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IONCORPORTHA

(THE SALMON RESEARCH TRUST OF IRELAND INCORPORATED)

Sponsored by Arthur Guinness & Sons P.L.C.
and the Minister for Fisheries & Forestry.

ANNUAL REPORT
No. XXVII

REPORT FOR THE YEAR ENDED 31st DECEMBER, 1982.

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Glossary.

The Annual Report was prepared as follows:-

TFC : Section A7, B7-10 & 12, C2(iv), 3 & 4, E1-3 and general editing.
CPRM : Section B6, 11 & 16, C1(ii)d,e, C2 (ii), (iii), D1-3.
DJP : Section A1-5, B1-5 & 13, C1 and 2(i) & (v), D4 and general editing.
DTQ : Section A6, B14 & 15.

Thanks are due to Geraldine O'Donnell for providing the data for Section B1-5, 7-9, 12 & 13, to Dr. G. Mahon for computer analysis used in Section D2 and Theresa Maguire and Lesley Mills for collating data.

COMMITTEE OF MANAGEMENT

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J. Power
Miss Eileen Twomey
(as Nominees of the Minister for Fisheries and Forestry)

Prof. Máire Mulcahy
M. Phelan
(Elective Members)

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SECTION A : GENERAL

1. COMMITTEE OF MANAGEMENT

The composition of the Committee (Chairman: T. K. Whitaker) remained unchanged during 1982.

2. CONSULTATIVE COMMITTEE

The Committee membership remained unchanged in 1982. At a meeting in June, it was proposed that the Trust should take a more active part in collecting and collating data from other organisations on conservation of Irish salmon stocks, and in influencing public opinion on this subject. This policy was pursued during 1982.

3. PERSONNEL

Mr. J. O'Kelly was given unpaid leave of absence during 1982, in order to complete his studies for the degree of Ph.D. at University College, Galway. He later resigned from his employment with the Trust as from December 31st, 1982. Miss Geraldine O'Donnell, was appointed as Temporary Biologist, with effect from January 1st, 1982. Mr. D. T. Quigley attended a course on fish farming techniques for one month at Inverness Technical College, sponsored by the EEC Young Workers Exchange Scheme. He was replaced during that period by Mr. Gerard Rogan.

Five students (Angela Kelly, Geraldine Meade, Arthur Neiland, Fergal Nolan and Michael Horgan) were employed as Temporary Scientific Assistants from early July to late September. Three French students (Michel Bertignac, Luc de la Franssu and Philippe Stipon) were accommodated by the Trust on short, unpaid study visits, as was James Dwyer (Ireland).

4. INSTALLATIONS

During the spring and early summer, a new 4" plastic pipeline was installed at the Mill Race, furnishing an independent water supply for the 2m ponds. At the same time, early-feeding facilities were increased by the installations of 4 new GRP ponds (2m diam.) manufactured by Munster Marine Ltd., Middleton, Co. Cork. Also at the Mill Race, a 4" gate-valve was inserted in the pipeline serving the 2-years-old smolt ponds, so that flood-borne detritus can be flushed out of the pipe more easily.

At the Salmon Leap, a new reinforced concrete platform was constructed around the watch-hut and a steel door fitted to the downstream-trap hut.

At Treanlaur, two broodstock holding raceways were constructed by modification of the existing rectangular ponds. A difficult U-turn in the access road has been bypassed by a new section of road and the harbour entrance was dredged. The sale of Treanlaur Lodge to An Óige was concluded during the year.

5. METEOROLOGICAL DATA

Despite very low rainfall amounts in April and July, total precipitation for the year was 109% of the average for 1971-81. Heavy rainfall in November and December is a regularly recurring climatic feature and provides optimum conditions for the spawning of salmon and sea trout.

The spell of cold weather in January reduced the water temperature to 3°C but this quickly reverted to the more normal value of 5°C by the end of January and reached 10°C by April 25. The combination of sunshine and lack of rain in July increased the mean daily water temperatures to 21°C for a period of six days, these being the highest values recorded since 1976.

Table 1. Monthly rainfall totals (mm) and annual total (mm and ins) for 1971-82.

January	139.1	1971	1174.3	46.2
February	119.3	1972	1275.4	50.2
March	178.6	1973	1468.7	57.8
April	30.7	1974	1573.2	61.9
May	89.4	1975	1299.6	51.2
June	120.1	1976	1266.7	49.8
July	25.1	1977	1579.7	62.2
August	135.4	1978	1592.2	62.7
September	114.6	1979	1653.3	65.1
October	152.5	1980	1792.1	70.6
November	206.4	1981	1646.8	64.8
December	298.4	1982	1609.6	63.4
Total	1609.6 (63.4")	Average	1494.3	58.8

6. pH OF RAINFALL AND MILL RACE WATER

Pure water in contact with the atmosphere has an equilibrum pH value of 5.65 at 20°C, due to the carbon dioxide in the air. Acid rainfall has been defined as precipitation with a pH value below 5.6. The pH values of lakes and rivers may be adversely affected by 'acid rain'.

The viability of salmon eggs has been shown to be adversely affected by low pH values (Peterson and Martin-Robichaud 1982. *Trans. Am. Fish. Soc., 111:* 772-774). Sperm motility in pike is also affected by low pH values (Duplinsky, 1982. *Trans. Am. Fish. Soc., 111,* 768-771). Structural alterations in embryos and alevins may also be due to acidic levels of pH (Daye and Gasside, 1980. *Can. J. Zool., 58:* 27-43).

In Ireland, the Meteorological Service has been measuring the acidity of rain at various stations throughout the country since 1958. The acidity of Irish rain has shown an overall increase during the period 1960-1979 (Mathews, McCaffrey and Hart, 1980. *J. Environ, Sci., 1* (2): 47-50). Since the beginning of November, 1982, the pH of the rainfall and the Mill Race water supply has been measured on a regular basis. Details of pH measurements are shown below.

Fig. I.

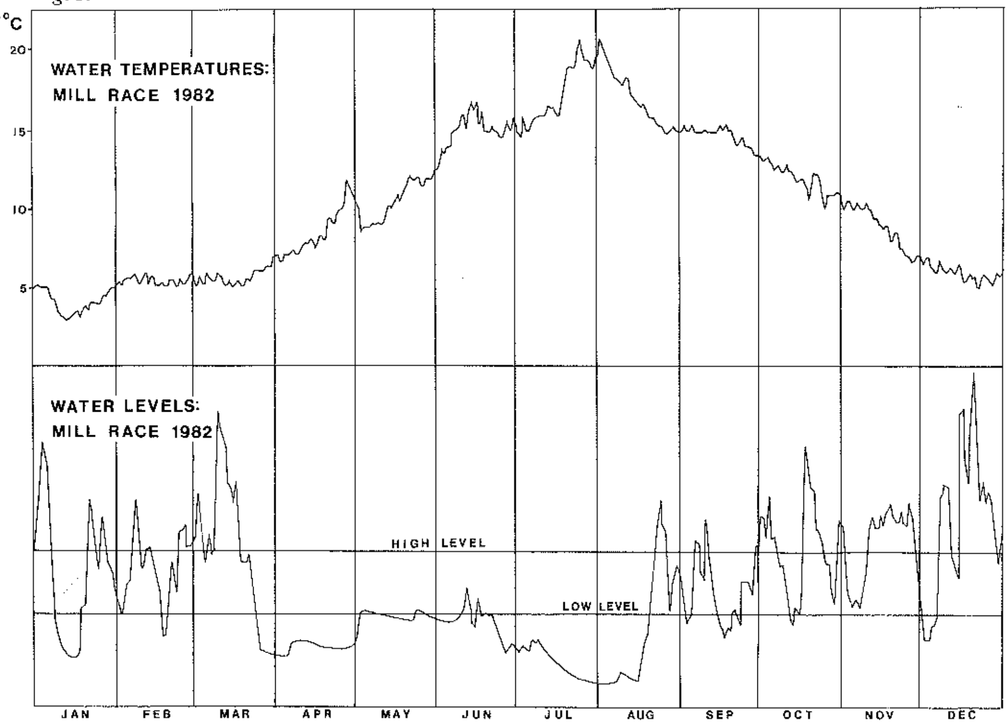

Table 2. pH of rainfall and Mill Race water.

	Rainfall			Mill Race		
	Max	Min	Mean	Max	Min	Mean
November 1982	6.72	6.15	6.44	6.90	6.49	6.70
December 1982	7.00	5.40	6.20	7.00	6.49	6.75

From these limited amounts of pH data, it would appear that the Burrishoole system is not presently under the threat of acid rain. However, on December 14th, the rainfall pH was 5.40, which indicates that acid rain does occasionally fall on the Furnace area.

7. VISITS AND COMMUNICATIONS

A meeting of the COST 46/4 Committee (EEC — European Cooperation in the field of Scientific and Technical Research) was held in the Farran Laboratory during early May. The meeting was followed by a seminar and field trip to fishery installations in the west of Ireland.

The Director read a paper at the Institute of Fisheries Management Study Course at Aberystwyth in September. In October, he attended the 70th Statutory Meeting of the International Council for the Exploration of the Sea, held in Copenhagen, in his capacity as Chairman of the Anadromous and Catadromous Fish Committee. He also attended the final meeting of the COST 46(4) committee on Salmon Sea Ranching, held in Lisbon at the end of October. He read a paper at the Workshop arranged in conjunction with this meeting.

Dr. Cross attended a meeting of the Population Genetics Group in Oxford during January. In May, while on holiday in the U.S.A., he visited the Universities of California at Berkeley and Davis, where work is in progress on salmonid physiology and genetics. He also visited the Marine Laboratory at Bodega Bay where he delivered a research seminar. In October, he gave an invited paper at a meeting at U.C.C. to mark the retirement of Prof. F. J. O'Rourke.

Mr. Mills attended a meeting on "Salmonid Migration" in London, organised by the Freshwater Biological Association and a meeting in Derry of the Institute of Fisheries Management.

Papers and technical articles presented in 1982.

Cotter, D. and D. J. Piggins, 1982. A comparison of the performances of steelhead trout and rainbow trout *(Salmo gairdnerii)* in sea cage farming operations. *ICES, Anacat Comm. CM.1982/M:27.* Mimeo, 6p.

Cross, T. F. 1982a. The possible use of biochemical genetics to distinguish stocks of salmon in the Faroes fishery. *ICES. Discussion document to the Working Group on North Atlantic salmon.* Mimeo, 3p.

1982b. Interim report on the possible use of biochemical genetics to discriminate stocks of salmon in the Faroes fishery. *ICES. Working Group on North Atlantic salmon.* Mimeo, 3p.

Cross, T. F. and J. King. Genetic effects of hatchery rearing in Atlantic salmon. *Aquaculture* — in press.

Cross, T. F. and D. J. Piggins, 1982. The effect of abnormal climatic conditions on the smolt run of 1980 and subsequent returns of Atlantic salmon and sea trout. *ICES, Anacat Comm. CM.1982/M:26.* Mimeo, 8p.

Mills, C. P. R. and D. J. Piggins. The release of reared salmon smolts *(Salmo salar)* into the Burrishoole river system (western Ireland), with particular reference to their contribution to the rod and line fishery. *Fish. Mgmt.* — in press.

