3.3-12.6
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.	1	3.0
Trout (brown) *Salmo trutta* L.		
Eel *Anguilla anguilla* L.	2 <30 cm	1 > 30 cm

SECTION 7

Date fished	6 September 1995
Area	Upstream of Section 6 - Yarm road bridge
Length	1140 m
NGR	NZ418132 - NZ423122
Time	13.45-15.30
Fishing method	Boom boat
Site description	High banks. Yarm on south bank. Open meadows on north bank.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	15	2.7-11.4
Dace *Leuciscus leuciscus* (L.)	102	3.9-20.1
Flounder *Platichthys flesus* (L.)	15	15.2-26.6
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)	2	3.6-14.7
Minnow *Phoxinus phoxinus* (L.)	5	2.8-6.0
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	20	3.1-16.8
Salmon *Salmo salar* L.		
Sone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.	4	3.0-3.8
Perch *Perca fluviatilis* L.	1	9.9
Trout (brown) *Salmo trutta* L.		
Eel *Anguilla anguilla* L.	10 < 30 cm	13 > 30 cm

SECTION 8

Date fished	6 September 1995
Area	Yarm road bridge - Yarm railway bridge
Length	80 m
NGR	NZ417132 - NZ418132
Time	13.30-13.45
Fishing method	Boom boat
Site description	High banks. Gravel bar on south bank. Water otherwise deep.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	9	3.2-10.5
Dace *Leuciscus leuciscus* (L.)	14	4.6-12.0
Flounder *Platichthys flesus* (L.)		
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)	1	3.3
Minnow *Phoxinus phoxinus* (L.)		
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	1	3.1
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.	1	16.5
Eel *Anguilla anguilla* L.	1 <30 cm	

SECTION 9

Date fished	6 September 1995
Area	Yarm railway bridge - upstream to outfall on north bank
Length	300 m
NGR	NZ415131 - NZ417132
Time	12.30-13.15
Fishing method	Boom boat
Site description	Flood defence construction on south bank. On north, high bank with bushes and herbaceous vegetation.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	11	2.9-5.2
Dace *Leuciscus leuciscus* (L.)	22	4.3-19.8
Flounder *Platichthys flesus* (L.)	2	16.5-19.5
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)	1	4.7
Minnow *Phoxinus phoxinus* (L.)	8	2.7-6.2
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	14	3.5-6.8
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.	3	3.3-4.6
Trout (brown) *Salmo trutta* L.		
Eel *Anguilla anguilla* L.	3 <30 cm	

SECTION 10

Date fished	6 September 1995
Area	Upstream of section 9 - downstream of section 11
Length	560 m
NGR	NZ415122 - NZ415131
Time	10.30-12.15
Fishing method	Boom boat
Site description	High banks. Thin line of trees and shrubs on the north bank, more open on the south bank.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	38	2.9-31.2
Dace *Leuciscus leuciscus* (L.)	104	4.0-21.3
Flounder *Platichthys flesus* (L.)	8	11.6-22.8
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)		
Minnow *Phoxinus phoxinus* (L.)	6	3.3-6.9
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	38	2.1-10.7
Pike *Esox lucius* L.	1	48.2
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.	1	4.2
Trout (brown) *Salmo trutta* L.		
Eel *Anguilla anguilla* L.	3 <30 cm	10 > 30 cm
Perch *Perca fluviatilis* L.		

SECTION 11

Date fished	6 September 1995
Area	Aislaby at The Cabins - bend downstream
Length	840 m
NGR	NZ407123 - NZ415122
Time	09.15-10.30
Fishing method	Boom boat
Site description	High banks. Wooded area

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)	2	5.0-5.8
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	28	2.5-31.5
Dace *Leuciscus leuciscus* (L.)	79	4.1-10.6
Flounder *Platichthys flesus* (L.)	9	13.5-19.2
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)		
Minnow *Phoxinus phoxinus* (L.)	10	3.0-5.9
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	17	2.5-17.0
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.	1	21.5
Eel *Anguilla anguilla* L.	13 <30 cm	20 > 30 cm

SECTION 12

Date fished	6 September 1995
Area	Aislaby at The Cabins - middle of 1st bend upstream
Length	440 m
NGR	NZ405120 - NZ407123
Time	17.30-18.45
Fishing method	Boom boat
Site description	High banks, meadows with few overhanging trees

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)	1	7.0
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	22	2.8-41.3
Dace *Leuciscus leuciscus* (L.)	71	4.1-10.8
Flounder *Platichthys flesus* (L.)	10	15.1-23.1
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)	7	12.0-13.6
Minnow *Phoxinus phoxinus* (L.)	3	3.5-6.7
Perch *Perca fluviatilis* L.	1	10.4
Roach *Rutilus rutilus* (L.)	9	3.8-21.8
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.	2	12.9-23.5
Eel *Anguilla anguilla* L.	10 <30 cm	14 >30 cm

SECTION 13

Date fished	7 September 1995
Area	Upstream of Aislaby, end of Section 12 - next bend upstream
Length	600 m
NGR	NZ404114 - NZ405120
Time	09.30-10.40
Fishing method	Boom boat
Site description	High banks, meadows with few overhanging trees

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	33	3.0-40.3
Dace *Leuciscus leuciscus* (L.)	53	4.4-20.0
Flounder *Platichthys flesus* (L.)	7	14.4-31.2
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)		
Minnow *Phoxinus phoxinus* (L.)	5	2.8-5.1
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	6	2.6-14.7
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.	1	24.3
Eel *Anguilla anguilla* L.	22 <30 cm	31 >30 cm

SECTION 14

Date fished	7 September 1995
Area	End of Section 13 - next bend upstream
Length	1040 m
NGR	NZ401105 - NZ404114
Time	10.40-12.30
Fishing method	Boom boat
Site description	High banks, more wooded than sections 12 and 13. Deep water

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	41	2.5-48.0
Dace *Leuciscus leuciscus* (L.)	111	4.2-11.0
Flounder *Platichthys flesus* (L.)	3	16.1-17.2
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)	1	9.0
Minnow *Phoxinus phoxinus* (L.)	11	2.9-7.3
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	8	2.4-23.0
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.	2	22.4-27.8
Sea Trout *Salmo trutta* L.		
Eel *Anguilla anguilla* L.	9 < 30 cm	16 >30 cm

SECTION 15

Date fished	7 September 1995
Area	Pumping station - bend downstream. Lower limit opposite upstream limit of section 14.
Length	580 m
NGR	NZ395103 - NZ401105
Time	12.45-14.00
Fishing method	Boom boat
Site description	High banks, wooded section. Shallow water with gravel banks

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)	1	4.0
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	41	2.4-31.9
Dace *Leuciscus leuciscus* (L.)	95	4.2-19.1
Flounder *Platichthys flesus* (L.)	7	15.8-26.0
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)	54	2.8-4.8
Minnow *Phoxinus phoxinus* (L.)	28	2.4-6.4
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	36	2.0-10.4
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.	1	4.5
Trout (brown) *Salmo trutta* L.		
Eel *Anguilla anguilla* L.	5 <30 cm	18 >30 cm

SECTION 16

Date fished	Not fished
Area	Lower Worsall - pumping station
Length	400 m
NGR	NZ392103 - NZ395103
Time	
Fishing method	Boom boat
Site description	Banks less steep. Open meadows upstream with tree cover increasing downstream. Shallow water.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)		
Dace *Leuciscus leuciscus* (L.)		
Flounder *Platichthys flesus* (L.)		
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)		
Minnow *Phoxinus phoxinus* (L.)		
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)		
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.		
Eel *Anguilla anguilla* L.		

SECTION 19

Date fished	Not fished
Area	Fardeneside Farm to top of second island upstream.
Length	200 m
NGR	NZ371095 - NZ373095
Time	
Fishing method	Twin anode wading
Site description	Very high, steep, wooded banks. Uniform area downstream with little macrophyte cover but dense bushes on the bank overhanging the water.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)		
Chub *Leuciscus cephalus* (L.)		
Dace *Leuciscus leuciscus* (L.)		
Flounder *Platichthys flesus* (L.)		
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)		
Minnow *Phoxinus phoxinus* (L.)		
Roach *Rutilus rutilus* (L.)		
Rudd *Scardinius erythrophthalmus* (L.)		
Salmon *Salmo salar* L.		
Sea lamprey *Petromyzon marinus* L.		
Stone loach *Barbatula barbatula* (L.)		
Trout (brown) *Salmo trutta* L.		
Bullhead *Cottus gobio* (L.)		
Eel *Anguilla anguilla* L.		

SECTION 21

Date fished	5 September 1995
Area	Downstream of ford below Low Moor weir
Length	260 m
NGR	NZ365106 - NZ376104
Time	11.45-13.30
Fishing method	Twin anode wading
Site description	High banks with some trees on the south bank. Open meadows. A small number of willows overhanging the water on the north bank. Water generally up to 80 cm with deeper pools under overhanging trees. Substratum cobbles/gravel with fine organic sediment in areas of low flow.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)	14	3.9-24.6
Bullhead *Cottus gobio* L.	2	6.3-7.3
Chub *Leuciscus cephalus* (L.)	35	3.0-47.0
Dace *Leuciscus leuciscus* (L.)	108	4.6-20.3
Flounder *Platichthys flesus* (L.)	42	11.8-25.8
Grayling *Thymallus thymallus* (L.)	4	21.0-32.3
Gudgeon *Gobio gobio* (L.)	19	3.6-14.1
Minnow *Phoxinus phoxinus* (L.)	76	3.0-6.7
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	43	3.1-10.0
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)	8	4.4-8.1
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.	1	26.6
Eel *Anguilla anguilla* L.	15 <30 cm	75 >30 cm
Pike *Esox lucius* L.		

SECTION 25

Date fished	5 September 1995
Area	Low Dinsdale toll bridge - first bend upstream
Length	350 m
NGR	NZ350113 - NZ345114
Time	08.30-11.00
Fishing method	Twin anode wading
Site description	Fast flowing over bedrock. Gravel banks present in places usually near the bank. Very high wooded banks. Fallen trees in the water often with associated macrophyte debris.

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)	4	4.5
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	97	1.6-43.4
Dace *Leuciscus leuciscus* (L.)	137	5.4-16.0
Flounder *Platichthys flesus* (L.)		
Grayling *Thymallus thymallus* (L.)	1	11.0
Gudgeon *Gobio gobio* (L.)	26	4.8-8.5
Minnow *Phoxinus phoxinus* (L.)	59	3.1-7.7
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	44	3.8-32.0
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.	4	18.0-31.4
Eel *Anguilla anguilla* L.	22 <30 cm	15 >30 cm

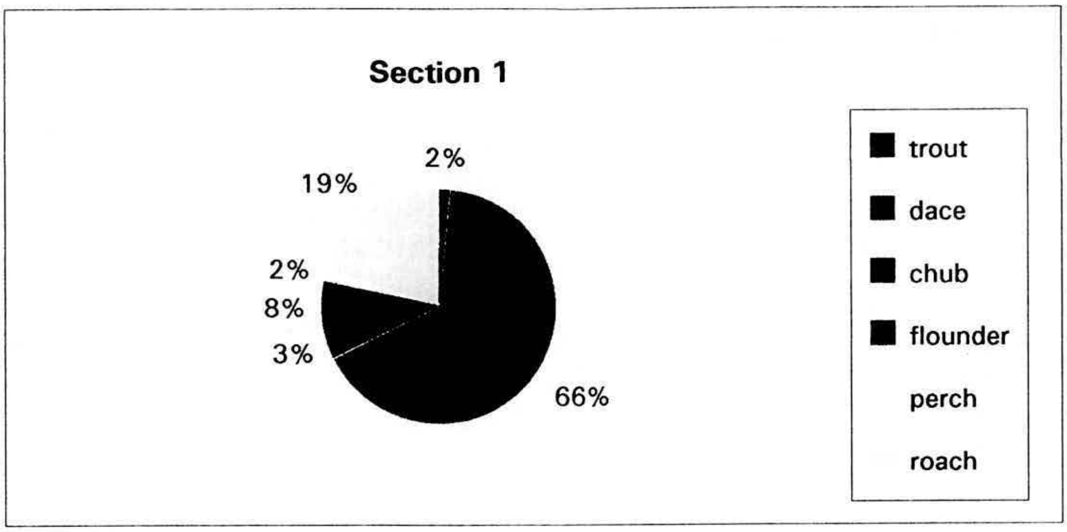
ORSU 1

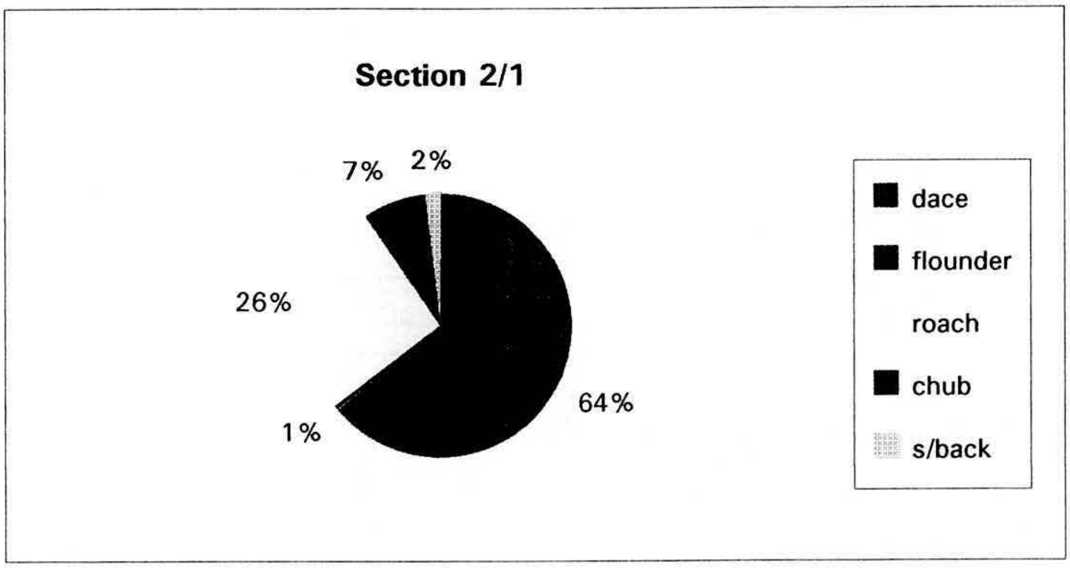
Date fished 5 September 1995

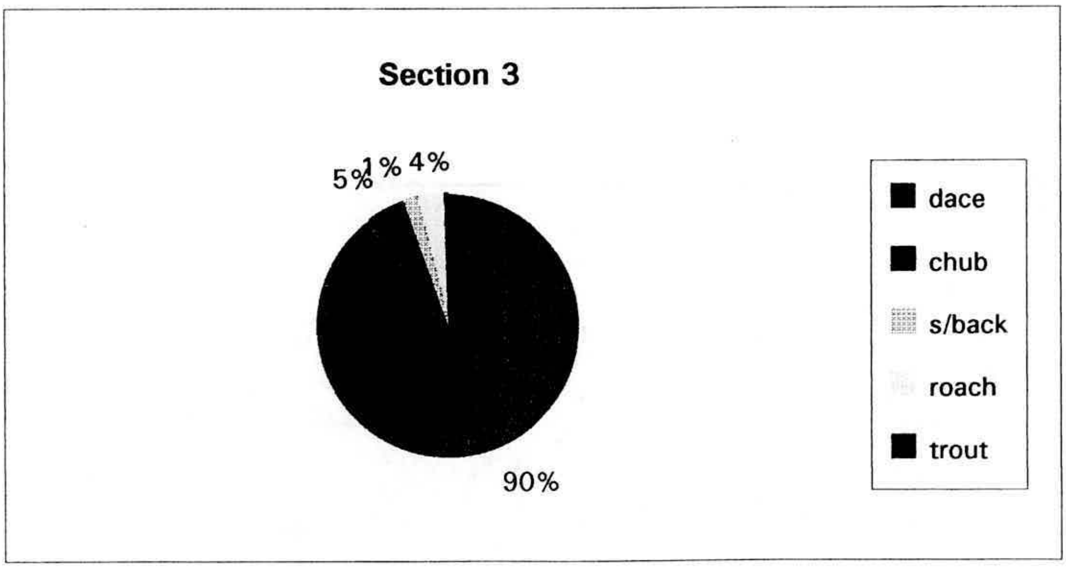
Time 14.45-15.30
Fishing method Single anode from dinghy
Site description Shallow water, silt substratum

