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DEE STOCK ASSESSMENT PROGRAMME: ANNUAL REPORT 1991

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SUMMARY

1. This report is the Second Annual Report of the Dee Stock Assessment Programme (DSAP) and describes results from the first year (1991) of trapping and tagging at Chester Weir, as well as from other components of the programme. Details of the radio-tracking programme for 1991 will be reported elsewhere.

2. Salmon net catches in 1991 were slightly improved on 1990 but still below the previous 5-year mean; provisional estimates for the rods indicate a similar picture. In contrast, commercial sea trout catches were significantly higher than 1990 and above the 5-year average; however, rod catch rates were markedly down on last season.

3. 1162 salmon and 613 sea trout were captured at Chester Weir between 20th May-31st Dec, and 787 salmon and 422 sea trout were tagged up to the end of the angling season (including 48 radio-tagged salmon). 50 salmon and 3 sea trout were recaptured by the rods in-season.

4. Median (overall 27 days) and minimum times to angling recapture of tagged salmon released at the trap tended to increase with distance upstream, although maximum times remained relatively constant (57-58 days) throughout. This may indicate a consistent upper time limit to the period of catchability for Dee salmon.

5. Provisional mark-recapture estimates of (in-season) salmon run size (5465; 95%CL 4146-7206) have confidence limits close to those recommended (+/-20%) for monitoring needs and demonstrate that trap efficiency, tagging and tag reporting levels are suitable for meeting the programme's objectives. Estimates for 1991 may tend towards the 'worse case' because of the part season tagging programme (Jun-Oct) and dry summer (with associated low (6.4%) rod exploitation rates), factors likely to result in small numbers of recaptures, inturn influencing confidence limits.

6. In spite of the significant numbers of sea trout captured and tagged at Chester trap, tag returns indicate that a rod fishery based estimate of run size will not be feasible at present levels of exploitation.

7. There was no evidence of tag related mortality as a result of Floy or radio tagging procedures at Chester Weir or of significant numbers of tagged fish being lost or unavailable to the rod fishery due to downstream movement after release, residence below the rod fishery, or entry after the end of the season.

8. It is too early to make any firm statement about the impact of trap operation on fish movements around Chester Weir. Further evidence will become available following the second year of radio-tracking.

9. Progress in other areas of the DSAP, include: i) improved circulation of the Anglers logbook (up by 20% in 1992 to 451); ii) marked increases in microtag stocking rates (15,000 S1's in 1992) and iii) start of a rolling programme of intensive sub-catchment juvenile monitoring/habitat evaluation (HABSCORE).

10. Reinstatement of the Manley Hall fish counter remains a priority for the DSAP in 1993-94; design and submission for tender by the end of 1992-93 will allow contractors the early (May) start in 1993 (funding permitting) necessary to ensure completion of the scheme in the low flow period. Other priorities for the DSAP (in line with the strategy document) are also identified.

KEY WORDS: Salmon, sea trout, River Dee, stock assessment, adult trapping, mark-recapture, fishery performance, automatic fish counting, microtagging, juvenile monitoring, radio-tracking.

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1 INTRODUCTION

This is the second annual report of the Dee Stock Assessment Programme (DSAP). It describes progress with scheme development and the derivation of salmon and sea trout stock performance measures for the year 1991.

DSAP became fully operational by May 1991 with completion of the Chester Trap and start of a three-year radio tracking project. This report therefore describes the methodology employed as well as the format for future annual reports. Occasional reports dealing with specific issues and investigations will be produced as data and circumstances require.

2 AIMS AND OBJECTIVES

The overall purpose of the DSAP is to provide and interpret performance measures for salmon and sea trout stocks on the River Dee. In so doing it fulfills a dual role of monitoring and investigation, and will contribute to the wider objectives of environmental management through integrated catchment planning.

Specific objectives include:

... **monitoring** of run size, year class strength, seasonal run pattern, catch, effort and catch-per-effort statistics, exploitation rates and abundance of fry and parr.

... **investigation** of relationships amongst stock, catch and recruitment, the effects of environmental factors on run, catch and recruitment.

... **setting of targets** against which stock and fishery performance can be assessed.

DSAP data will be used to review the status of fishery resources and assist in the identification of management needs that can be incorporated into catchment and corporate planning.

In addition to the benefits to local management, some of the information produced by the DSAP on eg. stock trends, the effects of environmental factors on behaviour and ecology, will contribute to the better management of rivers elsewhere.

3 METHODS

3.1 Fishery census

Nets

Four trammel and twenty (of a possible 30) draft net licencees operated on the Dee in 1991, in the area of the estuary shown in Fig 1. The season for both

gears runs from 1st March-31st August, inclusive, with close times between 24.00 hours Thursday and 24.00 hours Sunday. Statistics on salmon and sea trout catch and CPUE (catch per tide) were derived from the standard catch return form which licencees are obliged to submit at the end of each month.

Rods

The rod fishing season runs from 27th January-17th October, inclusive. Catch statistics are collected via licence returns and the Anglers logbook. The former is a statutory return and provides the most complete catch declaration but is not available until the summer following the season in question. Before the advent of the licence return/reminder system (1975), bailiff returns - largely based on the reported catches of individual fishery owners, formed the best measure of rod catch on the Dee.

The logbook system, in operation since 1989, is a voluntary system and requests more detailed information on fishing activity than that required for the licence return - in particular it provides a measure of CPUE (as catch per hour) and records catches by river section (Fig 1). However, the circulation of the logbook is largely restricted to the major clubs and syndicates on the Dee through which individual anglers can be contacted. As a consequence, the logbook return represents only part of the total salmon and sea trout catch declared through the licence return.

3.2 Trapping and mark-recapture

Trap design and operation

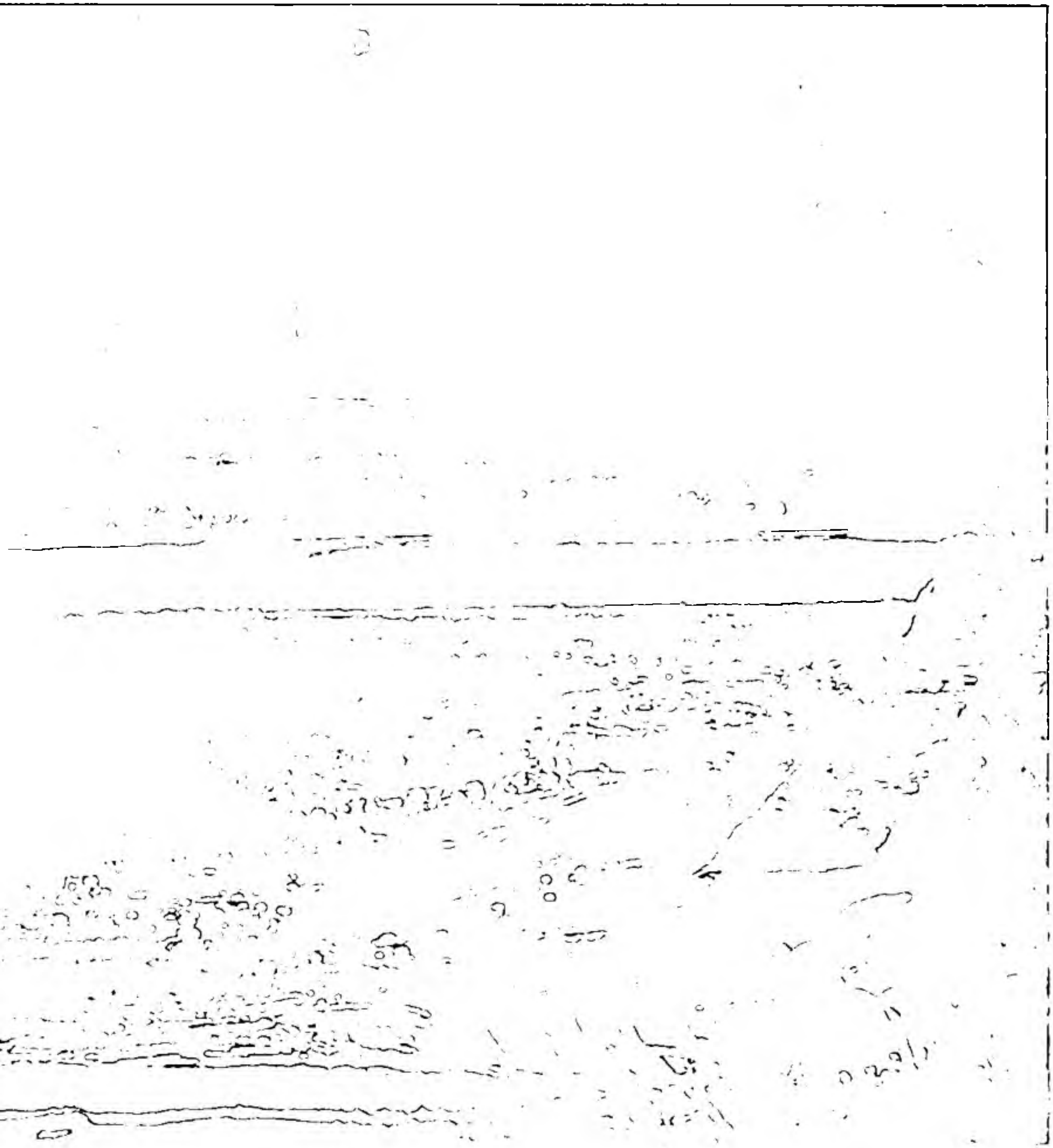
Chester trap (Fig 2a) lies in a covered channel (initially constructed to house an automatic fish counter) on the left bank of Chester Weir and at the head of the fish pass. A series of oversails overhang the weir crest in this region to encourage fish into the trap channel. Within the channel, V-shaped inscales and a sloping floor lead fish into the main body of the trap through a narrow entrance set about 300mm above floor level (Fig 2a). This aspect of trap design is common to many other upstream traps which have proved successful in the capture of adult migratory salmonids.

When checking the trap, motorised penstocks at the upstream and downstream ends of the channel are closed to shut off the flow. The sealed channel is then drained to an appropriate level via an adjustable intake pump which discharges to the mill race. Operation of all penstocks (including the mill race penstock which compensates for river level changes; Fig 2a), and the pump, is controlled from a panel in the main trap building.

Once water levels have been reduced in the channel, fish are caught and processed (below) in the main body of the trap - working from fold-down tables within the channel wall. Processed fish are then passed through doors in the upstream grill to the release pool (Fig 2a), where, following completion of the checking session and opening of the penstocks, they are free to move out of the trap channel. When the trap is not being fished, the inscales can be unlocked and moved to a position parallel with the flow, and the upstream doors opened, to create an open channel through which fish can freely pass (Fig 2b).

PLATE I

UPSTREAM VIEW OF CHESTER WEIR FISH TRAP. Fish approach the trap via the stepped pools of the fish pass; in this photograph the penstock at the downstream end of the trap channel is in the closed position.



Trapping regime

Trapping began on a regular basis from the 20th May with the final trapping session of 1991 on the 20th December. For the bulk of this period, the trap was fished from Sunday evening to Friday evening continuously and checked twice daily (generally between 8.00-9.00 and 15.00-18.00). This regular trapping regime was maintained in an attempt to ensure that the ratio of tagged to untagged fish in the population remained relatively constant - a requirement of the population estimates used (NRA, 1991b). (Note: Prior to the 8th July the trap probably operated less efficiently because the top of the fish pass remained open to fish passage until this date - when canoe pass oversails and sealing plate were fixed.)

The frequency at which the trap was checked was determined by the numbers of fish being caught; for the May-October period a twice daily check was invariably maintained to avoid undue stress from overcrowding and long periods of confinement. Once catches began to decline (November-December) and Floy tagging had ceased (17th October), a single daily check was carried out with trapping beginning on the Monday morning instead of the Sunday evening.

The length of the checking period depended on the number of fish to be processed, but ranged from around 0.5-2.5 hours. This included the time taken for the penstocks to operate and for the trap to be drained - the latter determined by river flow/tide height. From Friday evening to Sunday evening the trap was usually left open (Fig 2b); exceptions to this occurred on two weekends (in August) and four Friday nights when the trap was fished.

Fish handling and tagging

Fish were captured either by hand net or in a PVC bag and then anaesthetised in a solution of Phenoxyethanol in river water. Following anaesthesia, two scales were removed for ageing purposes and fish were examined for signs of damage, disease and external parasites, and presence of tags (Floy, radio or microtags). Fish were then measured for length (fork-snout) before Floy (or radio) tagging, weighing and recovery (in a tank of aerated river water). The area around the Floy tag was treated with 1:2 mixture of antibiotic powder (Terramycin) and dental adhesive (Orahesive) to minimise the risk of infection. As fish began to regain their swimming ability, they were passed from the recovery tank into the release pool and allowed to become fully active prior to opening the penstocks. At this stage, the penstocks were at first raised only partly to give fish time to readjust to flowing water.

On occasions when large numbers of fish were present (usually >30), a proportion would be passed through to the release pool without processing (identifying only species) in order to prevent undue stress through prolonged confinement.

Recaptures

Tag rewards (Floy tag £5.00; radio-tag £20.00) were offered to encourage anglers and net fishermen to report recaptures. In order to promote returns, the tagging programme was heavily publicised both before and after it's start.

3.3 Radio-tracking

The radio-tracking programme began in May 1991 and concentrated on salmon only. Fish were tagged both in the estuary (purchased from licenced net fishermen) and at Chester trap using radio and combined radio and accoustic (CART) tags - the latter confined to estuary tagged fish as only the accoustic signal can be detected in waters of high salinity.

A total of 36 automatic listening stations were positioned at regular intervals throughout the catchment (from Connahs Quay to Bala; Fig 1) to record the presence of tagged fish. These were largely confined to the main Dee and major tributaries; in the middle estuary, listening stations were associated with accoustic buoys - required to convert accoustic signals to radio signals. Additional information on fish location was collected actively, tracking on foot, by boat and by light aircraft; the latter was used on 6 occasions to search for fish in the Dee and neighbouring catchments (Conwy and Clwyd).

Further details of the radio-tracking methodology and results additional to those given here, will be reported separately (NRA, in prep.).

3.4 Microtagging

Salmon parr (1+) and smolts (S1 and S2) have been reared and microtagged at the Authority's Maerdy hatchery (on the River Ceirw; Fig 1) annually since 1986. Screening programmes for microtagged adult salmon operate on the high seas and home water fisheries, in addition, the tagging programme has been extensively publicised among rod and net fishermen on the Dee and other Welsh rivers with a £5.00 reward offered for the return of a tagged fish.

3.5 Juvenile surveys

Annual (July-September) electrofishing surveys for juvenile salmonids have been carried out on the Dee since 1985. Sites (normally 50m long) have been confined to the major tributaries upstream of Llangollen, and fished using both quantitative and semi-quantitative techniques. More recently (1990 and 1991), five-minute fry sampling (on riffle habitat only) has been introduced on the main Dee and Ceiriog.

In 1991, a total of 6 quantitative, 26 semi-quantitative and 27 five-minute fry sites were fished. Most of the quantitative and semi-quantitative sampling was concentrated on three tributaries (Ceiriog, Mynach and Meloch) as part of a rolling programme in which individual subcatchments are selected in turn for more detailed survey (this includes habitat evaluation (HABSCORE) on quantitative sites).

4 RESULTS

4.1 Fishery statistics

4.1.1 Nets

Declared catch

Salmon net catch for both gears combined (855) was slightly up (+1.3%) on the 1990 catch, but still below the 5-year mean (981). In contrast, sea trout catches (142) were considerably increased on both 1990 (+255%) and the 5-year mean (Table 1). CPUE (catch per tide) data for salmon (0.5089) and sea trout (0.0845) are reported for the first time in 1991.

Monthly salmon catch and CPUE (catch per tide) was greatest in August for both drafts (358 and 0.9775) and trammmels (108 and 1.4595, respectively), but for sea trout peaked in June for drafts (35 and 0.1207) and July for trammels (39 and 0.4021) (Table 2).

Age composition

Salmon age composition data (Table 3) are based on a combined sample of 125 scales submitted directly by net licencees and provided from radio-tagged fish. These data refer to fish sampled in July-August only and represent 14% of the total catch in this period (declared net catch = 826 + radio-tagged fish = 61); only two fish were scale sampled prior to June (both in May). The sample was dominated by 1SW (61%) and 2SW (37%) salmon, with few 3SW fish (2%) and no previous spawners. The majority (61%) of these fish were aged as 2 year-old smolts and the remainder as 1 year olds.

No sea trout scales were sampled from the net fishery.

Year class composition

The year class composition of the salmon net catch (June-August) is given in Table 4. These estimates were derived firstly on the basis of sea age/weight composition (Appendix I) and then from the smolt age composition of each sea age class (Table 3). No estimates were given before June because of insufficient scale data.

4.1.2 Rods

Licence return

At the time of writing, declared catches from the licence return system are still awaited for 1991, hence the absence of data in Table 1.

Anglers logbook

Logbook returns to date include the bulk of returns expected for 1991. From these, the overall salmon catch per hour (0.0122) was only slightly down (-8.4%) on that of 1990, with the peak CPUE (0.0303) and over 40% of the total catch occuring in October (Fig 3a and Appendix II). In contrast, the overall CPUE for sea trout (0.0086) was well down (-87.9%) with only two fish (June

PLATE II

WEIGHING A FISH WITHIN THE TRAP CHANNEL. Anaesthetic and recovery tanks, measuring board and tagging equipment are shown on the fold-down tables.

and October) reported for the whole season by anglers fishing for "sea trout or both species" (Fig 3b and Appendix II).