Piggins, D. J. 1982a. Salmon ranching in Ireland. *COST 46(4) Workshop Sea Ranching of Atlantic salmon, Proceedings of the EEC Commission of the European Communities:* Doc. XII/1023/82, pp73-80.
C. Eriksson, M.P. Ferranti and P. O. Larsson, Eds.

1982b. Census work on runs of migratory fish in Ireland. *Proceedings of the 1982 Study Course, Institute of Fisheries Management* — in press.

SECTION B : SALMONID REARING

1. GRILSE OVA HATCHED IN 1980

Table 3. Survival during freshwater life.

Original stock of eyed ova (March 1980)	:	50,982	
No. of underyearling parr, December 31, 1980 (corrected from 36,574)	:	38,335	
1+ smolts produced in 1981	:	14,405	(40%)
1+ parr disposed of in 1981	:	13,000	
Recorded losses in 1981	:	3,296	
1+ parr remaining December 31, 1981	:	7,634	

Losses in January	:	28
February	:	30
March	:	86
April	:	115
May	:	13
Total	:	272

No. of 2+ smolts produced in 1982 : 6,900 90% survival
as: 2438 "T" brand, adipose finclip, morpholine-imprinted
2518 "V" brand, adipose finclip, controls to imprints
1944 "O" brand, adipose finclip, coded-wire tagged
Unaccountable losses (probably due to counting errors) : 462

An outbreak of furunculosis in the coded-wire tagged group occurred in April, causing the major part of the losses during that month and requiring two courses of treatment with flumequine. (See Section B, 14, "Investigations of mortalities and therapeutic treatments".) All the 2+ smolts had been released by early May from the release ponds. When measured prior to release, the 2+ smolts had average lengths of:

"T" brand	:	16.4cm
"V" brand	:	16.3
"O" brand	:	18.5

2. GRILSE OVA HATCHED IN 1981

Table 4. Survival during freshwater life.

Stock of eyed ova, March 1, 1981	:	43,366
No. of under yearling parr, December 31, 1981	:	24,949 (57.5% survival)

Losses in	January, 1982	86
	February	139
	March	313
	April	608
	May	573
	June	651
	July	101
	August	20
	September	14
	October	7
	November	8
	December	75
Total		2,595

No. of 1+ smolts released in April and May	:	8014
All marked "S" brand and adipose fin-clip		
Sale of 1+ parr to Curraun Fisheries Ltd.	:	8476
Unaccountable losses (probably counting errors)	:	687

At release the smolts had reached an average length of 13.7cm and an average weight of 27.9g.

5177 parr (July 1) were retained for on-rearing to 2+ smolts and of these 5061 (98%) remained on December 31, 1982. They had an average length of 17.8cm and an average weight of 75.8g having grown since September from 15.5cm and 56.4g. These fish will be marked with coded-wire tags injected into the nasal cartilage, forming part of a programme whereby all reared smolts released in 1983 will have these tags, as well as a cold brand or a panjet mark.

Papillomatosis was noted on some of the 1+ grilse-parentage parr in October and November. Losses from this cause were light and the condition became less noticeable as the water temperature decreased.

3. TWO-SEA-WINTER FISH OVA HATCHED IN 1981

Table 5. Survival during freshwater life.

Stock remaining December 31, 1981			: 9,984 (corrected figure)
Losses in January, 1982	:	25	
February	:	45	
March	:	97	
April	:	198 —— 365	9619
May	:	224	
June	:	76	
July	:	150	
August	:	15	
September	:	9	
October	:	3	
November	:	13	
December	:	0	
Total	:	855	

No. of 1+ smolts released in April, 1982:	
"K" brand, adipose fin clip	: 2942
Sale of 1+ parr to Curraun Fisheries Ltd.	: 1523

At release in late April, the 2942 "K" brand smolts had reached an average length of 13.8cm. 3007 parr were retained for on-rearing to 2+ smolts and of these, 2764 remained at December 31, 1982.

Some 1900 fish disappeared between December 31, 1981 and smolt grading in May. 2942 smolts were produced and 4530 parr sold or retained, after recorded losses of only approximately 600. The most likely cause of a loss of this magnitude would be an unrecorded overflow of the rearing pond, since the fish were hand-counted, with reasonable accuracy, at the end of 1981.

The yearling parr remaining for on-rearing to 2+ smolts had an average weight of 67.9g and average length of 17.8cm when measured at the end of December, 1982. They had grown from an average of 15.7cm and 57.5g in early September. All of these parr were marked with coded-wire tags on November 4, 1982.

4. GRILSE OVA HATCHED IN 1982

Table 6. Survival during freshwater life.

Original stock of fertilised ova	: 265,549
Stock of eyed ova	: 247,425 (93% survival)
Sold as eyed ova	: 166,823
Exchanged for 2SW ova	: 20,029
Stock of eyed ova remaining for programme (as at March 1, 1982)	: 50,040

Losses in March	3174
April	619
May	1505
June	9411
July	2365
August	740
September	465
October	329
November	100
December	61
Total	18,769

(See Section B, 14 for causes of losses during the year)

Of the 50,040 eyed ova and alevins retained as from March 1, 30,253 underyearlings remained at December 31, 1982 against an estimated total of 31, 271. This indicates a slight overestimation in egg counting. A survival rate of 60.5% from the eyed egg stage was obtained, compared with 55% in 1981.

The underyearling grilse offspring were graded into two groups, by December 31, 1982:

Large grade	11.8cm	13,296
Small grade	6.9cm	16,957

5. TWO-SEA-WINTER FISH OVA HATCHED IN 1982

These ova were received at the eyed ova stage from the Cong hatchery of the Western Regional Fisheries Board, repeating the experiment begun in 1981, when grilse parentage ova were supplied on an exchange basis. Their number was estimated volumetrically at 20,000.

Mortalities were light at hatching, during initial feeding and up to the beginning of June (6% mortality up to June 1). During the month of June mortalities increased, giving a total loss of 26% by July 1.

During this period, pond population densities were reduced and the fish were treated with Furanace. Losses decreased during July and August, and were light for the remainder of the year, except that in November, an overnight water blockage caused the loss of 1553 fish.

Table 7. Survival during freshwater life.

Original stock			20,000 (estimated)
Losses in February, 1982	:	16	
March	:	134	
April	:	256	
May	:	223	
June	:	4022	
July	:	1596	
August	:	232	
September	:	67	
October	:	17	
November	:	1579 (water block: 1553 dead)	
December	:	14	
Total		8156	

11,747 underyearlings were hand-counted by December 31, 1982, resulting in an unaccountable loss of less than 100 fish. They were graded into two groups as:-

Large grade	:	7.5cm	:	3202 fish
Small grade	:	6.5cm	:	8545 fish

6. GRILSE OVA LAID DOWN IN 1982

Collection of grilse broodstock commenced on October 2. All fish were transported from the Salmon Leap or Mill Race traps to two 8m circular ponds at Treanlaur. No mortalities were recorded amongst the female fish, however, one male died as a result of severe fungal infection. A number of other males developed fungal infections which necessitated their early release after stripping. A small number of female fish had lesions on the dorsal surface of the head, characteristic of UDN. Treatment with Malachite Green, at an early stage, prevented secondary fungal infections developing on these lesions.

A total of 120 females and 52 males were used in hatchery operations. The males included 21 wild fish which were introduced to increase the genetic variability of the stock. Fish were anaesthetised before stripping and all female fish were weighed and measured. In 1982, the actual condition factor of the female broodstock averaged 1.03 compared with 1.05 in 1981. Using volumetric estimates, there were 433,500 ova at the fertilised egg stage and this figure will be checked at the eyed egg stage.

Stripping commenced at an early date (November 25), as in 1981, and 75% of the females had been stripped by December 23. Any kelt that gave a positive result when tested with the coded-wire tag detector or that bore an external mark (brand mark or finclip) corresponding to those of coded-wire tagged fish was used for scientific purposes. All other kelts were released directly into L. Furnace.

Table 8. Grilse fecundity values (as green eggs)

No. of females	:	120
Vol. of ova produced	:	81.61 litres
No. of ova produced	:	433,500
No. of ova per fish	:	3.612
No. of ova per litre	:	5,312
Av. weight of female fish	:	2.8kg
No. of ova per kg weight	:	~~1,290~~ 1290 ✓

7. SEA TROUT OVA HATCHED IN 1980

Table 9. Survival during freshwater life.

	Burrishoole		Connemara
Original stocks of ova at January 1, 1980	33,282		15,500
Stocks remaining December 31, 1980	2,717		1,618
Stocks remaining December 31, 1981	1,938		1,001
Losses in January, 1982	7		6
February	8		8
March (stocks tagged and combined)		4	
April		1	

These fish were retained in one circular pond during early 1982, the "Connemara" stock being identified by adipose fin clip. On March 1, all were marked with modified "Carlin" tags and the "Burrishoole" fish adipose fin clipped. There were 1753 "Burrishoole" fish, averaging 20.6cm fork length and 117g weight, and 1090 "Connemara" fish, averaging 21.4cm and 124g, at tagging. These data indicate coefficients of condition of 1.34 and 1.27 respectively, much higher that that of wild sea trout smolts (see section C, 3, iv, a). All were held in a circular pond after tagging and released into L. Furnace on April 16. Details of recaptures are given in Section C,4.

Length frequency analysis of all 2,843 smolts at tagging indicated an approximately normal unimodal distribution. Final survival of the sea trout ova hatched in 1980 combining tagged smolts with 556 pre-smolts moved to a cage in the sea at Doughill (*Ann. Rep. XXVI,* Section B, 6) was 7%, but the major mortality was at the fry stage.

8. SEA TROUT OVA HATCHED IN 1981

Only 46 fish from the original stock of 10,337 ova remained at December 31, 1981. These were moved, together with a small number of F_1 salmon x rainbow trout hybrids, to a small cage in the stock pond at Furnace in March, 1982. Heavy mortalities due to fungus occurred during the summer and only 26 sea trout remained on September 18, when they were tagged with black square plastic tags and released into L. Furnace. Average fork length at release was 23.7cm.

9. SEA TROUT OVA HATCHED IN 1982

Table 10. Survival in freshwater.

	Burrishoole	Connemara
Original stock of ova	9,005	21,150
Losses in December, 1981	107	—
January, 1982	84	—
February	193	4,142
March	1,963	842
April	3,206	1,991
May	1,588	8,851
June	69	643
July	70	29
August	135	10
September	69	1
October	12	12
November	2	2
December	1	1
Total estimated losses	7,479	16,542
Actual stock remaining December 31, 1982	992	4,554
	(11% survival)	(21.5% survival)

Ova from both of these stocks of sea trout hatched successfully but, as in the two previous years, there was heavy mortality at first feeding. However, year-end survival of the "Connemara" stock was the best achieved in recent trials. It will be noticed that recorded losses do not account for all mortalities, especially in the "Burrishoole" stock. When mortalities are very high the tendency is to under-count them slightly each day and this error accumulates to give the observed discrepancy. The two stocks were mixed in November, the "Burrishoole" fish being adipose fin clipped to identify them. The combined group was graded in November, yielding 2575 large (average fork length 13cm, average weight 36g) and 2973 small (10 cm, 14g) sea trout parr.