Species	No. of individuals	Size range (cm)
Barbel *Barbus barbus* (L.)	1	3.5
Bullhead *Cottus gobio* L.		
Chub *Leuciscus cephalus* (L.)	13	2.5-4.1
Dace *Leuciscus leuciscus* (L.)	6	4.4-11.6
Flounder *Platichthys flesus* (L.)	8	20.6-32.2
Grayling *Thymallus thymallus* (L.)		
Gudgeon *Gobio gobio* (L.)	101	2.5-9.3
Minnow *Phoxinus phoxinus* (L.)	63	1.6-4.2
River Lamprey *Lampetra fluviatilis* (L.)		
Roach *Rutilus rutilus* (L.)	68	2.1-9.9
Salmon *Salmo salar* L.		
Stone loach *Barbatula barbatula* (L.)		
Three spined stickleback *Gasterosteus aculeatus* L.		
Trout (brown) *Salmo trutta* L.		
Eel *Anguilla anguilla* L.	0 <30 cm	10 >30 cm

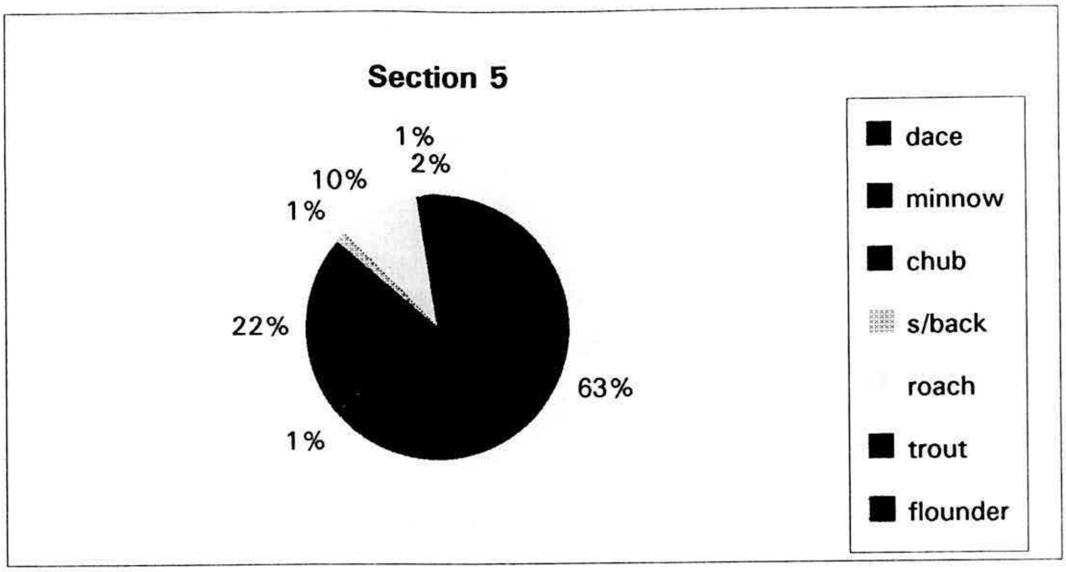
Appendix 6. Species composition of fish in each section in September 1995.

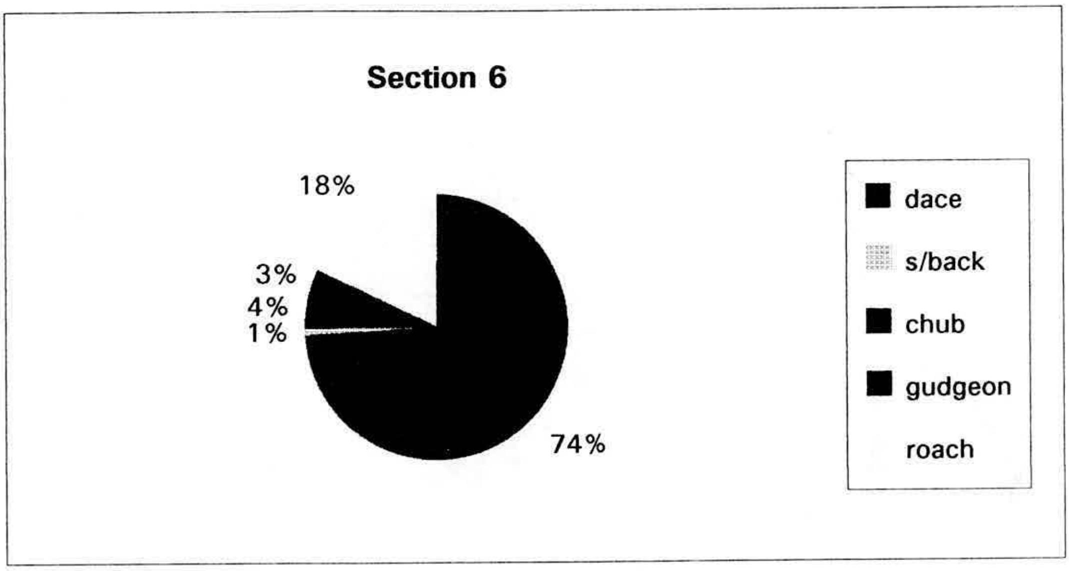


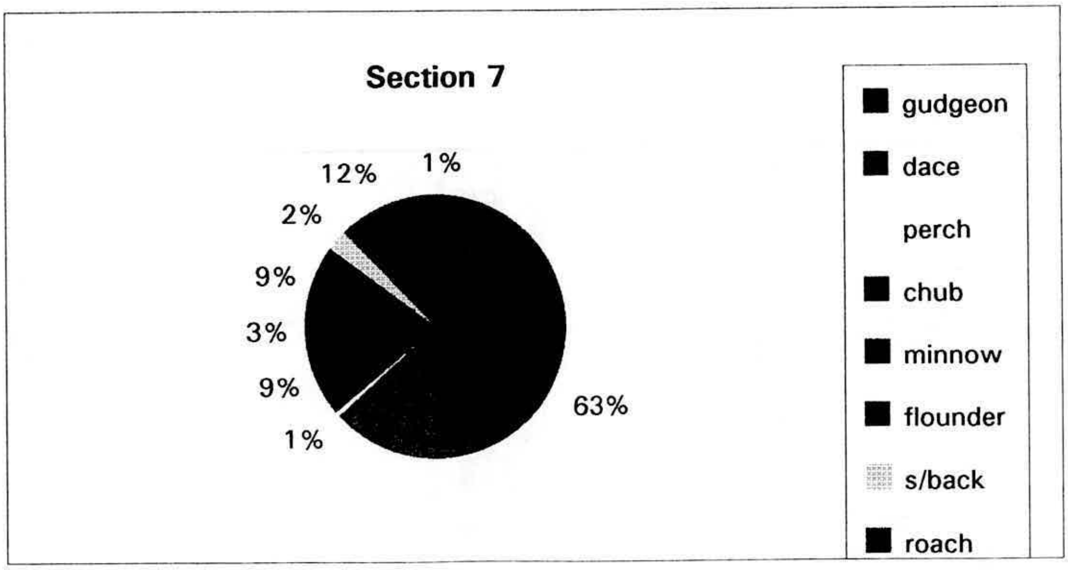




Appendix 6 continued







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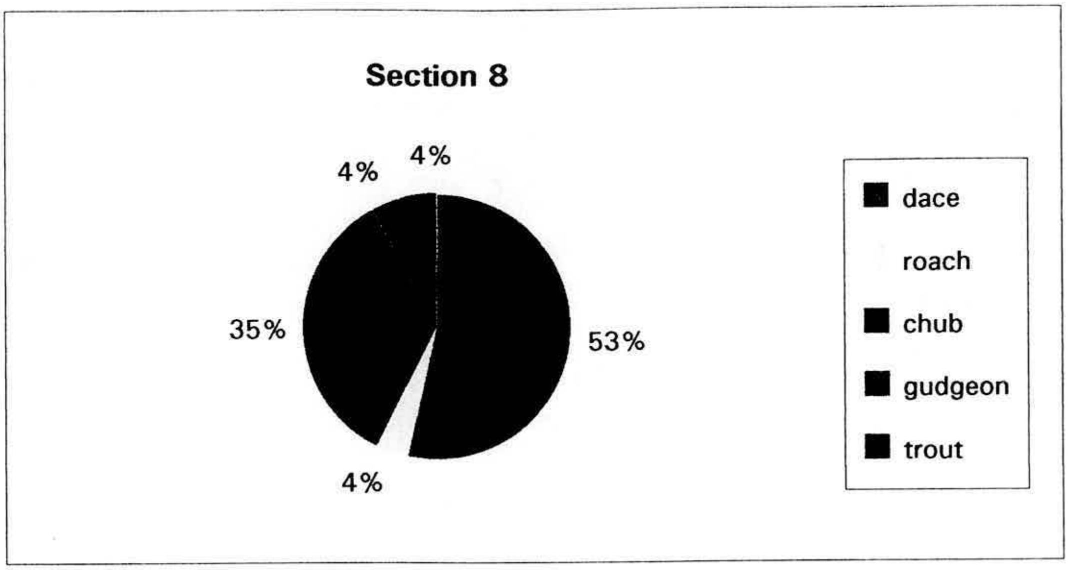

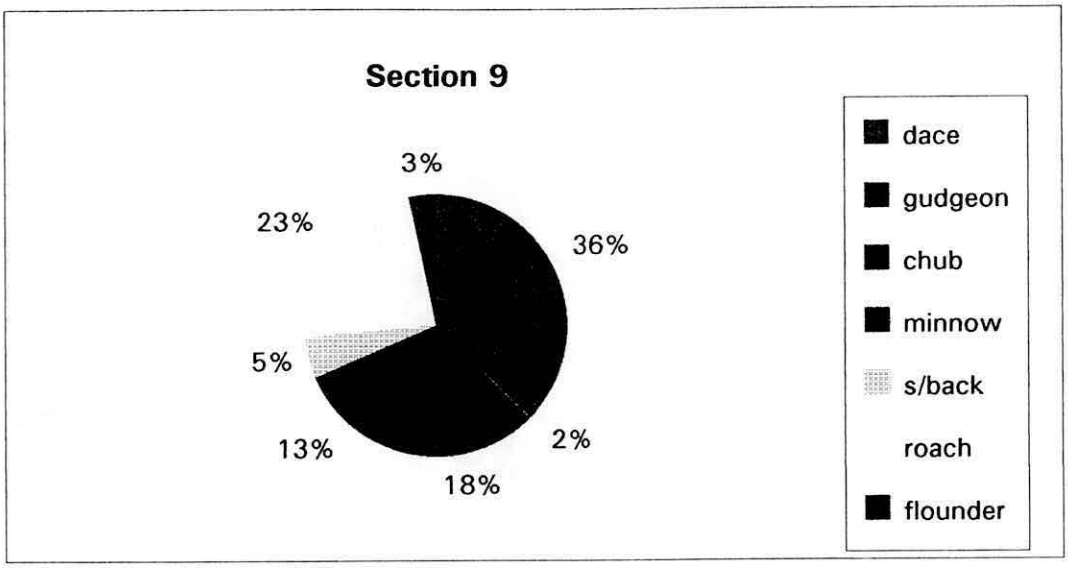

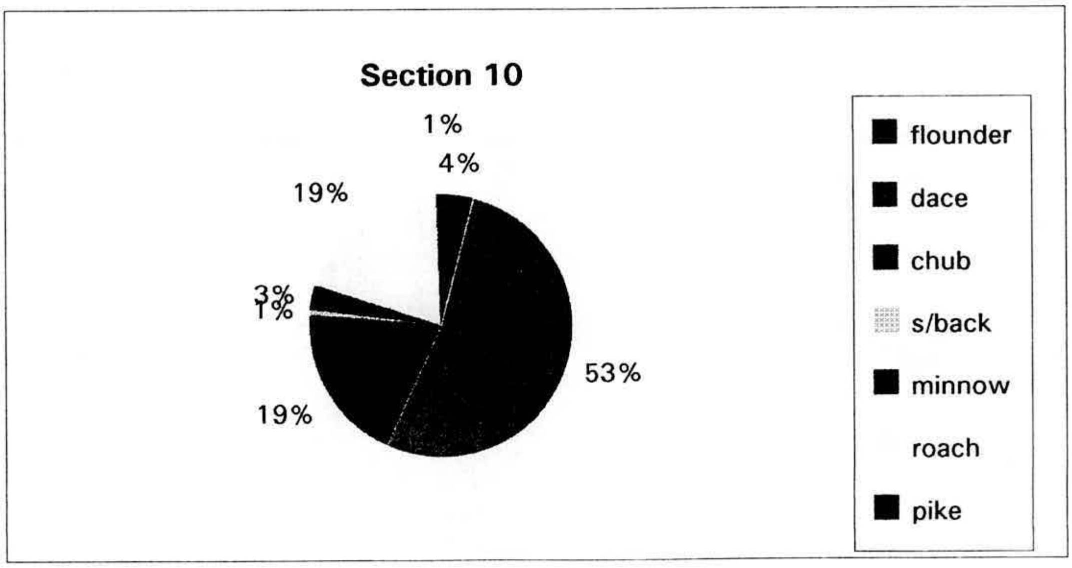

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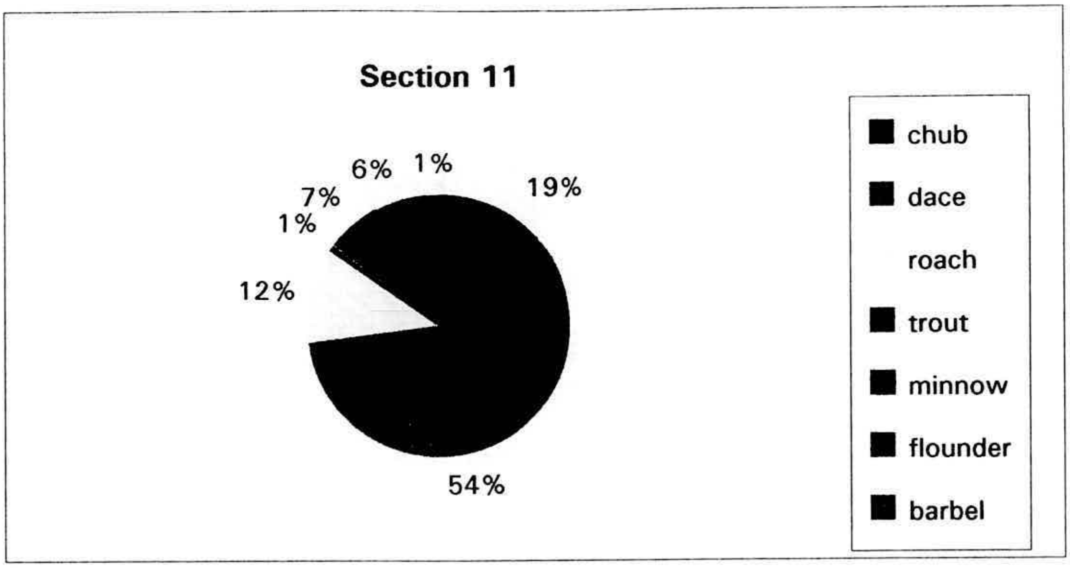