Fishing activity was reported in Angling Sections 1-5 only, with Sections 3 and 4 and 2 and 3 each accounting for almost 70% of the total effort (hours fished) for salmon and sea trout, respectively (Fig 4 and Appendix III). Peak CPUE for sea trout (0.0143) occurred in one of the heavily fished Sections (3), but for salmon, Section 5 - with the lowest recorded effort (6% of the total), produced the highest catch rate (0.0225).

Logbook circulation in 1991 reached 377, an increase of 43% and 2% on 1989 (215) and 1990 (369) respectively (Table 5). However, over the same period, the proportion of total returns received steadily declined from 54% (1989) to 37% (1991); despite this, the quality of returns has improved - with numerically more 'Complete returns' provided in 1991 (103) than in any other year.

No firm estimates are available of the total number of salmon and sea trout anglers fishing the Dee, although in 1988, 955 anglers reported visiting the river - a figure based on an incomplete (63%) Regional licence return (Bunt, 1991). This could indicate a total angling population of around 1500, with the logbook targetting up to 25% of fishermen and accounting for 17-22% and 28-64% of the declared salmon and sea trout catch respectively (Table 5).

Age composition

Few scales (11 salmon; 0 sea trout) were supplied directly by anglers, despite an appeal sent out with the 1991 logbooks (NRA 1991a). As a result, no age composition analysis is included here.

4.2 Chester trap statistics

4.2.1 General

Catches and tagging

In total, 1162 salmon and 613 sea trout were captured from the 20th May to the 31st December 1991, with an overall catch per hour of 0.4465 and 0.2355, respectively, in 2602.75 hours of fishing (51% of available time excluding checking time) (Table 6).

Of the total catch, 94% of salmon (1096) and 93% of sea trout (569) were taken inseason (20th May - 17th October), and of these fish, 72% of salmon (787) and 74% of sea trout (422) were Floy or radio-tagged (the latter in the case of salmon only; Table 6). No fish were Floy tagged outwith the season, although three salmon were radio-tagged after 17th October. August had the lowest proportion of salmon Floy or radio tagged in any one month (54%) compared with July (83%) - the next lowest month. This resulted from two experimental weekend fishings in August, and one Monday fishing, when 198 salmon were caught but not tagged. (Subsequent analyses exclude data from weekend and Friday night fishings.)

Age composition

Scales were sampled from 858 salmon and 524 sea trout, 74% and 86% of the total 1991 trap catch, respectively (Table 7). For salmon, 1SW fish formed the dominant sea age group (84%); no 3SW fish were found with 2SW fish (14%) and Previous Spawners (2%) making up the remainder (Table 7a). One and two year old smolts were the main river age groups (43% and 57%, respectively) with few (<1%) three year old fish (Table 7a).

In contrast to salmon, large proportions (23%) of returning sea trout were previous spawners, with one fish returning to spawn for the sixth successive year. The remaining sea age groups were dominated by 0SW (31%) and 1SW (41%) fish (Table 7b). Also, in marked contrast to salmon, a large majority (88%) of sea trout appear to have emigrated as 2 year old smolts.

No significant differences (G-test; $P>0.05$) were found between the length and weight compositions of salmon and sea trout sampled for scales, and those of the trap catch as a whole, both for all and individual monthly samples.

Sex composition

Sex was determined from external characteristics in 94% (832) salmon and 81% (445) sea trout examined. For the former, the sex ratio (overall months) was close to unity (F/M = 1.04), but for the latter 5.5x as many females as males were recorded (Table 8a).

Where fishery recaptures allowed an independent but uncorroborated check, the same sex was assigned in 86% of cases for female salmon (12 fish) and 94% of cases for male salmon (15 fish). For sea trout, males only (2 fish) could be compared, producing 100% agreement.

General condition

Sea lice (Lepeophtheirus) were a common external parasite of both salmon (73%) and sea trout (78%), although levels of infestation were not considered harmful (Table 8b). Other external parasites occasionally reported on both species included the freshwater louse (Argulus) and the fish leech (Piscicola).

Aside from parasitic infection, fin rot (recorded from 28th June onwards) was found in 26% of sea trout but was virtually absent in salmon (0.1%) (Table 8c). This condition predominently affected the dorsal fin, but usually had not advanced beyond the outer edge of the fin and did not appear detrimental to health. Other conditions noted but not identified, included the presence of small (5mm diam.) red marks on the underside and lower flanks of the later running salmon (September onwards) and also the occurence of swollen eyes in a small proportion of sea trout. Again, neither condition appeared to affect behaviour or health.

Signs of physical injury were categorised as either predator or net damage, and occurred at a similar incidence (17-18% and 10-12%, respectively) in both species, although were rarely severe (Table 8 d and e).

Other species

Species other than salmon and sea trout captured at Chester trap are listed in Table 9. The most notable were the Allis shad (recorded in July) - a protected species in England and Wales, and a terrapin (captured in August).

4.2.2 Catch variations

Daily trends

Mean night session catch rates (catch per hour) for salmon were significantly greater (1.9x) than those of the day ($P<0.001$) - where a 'night session' contains >4 hours darkness defined from tide tables as the period between sunrise and sunset. Sea trout showed a similar but less marked trend - with night session catch rates 1.3x those of the day ($P>0.05$) (Fig 5 and Appendix IVa).

Night session catch rates for salmon during the netting season appeared greater at the beginning (Sunday) and end (Thursday) of the trapping week than in mid-week (Fig 6), although differences between days were not statistically significant ($P>0.05$). This pattern may have been influenced by the activity of the net fishery which was closed from 24.00 Thursday to 24.00 Sunday (Section 3.1). However, salmon catch rates outwith the net season also showed the same daily pattern (again with no significant differences between days; $P>0.05$).

In contrast, inseason catch rates for sea trout tended to increase as the week progressed although no such trend was apparent out-of-season (Fig 6 and Appendix IVb); again, in both cases, differences in daily catch rates were not significant ($P>0.05$).

Environmental effects:

Day and night session catch rates for salmon only, are shown with river (up weir) and tidal (down weir) levels in Fig 7. Flow reversal occurs at the trap site when tidal levels exceed the weir crest height (4.3m A.O.D.); this normally corresponds to a tide height of 9.0m A.C.D as predicted in the Liverpool Tide Table.

From this superficial examination, it appears that any tidal influence on salmon catches may be more marked at night than during the day. The effect of river levels on catches is difficult to determine as the former remained stable throughout most of the trapping period, with the first major rise in river levels only occurring once the run was in decline.

(No data are given here for sea trout, although this species showed similar catch trends to those of salmon.)

4.2.3 Stock estimates

Tag recaptures

Of 54 salmon and 4 sea trout captured inseason by the fisheries, 93% (50) and 75% (3), respectively, were recaptured by the rods (Table 10). A number of tagged fish, particularly salmon (27), were reported above Chester Weir as post spawning mortalities (ie. found dead after the end of November 1991) or

PLATE III

FISH RELEASE TO THE RELEASE POOL.
The Floy tag is clearly visible below the dorsal fin; a small patch of antibiotic powder surrounds the base of the tag.

kelts. Only one tagged fish, a salmon, was found dead (in the estuary) prior to spawning. A single salmon, Floy tagged at Chester Weir in August, was recaptured on another river - the Ribble, Lancs., by bailiffs from North West NRA fishing for broodstock in December.

Of salmon recaptured by the rods inseason, 50% were taken within 26 days of release from Chester weir and no fish were recaptured beyond 58 days (Fig 8a). The median time from tagging to recapture increased with distance upstream, ranging from 15.0 days in Angling Section 1 (15Km upstream Chester Weir) to 43.5 days in Section 5 (89Km upstream Chester Weir) (Fig 8b and Table 11a). The minimum time to capture in each Section also increased between Sections 1-5 from 3-29 days, except for one fish taken in the Alwen (Section 7 - 89Km upstream Chester Weir) after only 10 days. In contrast, the maximum time to capture was very similar between most Sections (2-5) ranging from 57-58 days.

Recapture times for sea trout (3 fish only) were generally greater than those of salmon with one fish recaptured after 112 days (Table 11b).

Population and exploitation estimates

Schaefer and Petersen estimates of inseason salmon populations are shown in Appendix V. These were derived from inseason rod recaptures of Floy and radio-tagged fish released at Chester Weir (Table 10) (excluding fish recaptured by the nets or found dead in the estuary) and assume a projected total declared rod catch for the tagging period (1st June-17th October) of 349. The latter was based on the monthly distribution of catch from the 1991 logbook (Appendix II) and assumes a similar total catch (400 fish) to 1990.

Schaefer estimates of the salmon population at the point of tagging range from 298(June)-1933(Sept), with an overall estimate of 5038 (Appendix V). The latter is similar to the equivalent Petersen estimate of 5465 with lower and upper 95%CL of 4146-7206. (Confidence limits cannot be calculated for the Schaefer estimate although this estimate is considered the more robust; NRA, 1991b).

Estimates of angling exploitation range from 0.74% (upper and lower 95%CL 0.11-4.19%) for October tagged fish to 23.54% (95%CL 9.04-60.60%) for June fish, with an overall exploitation rate of 6.39% (95%CL 4.84-8.42%) (Appendix V).

4.2.4 Year class composition

The year class composition of the estimated salmon run at Chester Weir is shown in Table 12. This has been solely derived from the age composition of scale sampled fish at the trap (Section 4.2.1 and Table 7a), firstly defining the contribution of seperate sea age groups to the run, and secondly, reducing these groups to their various year class components on the basis of the smolt age composition.

This process has been carried out for the periods Jun-Jul, Aug, and Sep-Oct, to allow direct comparison with the year class breakdown for the net catch (Jun-Aug) (Section 4.1.1). However, in a full season of tagging, estimates would cover the whole inseason period (27th Jan-17th Oct). The fish counter at Manley Hall (once operational; Section 4.3), will provide information on run-size outwith the season to allow year class estimates (again on the basis of age composition at the trap) to be completed for the whole year.

4.3 Manley Hall fish counter

Failure of the Aquantic 'Logie' 2000A counter (operating on the left bank 'low' weir) occurred in June 1991. On site tests carried out between June and July (including tests by the manufacturers) suggested that the fault lay with the electrodes and their connections and not the counter, with inter-electrode resistences falling below the 10 ohm minimum. Temporary repairs were attempted in December 1991 involving the reforming of cable connections to the electrodes, but these failed to increase inter-electrode resistences - indicating that improvements to the electrode insulation were required.

For the counter to operate under all conditions, and be sensitive enough to allow the sizing of fish, it was proposed that the electrodes are refitted in a precast bed of 'Reebafil' concrete to provide insulation across the entire electrode span (not just in a narrow channel surrounding each electrode - as at present). Although a sum for reinstatement (£50K) was secured in the 1992-93 capital programme, consulting engineers have advised that the scheme should not go ahead this year because of the strong possibility that flooding could prevent completion. This risk was unacceptably high given the late start (mid-July) which was unavoidable due to the design and tendering process which had to preceed appointment of a contractor. The consltants also estimated that the scheme may cost up to £89K which includes a considerable risk element £41K.

Accordingly, the reinstatement will be delayed until 1993-94 (providing a new Corporate Plan bid is accepted), although design and tendering will be carried out in 1992 to ensure that contractors can be appointed as early as possible in 1993.

4.4 Microtagging

No microtagged salmon were recaptured at Chester Trap in 1991, and only 3 fish were reported from the Dee or High seas fisheries (the former all from the rods; Table 13). However, in recent years (1989-90) under 5,000 microtagged smolts (S1) have been stocked to the Dee (from the Authority's Maerdy hatchery) and so few returns were anticipated in 1991.

Recent improvements to the hatchery have increased the numbers of microtagged salmon released annually, with almost 13,000 S1/1+ fish stocked in 1991 and at least 15,000 S1 fish in 1992 (Summer 1+ stocking to be completed). (Further details of the microtagging programme throughout Welsh Region are given in NRA, 1991c.)

4.5 Juvenile monitoring

Quantitative and semi-quantitative sites

Salmon and trout fry and parr densities/site classifications for 1991 are shown in Fig 9a, b and c and Appendix VI. No change in the salmon and trout classifications was observed for those sites fished in 1990 and 1991; in addition, densities were generally within the range found in the last three years. Exceptions to this pattern occured on the Alwen - where salmon fry populations were unusually low in 1991 (4-13 100M-2), and on the Meloch, Mynach and Ceiriog which experienced significant declines ($P<0.05$) in trout densities.

PLATE IV

ATTENDING AN AUTOMATIC FISH TRACKING DEVICE (LISTENING STATION).
One of several automatic listening stations positioned throughout the catchment.

Five-minute fry sites

The overall mean salmon fry catch for main Dee sites (10 per 5 min) was low compared to the moderate classificaton on the Wye (11-25 per 5 min), although, the mean catch on the Ceiriog was substantially higher (29 per 5 min) (Appendix VI). Salmon fry catches on the main Dee were markedly higher upstream of site 78 (mean=15; n=8) than below (mean=6; n=9) (Fig 9d).

(Unlike salmon fry, trout fry do not tend to favour riffle habitats, thus the relatively low numbers of trout fry caught in the five-minute samplings for this species are unlikely to be representative.)

5 REPORTS

Reports produced since the launch of the DSAP:

NRA (1991). Dee Stock Assessment Programme: Annual Report, 1989-1991. EAN/90/09.

NRA (1991) Approaches to the use of mark-recapture techniques to estimate adult migratory salmonid populations on the River Dee. EAN/90/10.

Ellery, D.S. (1991). The movements of Atlantic salmon (Salmo salar, L) in the estuary of the River Dee, North Wales. M.Sc. Thesis, Plymouth Polytechnic.

NRA (1992). Dee Stock Assessment Programme Strategy 1/4/92.

6 DISCUSSION

6.1 Fishery performance

Temporal trends

The net fishery had a mixed season in 1991 with salmon catches similar to 1990 but still below the previous 5-year average; in contrast, sea trout catches were above average and the highest since 1988 (176 fish). Pending the declared catch from the rod fishery, CPUE data from the logbooks indicate a similar pattern for salmon to the nets, but a marked decline in sea trout catch on 1990.

For the rod fishery at least, below average flows throughout the latter part of the season (May-Oct; Table 14) may have reduced catchability, accounting for the relatively low overall salmon exploitation rate (6.4%) (Section 4.2.3) compared with Mills (1991). However, a rise in river level in early October, the first following the dry summer, was probably the main factor promoting the sharp increase in rod catch/CPUE which occurred in this 'short' month (season close 17th October).

Spatial trends

The spatial distribution of rod catch and fishing effort from the logbook returns (Section 4.1.2) in part may reflect bias toward the lower/middle reaches of the fishery (Angling Sections 2-5). This effect is illustrated by the difference in salmon catch distribution from the logbook returns (Appendix III) compared to that from tag recaptures (Table 11), where, for example, Sections 1 and 7 appear under represented in the logbook returns.

To some extent, such bias is unavoidable as the major and most supportive clubs and syndicates tend to be concentrated in the lower/middle reaches. In future, however, the distribution (and certainly the circulation) of logbooks should improve as new contacts are formed with anglers reporting the capture of tagged fish, and every effort should be made to encourage these contacts. Partly as a result of this approach, logbook circulation in 1992 (451) has increased by 20% on 1991.

Despite reservations about bias in the logbook sample, the shortage of returns from upper angling sections probably reflect poor catches in these areas. Indeed, recent catch records suggest this; for example, for the period 1980-84, less than 11% of the total salmon catch was reported above Section 4 or on the Alwen (Section 7). This may simply mean that fish are less available to anglers in upper sections - resulting, for example, from the capture or residence of part of the run in lower reaches, or arrival in the upper river late in the season or even after its end.

Certainly, in relation to the latter, the evidence from salmon tag recaptures indicates that the higher up the system a fish is caught, the longer it is likely to have been in-river (Section 4.2.3). However, the radio-tracking programme should produce the definitive answer as to how travel times and environmental conditions (especially flow) influence the availability of fish to the rods.

It is also apparent from salmon recaptures, that, irrespective of the section in which a fish is caught, the period of catchability is limited to 57-58 days after release from Chester Weir (Section 4.2.3). This effect could also have a greater influence on catches in the upper reaches where, on arrival, fish are perhaps more likely to be approaching the end of their 'catchable' period, or may even be beyond it. The existence of such a limit would also be an important factor to consider if, for example, seeking to protect part of the stock by altering the angling season. (Interestingly, sea trout appear to have much a greater maximum recapture time than salmon; 112 days on the Dee and 94 days on the Tywi (NRA, 1991d)).

Clarke and Purvis (1989) found that the majority of radio-tagged salmon (6 of 8) on the Tywi were captured within 15 days of entry into freshwater (c.f. a median time of 27 days on the Dee). They and others have identified this initial entry period as one when fish were most vulnerable to capture - preceding a quiescent phase (with usually little movement) in which catchability declines sharply. During periods of intermittent movement and a final spawning run (Milner 1990), fish can again become vulnerable to capture. The extended duration of high catchability on the Dee compared to the Tywi, may be more typical of salmon in a larger river.

6.2 Trap catches

Daily trends

Among the most unusual variations in catches observed were the week-day trends in salmon catch rate which it appears cannot be explained in terms of the activity of the net fishery (Section 4.2.2). Infact, similar trends have been observed from trapping studies on the Tywi (W. Purvis, pers com) where it was thought that fish were held up below a trap once it was set, and increasingly avoided capture as their experience of the structure grew throughout the week.