10. SEA TROUT OVA LAID DOWN IN 1982

In view of the small number of wild upstream migrants in 1982, it was decided to use the reared sea trout which had been kept in a sea cage at Doughill since October 1981 (see *Ann. Rep. XXVI,* Section B, 6) as broodstock. These fish, which numbered 565 in October 1981 when initially placed in the cage, were inspected at approximately monthly intervals. Routine husbandry was carried out by Curraun Fisheries Ltd. There was no evidence of feeding until February, 1982. In early April, 357 remained (mean fork length, 22cm; weight, 153g), while in late May, only 198 were left. Small numbers of dead fish were present at each inspection so it seems likely that there was continuous mortality, with bodies decomposing and falling through the net. At the end of June, there were 184 sea trout in the cage, while on August 26, only 115 remained but average fork length was 30.2cm and weight 349g. Through the spring and summer of 1982, decreasing numbers of small, very thin sea trout were present. These were probably fish that never initiated feeding and there was a much higher mortality in this group. In early October, 109 fish (mean fork length 31.2 cm) remained. Since about 2/3 of each sex seemed likely to mature, they were moved to a freshwater release pond at Furnace on October 16.

During the 13 months in the sea cage, mean length had increased from 20.0cm to 31.2cm. The lengths of the only two fish which retained their tags increased from 22.5cm to 37.0cm and 21.6cm to 35.5cm respectively. Thus the average increase in length of these fish in the sea was 56%. This increase may be compared with those from wild sea trout smolt to finnock (40%) or to 1+ maiden (86%). However, the lack of feeding in the initial months in the sea and the high mortality suggest that marine transfer was effected at the wrong time. It may be that in the sea-going form of *Salmo trutta,* transfer to sea at the time of year when smoltification occurs is more important for success than body size. Size alone appears to be important in freshwater rainbow trout *(Salmo gairdneri),* although not for the "steelhead" form of this species.

Between November 20 and December 30, 33 cage reared females were stripped and their ova fertilised by the milt from more than 26 males. Two or more males were used with each female and males were stripped repeatedly. By the time of stripping, all had contracted fungus and the rest of the cage reared fish either died of fungus or were released into brackish water because of the severity of the condition. In addition to the farmed fish, 3 reared, ranched finnock and one wild sea trout female were stripped in mid-November. All kelts were released immmediately into L. Furnace, the untagged fish being marked with yellow "Floy" anchor tags.

Table 11. Sea trout fecundity values.

No. of female fish	:	37
Vol. of ova produced	:	2.96 litres
No. of ova produced	:	26,546
No. of ova per female	:	717
No. of ova per litre	:	8,968

11. BROWN TROUT OVA LAID DOWN IN 1982

Between September 14 and October 12, 33 brown trout of 10 inches or greater in length were caught on rod and line in L. Feeagh and transported alive to a 2m pond at Furnace. 9 fish with severe fungal infections had to be removed before stripping. Two females were stripped on December 14 and 7 others had produced eggs by January 17. Scales were removed from all fish stripped, male and female, to confirm that they had never migrated to sea.

Table 12. Brown trout fecundity values.

No. of female fish	:	9
Vol. of ova produced	:	309 ml
No. of ova produced	:	2,333
No. of ova per female	:	259
No. of ova per litre	:	7,550

12. F_2 SALMON x RAINBOW TROUT OVA LAID DOWN IN 1982

First generation of (F_1) salmon x rainbow trout fry were donated by Curraun Fisheries in late 1982. It was intended to grow these hybrids to sexual maturity and to produce a second generation (F_2). Of the surviving 21 hybrids, one was a ripe female of 31.5cm, which yielded 603 ova which were fertilised by milt from a hybrid male. All 21 were then tagged with yellow square plastic tags and placed in the holding pond at Furnace.

13. RAINBOW TROUT

Only a small number of fish (less than 5 females) maintained in the broodstock pond during 1981 proved to be capable of being stripped of ova in November and December, 1981. These fish were old (4+ and 5+ years old) and produced 11,300 poor quality ova.

From these ova there was very poor survival to the early feeding stage at the end of April, resulting in a 19.5% survival rate (2,200 fish) to the end of the year. These fish were maintained in the Visitors' Display Area and growth was satisfactory.

The remaining 557 1+ rainbow trout in these tanks were released into Lough Furnace during May, 1982 at an average weight of 80-100g. It was hoped that they might contribute to the summer rod-catch on this lake but very few were recaptured during 1982.

14. INVESTIGATIONS OF MORTALITIES AND THERAPEUTIC TREATMENTS

Mortalities of reared juveniles during 1982 were, in general, higher than in 1981. High water temperatures (21°C in July) made 1982 a difficult year for rearing juvenile salmonids.

(i) Salmon.

a) 1+ and 2+ smolts released in April and May 1982.

No serious mortalities were experienced among the 1+ smolt population released in 1982. However, furunculosis outbreaks occurred among the 2+ smolt population from January up to the time of their release. Furunculosis accounted for the death of 1.6% of the 2+ smolt population.

The strains of *Aeromonas salmonicida* isolated in 1982 were found to be somewhat resistant to oxytetracycline but sensitive to flumequine.

b) 1+ parr.

Mortalities in 1+ parr were, on the whole, higher than in 1981. Low level losses due to fungal infections of the caudal and pectoral regions of the body, occurred during the late winter and early spring. Malachite Green flush treatments were successful in controlling these fungus outbreaks.

Relatively high water temperatures during the summer and early autumn (May to September) led to continuous outbreaks of furunculosis. The strain of *A. salmonicida* isolated was sensitive to flumequine.

During the late autumn, unilateral eye loss and severe fin and tail rot caused some losses among the smaller grade parr.

Treatment with "Furanace" (1ppm) was effective in containing these losses.

Papillomas first appeared in early October but very few losses could be directly attributed to the infection. The incidence of the disease decreased as the temperature dropped during the late winter. Secondary invasion by *Saprolegnia* fungus of the lesions left by papilloma infections caused some mortalities throughout the winter period.

c) Fry.

Mortalities among salmon fry were quite low during hatching and there were no serious problems at first feeding. However, large numbers of skeletal deformities were found in two batches of grilse fry and this necessitated major culls at the early feeding stage.

Mortalities increased during June and July when low water levels and high water temperatures were experienced. *Costia* outbreaks were successfully controlled with salt (1%) and formalin (100ppm) flush treatments. Losses continued, but although low-level myxobacterial infection was identified, it was not serious enough to cause the heavy losses. The gills showed thickening of the epithelium. Successive treatments with "Furanace" (1ppm) and a reduction in pond densities brought the condition under control and mortalities were reduced to a low level by early August.

Table 13 summarises the main disease problems affecting juvenile salmon during 1982.

Table 13. Summary of main disease problems affecting juvenile salmon during 1982.

	Hatchery fry	0+ Fish*	1+ Fish	2+ Fish
January			Fungus	Papilloma Furunculosis
February			Fungus	Furunculosis
March			Fungus	Furunculosis
April	Deformities		*Costia*	Furunculosis
May	Deformities		Furunculosis	Furunculosis
June	*Costia*		Furunculosis	
July	Myxobacterial Gill Disease		Furunculosis	
August		*Costia*	Furunculosis	
September		Tail Rot	Furunculosis	
October		Tail Rot	Eye Loss Tail Rot	
November		Fungus	Papilloma	
December		Fungus	Papilloma	

*Hatchery fry moved to outdoor ponds in August

(ii) Sea trout.

a) 2+ Burrishoole and Connemara sea trout smolts released in April 1982.

No serious mortalities was experienced with the 2+ sea trout populations in 1982. Nevertheless, low level infection of *A. salmonicida* was detected from January and up to the time of release in April. The strain of *A. salmonicida* isolated was resistant to oxytetracycline but sensitive to "Tribrissen" and flumequine.

b) Fry.

As in 1980 and 1981, heavy losses were experienced with the Connemara and Burrishoole sea trout fry in 1982. High mortalities occurred at all early stages of development (i.e. from eyed ova to first feeding) and there were appreciable numbers of deformed fish in the Connemara stock.

No causative organism of the heavy losses was isolated but small numbers of *Costia* were detected. Tests by the Fisheries Research Centre, at Abbotstown, for Infectious Pancreatic Necrosis virus (IPN), proved negative.

Successive flush treatments with salt (1%), formalin (100ppm) and Betacide (1ppm) failed to check the mortalities. However, losses began to decline after daily administration of "Furanace" (1ppm). This latter drug is especially effective against myxobacterial gill disease, although it should be stressed that this condition was not confirmed. Losses for the remainder of the year were relatively low.

(iii) Rainbow trout.

a) 1+Rainbow trout.

No serious mortalities were experienced with the 1+ population of rainbow trout during 1982.

b) Fry.

As in 1981, substantial mortalities were experienced with rainbow trout fry in 1982. Heavy losses occurred at all early stages of development.

High infestation with *Costia* was the main problem with early feeding fry. Flush treatments with salt (1%) and formalin (100ppm) brought the disease under control. Mortalities were reduced to a low level by the end of the summer.

15. *AEROMONAS SALMONICIDA:* DETECTION OF ASYMPTOMATICALLY INFECTED JUVENILE SALMON

Furunculosis, caused by *Aeromonas salmonicida,* is a major disease of salmonids and the causal bacterium can be isolated easily from acutely diseased fish, but only with difficulty from fish with chronic infection. Fish which survive exposure to the causative agent may become asymptomatic carriers of the disease. Experiments were undertaken in order to detect the level of asymptomatic carrier fish on the farm.

Test fish.

Samples of twenty 0+, 1+ and 2+ juvenile salmon were tested monthly between October 1981 and October 1982 inclusive. The 1+ parr samples were taken from a population which had suffered furunculosis outbreaks in November 1981 and from May to September 1982. Furunculosis outbreaks also occurred in the 2+ smolt population from March to May 1982. No cases of furunculosis had occurred in the 0+ parr population sampled.

Test procedure.

The sample fish were starved for two days in a $1m^2$ tank and then acclimatized for a further two days at 11°C. On the first day of each experiment, the fish were injected intramuscularly with 20mg/kg prednisolone acetate (Deltastab) and then placed individually in a 5l plastic bucket at 20°C. Fish were held until they died, or for 14 days. All mortalities were tested for furunculosis by streaking anterior kidney material on Tryptone Soya agar and incubating at 20°C for two days.

Results.

The combination of immunosuppression injection and heat stress resulted in the death of 55% of all the fish sampled (440). However, only 5.8% of the mortalities yielded cultures of *A. salmonicida*. The detection of asymptomatic furunculosis was confined to the 2+ fish sampled in February and March 1982. The percentage of carriers among the 2+ population during these latter months was 10% and 60% respectively. All fish which died from furunculosis were found to be precocious males.

Discussion.

Despite serious outbreaks of clinical furunculosis among the 1+ parr population from May to September 1982, no cases of asymptomatic carriers of furunculosis were detected in the 1+ parr sampled from October 1981 to October 1982. It would appear that the carrier rate in the 1+ parr population, throughout the year, was very low.

No cases of furunculosis were detected in the 0+/1+ parr population or in the 0+ parr sampled. Among the 2+ fish sampled, the level of asymptomatic carriers was relatively high during February and March 1982, just prior to release as smolts in April and May. All carriers were found to be precocious males. It would appear that the incidence of covert furunculosis increased among 2+ smolts approaching their time of migration and that precocious sexual maturity causes increased stress on the fish at this time.

It is interesting to note that Dr. Peter Smith of University College, Galway, using a similar experimental technique, detected no covert furunculosis (in either 0+ or 1+ fish) at Parteen Rearing Station in 1982.