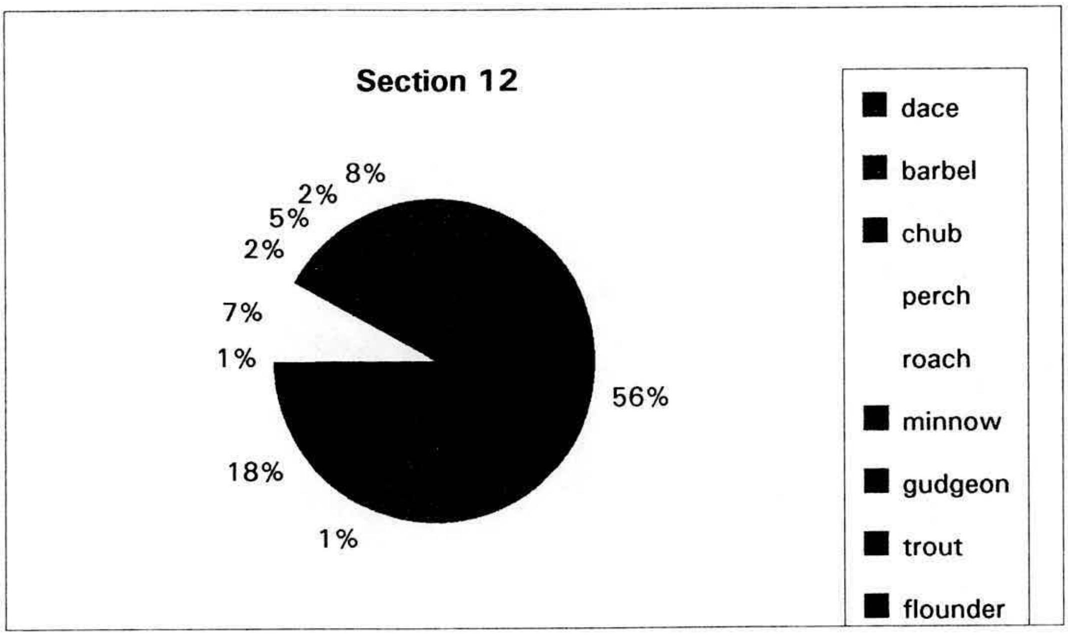

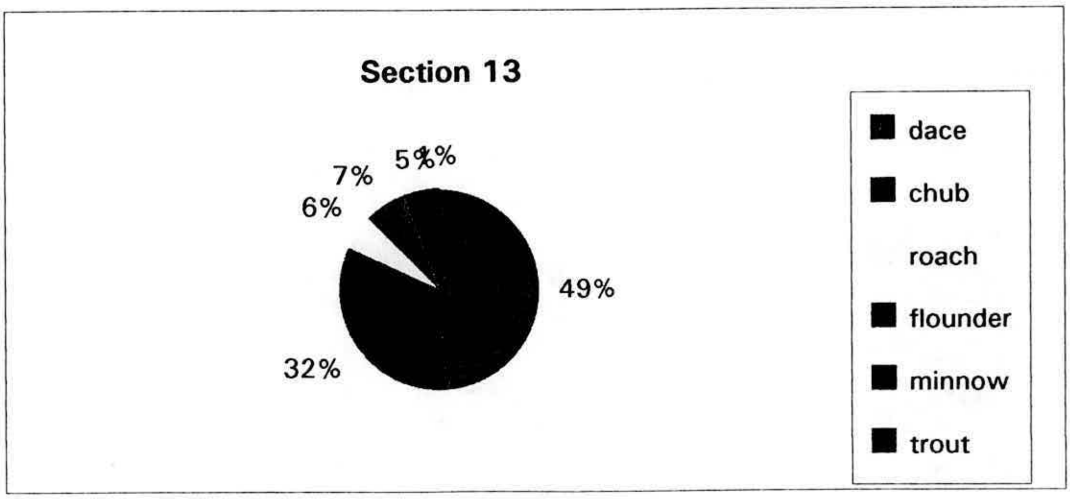

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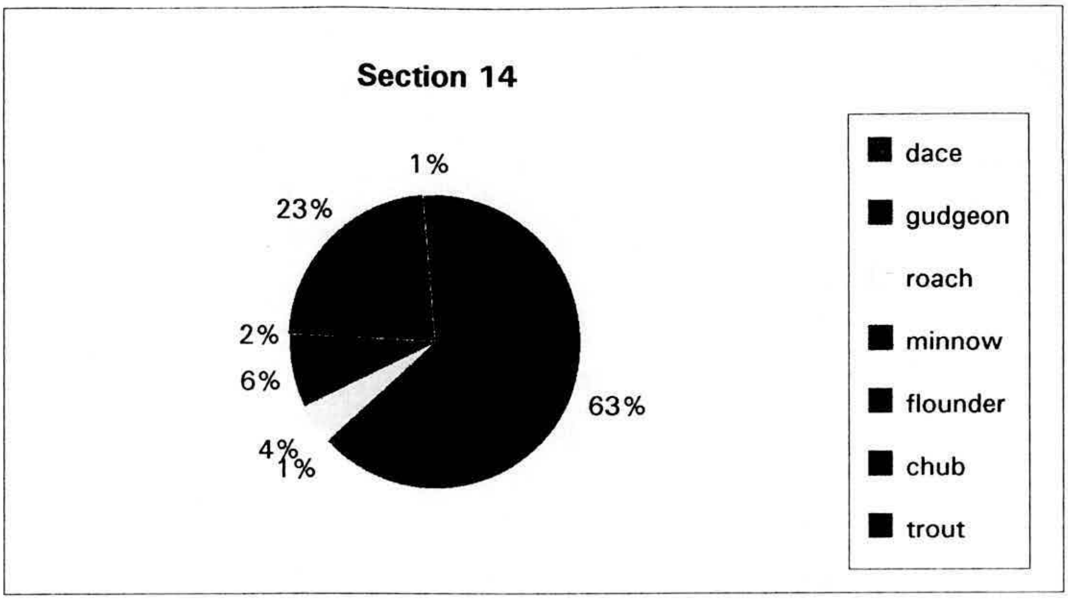

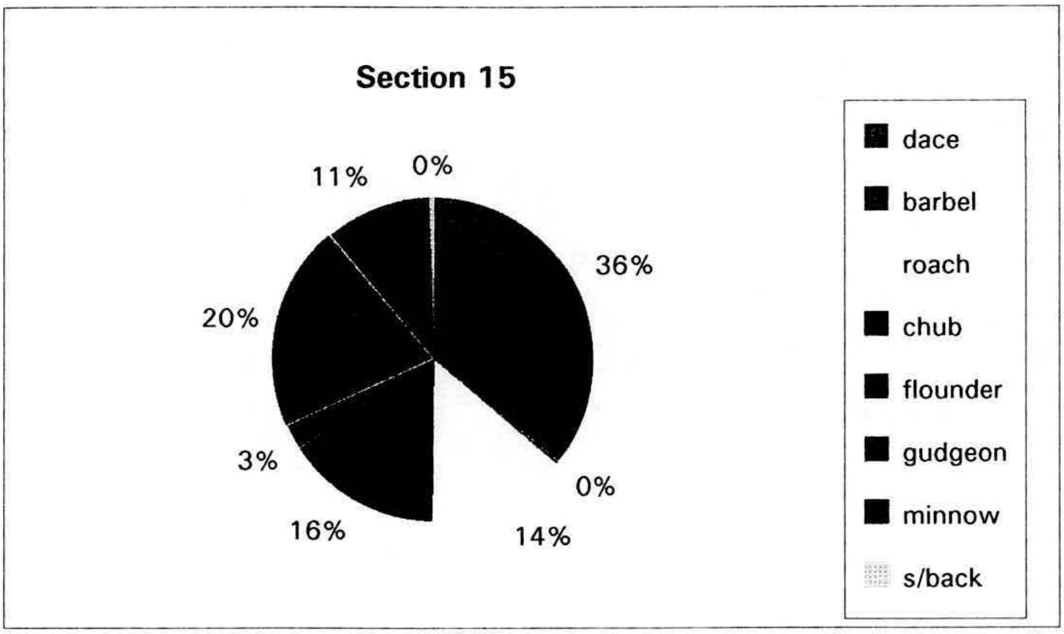

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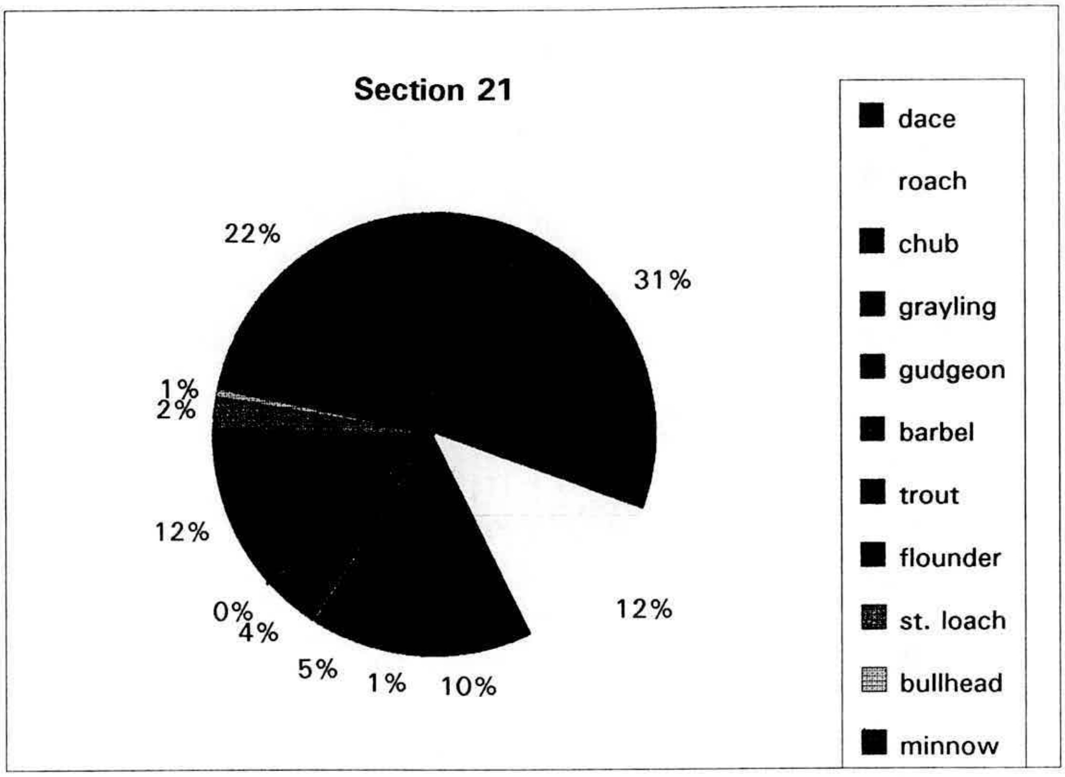
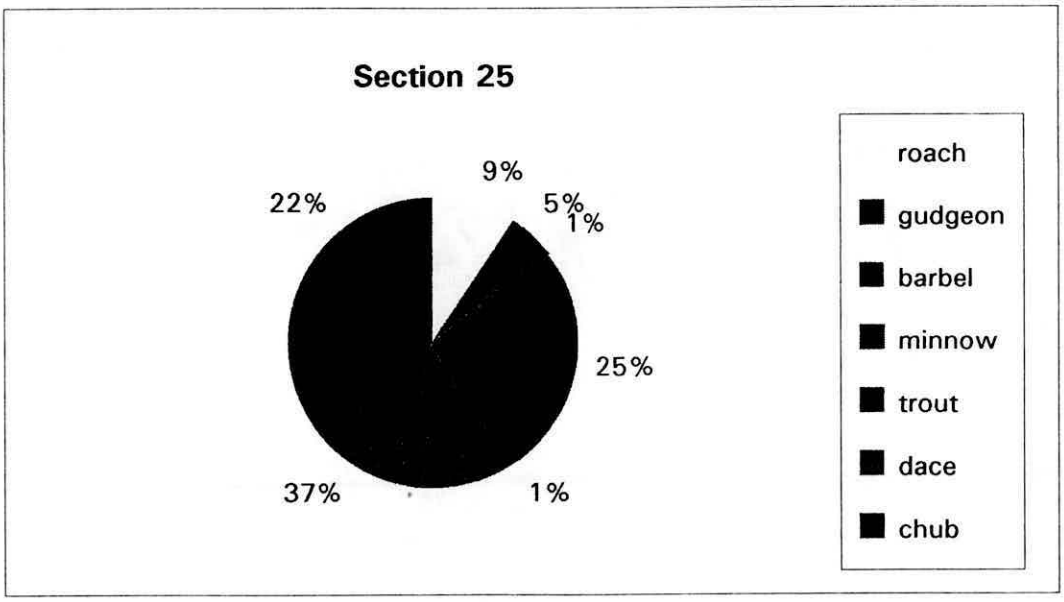
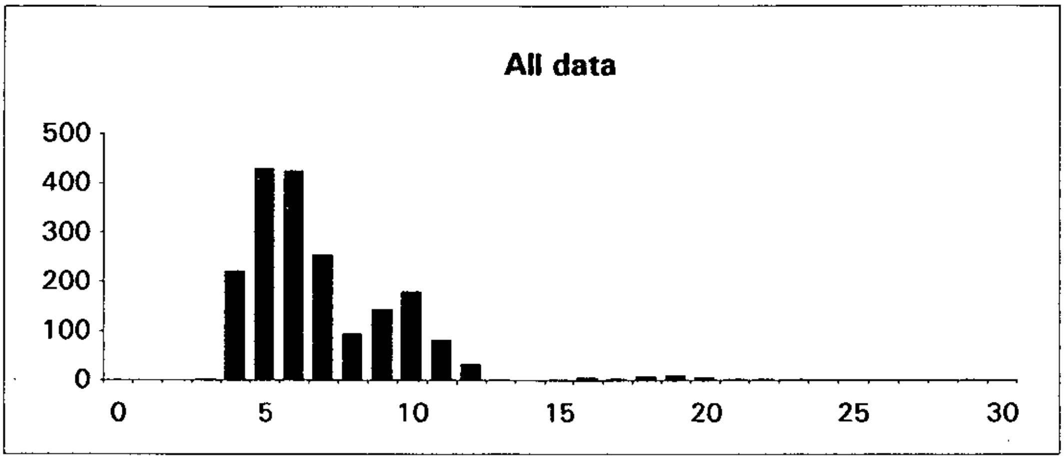
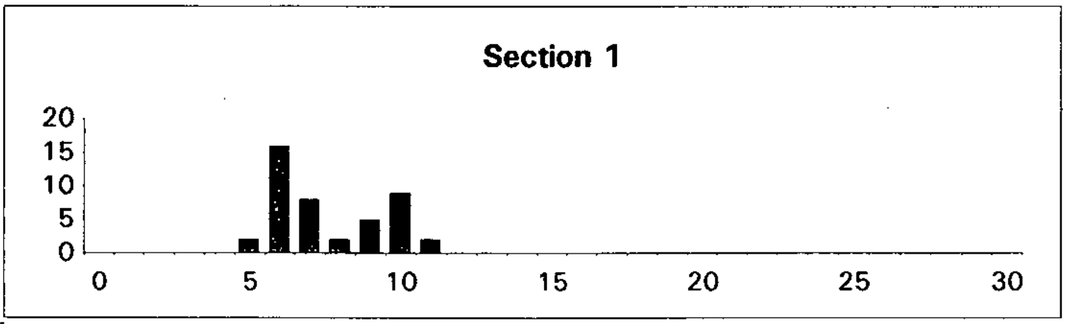
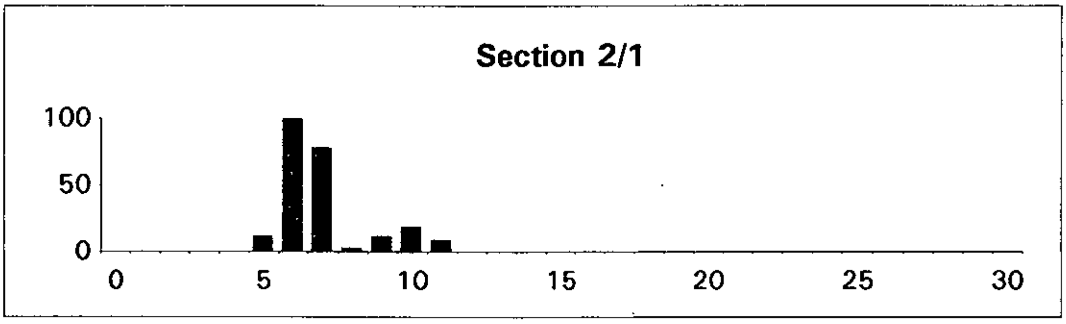


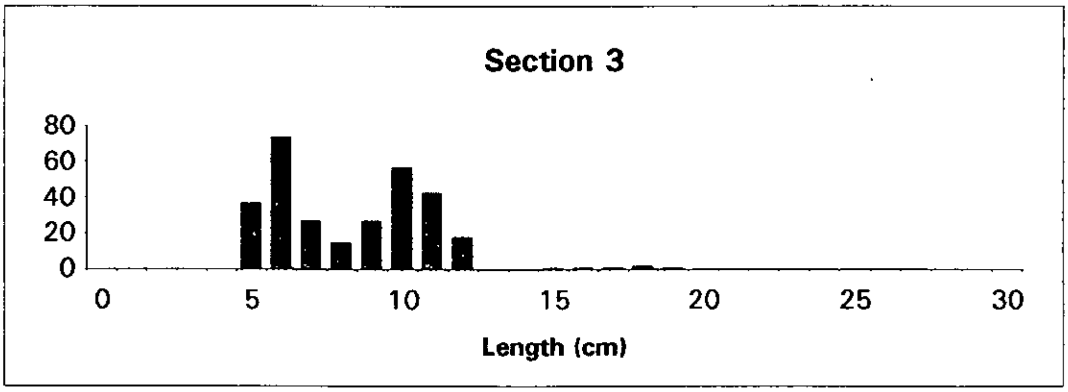


Appendix 7 Length frequency distribution of dace in the R.Tees in September 1995.