Only 20 radio-tagged salmon were detected below Chester Weir in 1991, too small a sample from which to draw any firm conclusions about the trends described above, especially as 11 of these fish arrived when the trap was not fishing (mainly at the weekend), and only two fish were recaptured in the trap. In fact, 75% of fish arrived at the weir between Thursday and Saturday, a pattern probably biased by the choice of tagging day (66% of fish were tagged on Wednesday or Thursday). There was some evidence that, when operational, the trap may have significantly delayed fish passage beyond the median delay period for all fish (9.5 hours), although this observation was based on only two fish (delayed 27 and 46 hours) (NRA in prep).

Obviously, information from a further two years of the radio-tracking programme will help to establish more clearly the effects of Chester trap and weir on fish movements and behaviour. Trends in week day catches need to be investigated further to clarify the influence of trapping and net fishery activity on catch rates; this should involve varying the start and end of the weekly trapping session on a systematic basis, both within and outwith the season.

Environmental effects

The positive influence of darkness on catch rates at Chester Weir, particularly those of salmon, is in keeping with studies (Milner, 1990) showing that movements predominently occur at night, except at higher discharges when day-time movements may be stimulated by a reduction in light penetration of the water column as water clarity falls (eg. through increased turbidity). The apparent influenece of tidal peaks on day-time trap catches (but less obviously those at night) may also relate to a similar turbidity affect associated with high tides.

The effect of river flow on trap catch is more difficult to judge as flows remained relatively low and stable (Table 14) until catches were in decline (from October onwards). However, despite these conditions, trap catch rates for one or both species were maintained, and there was no indication that movements of radio-tagged salmon up to and across the weir were restricted by flow (NRA, in prep.). (This has positive implications for the mark-recapture programme as, even in a relatively dry summer, we might expect (run size permitting) to tag adequate numbers of fish to meet statistical requirements (Section 7.3.1)).

More detailed examination of the effects of environmental variables on trap catch is beyond the scope of this report, but is an important objective of the DSAP and will be reported seperately as data become available.

6.3 Stock estimates

6.3.1 Overview

The provisional salmon population estimates produced for 1991, (Petersen estimate 5465) have 95% confidence limits (4146-7206) approaching the 20% (24.1-31.9%) error band recommended for monitoring and research needs (NRA 1991b). Although these estimates are only based on the June-October period (Section 4.2.3) they are likely to be overestimates because of the 'dilution' of the tagged population by untagged fish already present in the system at the start of tagging.

These provisional estimates confirm the success of the mark-recapture programme in its first season of operation, demonstrating that: (i) Chester Weir trap can provide large numbers of salmon for tagging (Section 4.2.1) and (ii) the rod fishery (with the support of anglers) is able to supply sufficient numbers of recaptures (Section 4.2.3). Furthermore, the 1991 estimates may tend toward the 'worse case' because of the part-season tagging programme and dry summer (with associated low rod exploitation rates), factors more likely to result in small numbers of recaptures, inturn influencing confidence limits (NRA, 1991b).

However, although the run as recorded at Chester Weir is substantial, it seems unlikely that a fishery based mark-recapture programme will prove successful for sea trout on the Dee because of the small numbers of angling recaptures (Section 4.2.3). Viable estimates may be generated in future from recaptures of previous spawners at Chester trap, an approach successfully used by Walker (1984) on the Findhu Glen Burn.

6.3.2 Sources of error

Under reporting of tagged fish

The extent of under-reporting is difficult to determine, but the rado-tracking programme produced no evidence of this within the rod fishery. For the purpose of mark-recapture estimates full reporting is not necessary, providing sufficient numbers of recaptures are obtained and the ratio of total catch:recaptures reflects that in the population as a whole (NRA, 1991b). However, underestimates of rod exploitation rates will result if recaptures are under-reported.

Availability of tagged fish

Of the radio-tagged salmon moving above Chester Weir inseason, (including those tagged at the trap) none remained resident downstream of the lowest angling section (Fig 1) and so were considered fully available to the rod fishery. The median travel time (for all radio-tagged fish) from Chester Weir to the lowest angling section was 18.5 hours, with around 90% of fish entering this Section within 2 days (although median rod recapture time in this section was longer (15 days); Table 11). As the last Floy or radio-tagged fish considered in the mark-recapture estimates were released at Chester Weir on the 11th October, it is assumed that all fish had entered the rod fishery (and so were available to anglers) before the last day of the season (17th October).

Loss of marks due to mortality and movements downstream

None of the 48 salmon radio-tagged at Chester Weir died as a result of this tagging procedure - a process involving the oral insertion of the radio tag into the stomach as well as application of a Floy tag (NRA, in prep). As radio-tagging is the more severe technique, requiring a greater degree of anaethesia, Floy tagging alone (the technique used on the majority of fish at Chester Weir; Table 6) was most unlikely to be a direct cause of mortality. Indeed, only one Floy tagged fish was found dead inseason (in the estuary) for which the cause of death was not known.

Of greater concern than the loss of marks due to tagging mortality were possible undeclared losses in the estuary of tagged fish which dropped downstream after release from Chester trap. Examination of the 15 salmon recaptured at or downstream of the trap (Table 6) indicated that fish released when the trap was opened were around 6x more likely to fall into this recapture group than fish released when the trap remained set. This may have arisen because when the trap was opened (Fig 2b) fish had the oportunity to drop downstream from the release pool; about 16% of tagged salmon (129 fish) fell into this category.

Despite this, there was no evidence to suggest that angling recapture rates of fish released when trap was opened (8.5%) were any less than those released at other times (5.9%). Furthermore, of the 48 radio-tagged fish released from Chester trap (11 when the trap was opened), all continued to move upstream. On this basis it is assumed that any undeclared losses resulting from movement into the estuary are insignificant and as a result there has been no adjustment to the tagged population other than to remove those fish known to have been recaptured by the nets or found dead inseason (Appendix V).

Loss of marks due to poor tag retention

No steps were taken to estimate Floy tag loss in 1991 (NRA 1991b) because of possible confusion and concern among fishermen over the use of more than one external mark in the first season of tagging. However, since the start of tagging in 1992, a single Alcian Blue panjet mark (placed just anterior to the pelvic fins) has been used as a second mark on both salmon and sea trout. Anglers contacted via the logbook scheme, have been asked to examine fish for this mark, although, because the mark is indistinct, the majority of screened fish are likely to result from trap recaptures, either at Chester Weir or Pont Barcer.

6.3.3 Year class strength

The year class estimates derived from the mark-recapture estimates apply only to those fish which survived to Chester Weir (Table 12). However, the full return to the river must also include fish lost to the net fishery (Table 4) and the best estimates of losses due to the illegal fishery and unknown sources of mortality in the estuary; these can only be derived from the radio-tracking programme. In addition, estimates from the latter should be available on the extent to which the Dee net fishery exploits a mixed stock.

A single year class estimate - combining data from the net fishery and the run at Chester Weir, is not included here because both are incomplete and the latter is only provisional at this stage. A complete (annual) estimate of year class composition for the run at Chester Weir, will require a full season

tagging programme and an operational fish counter at Manley Hall (Section 4.2.4). To improve the same estimates for the net fishery will necessitate a more comprehensive scale sampling programme; however, even with the latter, the quality of catch returns from licencees is suspect. For example, species are known to have been mis-identified (sea trout reported as salmon) and catches are likely to be under reported (W. Purvis, pers com.).

The mis-identification of sea trout as salmon may account for the significant differences (G-test, $P<0.05$) between the weight-frequency distributions of net and trap caught salmon, most pronounced for smaller fish (Fig 10). (Similar significant differences ($P<0.05$) for sea trout are probably influenced by differences in selectivity of the net and trap more than any other factor, the latter taking smaller fish; Fig 10). Given the errors associated with the declared net catch, the year class estimate for this component needs to be treated with caution.

6.3.4 Spawning escapement

Estimates of spawning escapement have not been made for 1991 due to incomplete data. These estimates will be based on the annual run at Chester Weir (Section 7.3.3) after adjustment for losses occuring prior to spawning. The main source of loss will be the rod fishery, but other less significant losses will include those due to straying of non-Dee fish, the illegal fishery and natural sources of mortality. The radio-tracking programme will contribute to the presently unknown components of total in-river loss.

On the basis of a final estimate of spawning escapement, information on weight and sex composition (Section 4.2.1) at Chester Weir will be used, along with literature values of fecundity, to estimate egg deposition.

6.4 Microtagging

Wild smolt tagging will allow important comparisons of exploitation and return rates to be made with hatchery reared fish (NRA, 1991c). Only small numbers of wild smolts have been tagged in the past (Wye and Usk); a smolt trapping facility on the Dee would make full use of the Chester trap in screening for adult returns. Feasibility and costs of this will be assessed during 1992.

6.5 Juvenile Monitoring.

A rolling programme concentrating quantitative and semi-quantitative sites on selected catchments will continue on the Dee in 1992. In addition, the 5-minute fry survey will be expanded to the whole catchment, providing an annual index of abundance and distribution (following a similar approach to that used by Kennedy and Crozier (1991) on the Bush). 1992 will also see the start of an extensive habitat mapping exercise whose purpose is to define the juvenile carrying capacity for the entire catchment, and by doing so, allow targets to be set for fishery improvement.

7 CONCLUSIONS

7.1 The first year of trapping and tagging at Chester Weir has been successful with significant progress towards attaining many of the programme's objectives. In particular, trap efficiency and levels of tagging and tag reporting by anglers have been shown to be suitable for achieving valid run and exploitation estimates for salmon.

7.2 Salmon net catches in 1991 were slightly improved on 1990 but still below the previous 5-year mean; provisional estimates for the rods indicate a similar picture. In contrast, commercial sea trout catches were significantly higher than 1990 and above the 5-year average, although, rod catch rates were markedly down on last season.

7.3 In spite of a significant sea trout population (as shown by the trap catch), tag returns indicate that a rod fishery based estimate of sea trout run size will not be feasible at present low levels of exploitation.

7.4 There was no evidence of tag related mortality as a result of Floy or radio tagging procedures at Chester Weir or of significant numbers of tagged fish being lost or unavailable to the rod fishery due to downstream movement after release, residence below the rod fishery or entry after the end of the season.

7.5 It is too early to make any firm statement about the impact of trap operation on fish movements around Chester Weir. Further evidence will become available following the second year of radio-tagging.

7.6 A number of advances have been made in other areas of the DSAP, including: i) improved circulation of the Anglers logbook (up by 20% in 1992 to 451); ii) marked increases in microtag stocking rates (15,000 S1's in 1992) and iii) start of a rolling programme of intensive sub-catchment juvenile monitoring/habitat evaluation (HABSCORE).

7.7 Priorities for the DSAP in 1992/93 (in line with the strategy document) are: i) completion of design and submission to tender of the Manley Hall counter reinstatement by the end of 1992/93, accompanied by a Corporate Plan bid for 1993-94; ii) identification of potential wild smolt trapping sites, provisional design, costs and Corporate plan bid for 1993/94; iii) expansion of the 5-minute fry survey to provide a catchment-wide index of distribution and abundance; iv) commencement of habitat mapping to define juvenile carrying capacity and assist in setting management targets.

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TABLE 1

River Dee, salmon and sea trout catch (C) and catch-effort (CE); rod and net fisheries, 1986-91. (Rod catch-effort calculated as catch per hour from Anglers Logbooks; net catch-effort as catch per tide from licencee returns.)

		5-year mean 1986-1990	1989	1990	1991	Percent change 1991 on 1990
a) Salmon:						
Rods	C:	617.4	269	427	N/A	-
	(CE):	(-)	(0.0084)	(0.0130)	(0.0122)	(-6.2)
Nets (drafts + trammels)	C:	981.2	1212	844	855	1.3
	(CE):	(-)	(-)	(-)	(0.5089)	
All methods	C:	1598.6	2424	1688	-	-
b) Sea trout:						
Rods	C:	117.0	76	84	N/A	-
	(CE):	(-)	(0.0557)	(0.0691)	(0.0086)	(-87.6)
Nets (drafts + trammels)	C:	125.4	108	40	142	255.0
	(CE):	(-)			(0.0845)	(-)
All methods	C:	242.4	292	164	-	-

TABLE 2

Monthly net catch and catch-effort 1991.

	Mar	Apr	May	Jun	Jul	Aug	All
a) Salmon:							
Drafts:							
Total catch	2	4	19	72	204	358	659
Tides fished	35	110	211	290	411	367	1424
Catch per tide	0.0571	0.0364	0.0901	0.2483	0.4964	0.9755	0.4628
Trammels:							
Total catch	0	0	4	7	77	108	196
Tides fished	0	5	29	51	97	74	256
Catch per tide	0	0	0.1379	0.1373	0.7938	1.4595	0.7656
Both methods:							
Total catch	2	4	23	79	281	466	855
Tides fished	35	115	240	341	508	441	1680
Catch per tide	0.0571	0.0348	0.0958	0.2317	0.5532	1.0567	0.5089
b) Sea trout:							
Drafts:							
Total catch	0	0	1	35	35	22	93
Tides fished	35	110	211	290	411	367	1424
Catch per tide	0	0	0.0047	0.1207	0.0852	0.0600	0.0653
Trammels:							
Total catch	0	0	0	10	39	0	49
Tides fished	0	5	29	51	97	74	256
Catch per tide	0	0	0	0.1961	0.4021	0	0.1914
Both methods:							
Total catch	0	0	1	45	74	22	142
Tides fished	35	115	240	341	508	441	1680
Catch per tide	0	0	0.0042	0.1320	0.1457	0.0499	0.0845

TABLE 3

Salmon age composition; net catch (drafts and trammels combined), June-August, 1991.

i) Scale sample

Smolt age:	Sea age: 1 SW	2 SW	3 SW	PS	UR	ALL
1	29	14	0	0	0	43
2	40	26	2	0	0	68
3	0	0	0	0	0	0
UR	7	6	0	0	0	14
ALL	76	46	2	0	1	125

ii) % Smolt age by sea age

Smolt age:	Sea Age: 1 SW	2 SW	3 SW	PS	UR	All
1	42.0	35.0	.0	.0	.0	38.7
2	58.0	65.0	100.0	.0	.0	61.3
3	.0	.0	.0	.0	.0	.0
UR	-	-	-	-	-	-
All	100.0	100.0	100.0	.0	.0	100.0

iii) % Sea age by smolt age

Smolt age:	Sea age: 1 SW	2 SW	3 SW	PS	UR	All
1	67.4	32.6	.0	.0	-	100.0
2	58.8	38.2	2.9	.0	-	100.0
3	.0	.0	.0	.0	-	.0
UR	53.8	46.2	.0	.0		100.0
All	61.3	37.1	1.6	.0	-	100.0

Where: SW = Sea winter
PS = Previous spawner
UR = Unreadable.

TABLE 4

Salmon year class composition: net catch (drafts and trammels combined), 1991.

		Period: Mar-May Sea age class:					Period: Jun-Aug Sea age class:				
		1SW	2SW	3SW	PS	All	1SW	2SW	3SW	PS	All
Declared catch:		-	-	-	-	29	659	161	6	0	826
Smolt age:	1	-	-	-	-	-	277	56	0	0	333
	2	-	-	-	-	-	382	105	6	0	493
	3	-	-	-	-	-	0	0	0	0	0
	All	-	-	-	-	-	659	161	6	0	826
Year class:											
	1985	-	-	-	-	-	-	-	0	-	0
	1986	-	-	-	-	-	-	0	6	-	6
	1987	-	-	-	-	-	-	105	0	-	105
	1988	-	-	-	-	-	382	56	-	-	438
	1989	-	-	-	-	-	277	-	-	-	277
	All	-	-	-	-	-	659	161	6	-	826*

* Estimates exclude Previous Spawners.

TABLE 5

Anglers logbook: returns, 1989-91.

	1989	1990	1991
Logbooks distributed	215	369	377
Complete returns(%)	76(35.3)	99(26.8)	103(27.3)
Incomplete returns(%)	16(7.4)	23(6.2)	13(3.4)
Did not fish(%)	23(10.7)	34(9.2)	22(5.8)
Total returns received(%)	115(53.5)	156(42.3)	138(36.6)
Total salmon catch (% of declared catch)	46(17.1)	93(21.8)	86(-)
Total sea trout catch (% of declared catch)	21(27.6)	54(64.3)	6(-)

TABLE 6

Fish trapping and tagging: Chester weir, 1991.

	Jan	Feb	Mar	Apr	May[(i)]	Jun	Jul[(ii)]	Aug	Sep	Oct (1-17)	Oct (18-31)	Nov	Dec	All
Salmon:														
Total catch					6	17	76	482	356	159	40	15	11	1162
Hours fished					139.25	245.00	346.25	505.25	344.00	203.25	181.50	359.25	279.00	2602.75
Catch per hour					0.0431	0.0694	0.2195	0.9540	1.0349	0.7823	0.2204	0.0418	0.0394	0.4465
No. Floy tagged					0	6	56	237	307	136				742
(% Floy tagged)					(0)	(35.3)	(73.7)	(49.2)	(86.3)	(85.5)				
No. Radio tagged						11	7	22	4	1	3			48
(% Radio tagged)						(64.7)	(9.2)	(4.6)	(1.1)	(0.6)	(7.5)			
Sea trout:														
Total catch					10	153	196	114	26	70	28	15	1	613
Catch per hour					0.0718	0.6245	0.5661	0.2256	0.0756	0.3444	0.1543	0.0418	0.0036	0.2355
No. Floy tagged					7	93	168	80	25	49				422
(% Floy tagged)					(70.0)	(60.8)	(85.7)	(70.2)	(96.2)	(70.0)				
No. Radio tagged														0
(% Radio tagged)														

Note: (i) Regular trapping operations began 20.5.91.
(ii) Trap modifications were not fully completed (including installation of the oversails) until 8.7.91.