16. MORPHOLINE EXPERIMENT

Imprinting of smolts:-

2,960 experimental fish (2+ salmon parr) were adipose fin clipped and cold branded ("T" brand) on March 4 and 5. After marking, these fish were put into a small release pond at Furnace. 2535 2+ salmon parr drawn from the same stock were also adipose fin clipped and cold branded ("V" brand) and then placed in an adjacent release pond on March 23. Sample measurements of the two groups showed the experimentals to have a mean length of 16.0cm and the controls 16.3cm.

A drip mechanism consisting of a modified Mariotte bottle was set to dispense morpholine (the imprinting chemical) to the experimental fish on March 26. Sufficient imprinting chemical was delivered over a 24 hour period to give a steady state concentration of approximately 5 x 10^{-5}ml of morpholine/litre of pondwater. This concentration of imprinting chemical has been determined as being detectable by *Salmo salar* (Scholz *et al.*, 1975. *Fish Management Report No. 80. Dept. of Natural Resources, Madison, Wisconsin*).

After 35 days imprinting, 2,438 experimentals were released from their pond into L. Furnace. The 2,518 controls were released at the same time.

SECTION C : CENSUS WORK ON FISH MOVEMENTS

1. WILD SALMON

(i) Upstream movements.

a) Timing and numbers.

The number of two-sea-winter fish (2SW) counted upstream through the traps in 1982 was significantly reduced, by comparison with 1981. The smolts in 1980 were prevented from migrating downstream until early June by a severe drought in April and May. Deleterious effects have been noted on the survival to adult of grilse and sea trout of 1981 *(Ann. Rep. XXVI,* Section C) and these effects appear to have carried over to the 2SW fish of 1982.

Fifteen 2SW fish were counted upstream in May, three in June and one each in August, September and October. The total of 21 was only one-third of the 1981 season.

The run of wild grilse improved slightly, compared with 1981, but the total of 438 was still well below the averages for the years 1970-74 and 1975-79 (see Table 15). The first grilse did not appear in the traps until early June but this was followed by quite good numbers of grilse for the remainder of the month (see Table 14). Low water levels in July inhibited upstream movements through the traps but there were indications that fair numbers of grilse were present in the lower lake at that time. The bulk of the wild grilse run (over 50%) occurred during August with only some 16% of the total being counted from September 1 to December 31. The relative proportions of the total run counted at the two traps were 54% at the Salmon Leap and 46% at the Mill Race, which was exactly the reverse of the situation in 1981. (See Fig. I for water levels throughout the year).

b) Net-marked salmon.

None of the 2SW fish in May was observed to be net-marked but these marks appeared in June on grilse, when almost one-third of the fish were affected to a greater or lesser degree. The frequency of net-marks was reduced, at 13.7% of the total run in 1982, compared with 22.9% in 1981. However, 44 net-marked fish were noted in August and September, after the close of the drift-netting season, suggesting that some illegal nets were still operating.

Table 14. Incidence of net-marked grilse in traps (includes wild and reared grilse).

	% incidence	Marked/Total
June	32.3%	(41/127)
July	22.2%	(4/18)
August	11.8%	(34/289)
September	18.2%	(10/55)
October	—	(0/122)
November	—	(0/38)
December	—	(0/1)

c) Spawning escapement.

The policy of not planting out ova or early-feeding fry was continued in 1982. This is to allow more accurate monitoring of survival rates from naturally spawned ova, derived from the calculated maximum spawning escapement of wild and reared salmon.

No UDN was noted on upstream-migrating wild salmon or grilse and no otter kills in the Mill Race or Salmon Leap were observed. Up to 2 seals at a time were seen in L. Furnace and occasional fish with seal bites were recorded in the upstream traps.

Table 15 gives the comparative escapements of wild salmon and grilse through the traps since 1970, expressed as the five-year averages for 1970-74 and 1975-79, with the relevant annual totals for 1980, 1981 and 1982. Details of earlier annual escapements (1970-79) may be found in *(Ann. Rep. XXIV* Table 8).

Table 15. Comparative escapements of wild salmon and grilse.

	Mill Race		Salmon Leap		Total	
Year	Salmon	Grilse	Salmon	Grilse	Salmon	Grilse
1970-74	7	630	7	515	14	1145
1975-79	9	278	27	425	36	703
1980	28	278	21	359	49	637
1981	21	177	43	149	64	326
1982	6	200	15	245	21	445

The total of 445 grilse includes 7 previously-spawned grilse.

Table 16 shows the monthly percentages of the combined total runs of grilse through the traps, again expressed as five-year averages for 1970-74 and 1975-79, with annual totals for 1980, 1981 and 1982. Figures in parentheses are the actual monthly totals of wild, maiden grilse.

Table 16. Monthly proportions of the grilse run.

	1970-74	1975-79	1980	1981	1982
May	—	1.0	—	1.5	—
June	5.8	15.6	28.6	14.1	28.1 (123)
July	18.9	17.7	40.8	45.2	4.1 (18)
August	26.8	24.1	8.5	15.0	51.6 (226)
September	25.5	26.2	16.5	15.0	3.6 (16)
October	17.6	13.7	3.7	5.8	9.4 (41)
November	4.8	1.4	1.1	2.5	3.0 (13)
December	0.6	0.3	0.8	0.9	0.2 (1)

Details of the trap counts, rod catches on L. Feeagh, escapements and maximum spawning stock for wild and reared fish are given in Table 17 (a). The usual deduction of 5% has been made for natural mortalities, poaching and disease etc. Table 17 (b) gives comparative figures for spawning stocks of previous years, employing five-year averages for 1970-74 and 1975-79.

Table 17. (a) Spawning stocks of salmon and grilse.

	Wild grilse (1SW) and previously spawned grilse	Wild Salmon (2SW)	Reared Fish
Counted through traps	445	21	219
Rod caught L. Feeagh	28	2	3
Hatchery use	21	—	151
Estimated mortalities (5%)	22	1	11
Escapements	374	18	54
Maximum spawning stock		446	

Table 17. (b). Comparative spawning stocks.

	Maximum escapement	Reared fish component
1970-74	1126	140
1975-79	725	42
1980	650	22
1981	440	85
1982	446	54

Thus, despite increased grilse numbers, the maximum escapement was maintained at the low level of 1981, due to smaller component of 2SW and reared fish.

d) Survival from brood year ova to smolts and grilse

The wild grilse in 1982 were largely the product of the 1978 brood year which had a total escapement of 491, including 62 reared fish. These latter fish are assumed to have spawned normally, there being no evidence to suggest that they are impotent or infertile. In succeeding calculations (see *Ann. Rep. XIX*, 1974 for original data parameters), a range of 50-55% females and 4000-4115 ova per female is assumed. An average and a minimum figure can then be calculated for ova deposition in the winter of 1978/79 (see Table 18). The resultant 1982 grilse total was 479 (trap count 445 plus Furnace rod-caught 41, minus 7 previous spawners).

Table 18. Survival from ova to grilse.

Spawning escapement in 1978 1979	491	926
No. of females	245-270	463 - 509
Ova deposition	980,000-1,111,050	1,852,000 - 2,094,[illegible]
No. of smolts produced in 1981	9434	10,460
Survival: ova to smolt	0.95-0.85%	0.56 - 0.50
No. of returning grilse in 1982	479	550 provisi[illegible]
Survival: smolt to grilse	5.1%	5.3%
Survival to grilse per grilse female	1.96-1.77	1.18 - 1.08

The ranges in values for comparable survival are available for nine brood-year-classes beginning with that of 1970. Values for 1970-74 are expressed as the five–year average in Table 19. Full details for those years are given in Table 15, *Ann. Rep. XXVI*, 1981.

Table 19. Comparative survival rates.

Brood-year-class	% Survival rates: ova to smolts	Survival rates to grilse per grilse female
1970-74	0.48-0.62	1.42-1.75
1975	0.52-0.63	2.03-2.37
1976	0.50-0.57	1.60-1.80
1977	0.78-0.88	0.93-1.02
1978	0.85-0.95	1.77-1.96

It is evident that a compensatory mechanism has operated for the 1977 and 1978 year-classes, when there has been an increased survival rate to the smolt stage, from smaller numbers of ova deposited. Thus, freshwater production levels continue to be satisfactory. There was a welcome improvement in 1982 in the survival rate from grilse female spawner to adult grilse of the succeeding generation. This value approached the level necessary for a self-sustaining population, but actual numbers were still small and there was no evidence of a net increase in stocks between generations.

(ii) Downstream movements.

a) Smolts: Timing and numbers.

The first salmon smolts appeared in the traps in early April but significant numbers did not migrate downstream until early May. The bulk of the run had passed through the traps by May 27 and 70% of the total was counted at the Salmon Leap trap.

The overall smolt total was 10,460 but this included 79 smolts found dead in the traps, so that the effective total released was 10,381. The relevant spawning escapement which produced these smolts was that of 1979, which was comparatively large, at 926. The survival rate from ova to smolt has decreased, therefore, to a range of approximately 0.5-0.6%, by comparison with the better survival rates from the 1977 and 1978 brood-year-class.

The sampling programme, investigating age structure, size and timing of the wild smolt run was continued in 1982 (see Section (d) below).

b) Survival of salmon smolts.

The following values were derived from the known numbers of salmon smolts counted through the traps each year and the total stock of returning wild adults in the two succeeding years. The adult stock comprises the count of wild maiden grilse through the traps, plus the rod-catch of wild grilse from L. Furnace and the returns of 2-sea-winter fish in the following year. Table 26 gives the 5-year averages for 1970-74 and 1975-79, with annual values for 1980, 1981 and 1982.

Table 20. Salmon smolt survival rates.

	Trap count	Furnace rod catch	2SW fish	Total	Relevant smolt total	% survival
1970-74	1146	120	31	1297	13,183	9.8
1975-79	700	62	35	797	11,397	7.3
1980	637	10	64	711	8,276	8.6
1981	305	17	21	343	11,208	3.1
1982	438	41	N/A	479*	9,434	5.1

*Survival to grilse only; spring and summer fish not due until 1983.

c) Tagging of salmon smolts.

No wild salmon smolts were tagged in 1982, both as a conservation measure and in order not to affect the smolt sampling programme.

d) Sampling of wild smolts.

To determine the age structure and mean length and weight of the wild salmon smolt population, 5 samples of approximately 60 smolts were collected between May 3 and May 20. The expected total number of smolts was estimated and the samples were taken at 5 regular intervals during the run. The fish were anaesthetised, measured to the nearest mm, weighed to the nearest g and a small sample of scales removed from the shoulder; after recovery, they were released.

Age categories were determined by scale reading viz. 1A, 1B, 2A, 2B, 3A and 3B (the figures indicate lifespan in years; the letters indicate growth type). A-type smolt scales show no growth after the end of their final winter in freshwater whereas B-type smolt scales exhibit more widely spaced circuli outside the final winter band of circuli, denoting spring growth before migration. In Table 21, these age categories have been reduced to 3 year classes, with the percentage age composition, average length, weight and condition factor given for each sample.

Table 21. Percentage age composition and sizes of wild salmon smolts.