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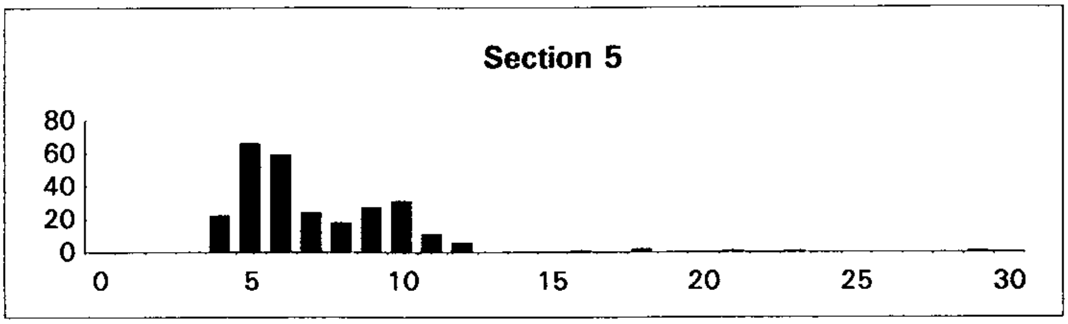

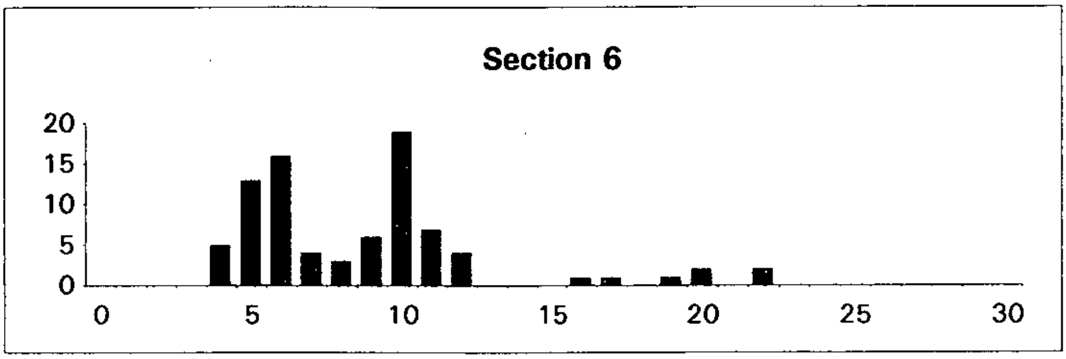

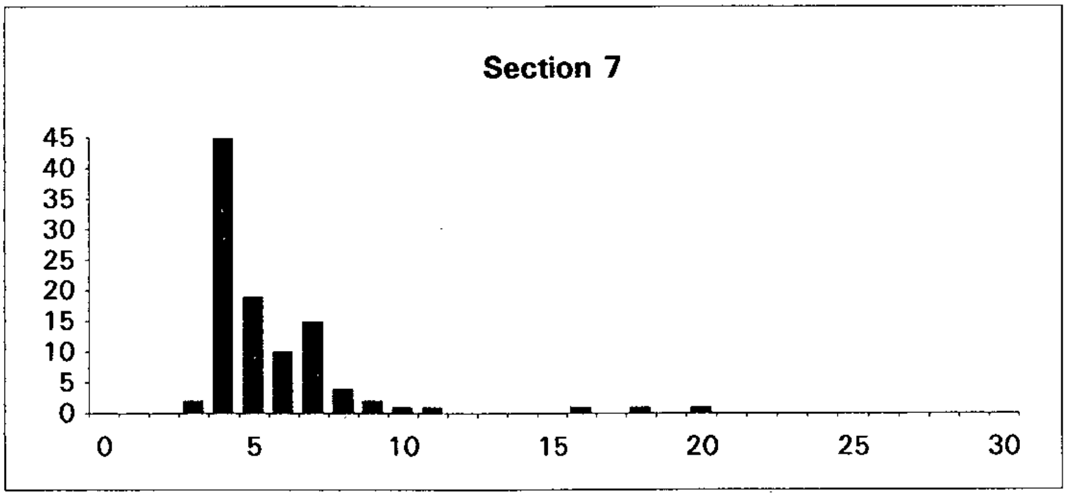

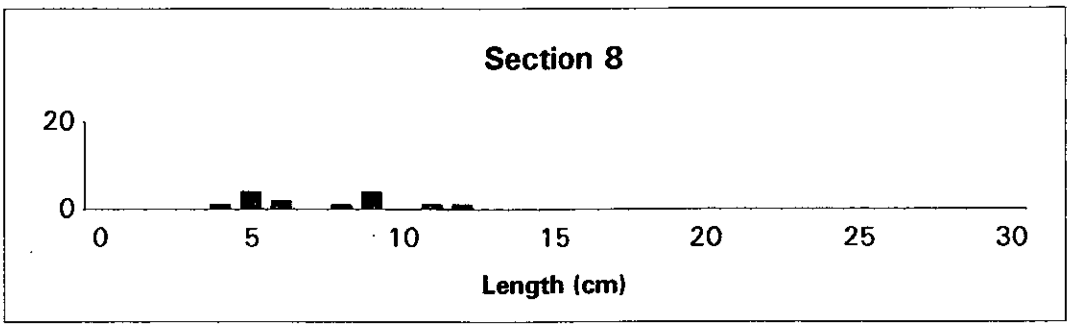

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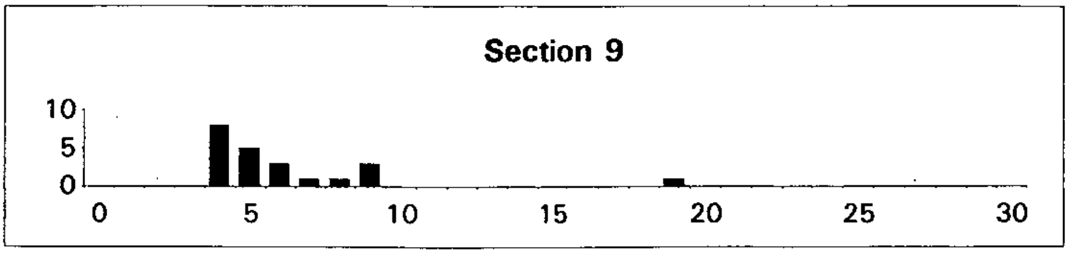

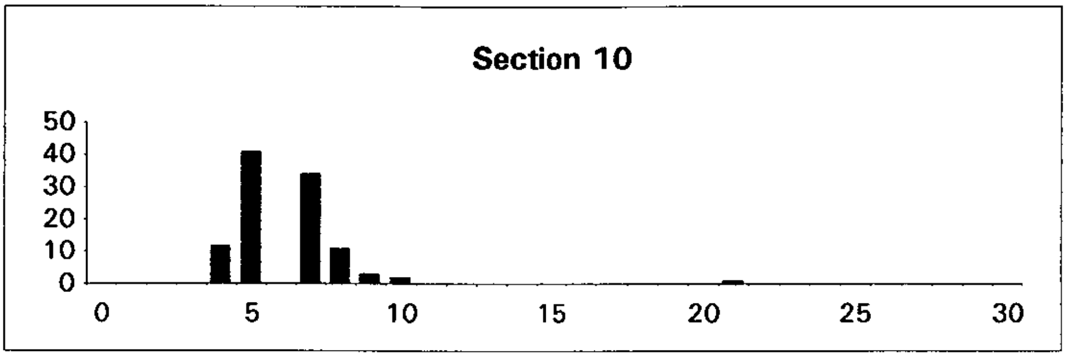

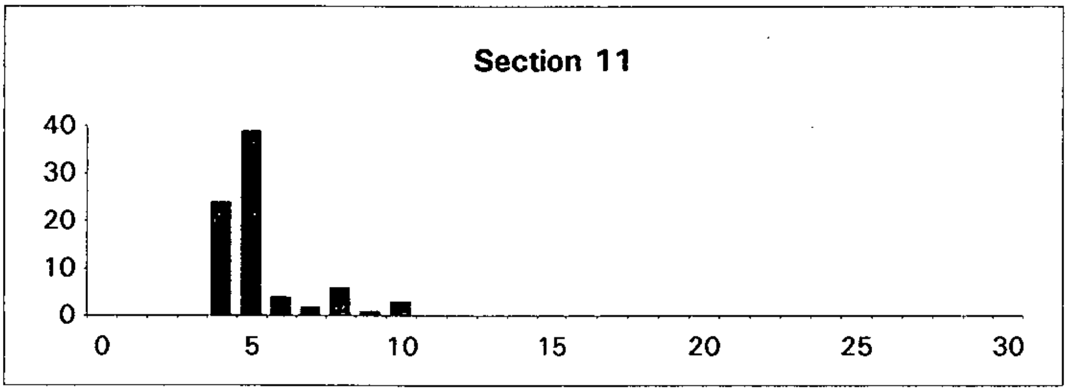

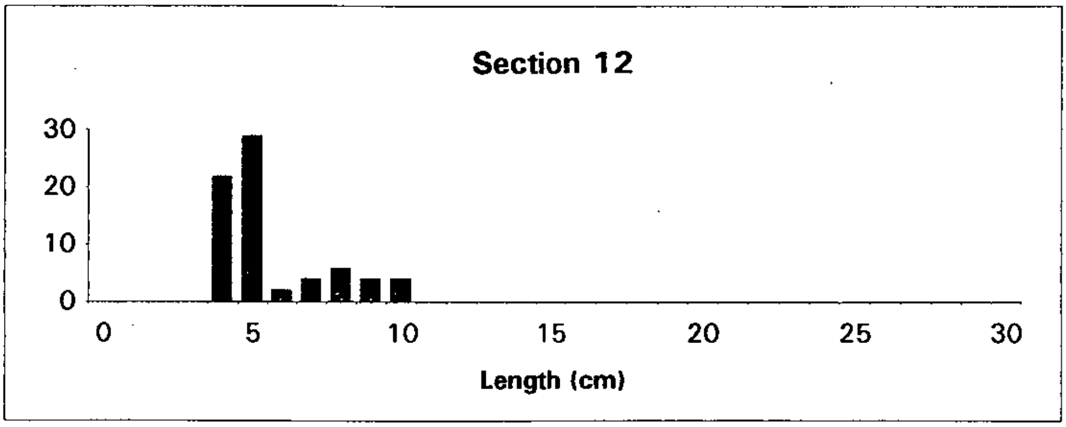

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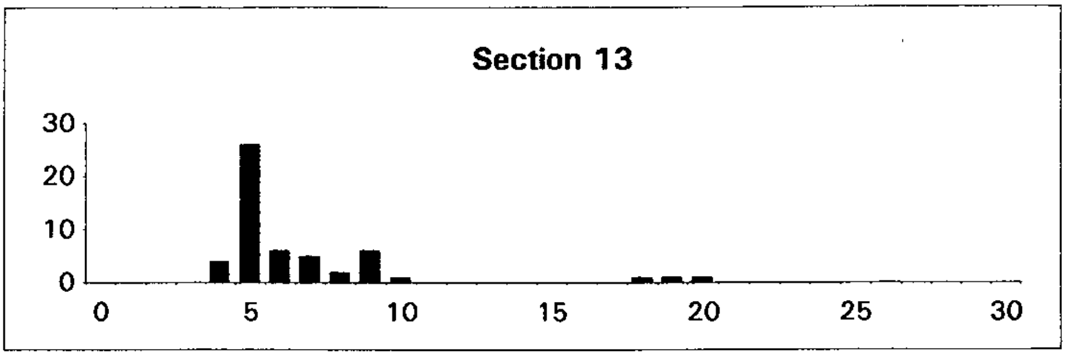