TABLE 7

a. Salmon age composition; trap catch, May-December, 1991.

i) Scale sample

Smolt age:	Sea age: 1 SW	2 SW	3 SW	PS	UR	ALL
1	250	13	0	2	0	265
2	270	69	0	12	1	352
3	5	0	0	0	0	5
UR	189	33	0	6	8	236
All	714	115	0	20	9	858

ii) % Smolt age by sea age

Smolt age:	Sea age: 1 SW	2 SW	3 SW	PS	UR	ALL
1	47.6	15.9	.0	14.3	.0	42.6
2	51.4	84.1	.0	85.7	100.0	56.6
3	1.0	.0	.0	.0	.0	.8
UR	-	-	-	-	-	-
All	100.0	100.0	.0	100.0	100.0	100.0

iii) % Sea age by smolt age

Smolt age:	Sea age: 1 SW	2 SW	3 SW	PS	UR	ALL
1	94.3	4.9	.0	.8	-	100.0
2	76.9	19.7	.0	3.4	-	100.0
3	100.0	.0	.0	.0	-	100.0
UR	82.9	14.5	.0	2.6	-	100.0
ALL	84.1	13.5	.0	2.4	-	100.0

Where: SW = Sea winter
PS = Previous spawner
UR = Unreadable

b. Sea trout age composition; trap catch, May-December, 1991.

i) Scale sample

Smolt age:	Sea age: 0 SW	1 SW	2 SW	PS	UR	ALL
1	1	2	1	1	0	5
2	68	90	15	43	0	216
3	10	9	0	5	0	24
UR	62	82	7	54	74	279
ALL	141	183	23	103	74	524

ii) % Smolt age by sea age

Smolt age:	Sea age: 0 SW	1 SW	2 SW	PS	UR	ALL
1	1.3	2.0	6.3	2.0	.0	2.0
2	86.1	89.1	93.8	87.8	.0	88.2
3	12.7	8.9	.0	10.2	.0	9.8
UR	-	-	-	-	-	-
All	100.0	100.0	100.0	100.0	.0	100.0

iii) % Sea age by smolt age

Smolt age:	Sea age: 0 SW	1 SW	2 SW	PS	UR	ALL
1	20.0	40.0	20.0	20.0	-	100.0
2	31.5	41.7	6.9	19.9	-	100.0
3	41.7	37.5	.0	20.8	-	100.0
UR	30.2	40.0	3.4	26.3	-	100.0
All	31.3	40.7	5.1	22.9	-	100.0

TABLE 8

Sex ratio and condition of salmon and sea trout captured at Chester Trap, 1991.

	Salmon		Sea trout	
a) Sex ratio				
	n		n	
Female(F)	423		376	
Male(M)	409		69	
Unknown	50		106	
Total	882		551	
F/M	1.03		5.45	
b) Sea lice infestation (tailed and untailed lice)				
	n	%	n	%
Present	641	72.6	430	78.0
Absent	242	27.4	121	22.0
Total	883	100.0	551	100.0
c) Fin rot				
	n	%	n	%
Present	1	.1	107	25.8
Absent	793	99.9	307	74.2
Total	794	100.0	414	100.0
d) Predator marks (old, healing and new wounds)				
	n	%	n	%
Bird mark	1	.1	2	.4
Seal damage	21	2.4	1	.2
Lamprey mark	0	.0	0	.0
Unknown	136	15.4	91	16.5
Absent	725	82.1	457	82.9
Total	883	100.0	551	100.0
e) Net damage (old, healing or new marks)				
	n	%	n	%
Present	103	11.7	57	10.3
Absent	780	88.3	494	89.7
Total	883	100.0	551	100.0

Where: n = sample size.

TABLE 9

Species list (excluding salmon and sea trout): Chester trap, 1991.

a) Fish:

Brown trout Salmo trutta, L

Rainbow trout Oncorynchus mykiss

Allis shad Allosa alosa, L

Common bream Abramis brama, L

Roach Rutilus rutilus, L

Dace Leuciscus leuciscus, L

Pike Esox lucius, L

Lampern Lampetra fluviatilus, L

Eel Anguilla anguilla, L

b) Reptiles:

Terrapin (Species unknown)

TABLE 10

Fate of fish Floy and radio-tagged at Chester Weir, inseason, 1991.

	Salmon	Sea trout
a) Total tagged	787	422
b) Fish recovered d/s Chester Weir		
Net (in-season)	4	1
(out-season)	1	0
Found dead (pre-spawning)	1	0
(post-spawning)	0	0
Other rivers	1*	0
c) Fish recovered at Chester Weir	8	5
d) Fish recovered u/s Chester Weir		
Rod (in-season)	50	3
(out-season)	2	1
Rod (kelt)	10	2
Found dead (pre-spawning)	0	0
(post-spawning)(i)	17	0
Pont Barcer	9	2

* Ribble, Lancs.

Note: (i) Fish found dead after 30th November are assumed to be post-spawning mortalities.

TABLE 11

Location of and time to rod recapture for trap tagged salmon and sea trout, 1991.

	Angling section: 1	2	3	4	5	6	7	8	ALL
a) Salmon:									
Recaps	14	5	11	17	2	0	1	0	50
(%)	28.0	10.0	22.0	34.0	4.0	.0	2.0	.0	100.0
Days at large:									
Mean	16.8	24.4	34.5	32.4	43.5	-	10.0	-	27.7
Median	15.0	19.0	36.0	30.0	43.5	-	10.0	-	26.5
Minimum	3	7	16	14	29	-	10	-	3
Maximum	43	57	58	57	58	-	10	-	58
b) Sea trout:									
Recaps	1		1	1	0	0	0	0	3
(%)	33.3	.0	33.3	33.3	.0	.0	.0	.0	100.0
Days at large:									
Mean	29.0		52.0	112.0	-	-	-	-	64.3
Median	29.0		52.0	112.0	-	-	-	-	52.0
Minimum	29		52	112	-	-	-	-	29
Maximum	29		52	112	-	-	-	-	112

TABLE 12

Salmon year class composition; estimated populations at Chester Weir, 1991.

	Jun-Jul Sea age class:					Aug Sea age class:					Sep-Oct (17th) Sea age class:					Total Sea age class:				
	1SW	2SW	3SW	PS	All	1SW	2SW	3SW	PS	All	1SW	2SW	3SW	PS	All	1SW	2SW	3SW	PS	All
Pop.estimate:	439	275	0	0	714	1315	139	0	29	1483	2450	303	0	88	2841	4204	717	0	117	5038
Smolt Age:																				
1	165	49	0	0	213	658	15	0	0	672	1137	59	0	18	1214	1959	122	0	18	2099
2	261	226	0	0	487	658	124	0	29	811	1279	244	0	70	1594	2198	595	0	99	2892
3	14	0	0	0	14	0	0	0	0	0	33	0	0	0	33	47	0	0	0	47
All	439	275	0	0	714	1315	139	0	29	1483	2449	303	0	88	2840	4204	717	0	117	5038
Year Class:																				
1985	-	-	0	-	0	-	-	0	-	0	-	-	0	-	0	0	0	0	0	0
1986	-	0	0	-	0	-	0	0	-	0	-	0	0	-	0	0	0	0	0	0
1987	14	226	0	-	240	0	124	0	-	124	33	244	0	-	277	47	595	0	0	642
1988	261	49	-	-	309	658	15	-	-	672	1279	59	-	-	1338	2198	122	0	0	2320
1989	165	-	-	-	165	658	-	-	-	658	1137	-	-	-	1137	1959	0	0	0	1959
All	439	275	0	-	714*	1315	139	0	-	1454*	2449	303	0	-	2752*	4204	717	0	0	4921*

* Estimates exclude Previous Spawners.

TABLE 13

Dee microtagged salmon: stocking and recaptures, 1986-1992.

			Adult recaptures:								
			Home waters			Foreign waters					
Year tagged	Number tagged	Life stage	Rod	Net	Other	Green -land	Faroes	N Ire -land	S Ire -land	N.E. Coast	Total
1986	287	S1		1					1		2
1986	8087	1+	1	3				3		1	8
1987	10454	1+	1	4	1		1		2		9
1987	9426	1+	1								1
1988	23984	1+	1*								1
1988	3407	S1							1		1
1989	2382	S1	3*								3
1990	2448	S1									
1991	4312	S1									
1992	8672	1+									
1992	15246	S1									
1992	-	1+	(To be tagged.)								

Where: S1 = 1 year old smolt
S2 = 2 year old smolt
1+ = 1 year old parr

* Origin of the 3 salmon recaptured in 1991, all taken by anglers on the Dee.

TABLE 14

River flow (Chester Weir) and temperature (Manley Hall), 1991.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
a) Mean flow (Cumecs):												
1981-90 (10-year mean)	61.1	45.5	42.9	26.9	14.1	10.9	7.6	12.4	17.2	37.7	46.1	55.0
1991	63.8	33.7	49.3	29.3	8.0	7.1	7.5	9.1	6.3	12.6	56.6	34.9
b) Mean temp.(C), 1991:												
Mean min	3.8	2.8	6.9	8.0	11.5	12.4	16.9	15.4	13.7	9.8	7.2	4.8
Mean max	4.6	3.7	7.9	9.4	13.2	14.0	18.7	17.2	15.1	10.7	8.0	5.8

FIG. 1

RIVER DEE CATCHMENT.

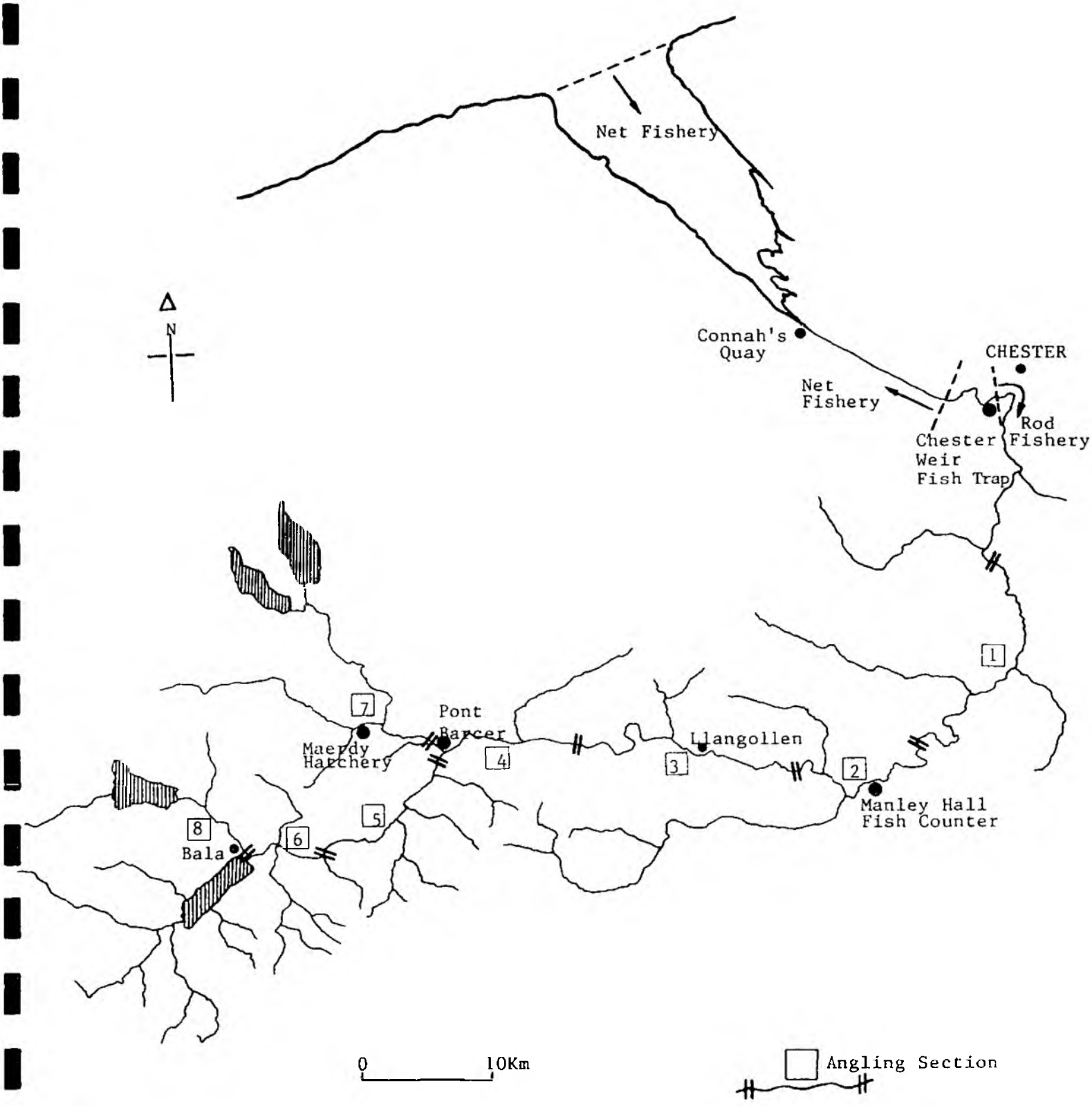


FIG. 2 CHESTER WEIR FISH TRAP - PLAN VIEW.

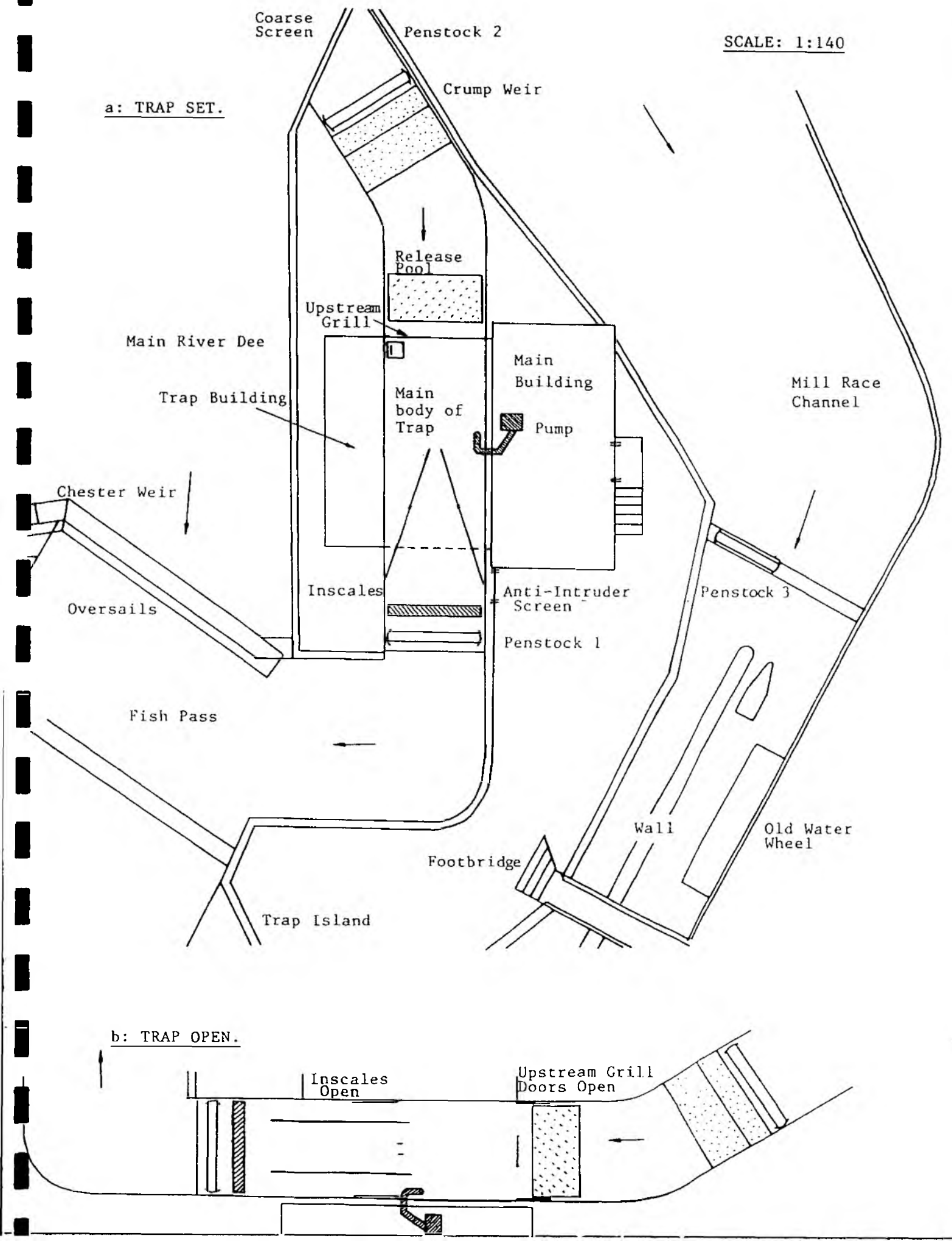
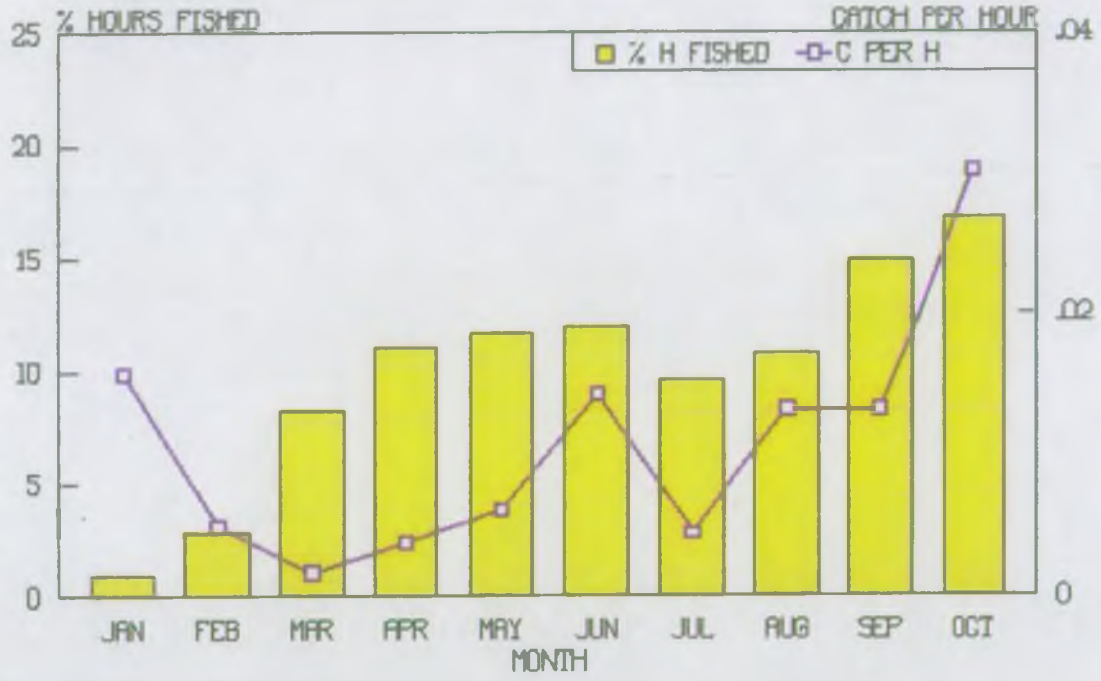


FIG. 3

DEE ANGLERS LOGBOOK 1991; SALMON:
FISHING SUCCESS BY MONTH.