Sample	N	% smolt age composition 1	2	3	Av. length (cm)	Av. weight (g)	C.F.
1	62	0	95.2	4.8	14.1	29.5	0.91
2	60	6.7	88.3	5.0	13.9	25.0	0.93
3	59	1.7	93.2	5.1	14.1	27.8	0.97
4	60	3.3	91.7	5.0	13.7	25.4	0.96
5	60	3.3	93.3	3.3	14.3	28.0	0.96
Mean:		3.0	92.4	4.6	14.0	27.2	0.95

As in 1981, the average length and weight of the 5 samples fluctuated but no relationship could be determined for these values between early and late samples.

Condition factors (see Glossary) of the smolts in the early part of the run were lower than those recorded during the latter part of the run.

Average length, weight and condition factor of the total sample in 1982 were similar to those recorded in 1981 and 1977 (see Table 22).

Table 22.

Year	Sample no.	Av. length (cm)	Av. weight (g)	Av. C.F.
1977	180	14.1	27.0	0.97
1981	272	13.8	26.4	0.97
1982	301	14.0	27.2	0.95

The percentage smolt age composition of the 1982 sample was also similar to that recorded in 1981.

Table 23.

Year	% smolt age composition		
	1	2	3
1977	9.0	84.7	6.3
1981	3.7	90.8	5.5
1982	3.0	92.4	4.6

Table 24. The average weight (in g) of different age categories in 1982 compared with those recorded in 1977 and 1981.

	Age Categories					
	1A	1B	2A	2B	3A	3B
1977	—	24.6	28.6	27.3	32.0	37.0
1981	—	24.0	27.9	26.2	27.9	29.8
1982	19.6	20.3	28.5	26.6	27.8	29.1

As in 1977 and 1981, there was no significant difference between the mean weight of 2A and 2B type smolts at the time of their migration in 1982. Furthermore, as recorded in 1981, the proportion of smolts exhibiting A-type growth tended to decrease as the run progressed, whilst the proportion exhibiting B-type growth increased.

e) Diurnal timing of smolt migration.

The wild salmon smolt run was monitored to determine the diurnal timing of downstream migration. Sampling over a 24 hour period was carried out 7 times at both the Salmon Leap and Mill Race traps. Two sampling programmes were used, smolts being counted at either 6 or 2 hourly intervals.

6 hourly samples.

The data obtained in three 2 hourly samples can be amalgamated to give a 6 hourly sample, making a total of 7 x 6 hourly samples.

During the first sample (May 5) the majority of the smolts migrated downstream between 12.00 and 18.00 hours. However, during the second sample (May 6), the maximum number of smolts were recorded between 20.00 and 02.00 hours. In the third and fourth samples, during the peak of the run (May 7 and 10), the main migration took place by day (12.00 to 14.00 hours) though smaller numbers of fish passed downstream at night. On May 11, during the fifth sample, 1507 out of a total of 1637 smolts counted, passed through the Salmon Leap trap between 14.00 and 24.00 hours. Relatively few smolts were recorded in the sixth and seventh samples (May 12 and 23), highest numbers being counted between 18.00 and 22.00 hours. As in 1981, the main smolt run in 1982 took place over a short period of time when 78.4% of all the smolts migrated between May 5 and 12. During this period, a similar pattern of diurnal migration to that recorded in 1981 was evident. Early migrants moved downstream by day and night; the peak of the run occurred during daylight hours and the latter part of the smolt migration took place mostly by night.

2 hourly samples.

These indicated more precisely the diurnal timing of the run. In the first sample (May 6), during the early part of the run when migration was mainly nocturnal, peak numbers of smolts were recorded at 20.00 hours. The second sample (May 10) during the peak run showed greatest downstream movement of smolts between 12.00 and 14.00 hours with a further significant peak at 18.00 hours (Salmon Leap only). However, at the Mill Race, where significantly fewer fish were recorded, peaks occured at 14.00 and 20.00 hours. No 2 hourly sample was carried out at the end of the run as there were too few smolts migrating to yield significant results.

Similar trends in the diurnal timing of downstream migration were recorded at both the Salmon Leap and Mill Race traps during both two and six hourly samples. The results obtained in 1982 indicated a similar pattern in the diurnal timing of downstream migration to that recorded in 1981.

f) Salmon kelts.

Table 25. Timing of salmon kelt run.

	Counted through traps
December 1981	4
January 1982	34
February	22
March	98
April	38
May	44
Total	240 incl. 48 fin-clipped = 192 wild kelts.

An appreciable proportion of the kelt run migrated downstream in April and May but this was confined to the Mill Race, water levels being too low for downstream movement at the Salmon Leap. During the earlier part of the run, most of the kelts used the Salmon Leap passage.

Almost all the kelts marked by UDN/fungal infection were noted in January and February; the major part of the run in March, April and May were clean and well-mended (85% of run). Survival from the spawning escapement to the kelt stage increased to 54% but comprised relatively few males (see Table 26).

Table 26. Comparisons of annual kelt runs.

	A	B	C	D	E
1975-79	75	18	14	30	8.1
1980	90	30	6	48	6.9
1981	69	15	8	33	16.5
1982	85	13	5	54	7.0

A : % healthy kelts in kelt run
B : % males in kelt population
C : % lightly marked with fungus
D : % survival from spawning escapement
E : % recaptures in first year

Of the 158 wild kelts tagged (60% at the Salmon Leap) only 11 recaptures were made (7.0%), including 3 in the Donegal drift-nets and 2 by rods on L. Furnace. This constitutes a much lower survival rate from kelt to second spawner than was found in 1981. One interesting recapture was that of a female returning for a third spawning, this being a relatively uncommon occurrence among local salmon stocks. It was detected by scale-reading, having been tagged on March 22, 1982 at a length of 72cm. No tag or tag scar was noted at that time. It was recaptured at a length of 78.5cm on August 22 in the Salmon Leap upstream trap.

Growth at sea from the tagged kelt stage to return to fresh water was normal, averaging 6.8cm in length (range 5.5-8.5cm) over an average period of 157 days (range 99-182 days). The absence period was longer than usual, due probably to low water levels inhibiting upstream movements during July.

No long-absence (over 12 months) previously-spawned fish were detected in 1982.

g) Ulcerative Dermal Necrosis/Fungal Infection.

1981-82 Spawning season.

The incidence of UDN/fungal infection decreased in 1982 and as noted above, only one diseased grilse kelt was seen out of 153 downstream migrants in March, April and May. In December, January and February, the relevant proportions were:- 40% clean, 35% lightly marked and 25% heavily infected. The situation among sea trout kelts was very satisfactory, in that only three fish out of a total of 1008 were noted as "lightly fungused" whilst another 6 were found dead in the traps, from other causes.

1982-83.

One reared female grilse was seen moving upstream on November 30, heavily infected by fungus but no further signs of disease were seen at either trap during December. During the season, a small number (less than 10) grilse were observed with skin papilloma. It is not known whether this condition predisposes the fish to secondary fungal infection.

Among downstream-migrating grilse (wild and reared) in November and December, there were 9 badly-marked and 2 lightly-marked fish, out of a total of 41.

Female grilse held in a broodstock pond at Treanlaur were mostly unaffected from early October until stripping in December. However, a large proportion of the males, held in a second pond, developed lesions and secondary fungal infections, despite daily treatment with Malachite Green. These fish were removed from the pond on first stripping and released in the brackish water of L. Furnace.

2. REARED SALMON

(i) Upstream movements.

Recapture rates.

Only 253 maiden grilse were recaptured from a release of 18,926 smolts in 1981, giving an overall survival rate of 1.34%, compared with 2.06% for the previous year. Two factors appear to be implicated: firstly, the 2+ smolts showed a lower survival rate than the 1+ smolts, and secondly, the exploitation of reared grilse from the SRTI programme by coastal drift nets appears to have been unusually severe in 1982. (See section on "Reared grilse caught in coastal nets".)

The overall survival rate of 1.34% from reared smolts to maiden grilse, may be compared with that of 5.1% from wild (unmarked) smolts to wild grilse. The wild fish survived better by a factor of 3.8 which is very similar to that which has been found in previous years.

The 1+ smolts released in 1981 gave a survival rate of 1.47%, which is similar to that of the previous year but the 2+ smolts showed a reduction in survival from an average of over 2% to only 1.23% in 1982.

Recaptures of 2-sea-winter-fish.

Only 2 specimens were recaptured in 1982. Both were small summer fish and both were derived from 2+ smolts of grilse parentage in 1980 (2.2+). One bore a discernible brand-mark but the other (approx. 6.4kg) had lost its brand.

Recaptures of previously-spawned reared grilse.

There were seven recaptures of this category of reared fish in 1982, all of which were short-absence fish, derived from the 1981/82 spawners. Five were caught in the Salmon Leap trap, one by rod-fishing on L. Furnace and one was returned from Killybegs Sea Foods, having been caught in one of the Donegal drift nets.

	Original data				
Tag no.	Date tagged	Length (cm)	Recapture date	Length (cm)	Place
00118	18-9-81	59.2	24-8-82	66	SL trap
05116	23-7-81	71.0	24-8-82	71	SL trap
00119	18-9-81	66.5	25-8-82	72.5	SL trap
00164	9-10-81	61.8	30-8-82	63	SL trap
L313	12-5-82	62.5	7-9-82	66.5	SL trap
X-brand + finclip — no tag			30-9-82	70.5	Furnace rod
5245	9-12-81	62.5	July 82	—	Donegal drift net

Fish unidentifiable by scale-reading or brand-marks.

Only one fish was unidentifiable, having no visible brand (NVB) and no readable scales in the sample. From size at capture, however, it was almost certainly a maiden grilse. A further 9 fish were classified from brand or panjet marks, scale samples having been omitted at capture. The proportion of fish with no visible brands was rather higher than was found in the earlier years of marking by this method. Some 25% of the grilse from 1+ smolts and 34% of those from 2+ smolts were classified "NVB", although the latter group included panjet-marks and dorsal fin-clipped fish, where the degree of "mark loss" is difficult to assess. By and large, panjet marks with Alcian Blue dye showed good persistence over one year at sea. These were diffuse marks on returning grilse and some were undoubtedly missed on examination of the fish in the traps. A simpler form of panjet marks will be adopted in 1983, following this trial.

Brand marks on the shoulder of the fish are frequently obliterated by abrasions caused by escape from meshing nets. Trials are planned for brand-marks at more distal locations on the body.

Recapture totals.

The recapture rates of maiden grilse and 2-sea-winter fish in 1982 are set out in Table 27 below:-

Table 27. Recaptures from smolts released in 1980 and 1981.

	Smolt age	Year of release	Number released	Brand	Returned as G	2SW	% recapture
1.	2+	1980	7768	V, T, NVB	178	2	2.32
2.	1+	1981	7902	U, X, NVB	116	N/A	1.47
3.	2+	1981	11,024	N, L, NVB Dorsal f/c, Panjet.	136	N/A	1.23

The 253 recaptures of maiden fish (excluding the 7 previous-spawners) were recorded in the following ways:-

Mill Race trap	:	71
Salmon Leap trap	:	142
Furnace rods	:	27
Estuary net	:	13

The disparity between the proportion of recaptures at the Mill Race (33%) compared with that from the Salmon Leap (66%) is thought to be due largely to the prevalence of high water conditions from September onwards, when the majority of the recaptures were made. However, a morpholine drip (forming part of an imprinting experiment) was operating on the Salmon Leap during the season and it is possible that this had a general, as well as a specific attractant effect.