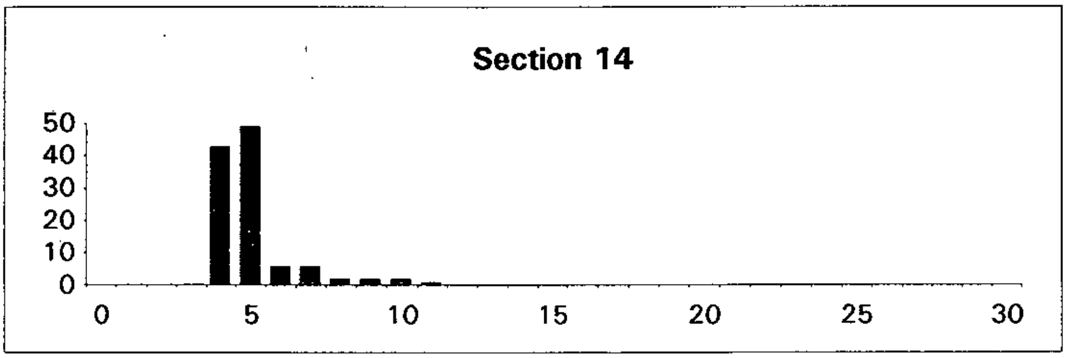

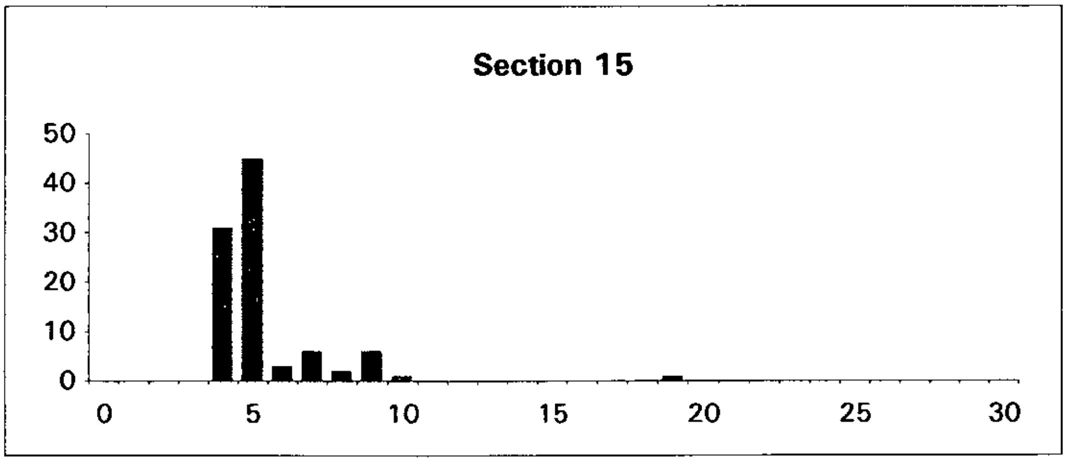

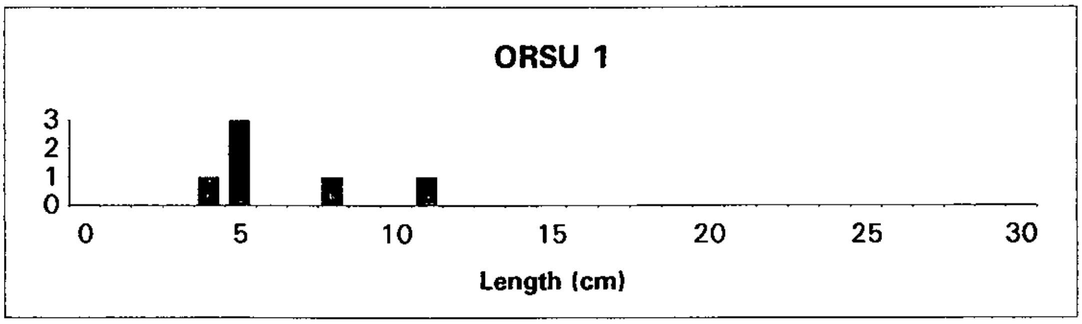

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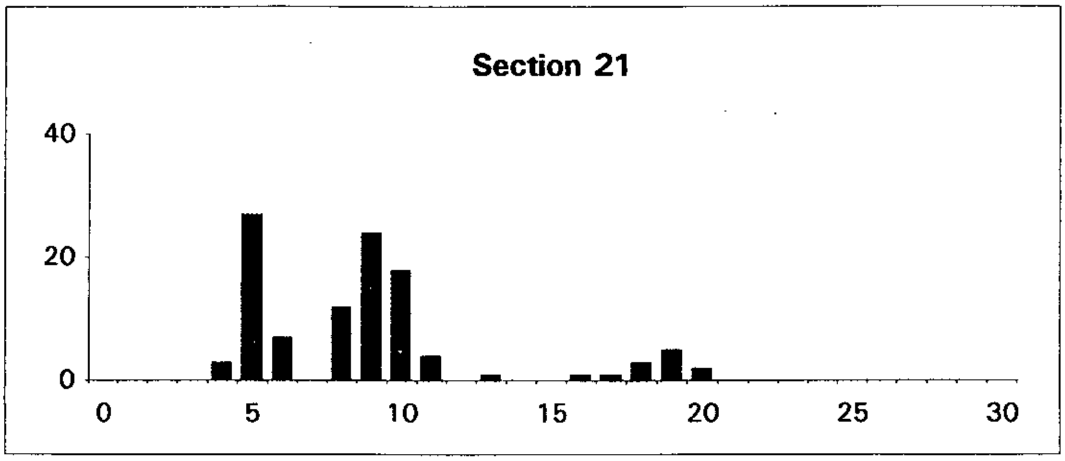
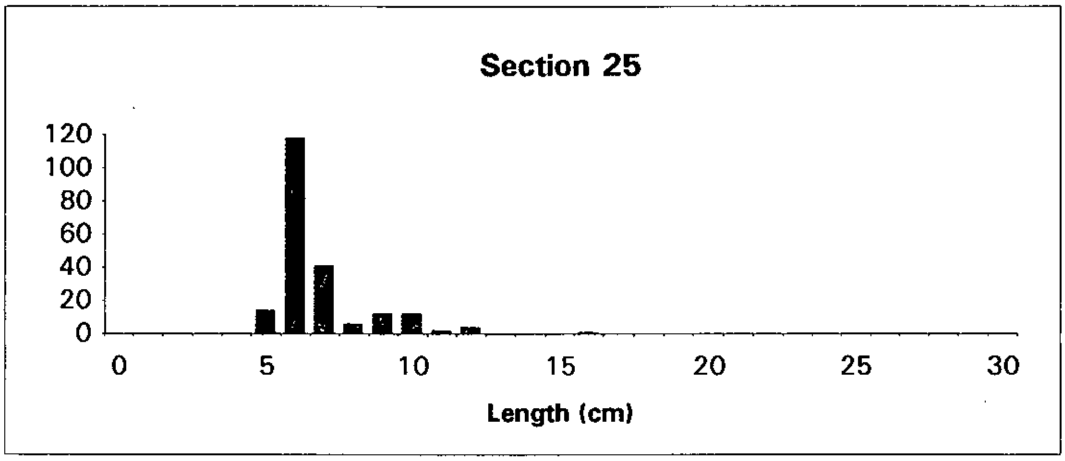
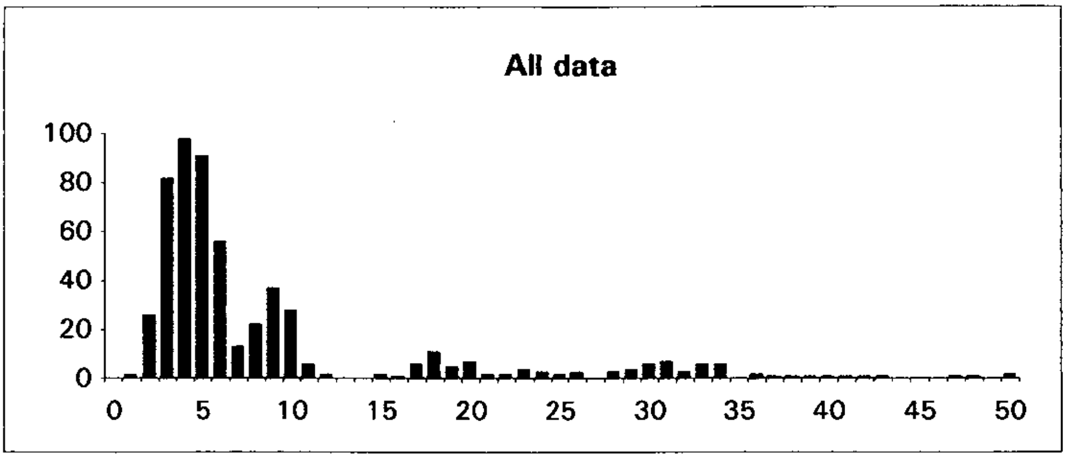
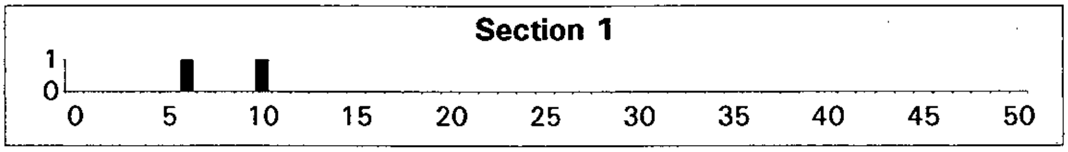
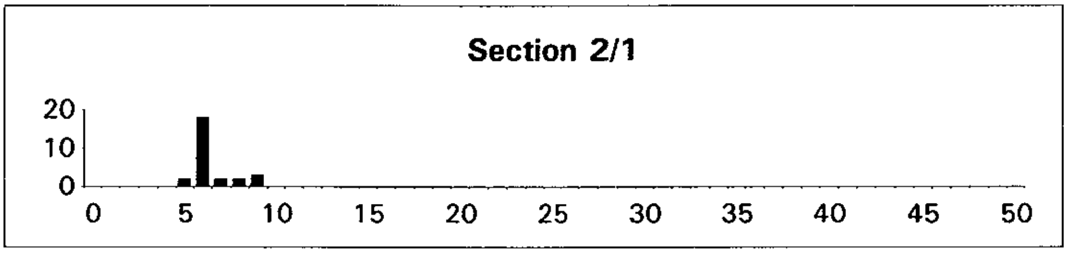


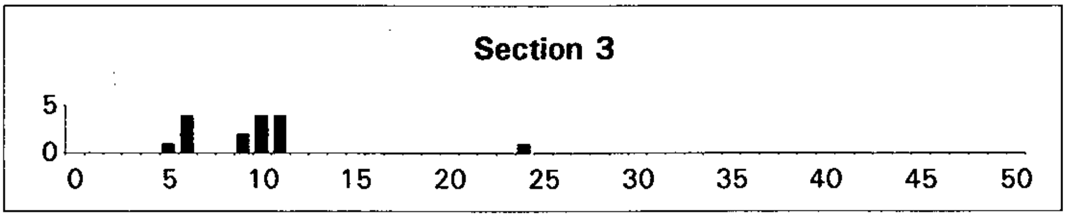


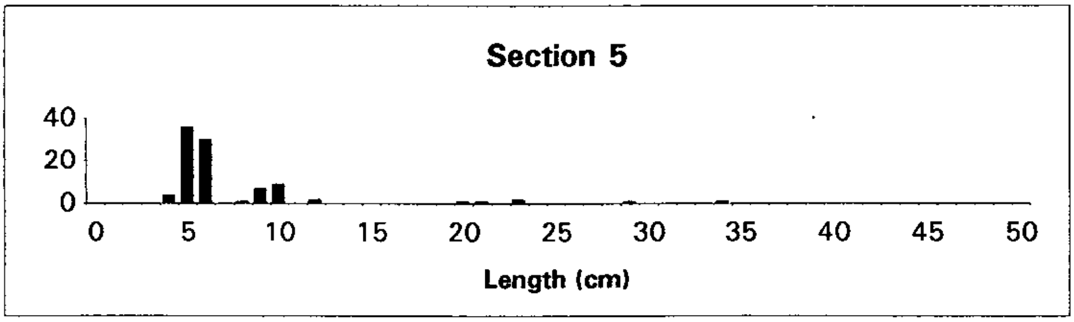
Appendix 8 Length frequency distribution of chub in each section of the R.Tees in September 1995.



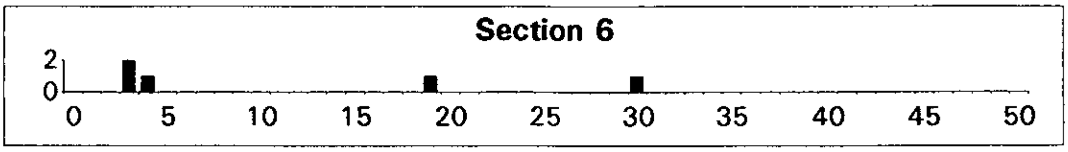


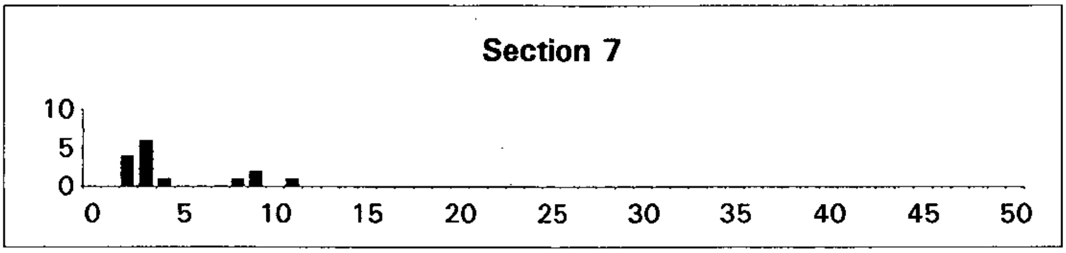


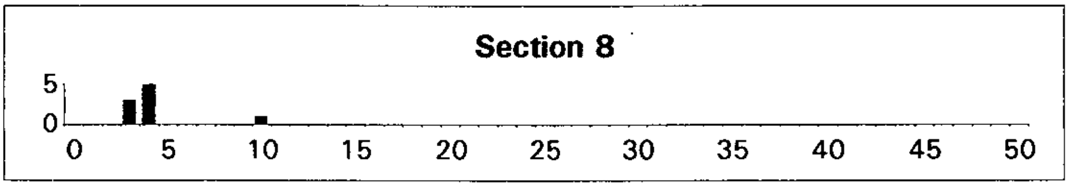


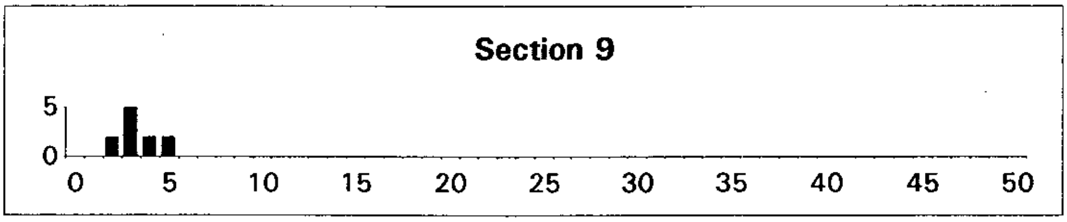


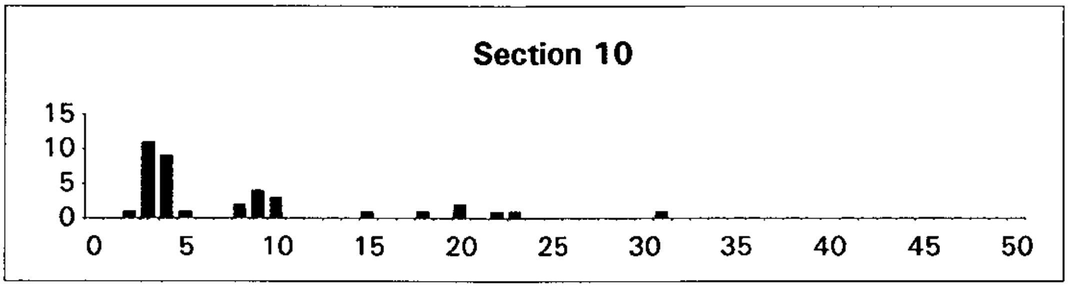
Appendix 8 continued

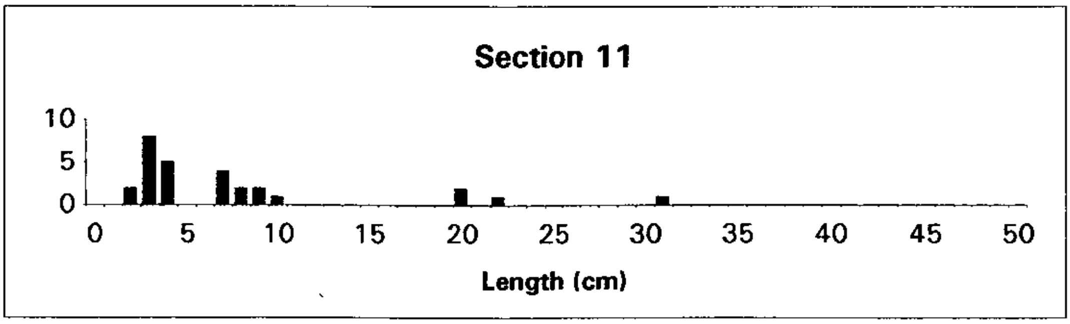












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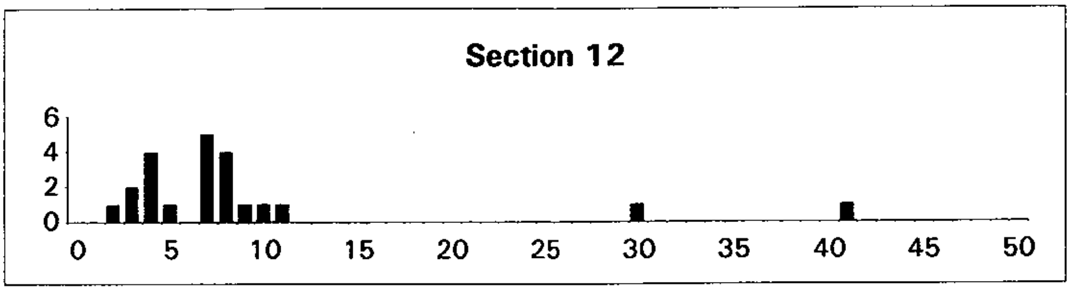