DEE ANGLERS LOGBOOK 1991; SEA TROUT:
FISHING SUCCESS BY MONTH.

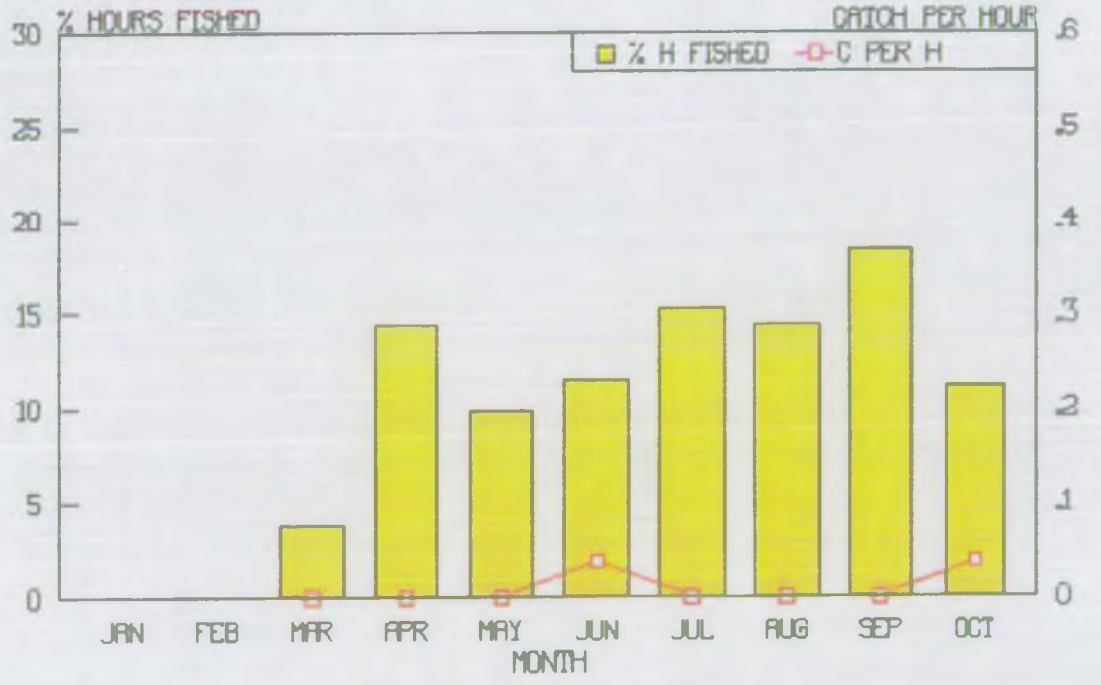
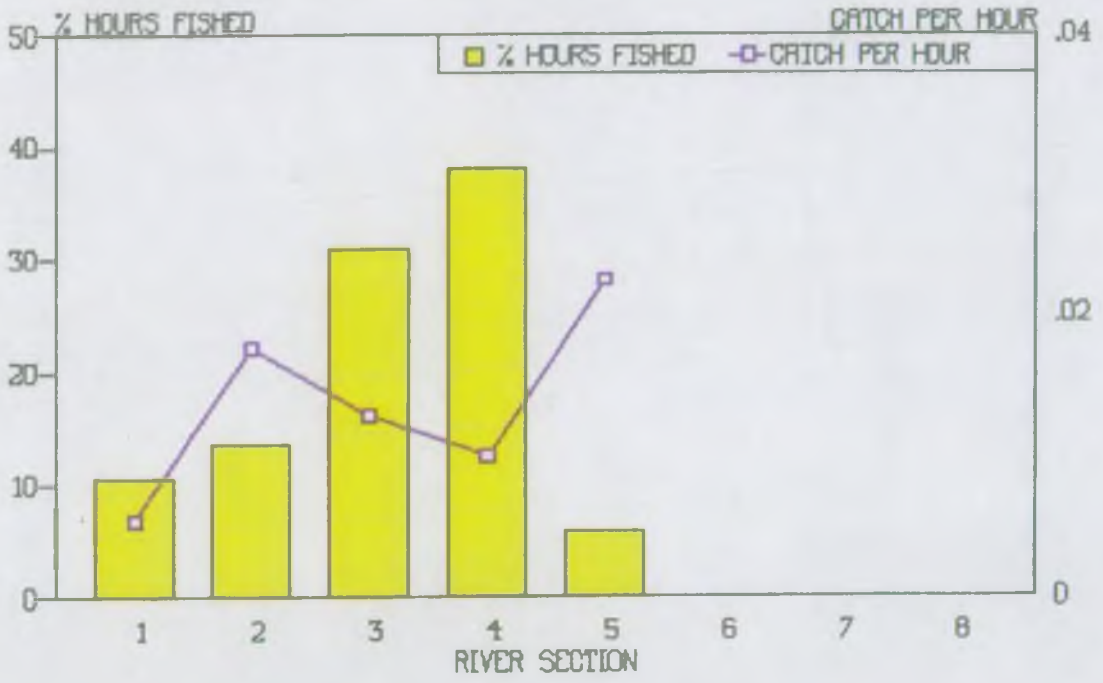


FIG. 4

DEE ANGLERS LOGBOOK 1991; SALMON:
FISHING SUCCESS BY RIVER SECTION.



DEE ANGLERS LOGBOOK 1991; SEA TROUT:
FISHING SUCCESS BY RIVER SECTION.

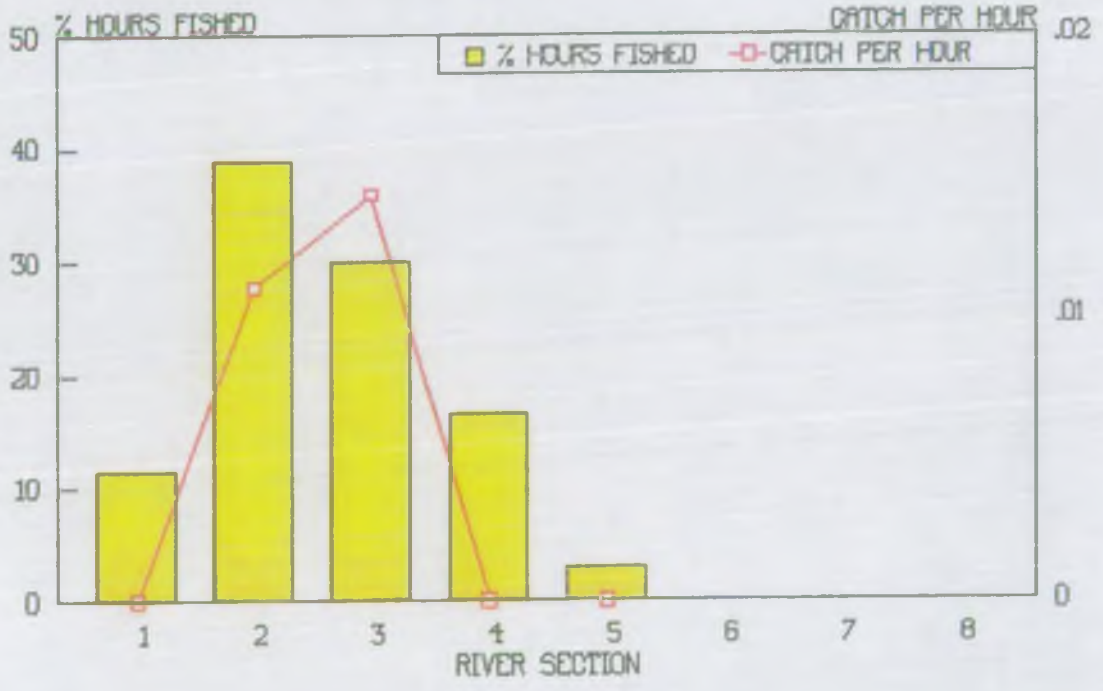
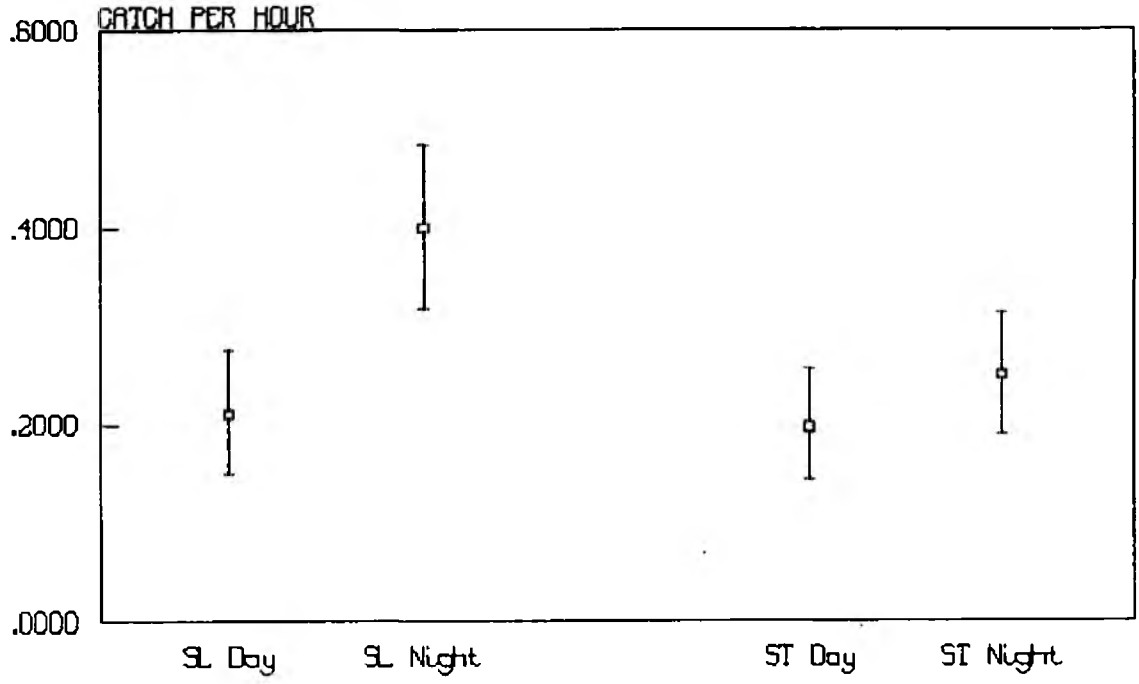


FIG. 5

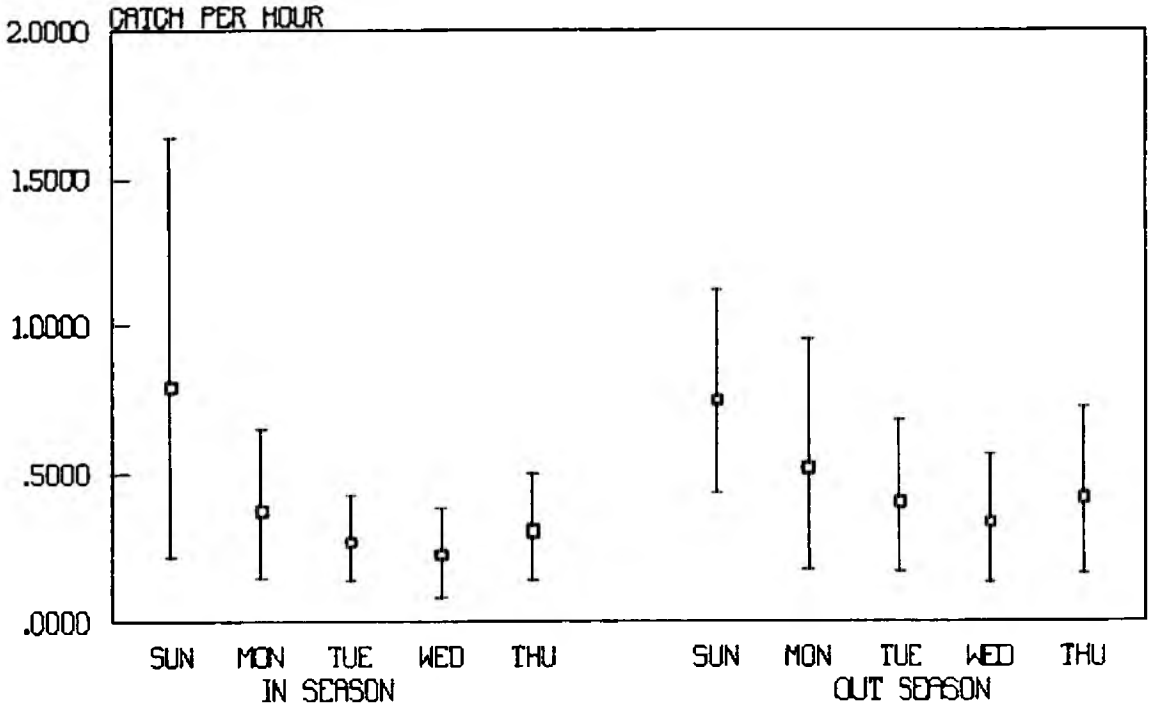
DAY AND NIGHT SESSION CATCHES; CHESTER TRAP, 1991:
SALMON (SL) AND SEA TROUT (ST).



NOTE: GEOMETRIC MEAN + 95% CON. LIMITS.

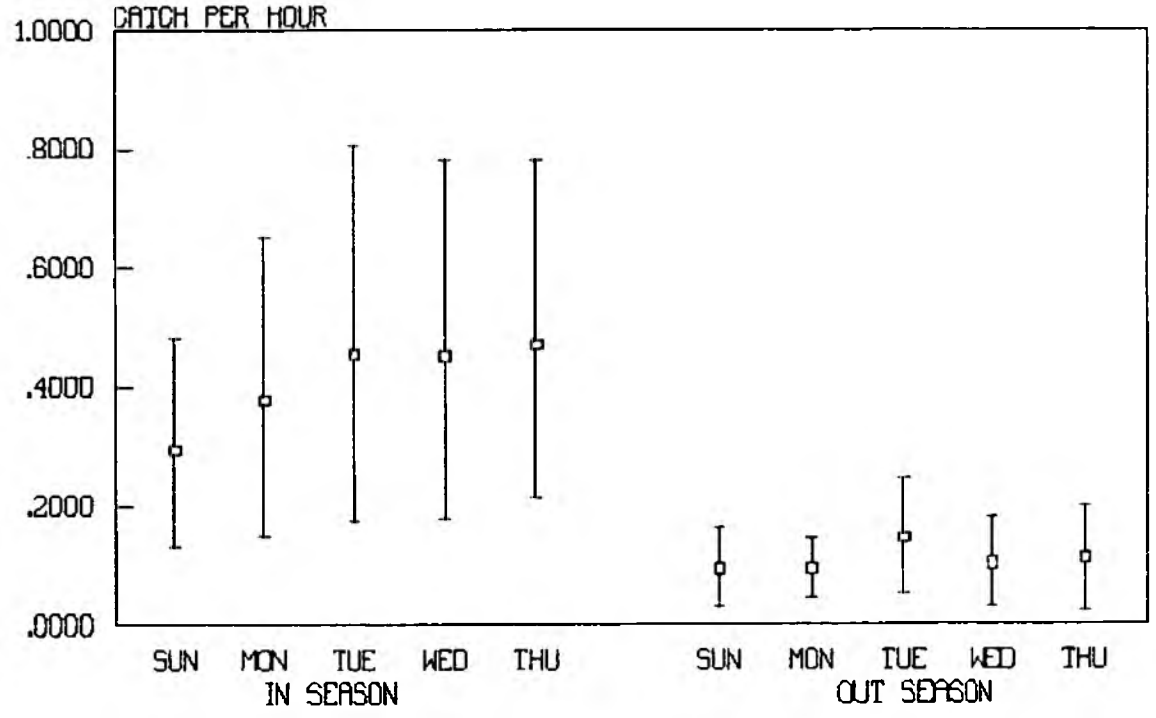
FIG. 6

SALMON NIGHT SESSION CATCH; CHESTER TRAP, 1991:
WITHIN AND OUTWITH NET FISHING SEASON.