Broodstock for artificial rearing and natural reproduction.

The incidence of UDN/fungal infection among broodstock has been described in Section C1,ii,g, where it was noted that the 120 reared females remained largely healthy. Of the 52 males, almost all developed fungal infections, to a lesser or greater degree but it should be noted that of these males, 31 were reared fish and 21 were wild males. Apart from the known greater susceptibility of males to *Saprolegnia* infection, it is possible that the wild males were more prone or were "carrier" fish. A total of 151 reared-fish was used in hatchery production, leaving a theoretical maximum of 54 fish for the reared fish component of natural reproduction, by subtraction from the maiden fish total.

Size of reared grilse.

In contrast to 1981, there were relatively few small males in 1982 among the grilse derived from 2+ smolts. The average size of these grilse reverted to normal, at 64.1cm compared with those from 1+ smolts at 60.5cm.

There was a marked disparity in the sex ratio among grilse derived from both 1+ and 2+ smolts in 1982. In previous years, females have seldom exceeded 55% of the population but the relevant ratios in 1982 were:-

Grilse from 1+ smolts	:	61% females	:	39% males
Grilse from 2+ smolts	:	65% females	:	35% males

The possibility was considered that precocious sexual maturity may have caused decreased survival among 2+ smolts. Some ten years ago, it was not unusual for 50% of the 2-years-old parr population to be ripe males in December and fears were expressed that artificial diets were hastening ontogeny and producing male precocity. Results of tests for precocious maturity in March 1982 showed that 29% (281/964) of the population of 2+ salmon parr were ripe males and that their average length was 160.8mm, compared with 163.8mm for immature parr. The proportion of mature males might have been higher had the test been made in December 1981, when all the precocious males would have been "running ripe".

Reared grilse were thinner than usual in 1982, in that a sample of 27 rod caught fish had a Coefficient of Condition of 0.99 and the female broodstock in December had a comparable value of 1.03. This may be compared with a value of 1.05 for both rod-caught and broodstock fish in 1981.

The Coefficient of Condition for wild rod-caught fish in 1982 was 0.97.

The average weights from a Coefficient of Condition of 0.99 for reared grilse were:

2.21kg (4.86lbs) from 1+ smolts
2.63kg (5.79lbs) from 2+ smolts

The largest grilse returning in 1982 was:-
Male : 79.0cm : 5.03kg (11.06lbs) : C of C = 1.02

Rod catches.

The rod-catch of reared grilse from L. Furnace in 1982 improved very considerably, to a total of 27 out of the overall total of 72 fish from this lake, or 37.5% of the catch. This can be attributed, at least in part, to their being held in this lake by low water conditions during July and part of August.

Only 3 reared fish (9.1%) contributed to the total of 33 salmon caught in L. Feeagh where this low exploitation rate was due to small numbers of reared fish present by the end of September and also to the "unsettled" condition of reared fish which have passed their homing point. This latter phenomenon has been remarked upon in earlier Reports and is responsible for reared fish moving downstream through the traps after having moved upstream to L. Feeagh.

Timing of wild and reared grilse returns.

Although influenced by the vagaries of floods and low water conditions, the timing of the run of reared grilse has been later than that of wild grilse in every year for which records are available. This may represent a later homeward migration from the sea feeding grounds or the reared grilse may delay their migration into fresh water because the Mill Race (flowing into L. Furnace) represents their homing point. Results from the detection of reared fish with coded-wire tags in the coastal net catch suggest that the timing of their homeward migration is similar to that of wild fish. An extension of the experimental work on artificial imprinting is planned, which should help to confirm any delay in L. Furnace.

Table 28. Timing of maiden wild and reared grilse return.

	Wild grilse %	Reared grilse %
June	28.1	1.9
July	4.1	—
August	51.6	29.7
September	3.6	18.4
October	9.4	38.2
November	3.0	11.8
December	0.2	—

Note that this late-running phenomenon may be peculiar to the Burrishoole system where reared smolts are released into L. Furnace and on return as adults may spend considerable time in this lough before migrating upstream through the traps.

Relative survival rates.

Reared smolt survival rates since 1966 are shown in Table 29 as the three 5-year-averages for 1966-70*, 1971-75 and 1976-80, with the individual values for 1981 and 1982:-

Table 29. Relative survival rates of 1+ and 2+ smolts.

Year	Smolts released	Number recaptured	% overall recaptured	% 2+ smolts	% 1+ smolts
1966-70*	13647	342	2.32	3.12	1.66
1971-75	8809	270	2.81	3.02	1.69
1976-80	15171	224	1.47	1.47	1.35
1981	10705	221	2.06	2.29	1.46
1982	18926	~~253~~ 278	1.34	1.23	1.47

Note that these figures refer to return to the river of origin and make no allowance for the unreported proportion of adults which is taken by coastal nets, where fin clips and brand marks largely go unnoticed. (See following section for coded-wire tag recovery programme).

*Mill Race traps only

Disregard red ink changes - due to inclusion of home-river caught fish.

Reared grilse caught in coastal nets.

In 1982, the Fisheries Research Centre, Abbotstown continued its programme of sampling catches by coastal drift nets, in order to detect grilse which had been marked with coded-wire tags as smolts, in 1981.

Smolts reared by the Salmon Research Trust, tagged by this technique numbered:-

	2481	1+ smolts.
and	3400	2+ smolts.

The sampling programme, carried out by Fisheries Research Centre personnel at various landing-places along the north, west and south coasts of Ireland during the period June 10-July 5, revealed an abnormally high exploitation of grilse derived from smolts reared by the Salmon Research Trust. Whereas batches of tagged smolts from other rearing stations showed lowered exploitation rates, compared with those found in 1981, the detection rate of SRTI smolts reached 3.1% of all 1+ smolts tagged and 2.7% of all 2+ smolts tagged.

Thus:-

3.1% of 2481 x 1+ smolts tagged	=	78 grilse	
2.7% of 3400 x 2+ smolts tagged	=	93 grilse	
Total		171 grilse	171 x 2.2

For 1+ smolts, 2481 were tagged, out of 7902 released, so that, by extrapolation, some 248 grilse from 1+ smolts were caught by coastal nets. Similarly, 301 grilse from 2+ smolts contributed to the net catch.

78/2481	=	248/7902	for 1+ smolts
93/3400	=	301/11204	for 2+ smolts
Total:		549	549 x 2.2 =

Since the return to the native river was 253 maiden grilse through the traps, plus 26 rod-caught maiden grilse from L. Furnace, this total of 279 may be compared with the estimated total of 549 caught in coastal drift nets. This gives an exploitation rate of 66% by these nets; which may be considered a minimum figure, owing to the impossibility of examining every fish caught along the entire coastline, both during and outside the legal fishing season.

No reason can be given for this abnormally high exploitation rate on grilse reared by the Trust. Possibilities include a concentration of effort on a particular migration route, or a better-than-usual survival of SRTI grilse as far as the offshore region of Ireland.

"Raising factor" of 2.2 → 549 x 2.2 = 1208 nets 81.2%
279 home 18.8%
1487

Disregard red ink changes - due to inclusion of home-river caught fish.

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"Raising factor" of 2.2 → 549 x 2.2 = 1208 nets 81.2%
279 home 18.8%
1487

The recaptures of reared grilse were reported from:-

Mayo	:	48%
Donegal	:	37%
Galway	:	6.5%
South of Galway Bay	:	8.2%

The distribution of grilse derived from 1+ and 2+ smolts was normal for all areas, except that only 2 fish from 1+ smolts were caught south of Galway Bay, compared with 12 from 2+ smolts. In all, 25 fish (15%) were recaptured from areas south of the parent river.

The data embodied in this section were taken from computer printouts kindly supplied by Mr. John Browne, Fisheries Research Centre, Dept. of Fisheries and Forestry, Dublin.

Summary of selective breeding programme.

To summarise the results of the selective breeding programme since 1966, the total returns (excluding previous spawners) can be divided into the following categories:-

Smolt parentage	Grilse	2SW fish	Pre-grilse
2SW	183 (87%)	27 (13%)	0
Grilse	4283 (98.4%)	70 (1.6%)	8
2SW x G	147 (96.1%)	6 (3.9%)	0

Note that recaptures from 2SW parentage smolts are expected in 1983, after a period of years when no 2SW smolts were produced. Further releases of 2SW smolts will occur in 1983 and 1984. In the summary table above, "Pre-grilse" refers to fish which return to fresh water after less than one year at sea, usually in the summer after release as smolts. "2SW fish" includes both small spring and small summer fish.

(ii) Attraction of imprinted adult salmon on their return to freshwater.

1275 experimental parr were imprinted with morpholine in 1981 whilst a control group of 1899 fish were reared under similar conditions but not artificially imprinted (see *Ann. Rep. XXVI)*. Fish from both groups returned to freshwater during the summer of 1982 as grilse. The experimental fish were identified by an N brand and adipose fin clip whilst the controls had adipose and dorsal fin clips.

A morpholine drip (modified Mariotte bottle) was located inside the Salmon Leap upstream trap, the objective being to attract a greater proportion of the imprinted than the non imprinted fish to migrate upstream via this trap. The drip concentration giving a steady state concentration of 5×10^{-4}mg of morpholine per litre of water was calculated at 5 different water heights and adjusted to the existing water height as necessary. The drip was started on July 10, when the first reared grilse was recaptured in the trap, and continued until November 30 when fresh grilse had ceased to run upstream.

Table 30. Numbers of Experimentals and Controls migrating upstream via either Salmon Leap or Mill Race traps.

	Nos. of Experimentals	Nos. of Controls
Salmon Leap Trap (morpholine drip)	11	9
Mill Race trap (no morpholine drip)	3	7

Although more imprinted fish migrated upstream through the Salmon Leap than non-imprinted, the difference was not statistically significant, due to the small number of recaptures.

About two-thirds of all reared grilse used the Salmon Leap as a route of upstream migration during the period of the experiment. Table 31 shows the proportion of wild and reared grilse passing upstream via the Salmon Leap trap for each year since 1970.

Table 31. Proportions of wild and reared grilse at Salmon Leap.