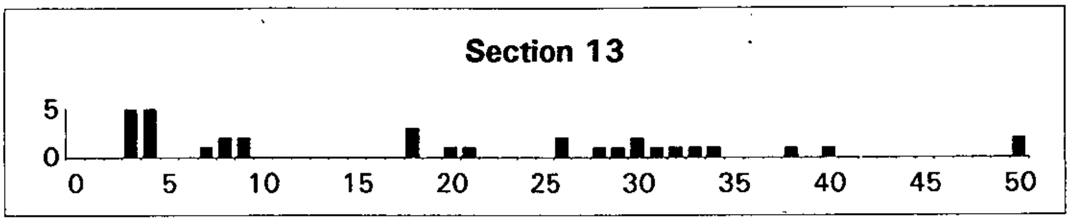

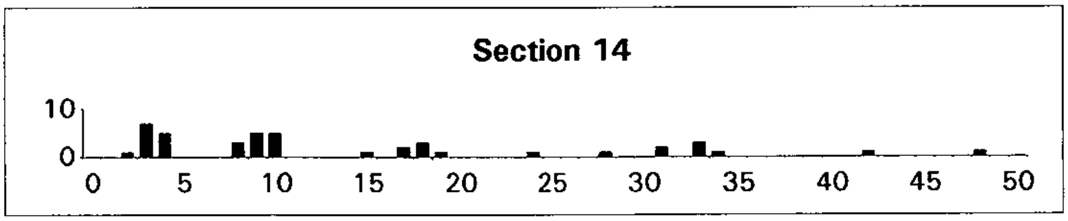

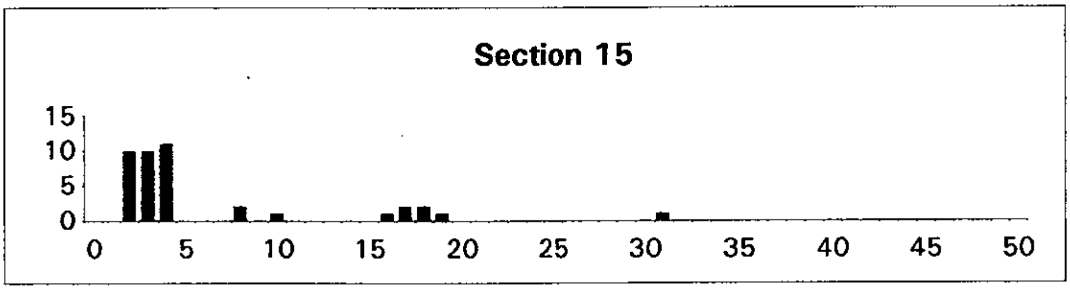

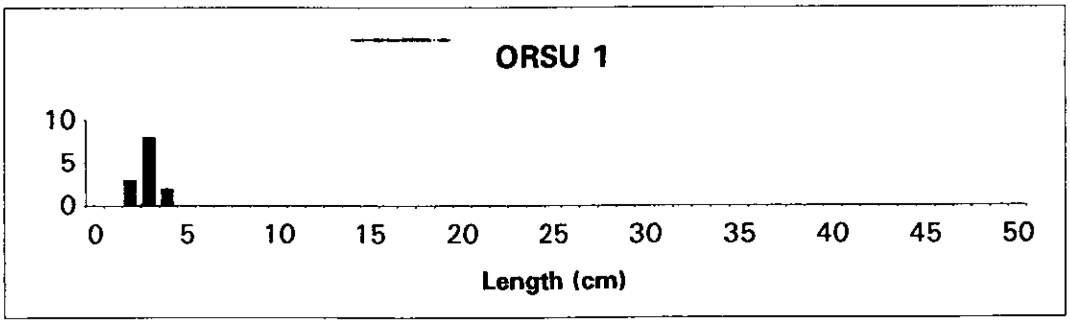

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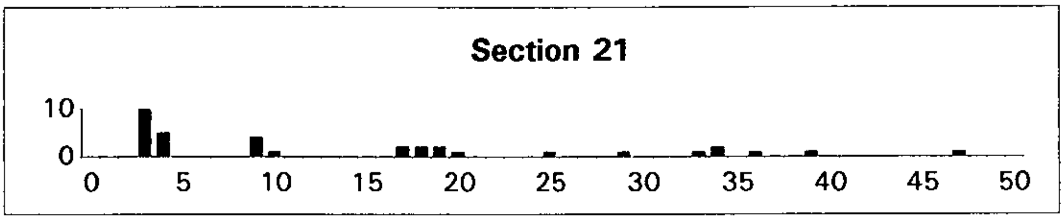
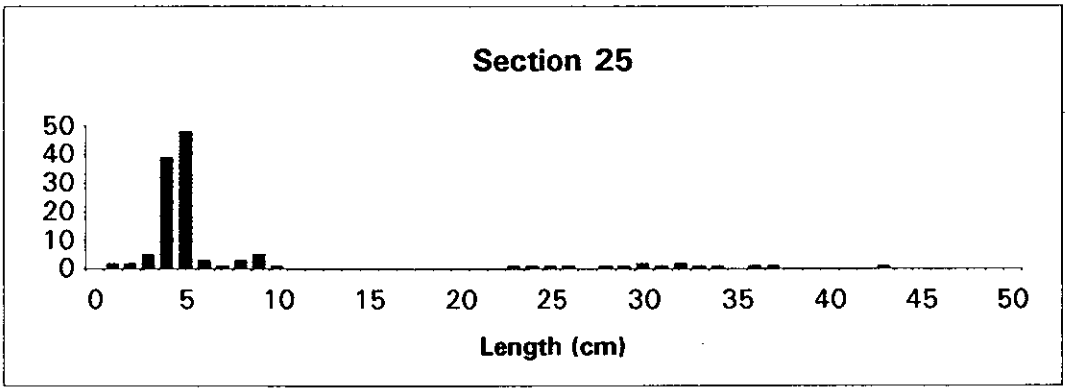
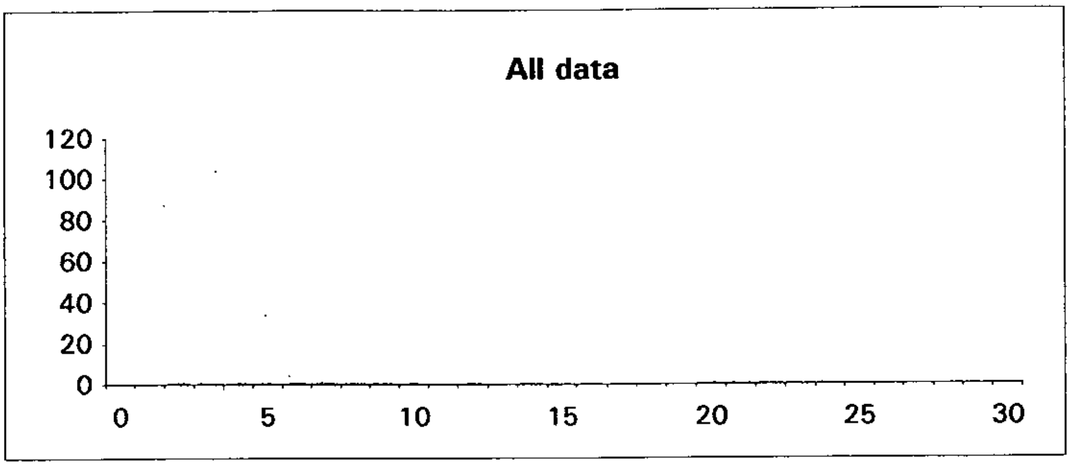
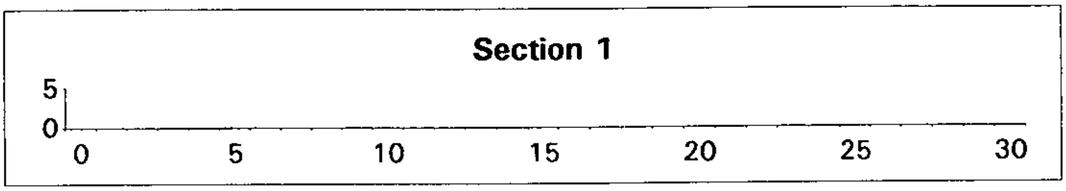
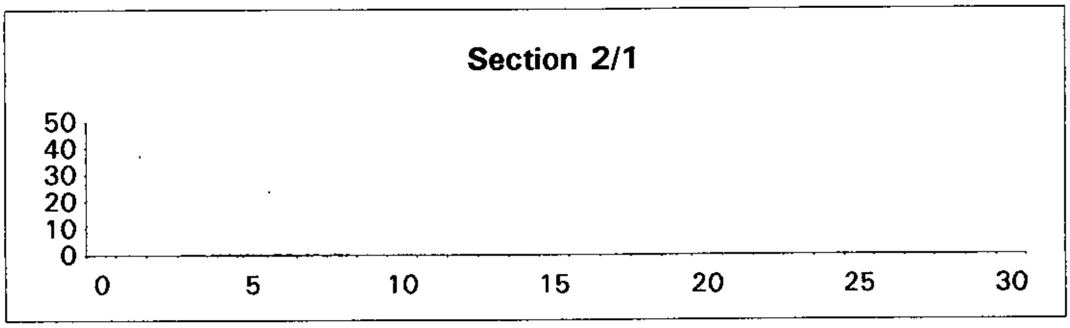


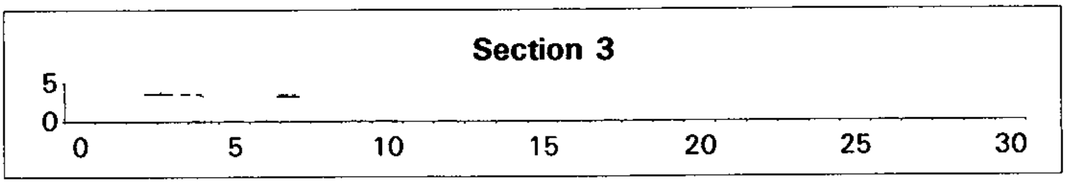


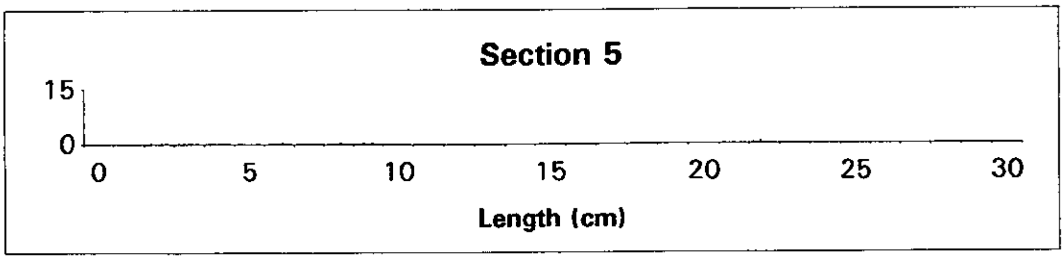
Appendix 9 Length frequency distribution of roach in each section of the R.Tees in September 1995.











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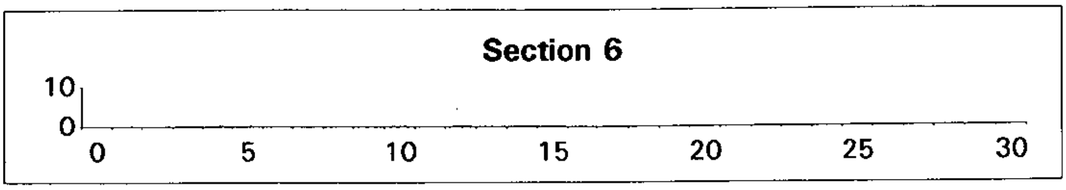

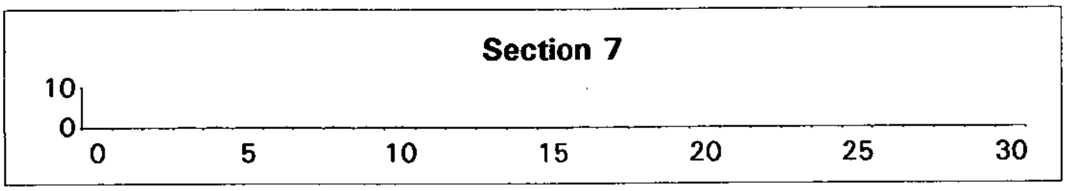

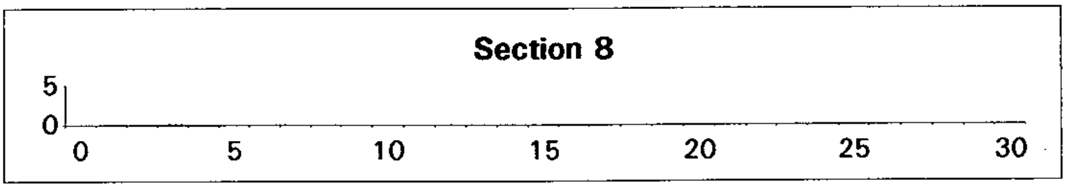

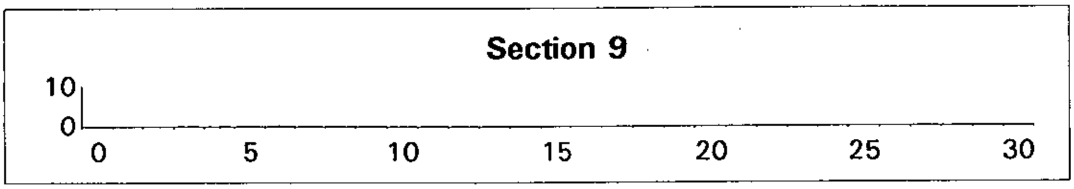

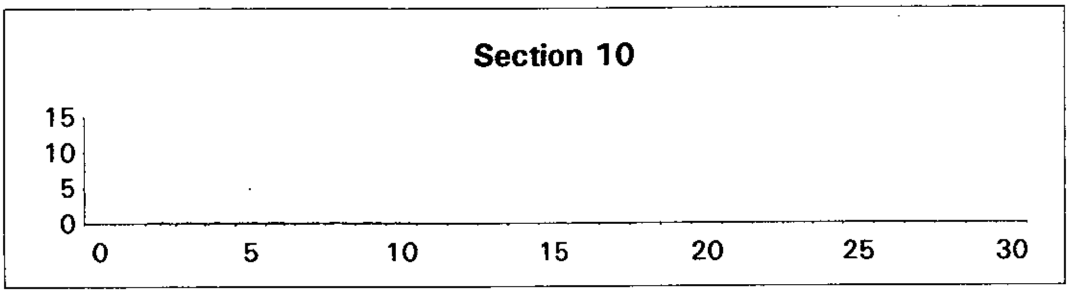

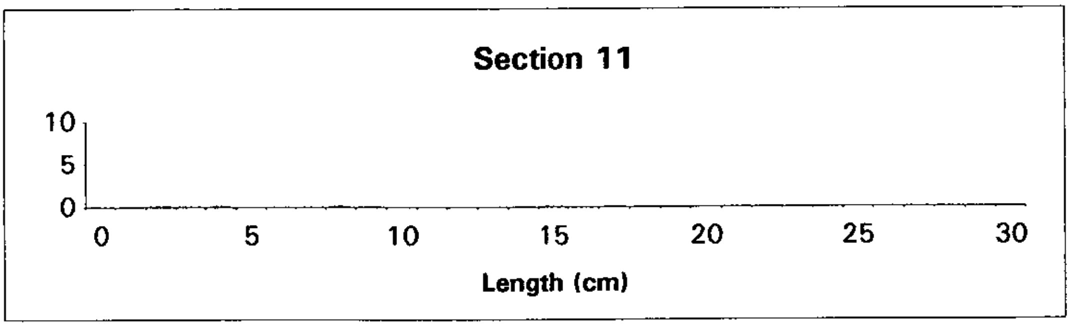

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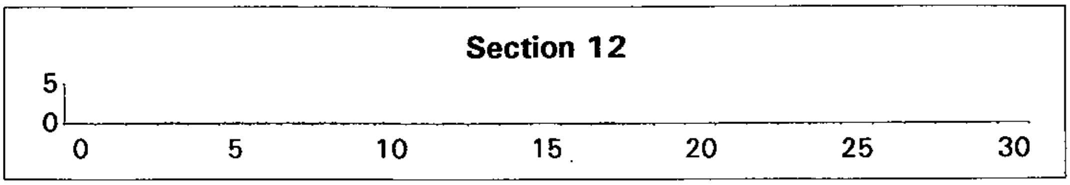