NOTE: GEOMETRIC MEAN + 95% CON. LIMITS.

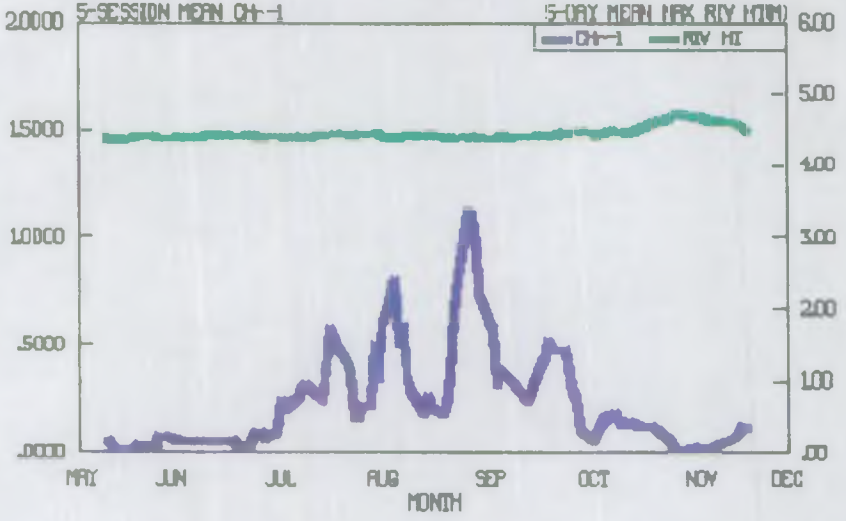
SEA TROUT NIGHT SESSION CATCH; CHESTER TRAP, 1991:
WITHIN AND OUTWITH NET FISHING SEASON.



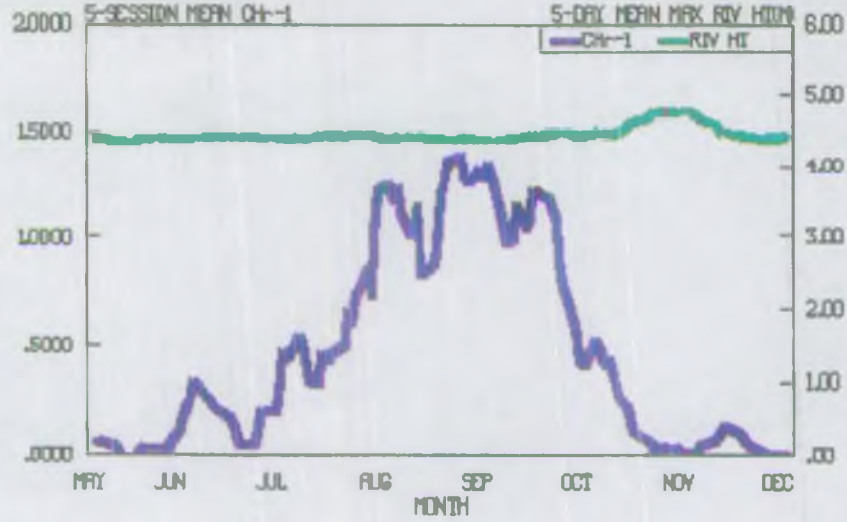
NOTE: GEOMETRIC MEAN + 95% CON. LIMITS.

FIG. 7

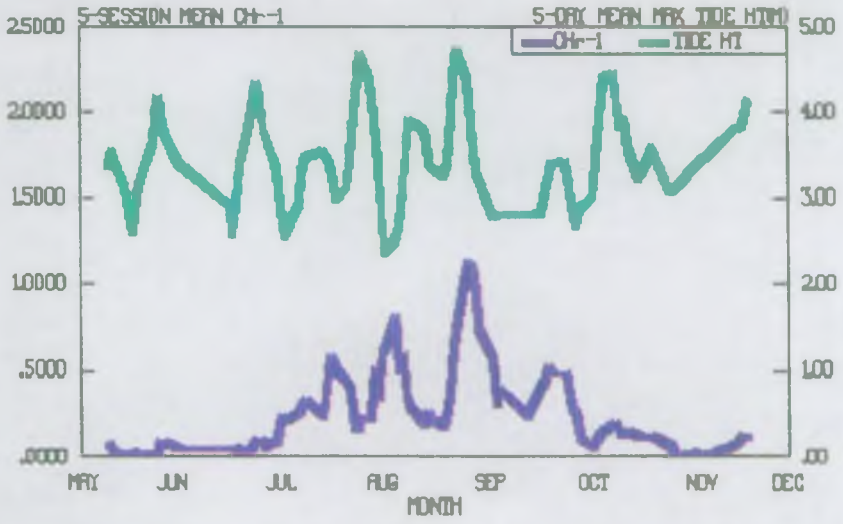
SALMON CATCH; CHESTER WEIR TRAP, 1991:
DAY SESSION DATA ONLY.



SALMON CATCH; CHESTER WEIR TRAP, 1991:
NIGHT SESSION DATA ONLY.



SALMON CATCH; CHESTER WEIR TRAP, 1991:
DAY SESSION DATA ONLY.



SALMON CATCH; CHESTER WEIR TRAP, 1991:
NIGHT SESSION DATA ONLY.

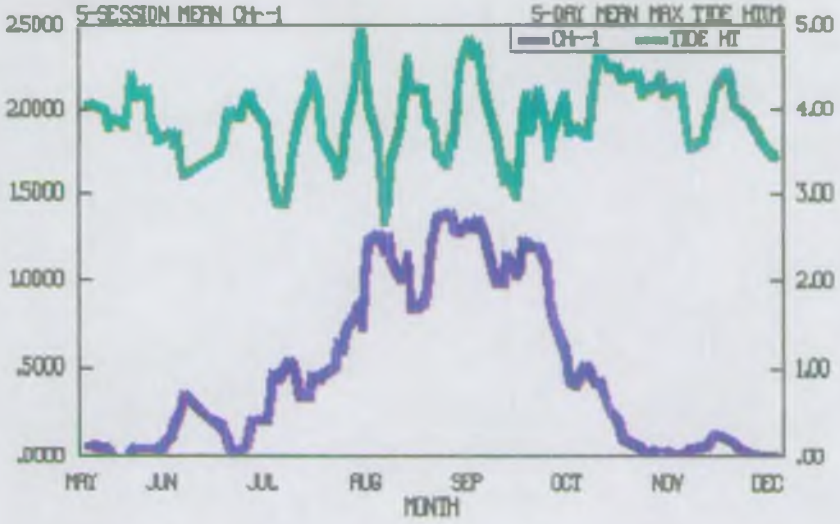
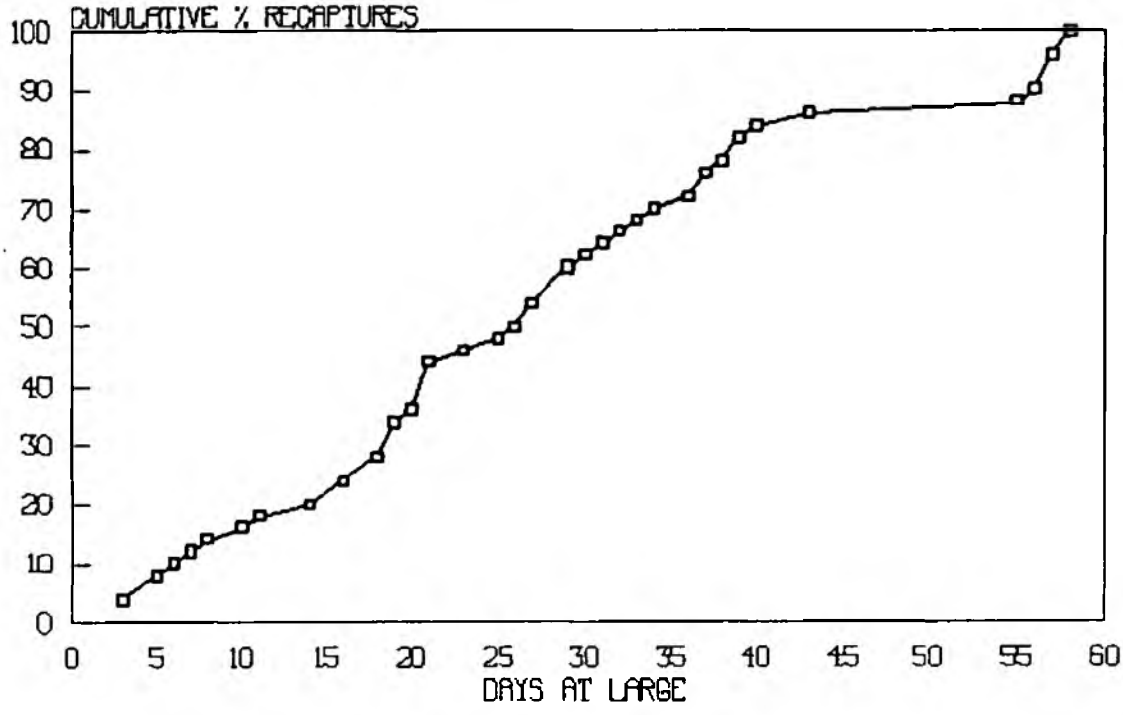
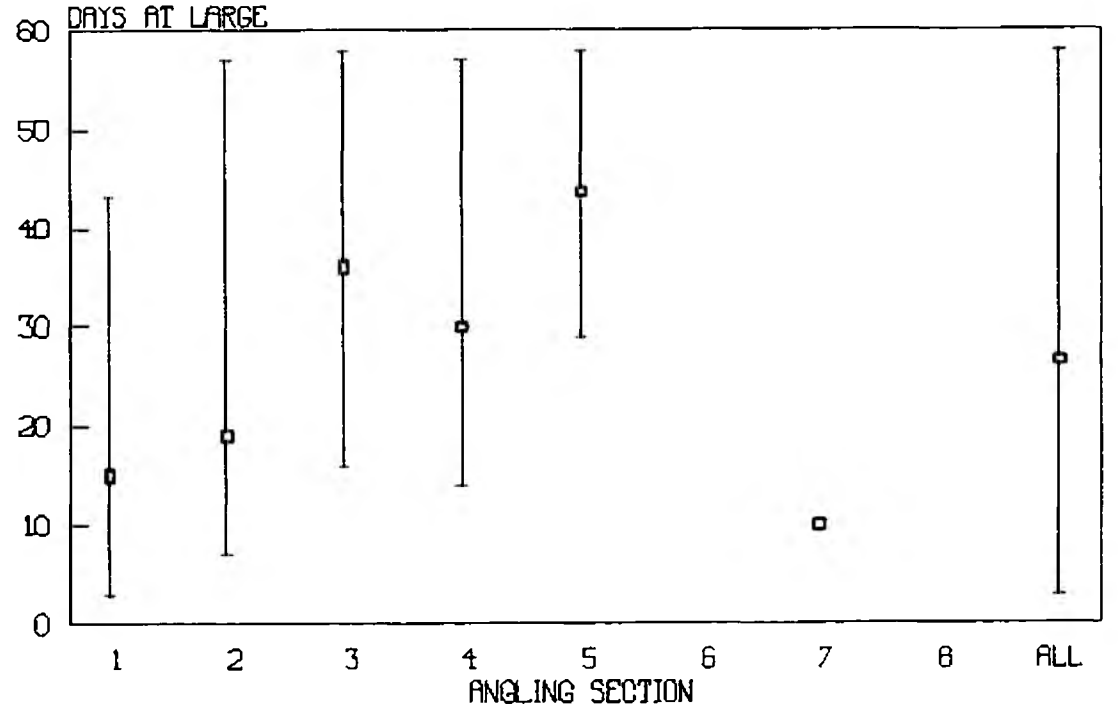


FIG. 8

a. TIME TO ROD RECAPTURE OF TRAP TAGGED SALMON, 1991.



b. TIME TO ROD RECAPTURE OF TRAP TAGGED SALMON, 1991: BY ANGLING SECTION.



NOTE: MEDIAN, MIN AND MAX TIMES INDICATED.

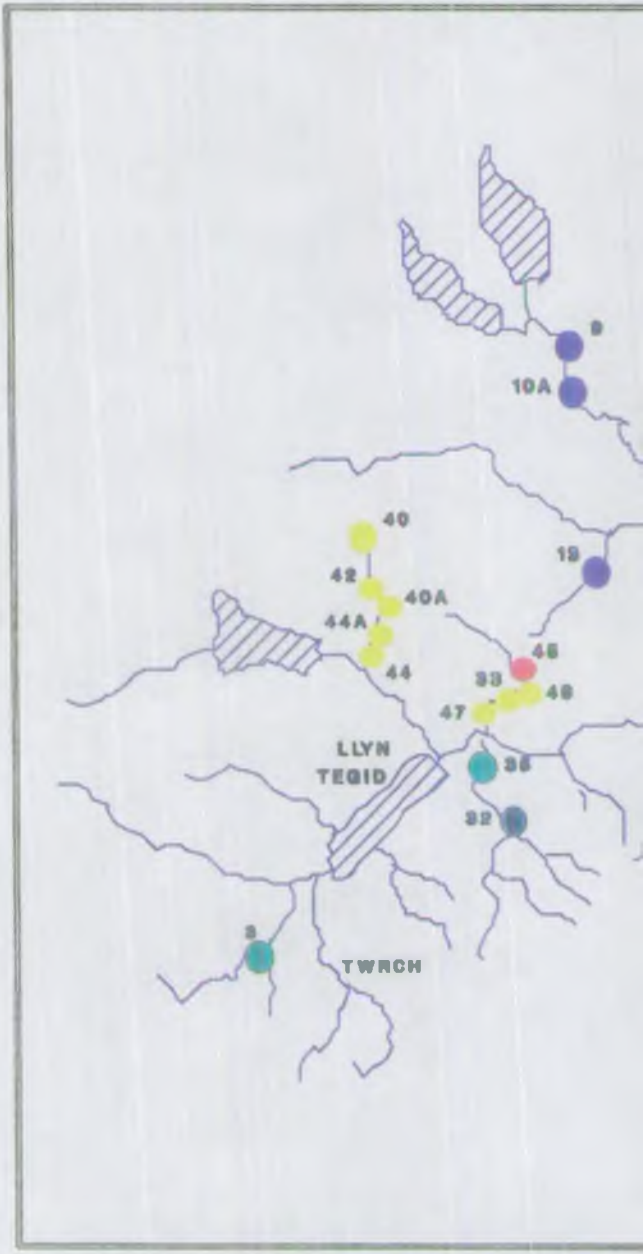

9
10A
40
42
40A
44A
44
19
46
33
48
47
LLYN
TEGID
35
32
3
TWRCH

FIG. 9a

RIVER DEE (UPPER)

SALMON DENSITIES

1991 SURVEY

FIG. 9b

RIVER DEE (UPPER)

TROUT DENSITIES

1991 SURVEY

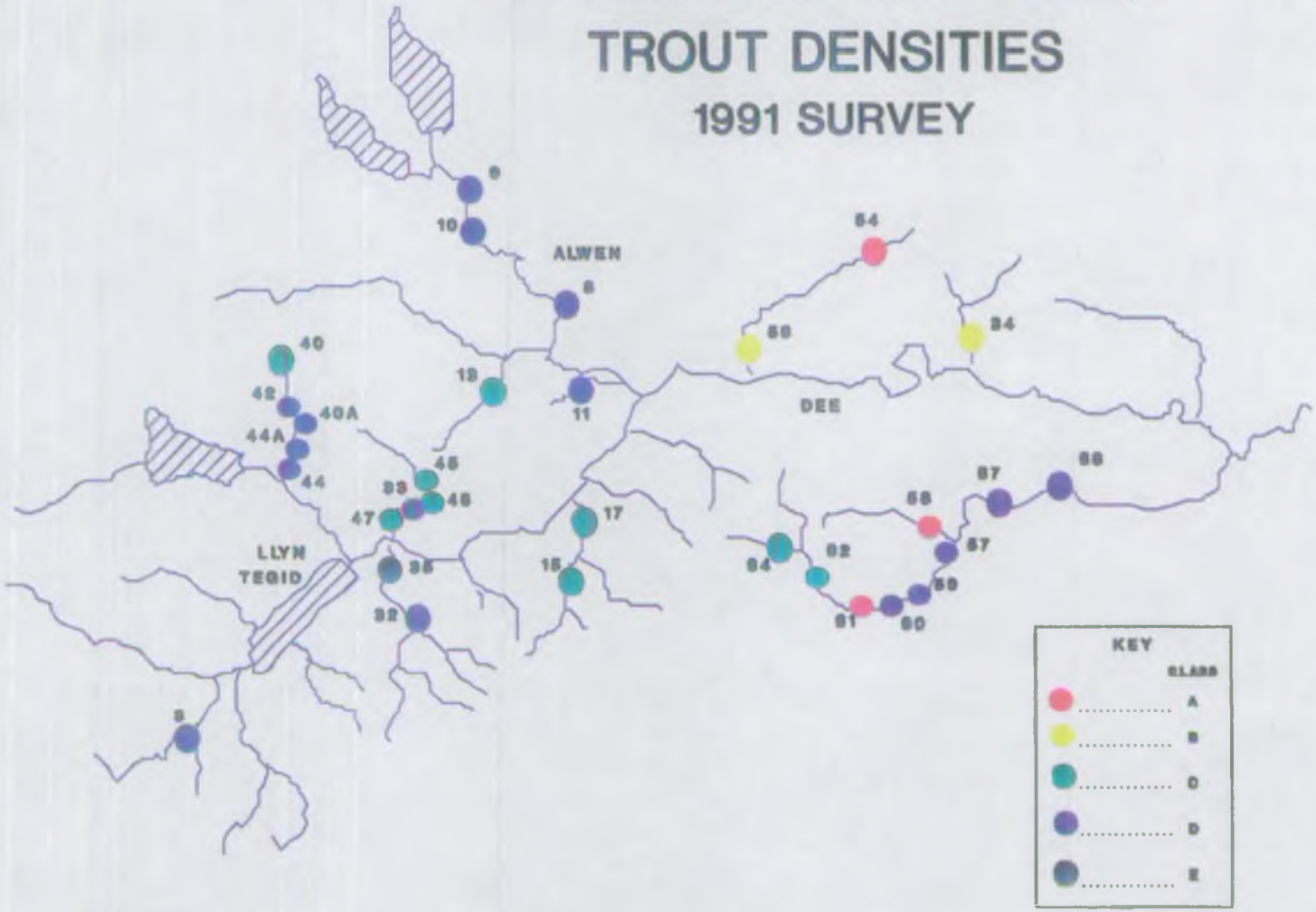


FIG. 9c

RIVER DEE - SALMON
% OF SITES IN EACH CATEGORY.