Year	% wild grilse	% reared grilse	
1970	60.0	14.7	
71	52.2	25.0	
72	26.1	14.3	
73	43.0	17.2	
74	58.5 (48.0)	48.0 (23.8	5 year average)
75	59.7	42.0	
76	68.5	37.1	
77	59.2	43.8	
78	75.6	64.0	
79	47.5 (62.1)	53.4 (48.1	5 year average)
80	57.1	37.4	
81	49.2	38.0	
82	56.2 (54.2)	66.2 (47.2	3 year average)
	(54.8)	(66.2)	13 year average

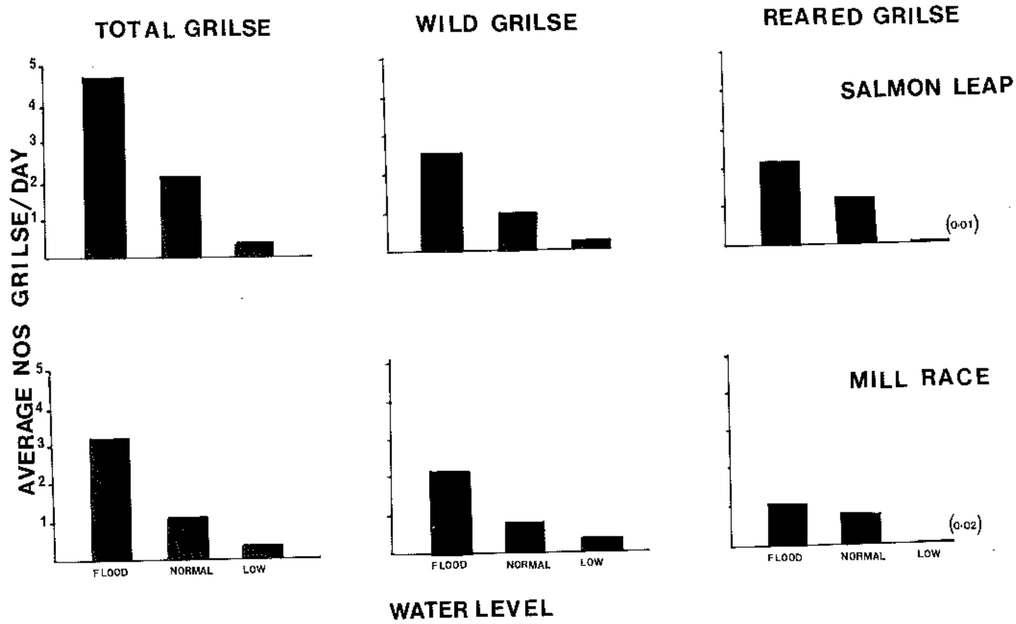
Although there is considerable yearly variation, the proportion of both wild and reared grilse using the Salmon Leap for upstream migration has increased since 1970-74. This trend is more marked for the reared grilse. The Table also shows that in all but 2 years (1979 and 1982) a greater proportion of wild than reared grilse migrated upstream via the Salmon Leap. This would be expected as the reared fish spend their freshwater life in ponds adjacent to the Mill Race and therefore this site constitutes their homing point.

The proportion of reared grilse (66.2%) migrating upstream via the Salmon Leap trap in 1982 during the experimental period was unusually high compared with previous years. In contrast, during the same period 54.6% of the wild fish chose this route, a proportion similar to the 13 year average of 54.7%.

The effect of water height on upstream migration.

The average number of grilse migrating upstream at different water heights in 1982 is shown below in Fig. II. The majority of grilse migrate upstream during floods both at the Salmon Leap and Mill Race. The proportion of fish (wild and reared) passing upstream at different water levels (flood, normal and low) is similar for both the Salmon Leap and Mill Race routes, with one exception. This is the low proportion of reared fish using the Mill Race during flood conditions. Water height does not, therefore, seem to have influenced at all the route of upstream migration chosen by wild fish and only to a minor extent that of reared fish, there being an apparent preference for upstream migration through the Salmon Leap under flood conditions in 1982.

Fig. II.



The effect of timing of run on upstream migration.

Whereas 81% of all wild grilse had migrated upstream by September 1, only 32.5% of all reared grilse had been counted through the traps by this date. It is therefore possible that factors operating from September onwards influenced a greater proportion of reared grilse to migrate upstream via the Salmon Leap trap.

One of these factors could have been the large numbers of floods whilst the majority of the reared fish were migrating upstream. Another, the morpholine drip which may have acted as a general attractant to all reared fish, whose sense of homing may be less exact than that of wild fish.

Summary.

1982 was the first year that artificially imprinted salmon returned to the Burrishoole system. The results obtained were not conclusive as to the effectiveness of attracting artificially imprinted grilse to a source of the imprinting chemical. Other variables, which include water height and timing of the run, could influence the route of upstream migration. However, this is an ongoing experiment and further results from larger experimental groups may clarify the situation.

(iii) Detection of coded-wire tags in adult salmon broodstock.

170 reared grilse collected as broodstock were tested (alive, anaesthetised) for coded-wire tags and 25 positive results were recorded. This tag detection rate in live fish of 14.7% may be compared with the proportion of smolts released with coded-wire tags which was 31%, assuming no differential mortality between tagged and untagged fish. The efficiency of tag detection in live fish, compared with dead fish has not yet been determined.

A non-random sample of 51 dead fish which were expected to contain tags gave 28 positive cores.

The information from broodstock tested for coded-wire tags in 1981 and 1982 will be collated with the results from returning reared grilse in 1984. All of these fish should contain coded-wire tags, compared with varying proportions of the grilse returning in 1981-83 inclusive.

(iv) Marine survival of salmon parr vaccinated against furunculosis *(Aeromonas salmonicida)* and released as 2+ smolts in 1981.

These fish were vaccinated against *A. salmonicida* in 1980 and released as 2+ smolts in April 1981. The vaccine consisted of formalin-killed *A. salmonicida* cells and was applied either by simple immersion or by the hyperosmotic infiltration method. Approximately equal numbers of control fish for each vaccination method were reared under similar conditions (see *Ann. Rep. XXV,* Section B, 7). Controls in each case were identified by adipose fin clip. No deaths due to furunculosis occurred in any of the four groups during the remainder of freshwater rearing. The four groups were marked individually with Alcian blue spots administered by a "Panjet" prior to release *(Ann. Rep. XXVI,* Section B, 11). Forty three grilse had "Panjet" marks on return in 1982. Details are given in Table 32.

Table 32. Details of survival of salmon vaccinated against furunculosis.

	Number of smolts released	Number of grilse recaptured	Percentage survival
Simple immersion controls	1518	5	0.33
Simple immersion vaccinated	1483	15	1.01
Hyperosmotic controls	1369	7	0.51
Hyperosmotic vaccinated	1312	16	1.22

It can be seen from Table 32 that survival of fish vaccinated by both methods was more than twice that of their respective controls. However, mean survival of all 2+ smolts returning as grilse in 1982 was 1.23%, a figure very similar to that recorded for both vaccinated groups. Thus the results of these vaccination experiments are somewhat equivocal.

(v) Smolt releases.

A total of 17,870 reared smolts (adipose fin-clipped) was released in 1982, comprising:-

1.	1+ 2SW smolts	:	2942	:	Brand K
2.	1+ Grilse smolts	:	8015	:	Brand S
3.	2+ Grilse smolts	:	2518	:	Brand V
4.	2+ Grilse smolts	:	2438	:	Brand T (morpholine imprinted)
5.	2+ Grilse smolts	:	1957	:	Brand O (coded-wire tagged)

Note that 2400 pre-smolts (2+ years old) escaped from a cage in L. Furnace operated by Curraun Fisheries Ltd. during March, 1982. The survivors will return as unmarked grilse in the summer of 1983. Due allowance will be made for upstream counts by applying the relevant survival rate for 2+ reared smolts.

3. WILD SEA TROUT.

(i) Upstream movements.

a) Timing and numbers.

The sea trout run at 1119 was the lowest since full trapping began in 1970. Low water conditions during July and August may have contributed to this reduction of numbers. It is also possible that a trend for increase in the size of the sea trout run during the 1970's is now being reversed (Table 33) or that unrecorded marine exploitation is increasing. The finnock (0+ sea years) proportion of the run was estimated at 26.4%. The highest number of sea trout moved upstream through the traps in August, unlike most of the previous thirteen years (Table 34). A larger proportion ascended the Salmon Leap (57%) than the Mill Race.

The totals of upstream-migrating sea trout, counted through the traps from 1970 onwards, were as follows:-

Table 33. Annual runs of sea trout.

Year	Mill Race	Salmon Leap	Total
1970	885	359	1244
71	889	518	1407
72	1799	426	2225
73	1596	1248	2844
74	1658	1261	2929
75	1651	1697	3348
76	894	2408	3302
77	731	1481	2212
78	427	1303	1730
79	443	1987	2430
80	399	1104	1503
81	390	886	1276
82	489	630	1119

The timing of the sea trout run, expressed as monthly percentages, is shown in Table 34, together with the runs for 1980 and 1981 and the averages for 1970-79. Note the equal spread of the upstream run over the months of June, July and August, compared with earlier years.

Table 34. Timing of sea trout run.

	1970-79	1980	1981	1982
May	—	—	0.8	0.1
June	13.1	41.5	17.5	32.4
July	54.4	40.2	60.3	24.1
August	15.8	6.8	10.1	33.8
September	7.6	7.2	6.8	4.2
October	6.4	2.7	2.4	3.9
November	2.4	1.5	1.6	1.5
December	0.3	0.1	0.5	—

b) Net-marked fish.

Twenty four sea trout were noted as net-marked in 1982. This was a large decrease from 1981, but typical of the previous years. Net-marks were observed in June, July and August, and in both traps.

c) Spawning escapement.

Table 35. Calculation of spawning escapement.

Live fish counted through traps	:	1,110
Rod catch on L. Feeagh	:	96
Maximum escapement	:	1,014

The maximum spawning escapement to the rivers running into L. Feeagh was very low in 1982 as can be seen from the following table:-

Table 36. Annual spawning escapement of sea trout in the last three years with the average for 1970-79.

Year	1970-79	1980	1981	1982
Maximum escapement	2,090	1,345	1,174	1,014

(ii) Downstream movements.

a) Sea trout smolts.

Early smolts began to move downstream in January but there was no migration in large numbers until March. The majority of the run occurred in May, with small numbers being recorded until July. Most sea trout smolts left L. Feeagh via the Salmon Leap (79%). The smolt run at 3907 approached the ten-year average from 1970-79 in contrast with 1980 and 1981:

Table 37. Annual sea trout smolt numbers.

Year	1970-79	1980	1981	1982
Sea trout smolt number	4,176	2,337	6,710	3,907

b) Autumn-migrating trout.

These are juvenile trout, which move down through the traps from September to December and cannot with certainty be identified as freshwater or sea-going *Salmo trutta*. The number of these trout at 2218 was smaller than all recent years except 1981 (Table 39) and in contrast with 1980 (*Ann. Rep. XXVI*, p.40) nearly 50% of these fish were shown by scale reading to be 0+ years old. It is doubtful whether these young fish will make any contribution to sea trout production in 1983.

Table 38. Timing and numbers of autumn-migrating trout.

	Mill Race	Salmon Leap	Total
September	28	512	540
October	145	922	1067
November	92	345	437
December	56	118	174

If it is assumed that all autumn-migrating trout contribute to the sea trout smolt run the following year, then a figure for total recruitment can be calculated (Table 39). The validity of this assumption was discussed in *Ann. Rep. XXVI*, Section C 3, iii.

Table 39. Total migrant juvenile trout production.

Year	Smolt total	Autumn juveniles (preceeding year)	Total recruitment
1970	3228	N/A	3228+
71	2961	3128	6089
72	5465	3620	9085
73	6071	2124	8195
74	4527	2606	7133
75	3587	2703	6290
76	5207	4171	9378
77	3889	2947	6836
78	3167	3506	6673
79	5656	2603	8259
80	2337	2351	4688
81	6710	2631	9341
82	3907	1730	5637
83	4852	2218	7070

c) Sea trout kelts.

The first kelts of the 1981/82 season were observed in November. The peak of the larger (over 30cm) sea trout kelt run occurred in March while the greatest number of smaller kelts (less than 30cm) passed downstream in May (Table 40). A fork length of 30cm roughly delimits finnock from adult sea trout. Very few kelts were "marked" with fungus in 1981/82, unlike the previous year.

Table 40. Timing and numbers of sea trout kelts.