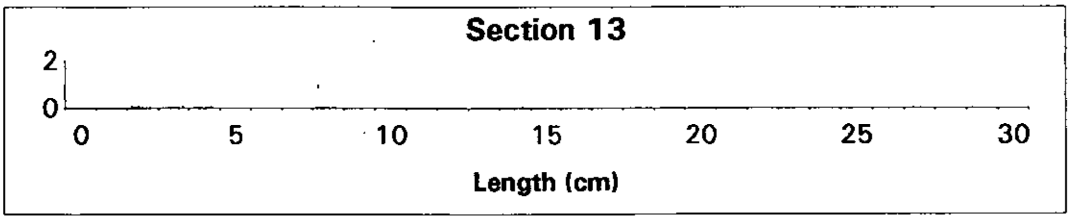

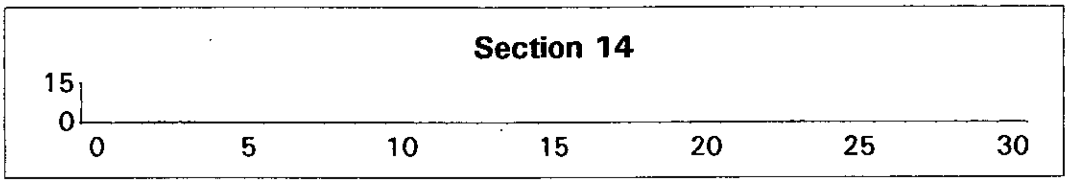

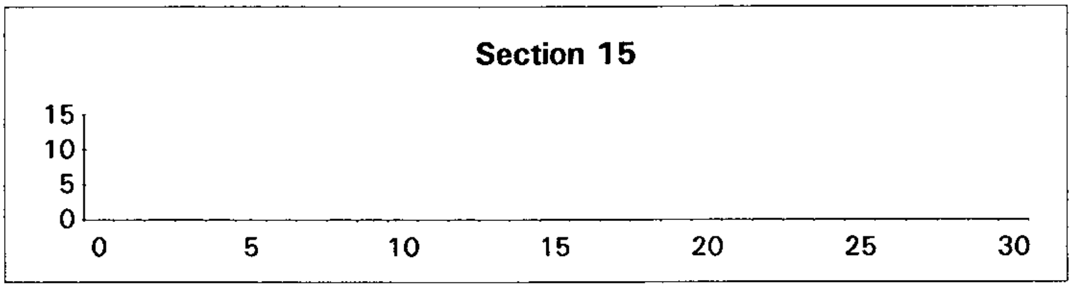

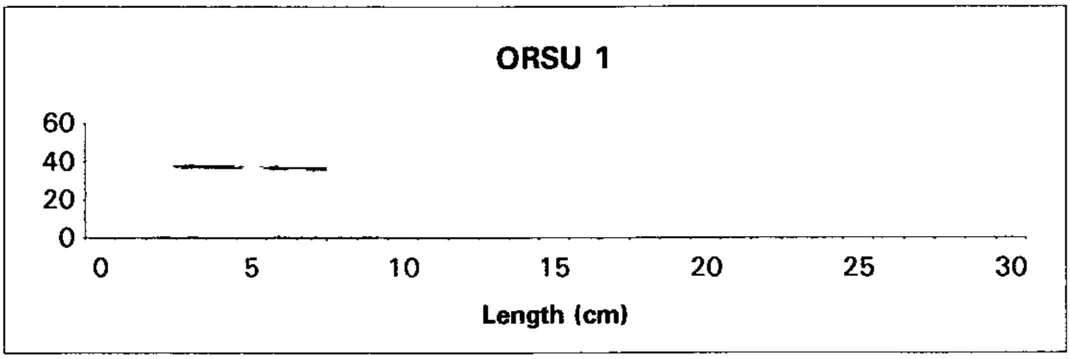

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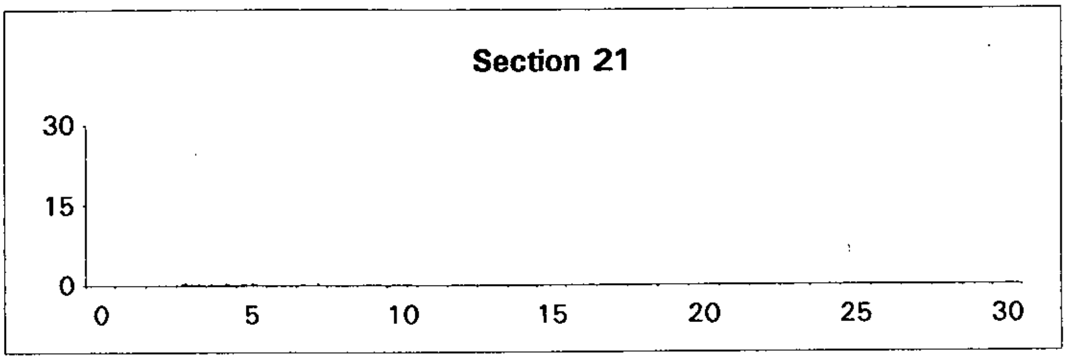
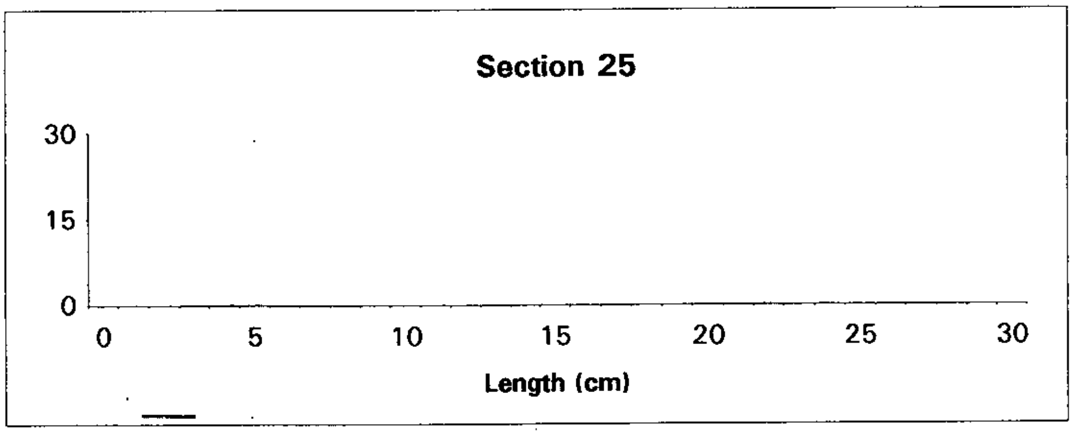
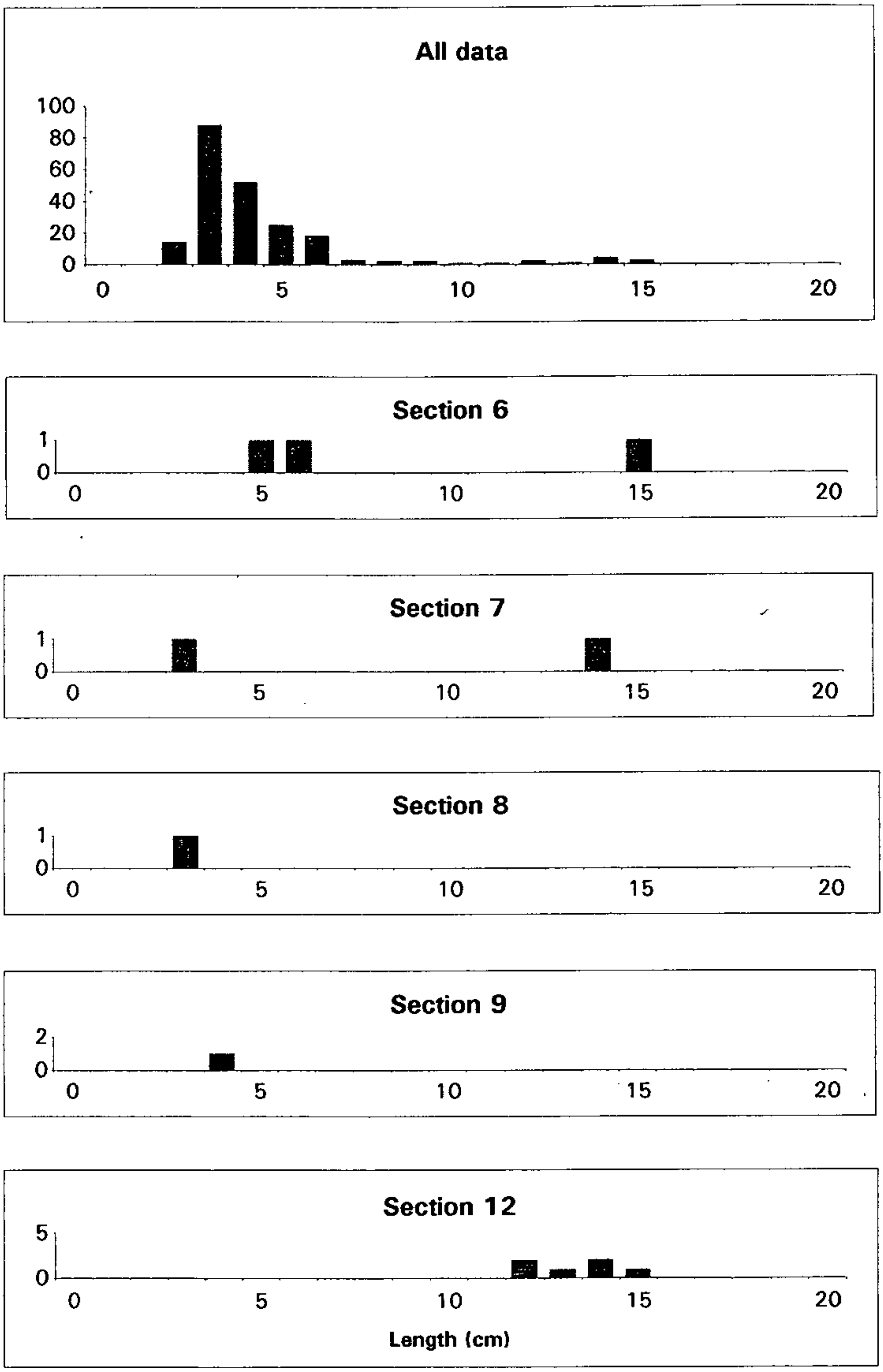
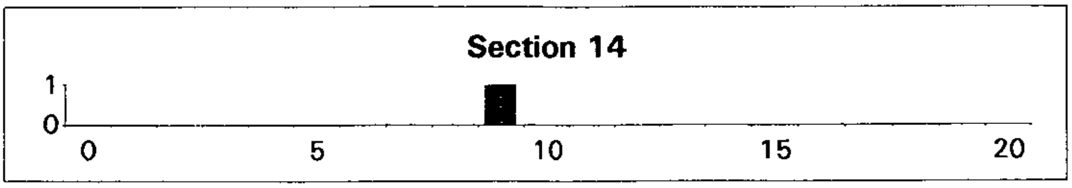


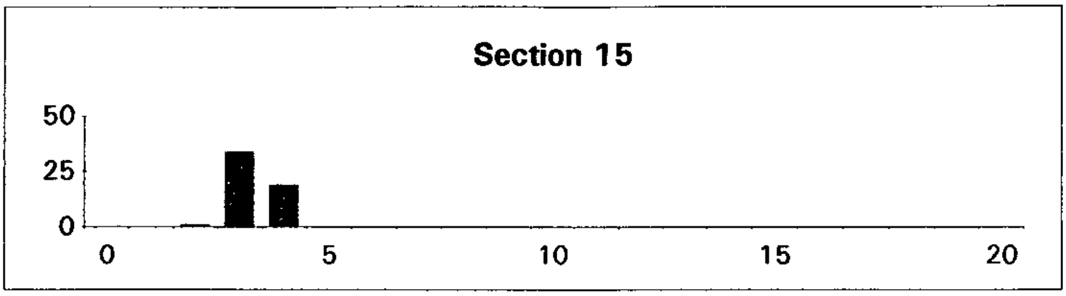


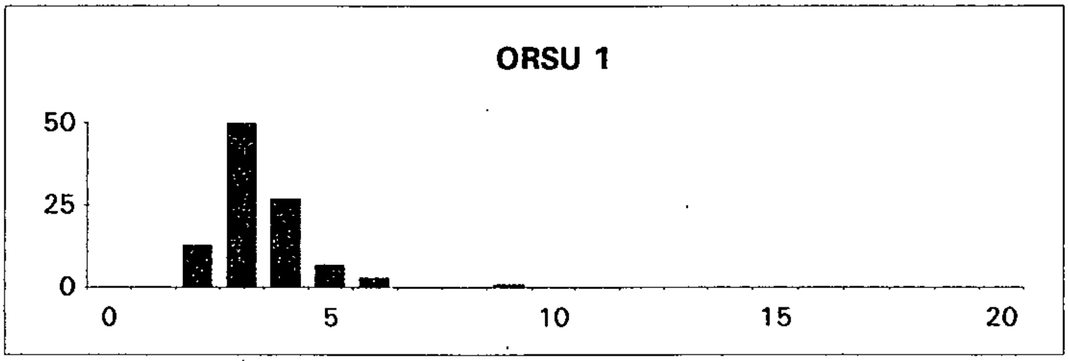
Appendix 10 Length frequency distribution of gudgeon in each section of the R.Tees in September 1995.

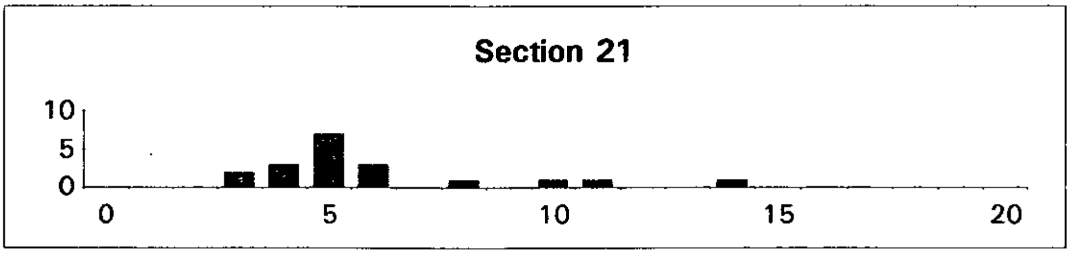


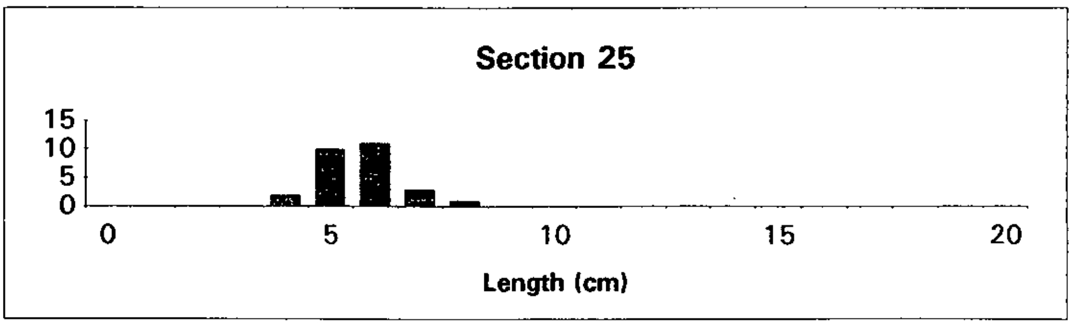
Appendix 10 continued











Appendix 11 Mean monthly temperatures at Low Moor, Ingleby Barwick and Stockton Quay

LOW MOOR

	1991	1992	1993	1994	1995
Jan			3.1	3	
Feb		5.7	5	2.1	
Mar		6.5	6.2	5.4	1.4
Apr		8.6	9	8	8.6
May		15.1	12	12.3	13.9
Jun		18.8	16.1	16.4	16.2
Jul	18.7	18	16.7	19.4	19.9
Aug	18.3	16.2	15.1	16.6	19.6
Sep	15	12.6	12.5	12.5	
Oct	9.8	7.7	8.1	9.4	
Nov	5.8	5.2	4.6	8.1	
Dec		3.6	3.4		

INGLEBY BARWICK

	1991	1992	1993	1994	1995
Jan		1.8	3.1	3.1	2.6
Feb		4.3	4.9	2.3	
Mar		6.4	6		
Apr		8.7	8.8	7.7	
May		15	11.9		10.8
Jun		18.4	16		13.7
Jul	19.2	18	16.7		16.4
Aug	18.5	16.4	15		17.5
Sep	15.3	12.7	12.5	12.4	13.2
Oct		7.8	7.9	9.3	11
Nov		5.1	4.6	7.9	6.9
Dec		3.6	3.7		