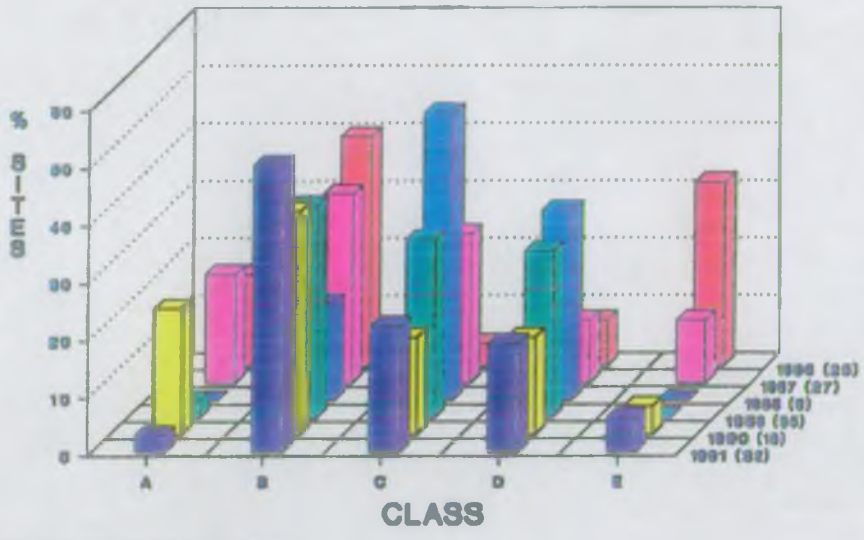
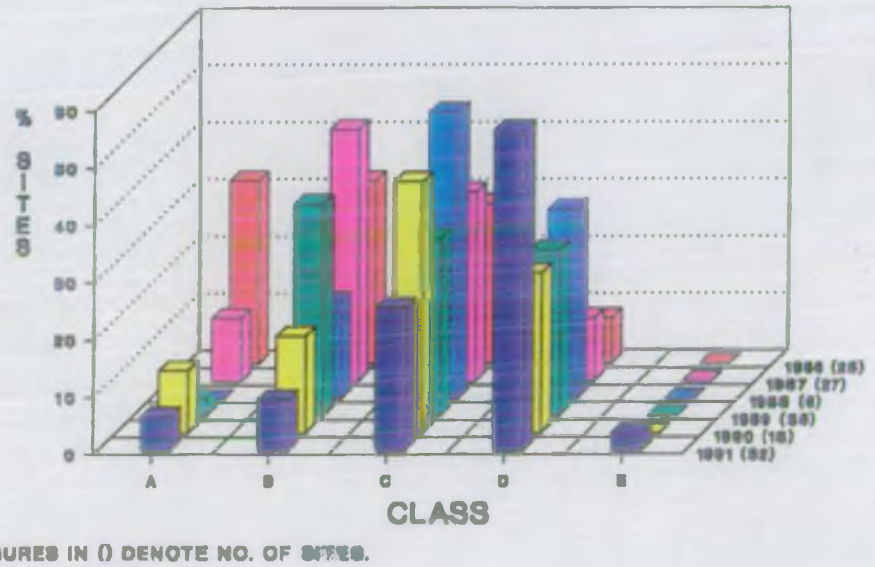


FIGURE IN () INDICATES NO. OF SITES.

RIVER DEE - TROUT
% OF SITES IN EACH CATEGORY.

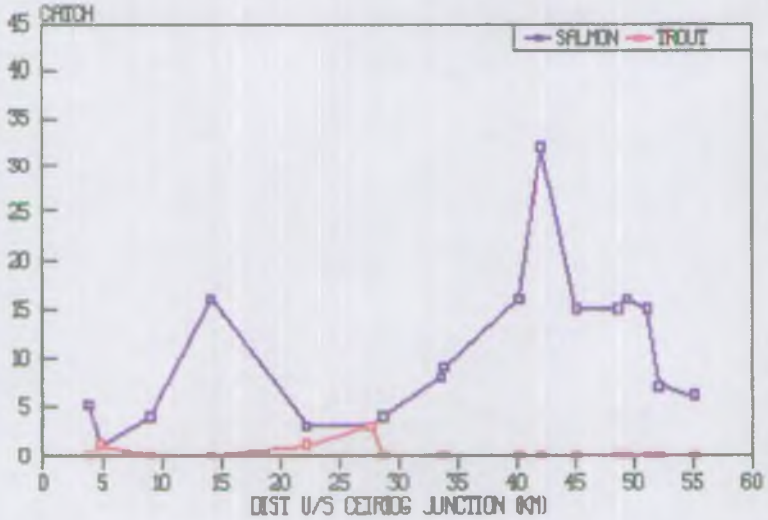


FIGURES IN () DENOTE NO. OF SITES.

FIG. 9d

Upper Dee 5 Minute Fry Sites, 1991.

TROUT & SALMON CATCH; 5 MINUTE FRY SITE, MAIN RIVER DEE, 1991



TROUT & SALMON; 5 MINUTE FRY SITE,
RIVER CEIRIOG, 1991

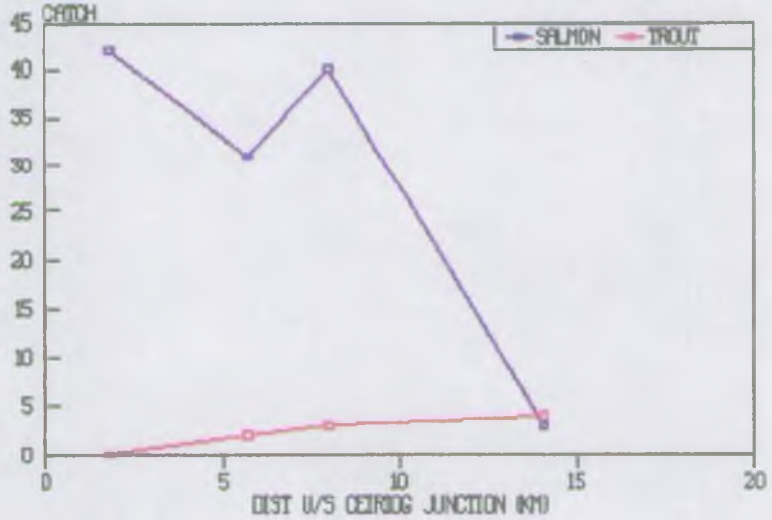
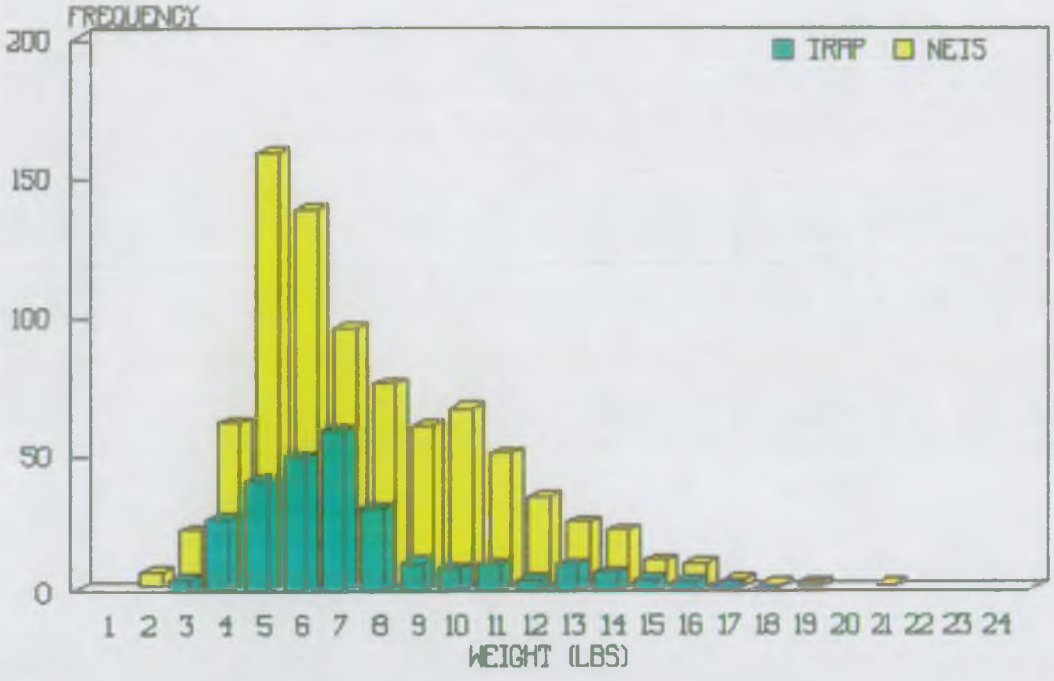
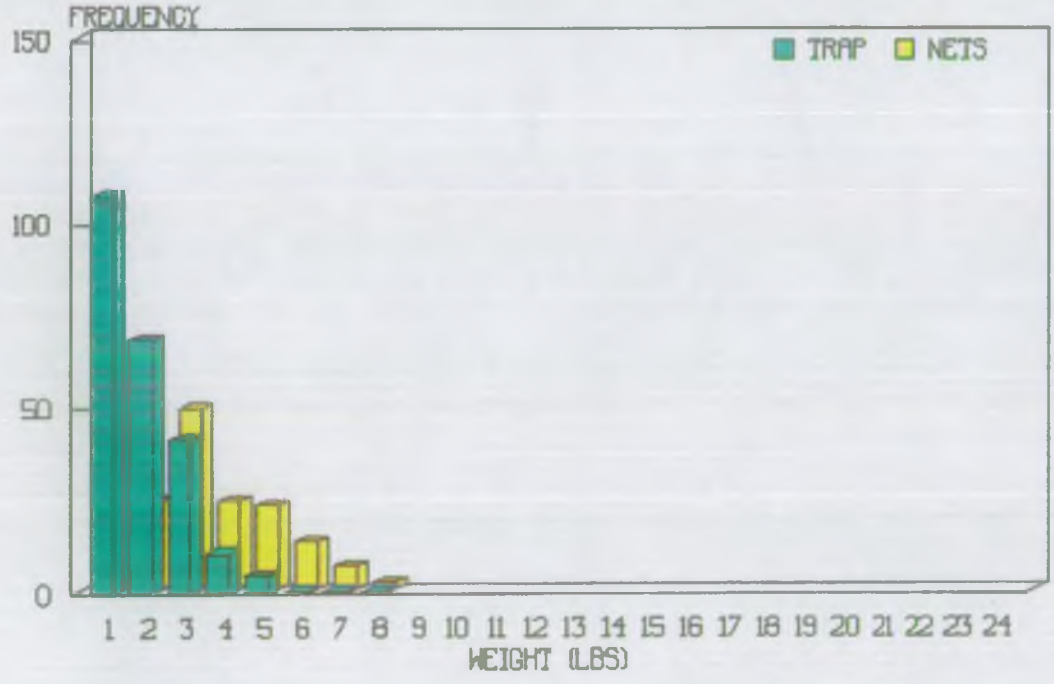


FIG. 10

SALMON WEIGHT-FREQUENCY DISTRIBUTION:
NET AND TRAP CATCH, JUNE-AUGUST, 1991.



SEA TROUT WEIGHT-FREQUENCY DISTRIBUTION:
NET AND TRAP CATCH, JUNE-AUGUST, 1991.



APPENDIX I

Estimated sea age composition of the declared salmon net catch (drafts and trammels combined), June-August, 1991.

a) Weight-frequency distribution of declared catch.

	Weight Category (lbs): 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Unkwn	Total
Catch	0	6	21	60	157	137	94	74	59	65	49	33	24	21	10	9	3	1	2	0	1	0	826

b) Sea age composition of scale sample.

	Weight Category (Lbs): 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Unkwn	Total
1SW	0	0	0	2	10	13	19	12	13	4	1	0	0	0	0	0	0	0	0	0	0	2	76
2SW	0	0	0	0	0	0	0	1	0	1	10	8	4	4	4	7	4	1	1	0	0	1	46
3SW	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2
PS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	2	10	13	19	13	13	5	11	8	5	4	4	7	5	1	1	0	0	3	124

c) % Sea age composition of declared catch - estimated from 'a' and 'b' (above).

	Weight Category (Lbs): 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1SW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.92	1.00	0.80	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2SW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.20	0.91	1.00	0.80	1.00	1.00	1.00	0.80	1.00	1.00	0.00	0.00
3SW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.20	0.00	0.00	0.00	1.00
PS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00

d) Sea age composition of declared catch - estimated from 'c' (above).

	Weight Category (Lbs): 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total
1SW	0.00	6.00	21.00	60.00	157.00	137.00	94.00	68.31	59.00	52.00	4.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	658.76
2SW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.69	0.00	13.00	44.55	33.00	19.20	21.00	10.00	9.00	2.40	1.00	2.00	0.00	0.00	160.84
3SW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.80	0.00	0.00	0.00	0.60	0.00	0.00	0.00	1.00	6.40
PS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	6.00	21.00	60.00	157.00	137.00	94.00	74.00	59.00	65.00	49.00	33.00	24.00	21.00	10.00	9.00	3.00	1.00	2.00	0.00	1.00	826.00

Note: Where possible, % sea age composition for each weight category has been based entirely on scale readings. For weight categories where scale samples were not available, the weight-frequency distribution was also used to estimate age composition.

APPENDIX II

Dee Anglers Logbook returns, 1989: Final results.

Logbooks distributed = 215

Complete returns = 76 (35.3%)

Incomplete returns = 16 (7.4%)

Did not fish = 23 (10.7%) Total salmon catch = 46

Total returns received = 115 (53.5%) Total sea trout catch = 21

(Figures in brackets indicate % of total logbooks distributed.)

Salmon statistics: Calculated from the returns of anglers fishing for salmon only or both species.

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Unkn	All
Visits	8	30	115	163	173	122	110	159	235	152	55	1327
% Total visits	0.6	2.3	8.7	12.3	13.0	9.2	8.3	12.0	17.7	11.8	4.1	100.0
Hours fished	40.00	108.95	465.25	654.75	714.00	508.50	426.00	668.25	1031.50	677.75	183.00	5477.95
% Total hours	0.7	2.0	8.5	12.0	13.0	9.3	7.8	12.2	18.8	12.4	3.3	100.0
Catch	0	0	3	4	4	7	4	3	14	5	2	46
% Total catch	0.0	0.0	6.5	8.7	8.7	15.2	8.7	6.5	30.4	10.9	4.3	100.0
Catch per hour	0.0000	0.0000	0.0064	0.0061	0.0056	0.0138	0.0094	0.0045	0.0136	0.0074	0.0109	0.0084

Sea trout statistics: Calculated from the returns of anglers fishing for sea trout only or both species.

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Unkn	All
Visits	0	0	1	6	5	4	6	12	2	1	0	37
% Total visits	0.0	0.0	2.7	16.2	13.5	10.8	16.2	32.4	5.4	2.7	0.0	100.0
Hours fished	-	-	6.00	24.00	21.50	24.00	16.00	40.00	6.50	5.50	-	143.00
% Total hours	-	-	4.2	16.7	15.0	16.7	11.1	27.9	4.5	3.8	-	100.0
Catch	-	-	0	0	1	0	1	6	0	0	-	8
% Total catch	-	-	0.0	0.0	12.5	0.0	12.5	75.0	0.0	0.0	-	100.0
Catch per hour	-	-	0.0000	0.0000	0.0465	0.0000	0.0625	0.1500	0.0000	0.0000	-	0.0557

APPENDIX II (Contd.)