STOCKTON QUAY

	1991	1992	1993	1994	1995
Jan		8.8	4.4	4.4	
Feb		7.1	5.9	3.8	
Mar		8.6			
Apr		9.3	8.6		
May		13.7	11.1		
Jun		16.2	13.3		
Jul	17	16.9	12.7		
Aug	17.4	16.1	14.8		
Sep		13.1			
Oct		9.5		7.7	
Nov		6.7		6	
Dec	10.9	5.2			

ORSU 1

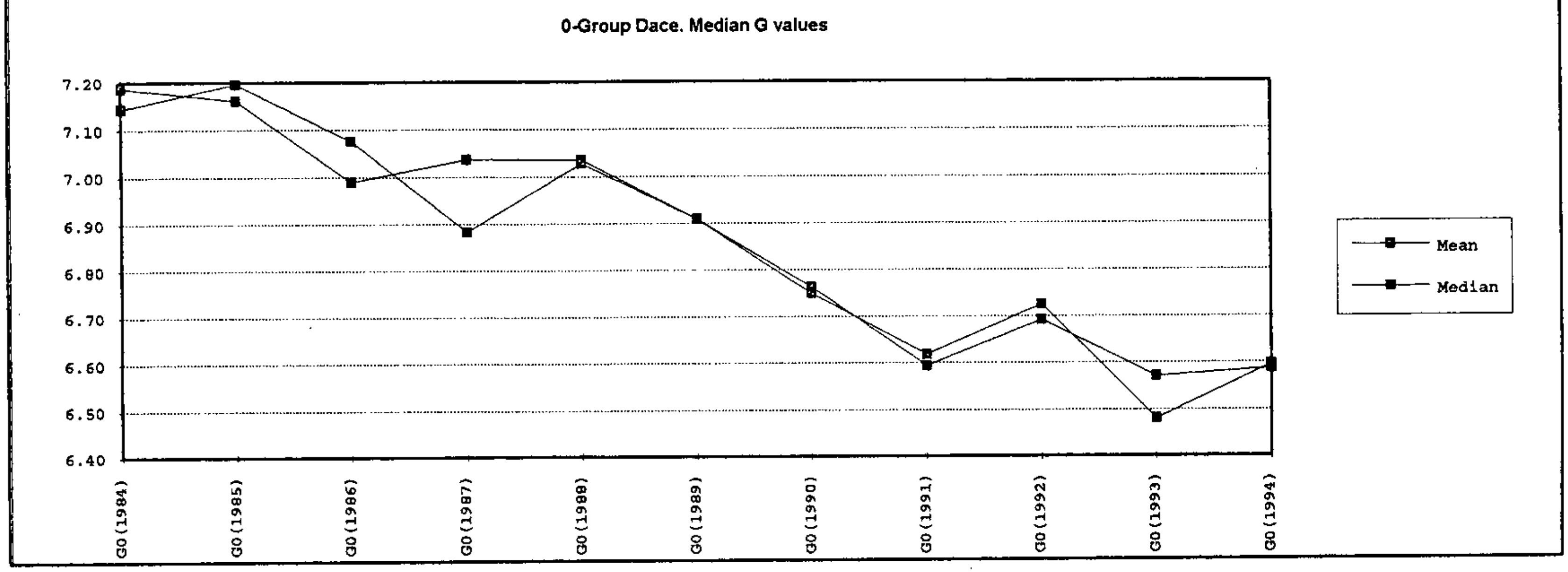
	1991	1992	1993	1994	1995
Jan				2.6	
Feb				0.2	
Mar				6.2	
Apr				7.5	
May			12.1	10.5	
Jun			16.7	16.1	
Jul			17	19.9	
Aug			15.5	16.8	
Sep			12.9	12.8	
Oct			8.8	9.5	
Nov			5	8.2	
Dec			3		

Appendix 12 Results of angling matches 1977-1995. $\bar{x}$ = mean catch per angler per match (ounces) ± 95% confidence limits; $\bar{y}$ = mean catch per angler per match (ounces) ± 95% confidence limits for the top 10 anglers in each match.

Year	$\bar{x}$	$\bar{y}$
1977/78	59.4 ± 6.0	111.2 ± 15.7
1978/79	68.3 ± 6.6	132.5 ± 15.0
1979/80	76.2 ± 8.6	113.9 ± 15.0
1980/81	58.3 ± 8.2	78.3 ± 12.5
1981/82	85.5 ± 11.7	125.5 ± 18.9
1982/83	66.1 ± 7.7	113.3 ± 15.1
1983/84	25.1 ± 3.6	75.2 ± 10.9
1984/85	14.8 ± 2.9	40.5 ± 7.6
1985/86	22.6 ± 3.0	52.6 ± 7.1
1986/87	20.4 ± 3.1	64.2 ± 9.0
1987/88	27.4 ± 4.0	85.2 ± 11.5
1988/89	30.9 ± 4.0	102.7 ± 12.2
1989/90	47.5 ± 5.7	145.3 ± 14.2
1990/91	62.1 ± 7.1	165.8 ± 19.4
1991/92	85.4 ± 10.0	186.1 ± 14.6
1992/93	54.0 ± 8.0	143.1 ± 19.1
1993/94	30.7 ± 4.0	66.3 ± 8.2
1994/95	33.0 ± 9.9	60.5 ± 19.3

Appendix 13 — Mean and median Instantaneous Growth Rates for 0-group dace

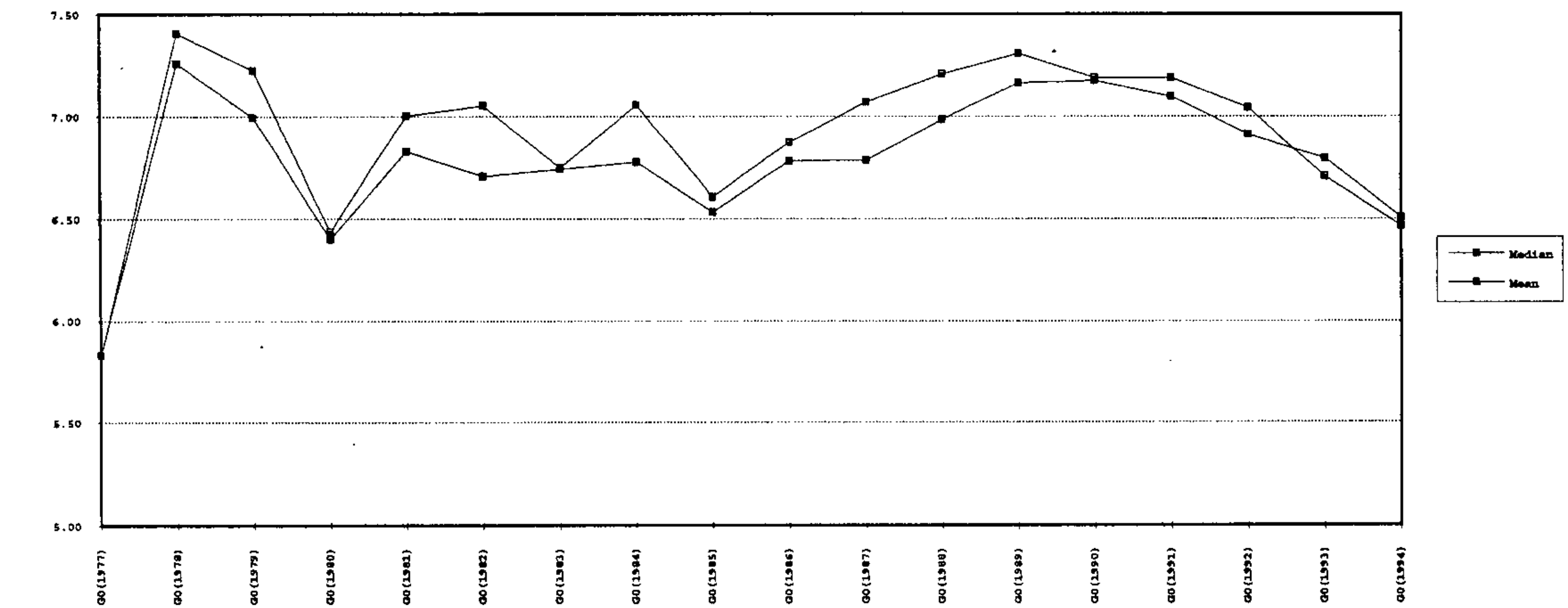
	G0(1984)	G0(1985)	G0(1986)	G0(1987)	G0(1988)	G0(1989)	G0(1990)	G0(1991)	G0(1992)	G0(1993)	G0(1994)
Mean	7.19	7.16	6.99	7.04	7.04	6.91	6.76	6.59	6.69	6.57	6.59
Standard Error	0.12	0.05	0.10	0.13	0.08	0.02	0.04	0.06	0.03	0.10	0.05
Median	7.14	7.20	7.08	6.88	7.03	6.91	6.75	6.62	6.73	6.48	6.60
Mode	7.14	7.37	6.25	#N/A	6.65	6.91	6.59	5.98	6.73	6.56	6.54
Standard Deviation	0.42	0.35	0.56	0.54	0.48	0.42	0.40	0.46	0.34	0.43	0.31
Sample Variance	0.18	0.12	0.31	0.29	0.23	0.18	0.16	0.22	0.12	0.18	0.10
Kurtosis	-0.86	-0.08	-0.80	1.11	0.53	1.26	-0.15	-0.29	0.14	1.38	-0.29
Skewness	0.11	-0.75	-0.35	0.95	-0.18	-0.03	0.35	0.10	-0.33	1.37	0.16
Range	1.40	1.42	2.13	2.09	2.20	3.44	1.91	2.01	1.86	1.63	1.41
Minimum	6.54	6.25	5.73	6.30	5.85	5.16	5.98	5.69	5.76	6.01	5.95
Maximum	7.93	7.67	7.86	8.38	8.04	8.60	7.89	7.71	7.62	7.64	7.36
Sum	93.43	286.45	237.63	112.57	239.21	1989.78	595.15	468.17	1030.51	131.42	316.19
Count	13.00	40.00	34.00	16.00	34.00	288.00	88.00	71.00	154.00	20.00	48.00
Confidence Level(95.000%)	0.23	0.11	0.19	0.26	0.16	0.05	0.08	0.11	0.05	0.19	0.09



Appendix 13 cont	Mean and median Instantaneous Growth Rates for 0-group chub								
	G0 (1977)	G0 (1978)	G0 (1979)	G0 (1980)	G0 (1981)	G0 (1982)	G0 (1983)	G0 (1984)	G0 (1985)
Mean	5.83	7.26	6.99	6.40	6.83	6.70	6.74	6.77	6.53
Standard Error	0.31	0.26	0.42	0.20	0.36	0.20	0.17	0.15	0.23
Median	5.83	7.41	7.23	6.44	7.00	7.05	6.74	7.06	6.60
Mode	#N/A	#N/A	#N/A	5.67	#N/A	5.46	6.08	5.81	#N/A
Standard Deviation	0.44	0.44	0.83	0.71	0.72	0.82	0.71	0.83	0.73
Sample Variance	0.19	0.20	0.69	0.50	0.51	0.67	0.51	0.68	0.53
Kurtosis	#DIV/0!	#DIV/0!	2.08	-0.70	2.45	-0.96	-1.68	-0.88	-2.06
Skewness	#DIV/0!	-1.33	-1.40	0.38	-1.34	-0.83	0.10	-0.03	-0.10
Range	0.62	0.85	1.90	2.27	1.68	2.45	1.95	3.15	1.81
Minimum	5.52	6.76	5.81	5.45	5.81	5.20	5.81	5.45	5.60
Maximum	6.14	7.61	7.71	7.71	7.49	7.65	7.76	8.59	7.41
Sum	11.66	21.78	27.98	83.21	27.31	113.94	121.27	196.40	65.32
Count	2.00	3.00	4.00	13.00	4.00	17.00	18.00	29.00	10.00
Confidence Level(95.000%)	0.60	0.50	0.82	0.39	0.70	0.39	0.33	0.30	0.45

	G0 (1986)	G0 (1987)	G0 (1988)	G0 (1989)	G0 (1990)	G0 (1991)	G0 (1992)	G0 (1993)	G0 (1994)
Mean	6.78	6.78	6.98	7.17	7.18	7.10	6.91	6.79	6.51
Standard Error	0.16	0.20	0.08	0.02	0.02	0.06	0.05	0.16	0.04
Median	6.87	7.07	7.21	7.31	7.19	7.19	7.04	6.70	6.47
Mode	#N/A	5.74	7.37	7.53	7.01	6.18	7.04	6.78	6.47
Standard Deviation	0.59	0.79	0.54	0.49	0.28	0.41	0.46	0.52	0.23
Sample Variance	0.35	0.62	0.29	0.24	0.08	0.17	0.21	0.27	0.05
Kurtosis	2.15	-1.27	0.82	3.15	1.40	1.00	-0.83	0.08	-0.41
Skewness	-1.05	-0.42	-1.33	-1.76	-0.87	-1.37	-0.40	0.85	0.13
Range	2.31	2.43	2.11	2.73	1.54	1.62	1.80	1.67	0.87
Minimum	5.29	5.37	5.45	5.29	6.30	6.06	6.06	6.12	6.06
Maximum	7.60	7.80	7.56	8.02	7.84	7.67	7.86	7.79	6.93
Sum	94.90	108.53	349.24	2859.13	1069.30	347.87	587.64	67.92	214.71
Count	14.00	16.00	50.00	399.00	149.00	49.00	85.00	10.00	33.00
Confidence Level(95.000%)	0.31	0.39	0.15	0.05	0.05	0.11	0.10	0.32	0.08

0-Group median G values



Appendix 13 cont — Mean and median Instantaneous Growth Rates for 0-group roach

	G0(1983)	G0(1984)	G0(1985)	G0(1986)	G0(1987)	G0(1988)	G0(1989)	G0(1990)	G0(1991)	G0(1992)	G0(1993)	G0(1994)
Mean	6.25743	6.501087	6.238705	6.00274	7.305915	7.472687	7.160429	7.18184	6.929425	6.979006	6.933488	6.879833
Standard Error	0.171948	0.120021	0.032525	5.3E-110	0.472533	0.170306	0.040017	0.08335	0.034541	0.043374	0.058411	0.041588
Median	6.2308	6.39752	6.238705	6.00274	7.61542	7.86898	7.0902	7.128415	6.89815	6.95071	6.96193	6.93609
Mode	#N/A	6.85831	#N/A	#N/A	#N/A	8.02336	6.93521	6.82766	6.89815	6.95071	6.93609	6.77589
Standard Deviation	0.343896	0.46484	0.045997	#DIV/0!	0.945066	0.761633	0.594896	0.55288	0.204345	0.198764	0.143077	0.161071
Sample Variance	0.118265	0.216076	0.002116	#DIV/0!	0.893149	0.580085	0.353902	0.305676	0.041757	0.039507	0.020471	0.025944
Kurtosis	-4.5281	0.706502	#DIV/0!	#DIV/0!	2.898891	0.250427	-0.59954	-0.7566	0.045108	1.771878	3.493558	-0.35939
Skewness	0.188458	0.741469	#DIV/0!	#DIV/0!	-1.63967	-1.17419	-0.02447	0.002799	0.412347	0.904215	-1.57765	-0.28289
Range	0.70418	1.7434	0.06505	0	2.12888	2.52632	2.75951	2.27445	0.83821	0.85717	0.42421	0.5889
Minimum	5.93197	5.85961	6.20618	6.00274	5.93197	5.78558	5.78558	6.00274	6.56444	6.67937	6.6645	6.54913
Maximum	6.63615	7.60301	6.27123	6.00274	8.06085	8.3119	8.54509	8.27719	7.40265	7.53654	7.08871	7.13803
Sum	25.02972	97.51631	12.47741	6.00274	29.22366	149.4537	1582.455	316.001	242.5299	146.5591	41.60093	103.1975
Count	4	15	2	1	4	20	221	44	35	21	6	15
Confidence Level(95.000%	0.337012	0.235237	0.063748	#DIV/0!	0.926146	0.333794	0.078432	0.163362	0.067698	0.085011	0.114483	0.081512