Dee Anglers Logbook returns, 1990: Final results.

Logbooks distributed - 369

Completed returns - 99 (26.8%)

Incomplete returns - 23 (6.2%)

Did not fish - 34 (9.2%) Total salmon catch - 93

Total returns received - 156 (42.3%) Total sea trout catch - 54

(Figures in brackets indicate % of total logbooks distributed.)

Salmon statistics: Calculated from the returns of anglers fishing for salmon only or both species.

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Unkn	All
Visits	2	33	213	179	201	141	130	132	245	253	19	1548
% Total visits	0.1	2.1	13.8	11.6	13.0	9.1	8.4	8.5	15.8	16.3	1.2	100.0
Hours fished	11.00	137.00	876.50	791.75	928.00	649.25	580.00	590.00	1227.50	1259.00	100.50	7150.50
% Total hours	0.2	1.9	12.3	11.1	13.0	9.1	8.1	8.3	17.2	17.6	1.4	100.0
Catch	0	1	5	5	9	3	6	3	22	39	0	93
% Total catch	0.0	1.1	5.4	5.4	9.7	3.2	6.5	3.2	23.7	41.9	0.0	100.0
Catch per hour	0.0000	0.0073	0.0057	0.0063	0.0097	0.0046	0.0103	0.0051	0.0179	0.0310	0.0000	0.0130

Sea trout statistics: Calculated from the returns of anglers fishing for sea trout only or both species.

Month:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Unkn	All
Visits	0	0	2	1	6	7	6	19	17	12	1	71
% Total visits	0.0	0.0	2.8	1.4	8.5	9.9	8.5	26.8	23.9	16.9	1.4	100.0
Hours fished	-	-	6.00	2.00	24.00	23.00	20.00	66.50	69.50	61.00	3.00	275.00
% Total hours	-	-	2.2	0.7	8.7	8.4	7.3	24.2	25.3	22.2	1.1	100.0
Catch	-	-	0	0	0	1	8	4	4	2	0	19
% Total catch	-	-	0.0	0.0	0.0	5.3	42.1	21.1	21.1	10.5	0.0	100.0
Catch per hour	-	-	0.0000	0.0000	0.0000	0.0435	0.4000	0.0602	0.0576	0.0328	0.0000	0.0691

APPENDIX II (Contd.)

Dee Anglers Logbook returns, 1991: Provisional results.

Logbooks distributed - 377

Complete returns - 103 (27.3%)

Incomplete returns - 13 (3.4%)

Did not fish - 22 (5.8%) Total salmon catch - 86

Total returns received - 138 (36.6%) Total sea trout catch - 6

(Figures in brackets indicate % of total logbooks distributed.)

Salmon statistics: Calculated from the returns of anglers fishing for salmon only or both species.

	Month: Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Unkn	All
Visits	14	49	127	189	171	183	150	147	250	241	24	1545
% Total visits	0.9	3.2	8.2	12.2	11.1	11.8	9.7	9.5	16.2	15.6	1.6	100.0
Hours fished	63.50	202.50	578.75	777.00	882.75	836.75	678.50	753.50	1054.75	1188.50	89.00	7045.50
% Total hours	0.9	2.9	8.2	11.0	11.7	11.9	9.6	10.7	15.0	16.9	1.3	100.0
Catch	1	1	1	3	5	12	3	10	14	36	0	86
% Total catch	1.2	1.2	1.2	3.5	5.8	14.0	3.5	11.6	16.3	41.9	0.0	100.0
Catch per hour	0.0157	0.0049	0.0017	0.0039	0.0061	0.0143	0.0044	0.0133	0.0133	0.0303	0.0000	0.0122

Sea trout statistics: Calculated from the returns of anglers fishing for sea trout only or both species.

	Month: Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Unkn	All
Visits	0	0	3	12	7	10	11	7	38	16	1	105
% Total visits	0.0	0.0	2.9	11.4	6.7	9.5	10.5	6.7	36.2	15.2	1.0	100.0
Hours fished	-	-	9.00	33.50	23.00	26.75	35.50	33.50	43.00	26.00	2.00	232.25
% Total hours	-	-	3.9	14.4	9.9	11.5	15.3	14.4	18.5	11.2	0.9	100.0
Catch	-	-	0	0	0	1	0	0	0	1	0	2
% Total catch	-	-	0.0	0.0	0.0	50.0	0.0	0.0	0.0	50.0	0.0	100.0
Catch per hour	-	-	0.0000	0.0000	0.0000	0.0374	0.0000	0.0000	0.0000	0.0385	0.0000	0.0086

APPENDIX III

Dee Anglers Logbook, 1991; returns by river section: Provisional results.

Salmon statistics: Calculated from the returns of anglers fishing for salmon only or both species.

	River section: 1	2	3	4	5	6	7	8	Unkn	All
Visits	184	276	460	518	87	0	0	0	20	1545
% Total visits	11.9	17.9	29.8	33.5	5.6	0.0	0.0	0.0	1.3	100.0
Hours fished	738.00	959.00	2175.00	2678.00	400.0	-	-	-	94.50	7045.00
% Total hours	10.5	13.6	30.9	38.0	5.7	-	-	-	1.3	100.0
Catch	4	17	28	27	9	-	-	-	1	86
% Total catch	4.7	19.8	32.6	31.4	10.5	-	-	-	1.2	100.0
Catch per hour	0.0054	0.0177	0.0129	0.0101	0.0225	-	-	-	0.0106	0.0122

Sea trout statistics: Calculated from the returns of anglers fishing for sea trout only or both species.

	River section: 1	2	3	4	5	6	7	8	Unkn	All
Visits	6	67	18	11	3	0	0	0	0	105
% Total visits	5.7	63.8	17.1	10.5	2.9	0.0	0.0	0.0	0.0	100.0
Hours fished	26.50	90.50	69.75	38.50	7.00	-	-	-	-	232.25
% Total hours	11.4	39.0	30.0	16.6	3.0	-	-	-	-	100.0
Catch	0	1	1	0	0	-	-	-	-	2
% Total catch	0.0	50.0	50.0	0.0	0.0	-	-	-	-	100.0
Catch per hour	0.0000	0.0110	0.0143	0.0000	0.0000	-	-	-	-	0.0086

APPENDIX IV

a) Day and night session catch per hour (CHr-1): Chester Trap, May-December, 1991.

		Geometric values: Mean CHr-1	St Dev CHr-1	-95%CL CHr-1	+95%CL CHr-1	n
Salmon:	Day	.2109	.2908	.1497	.2753	93
	Night	.3980	.4106	.3162	.4849	125
Sea Trout:	Day	.1969	.2605	.1419	.2546	93
	Night	.2501	.3282	.1894	.3139	125

b) Weekday night session catch per hour (CHr-1): Chester Trap, 1991: Within and outwith the net fishing season.

		Geometric values: Mean CHr-1	St Dev CHr-1	-95%CL CHr-1	+95%CL Chr-1	n
Salmon:						
	Sun	.7951	.6793	.2227	1.6354	7
	Mon	.3766	.4043	.1446	.6557	13
In Season	Tue	.2720	.2342	.1346	.4262	13
	Wed	.2231	.2437	.0812	.3837	12
	Thu	.3048	.3080	.1390	.4947	15
	Sun	.7461	.3270	.4353	1.1243	8
	Mon	.5149	.5971	.1745	.9539	13
Out Season	Tue	.3994	.4093	.1692	.6750	14
	Wed	.3309	.3739	.1333	.5630	15
	Thu	.4183	.4761	.1647	.7273	15
Sea trout:						
	Sun	.2940	.2027	.1286	.4835	7
	Mon	.3767	.3957	.1485	.6502	13
In Season	Tue	.4553	.4836	.1744	.8034	13
	Wed	.4503	.4395	.1801	.7822	12
	Thu	.4707	.4623	.2134	.7825	15
	Sun	.0939	.0922	.0291	.1629	8
	Mon	.0945	.0864	.0462	.1449	13
Out Season	Tue	.1464	.1743	.0539	.2471	14
	Wed	.1020	.1481	.0276	.1818	15
	Thu	.1092	.1698	.0246	.2009	15

APPENDIX V

Petersen and Schaefer population estimates.

a) Schaefer estimate

$$N = Nij = \frac{R_{ij} \cdot M_i \cdot C_j}{R_i \cdot R_j}$$

M_i - Number of fish marked in the ith period of marking.

C_j - Number of fish caught and examined in the jth period of recovery.

R_{ij} - Number of fish marked in the ith period which are recaptured in the jth recovery period.

R_i - Total captures of fish caught in the ith period.

R_j - Total captures during the jth period.

b) Petersen estimate

$$N = \frac{M.C}{R}$$

N - Size of population at time of marking.

M - Number of fish marked.

C - Catch.

R - Number of recaptured marked in the sample.

APPENDIX V (Contd.)

Schaefer and Petersen mark-recapture estimates: Salmon Flow and radio tagged at Chester Trap, 1991.

a) Schaefer estimates:

i) Total tagged and recaptured, and rod exploitation estimates (Ur) by month.

	Month tagged (i):											Tags recv.	Total catch	
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Rj	Cj	Cj/Rj
Month recovered (j) Dec	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jan	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Feb	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mar	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apr	-	-	-	-	-	-	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jun	-	-	-	-	-	-	2	-	-	-	-	2	56	28.0
Jul	-	-	-	-	-	-	2	0	-	-	-	2	14	7.0
Aug	-	-	-	-	-	-	0	3	4	-	-	7	47	6.7
Sep	-	-	-	-	-	-	0	0	9	5	-	14	65	4.6
Oct	-	-	-	-	-	-	0	0	7	17	1	25	167	6.7
												Sum 50	349	
Tags recovered (Ri)	-	-	-	-	-	-	4	3	20	22	1	50		
* Total tagged (Mi)	-	-	-	-	-	-	17	62	257	311	136	783		
Mi/Ri	-	-	-	-	-	-	4	21	13	14	136			
% Rod exploit.(Ur)-														
Ri/Mi	-	-	-	-	-	-	23.54	4.84	7.78	7.07	0.74	6.39		
-95%CL	-	-	-	-	-	-	9.04	1.61	5.03	4.67	0.11	4.84		
+95%CL	-	-	-	-	-	-	60.60	14.26	12.02	10.71	4.29	8.42		

* Tagged fish caught at the nets (Jul=1; Aug=2) or found dead (Oct=1), have been removed from the Mi monthly totals.

(ii) Population estimated by month.

	Month tagged (i):											
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Month recovered (j) Dec	-	-	-	-	-	-	-	-	-	-	-	-
Jan	-	-	-	-	-	-	-	-	-	-	-	-
Feb	-	-	-	-	-	-	-	-	-	-	-	-
Mar	-	-	-	-	-	-	-	-	-	-	-	-
Apr	-	-	-	-	-	-	-	-	-	-	-	-
May	-	-	-	-	-	-	-	-	-	-	-	-
Jun	-	-	-	-	-	-	238	-	-	-	-	238
Jul	-	-	-	-	-	-	60	0	-	-	-	60
Aug	-	-	-	-	-	-	0	416	345	-	-	761
Sep	-	-	-	-	-	-	0	0	537	328	-	865
Oct	-	-	-	-	-	-	0	0	601	1605	908	3114
Total	-	-	-	-	-	-	298	416	1483	1933	908	5038

b) Petersen estimate - Population estimate (N) all months.

M = 783 N = 5465 (95%CL: 4146-7206)
C = 349
R = 50

APPENDIX VI

Dee Juvenile Monitoring Programme, 1991.

a) Quantitative sites. (Fish numbers 100m-2)

Site no.	River	Width (m)	O.S. Map reference	Salmon: 0+	1+	>1+	Class	Trout: 0+	1+	>1+	Class	Other species:
11	Nant Ffrauer	2.5	SJ 043433	32.6	5.6	0	B	8.4	1.9	0	D	E,Bh,SL
17	Ceidiog	3.6	SJ 026352	0	0.6	0	D	3.3	10.6	2.8	C	
33	Meloch	3.4	SH 964384	41.9	14.7	0	B	14.3	2.8	0.6	D	
34	Abbey Brook	3.7	SJ 205457	49.5	11.1	0	B	39.7	11.4	1.2	B	
40	Mynach	4.8	SH 909415	62.5	7.5	0	B	4.9	5.6	0	C	SL,E
57	Ceiriog	6.7	SJ 196357	15.3	6.2	0	C	16.8	2.8	0.3	D	E
			Mean	33.6	7.6	0	B	14.6	5.9	0.8	C	

b) Semi quantitative sites. (Fish numbers per 100m-2.)

Site no.	River	Width (m)	O.S. Map reference	Salmon: 0+	1+	>1+	Class	Trout: 0+	1+	>1+	Class	Other species:
3	Dee	3.4	SJ 043438	41.9	15.3	0	B	14.3	2.8	0.6	D	E,Bh,SL
8	Alwen	14.7	SJ 029464	13.0	1.1	0	C	2.2	0.1	0	D	E,Bh
9	Alwen	13.2	SH 997487	6.5	0.5	0	D	1.4	0	0	D	E,Bh
10	Alwen	9.4	SH 988508	4.0	1.2	0	D	0.2	0.7	0	D	
10A	Alwen	11.5	SH 988508	4.8	1.2	0	D	1.9	0.2	0	D	
13	Merddwr	3.4	SJ 000426	0.5	2.0	0	D	11.8	1.0	0	C	
15	Ceidiog	5.4	SJ 031356	10.0	3.9	0	C	0.7	1.4	1.8	C	E,Bh
32#	Hirnant	4.2	SH 957323	0	0	0	E	0	2.1	2.7	D	
35	Hirnant	7.4	SH 949362	10.3	0.9	0	C	0	0	0	E	
40A	Mynach	5.7	SH 909410	23.8	4.4	0	B	1.7	0.4	0	D	SL
42	Mynach	4.2	SH 911418	44.6	8.2	0	B	1.5	2.2	0	D	E
44	Mynach	5.0	SH 906392	34.7	0.8	0	B	1.5	2.2	0	D	E,SL
44A	Mynach	6.1	SH 907397	23.5	1.4	0	B	1.4	1.1	0.4	D	
45	Meloch	4.0	SJ 963388	61.2	2.7	0	A	7.5	1.1	0	D	
46	Meloch	3.3	SH 963386	33.9	6.1	0	B	5.5	3.0	0.6	C	
47	Meloch	5.0	SH 952368	22.6	4.8	0	B	0.4	3.9	0	C	
54	Morwynion	2.1	SJ 145475	12.1	0	0	D	84.0	8.4	1.9	A	E,Bh,SL
56	Morwynion	3.6	SJ 112434	42.2	4.1	0	B	16.5	2.6	0	B	E,Bh
58#	Teirw	4.0	SJ 196358	0	0	0	E	33.5	11.5	1.0	A	
59	Ceiriog	6.0	SJ 188343	18.3	3.3	0	B	7.7	0	0	D	E,Bh,SL
60	Ceiriog	5.0	SJ 158328	39.1	1.3	0	B	10.2	0	0	D	E,Bh,SL
61	Ceiriog	2.1	SJ 157328	16.2	1.0	0	C	107.6	5.7	1.0	A	SL,L,Bh
62	Ceiriog	6.3	SJ 138342	7.1	2.5	0	C	10.3	0.6	0.3	C	
64	Ceiriog	2.9	SJ 136346	6.3	7.7	0	C	4.2	2.8	2.8	C	E,Bh,SL
67	Ceiriog	9.5	SJ 220373	15.8	9.5	0	B	2.4	1.1	0.3	D	E,Bh
68	Ceiriog	7.4	SJ 245385	18.6	2.4	0	B	3.0	0.7	0	D	E,Bh
			Mean	21.3	3.6	0	B	12.8	12.1	0.5	B	

c) Five minute fry (riffle) sites.

Site no.	River	O.S Map reference	Salmon 0+	Salmon >0+	Trout 0+	Trout >0+
67	Ceiriog	SJ 310 382	42	0	0	0
68	Ceiriog	SJ 279 373	31	0	2	0
69	Ceiriog	SJ 260 379	40	1	3	0
70	Ceiriog	SJ 208 379	3	10	4	6
		Mean	29.0	2.8	2.3	1.5
71	Dee	SH 983 366	6	0	0	0
72	Dee	SJ 009 373	7	0	0	0
73	Dee	SJ 016 368	15	0	0	0
74	Dee	SJ 027 378	16	0	0	0
75	Dee	SJ 028 384	15	0	0	0
76	Dee	SJ 043 403	15	0	0	0
77	Dee	SJ 054 423	32	0	0	0
78	Dee	SJ 069 432	16	0	0	0
79	Dee	SJ 114 437	9	0	0	0
80	Dee	SJ 117 437	8	0	0	0
81A	Dee	SJ 152 429	4	0	0	0
82	Dee	SJ 157 433	3	0	3	0
83	Dee	SJ 176 444	3	0	1	0
84A	Dee	SJ 232 422	16	0	0	0
85	Dee	SJ 268 417	4	0	0	0
86	Dee	SJ 296 416	1	0	1	0
87	Dee	SJ 292 421	5	0	0	0
		Mean	10.3	0	0.3	0

Probably inaccessible to migratory fish.