Month	Large	Small	Total	% "Marked"
November 1981	22	22	44	0
December	27	29	56	0
January 1982	51	27	78	0
February	64	20	84	2.4
March	149	69	218	0.5
April	84	95	179	0
May	90	259	349	0
Totals	487	521	1008	0.4

The comparable survival rates from the upstream runs to large and small sea trout kelts are expressed as percentages in Table 41.

Table 41. Annual % survival rate to kelt.

Year	Large	Small
1976	79	66
77	63	45
78	50	66
79	33	107
80	50	82
81	44	345
82	~~54~~ 53 ✓	~~194~~ 203

1174 < 257 finnock / 917 large

487/917 = 53%

521/257 = >200%

1008/1174

As in 1979 and 1981, the number of "small" sea trout kelts exceeded the number of finnock in the upstream run. Two possible reasons for this were proposed in *Ann. Rep. XXVI*:-

1. finnock can squeeze through the bars of the Salmon Leap upstream trap or those of the Mill Race fish fence and thus escape being counted.
2. large sea trout smolts are erroneously classified as finnock kelts in the downstream traps.
3. finnock are not always classified as such in trap catch

The latter possibility was tested by collecting sets of scales from [illegible] downstream migrating sea trout between 22cm and 30cm in fork length. Before release, these fish were classified subjectively as smolts or kelts. It was found that both types occurred within this size range and that the subjective classification was correct in 80% of cases. Of the remaining 20%, 13% of finnock kelts were erroneously classified as smolts and 7% of smolts were wrongly identified as kelts. Thus there does not seem to be a distinct bias in either direction, so the possibility of a large sea trout smolts being erroneously identified as finnock kelts can be excluded. Therefore, the former reason must cause the observed discrepancy. During 1982, finnock have been observed passing through the bars at the front of each upstream trap. Furthermore, of nine tagged finnock kelts recorded in early 1982, only three had been observed in the upstream traps. Thus a problem exists of incomplete census of upstream-migrant finnock. However, if the traps and fish fence were fitted with more narrowly spaced bars, considerable problems of detritus blockage would be encountered. See 1981 when "squeezing" through bars was discounted.

(iii) Tagging of autumn-migrating trout and sea trout smolts.

Each autumn and spring since September, 1979, wild autumn-migrating trout and sea trout smolts have been marked in the downstream traps using 1cm oval plastic tags (modified "Carlin") with double polyethylene thread attachment. Exceptions were the autumn taggings in 1979 and 1982, when numbered 0.5cm square plastic tags were used. Recaptures in 1982 are detailed and then total percentage recaptures to December 31, 1982 are given in Table 42.

Autumn-migrating trout 1980.

Two tagged finnock kelts were recorded in the downstream traps during spring 1982, one of which returned for a second time in June, having grown to 34cm fork length from 17.6cm at tagging.

Sea trout smolts 1981.

Twelve of these fish were recorded for the first time in 1982, mostly as kelts. These latter fish had not been observed in the upstream traps in 1981. Two further fish returned as adult sea trout.

Autumn-migrating trout 1981.

Two tag returns were recorded from this group in 1982, one as a finnock and one as a non-migratory trout.

Sea trout smolts 1982.

Sixteen of these fish were recaptured in 1982. In contrast to earlier years, all appeared to be finnock. One recapture was made in July in the Owenduff river, some 40 sea miles north of the Burrishoole river. Mean length at recapture was 28.5cm, slightly larger than the average length for rod-caught finnock (see Table 53). Thus, it does not appear that the presence of external tags is seriously impairing growth in the summer in the sea.

+1 as ST in 1984

Total 22/448

Autumn-migrating trout 1982.

387 were tagged and no recaptures were recorded in 1982.

Summary.

Table 42. Details of first recaptures of tagged downstream-migrating trout up to December 31, 1982.

Year	Type	Number tagged	Percentage recapture
1979	Autumn trout	353	0.8
1980	Smolts	448	0.4
1980	Autumn trout	522	1.7
1981	Smolts	456	6.4
1981	Autumn trout	336	0.6*
1982	Smolts	448	3.6*

(1979/1980: * drought year smolts; 1980/1981: factor of 3.8; 1981/1982: factor of 6)

*First returns of upstream migrating finnock only.

Note the improvement in tag recapture rates since 1979/80, which may be a reflection of poor survival of smolts after the spring drought of 1980.

(iv) Scales

a) Sea trout smolts 1982.

92 sets of scales were collected from sea trout smolts in 1982. Only two and three-years-old were found in the sample. Table 43 compares the percentage age composition of samples from the smolt runs of 1980, 1981 and 1982.

Table 43. Percentage age composition of sea trout smolt runs.

	Percentage composition		
Age	1980	1981	1982
1+	—	1	—
2+	64	68	72
3+	36	30	28
4+	—	1	—

Table 44.

Age	Length (cm)	Weight (g)	Coefficient of Condition
2+	19.2	70.3	0.99
3+	21.2	90.2	0.95

Lengths for both classes were intermediate between those of 1980 and 1981, but condition factors were indentical with those of the former year *(Ann. Rep. XXVI,* Table 36.). As in 1980 and 1981, there was a higher proportion of B-type growth among 2+ than 3+ smolts (Table 45).

Table 45. Proportion of A and B-type growth among 2+ and 3+ sea trout smolts in 1982.

Age	A-type	B-type
2+	34.8	65.2
3+	61.5	38.5

Table 46 shows the back-calculated lengths of the four classes of smolts at the end of the first, second and, in the case of the three-years-old, the third winter. At time of migration, all smolts have reached a similar mean size (approx. 20cm). 2A smolts exhibit the fastest growth pattern at all stages, while 3B show the slowest, 2B and 3A being intermediate.

Table 46. Back calculated fork lengths (cm) of sea trout smolts in 1982.

	At the end of:-			
Type	1st winter	2nd winter	3rd winter	Total length
2A	9.1	18.6	—	18.6
2B	7.4	16.1	—	19.5
3A	6.2	14.6	21.5	21.5
3B	5.6	12.8	19.5	20.8

b) Rod caught sea trout.

Scales were collected from the majority of the sea trout catch in 1982.

Table 47. Numbers of maiden fish and previous spawners in the 1980, 1981 and 1982 rod-caught sample. (Percentages are given in parentheses).

		Maiden fish		Previous	
	0+	1+	2+	spawners	Totals
1980	135 (36.4)	135 (36.4)	9 (2.4)	92 (24.8)	371
1981	197 (53.1)	107 (28.8)	10 (2.7)	57 (15.4)	371
1982	145 (58.2)	73 (29.3)	4 (1.6)	27 (10.9)	249

There seems to be a trend in the data for an increased finnock proportion and a decreased previous spawner proportion. Such a shift in the population could signify increased mortality of the larger fish,due to increased exploitation. On the other hand, we could be observing part of a natural cycle.

A higher proportion of finnock were caught on L. Furnace than L. Feeagh (Table 48). This may reflect meteorological conditions since lack of rain in July and most of August prevented upstream movement at what is usually the height of the finnock run and thus less finnock would be available to anglers on L. Feeagh.

Table 48. Proportions of sea trout of each type caught L. Furnace and L. Feeagh in 1982.

	Maiden fish 0+	1+	2+	Previous spawners	Number in sample
L. Furnace	64.8	25.4	0.5	9.3	193
L. Feeagh	35.7	42.9	5.4	16.0	56

In Table 49, the relationship between smolt age and the various categories of sea trout are expressed as percentages. Mean values for 1980-82 are given in parentheses.

Table 49. Distribution of smolt ages among the various categories of sea trout.

Smolt life (yrs)	Finnock	Maiden sea trout	Previous spawners	Total sample
1	— (0.2)	— (0.3)	— (0.3)	— (0.3)
2	55.2 (53.6)	61.0 (68.3)	70.4 (70.6)	58.6 (61.0)
3	42.8 (43.9)	39.0 (31.4)	29.6 (28.7)	40.2 (37.4)
4	2.0 (2.3)	— (—)	— (0.4)	1.2 (1.2)

Consideration of both the 1982 data and the three-year average (1980-82) indicate that there is a higher proportion of three-years-old smolts among finnock than in the other age categories.

Table 50. Age of previous spawners at first spawning. (Percentages are given in parentheses).

	+SM	1+SM	2+SM	3+SM
1950-58	39 (16)	191 (77)	18 (7)	—
1980	43 (47)	39 (42)	10 (11)	—
1981	25 (44)	30 (53)	1 (2)	1 (2)
1982	18 (48)	10 (37)	4 (15)	—

Table 51. Divided migration and return of the various year classes of sea trout, expressed as percentages.

Returned in 1982 as:	Hatched: 1975	1976	1977	1978	1979	1980
Finnock	—	—	—	1.2	24.9	32.1
1+	—	—	—	11.6	17.7	—
2+	—	—	0.4	1.2	—	—
With SM's	0.4	—	3.2	4.0	3.2	—

The designation, number, year of hatching, mean lengths, weights and coefficient of condition of the whole sample are given in Table 52:-

Table 52. Details of the rod-caught sea trout sample.

	Number	Hatched	Length (cm)	Weight (g)	Coefficient of Condition
2+	80	1980	27.2	199	0.99
2+SM+	8	1979	34.3	422	1.05
2.1+	44		34.2	410	1.02
3+	62		28.5	244	1.05
2+SM+	5	1978	42.6	773	1.00
2.2+	3		40.2	607	0.93
3+SM+	5		38.2	571	1.02
3.1+	29		36.5	495	1.02
4+	3		29.3	218	0.87
2.1+2SM+	1	1977	44.5	653	0.74
2.2+SM+	4		44.2	789	0.91
3.1+SM+	3		42.0	653	0.88
3.2+	1		41.5	734	1.03
2.1+4SM+	1	1975	52.0	1469	1.04

222/249 = 89% maidens

A comparison of mean fork lengths at capture of the different age groups of sea trout (Table 53) reveals a reduction in size of 1 sea-winter maidens in particular. Whether this results from increased marine exploitation or poor growth in the sea winter of 1981-82 cannot be determined.

Table 53. Fork lengths (cm) of sea trout smolts and of maiden fish with varying histories at sea.

	Smolts	+	1+	2+
1956-58	19.6*	27.9	36.1	40.9
1980	20.0	27.8	37.1	42.5
1981	19.8	27.0	36.3	43.2
1982	19.7	27.8	35.1	40.5

*Back-calculated length.

4. REARED SEA TROUT.

(i) Recapture rates.

For the first time in recent years, reared sea trout were released in 1982, as described in Section B, 7. These fish were 2+ smolts, 1090 from Connemara ova and 1754 from Burrishoole ova (total release = 2844). All were externally tagged with modified Carlin-type tags. Up to the end of 1982, 183 tagged fish were recaptured, whilst 157 others which had lost their tags but were identifiable by adipose fin clips, were also recorded. Thus there was a minimum recapture rate of 6.4%. If it is assumed that all fish which bore tags at first recapture did not subsequently lose their tags, the recapture rate could be as high as 12.0%. These figures may be compared to the 3.6% recapture of wild finnock, tagged by the same method in 1982. However, these comparisons may not be valid since, as discussed below, the behaviour of the reared fish differs from wild sea trout.

It was only possible to work out survival of the Burrishoole and Connemara stocks independently with fish that had retained their tags. Thus the data given in Table 54, represent minimum survival.

Table 54. Survival of reared sea trout.

	No. of smolts released	No. of recaptures in 1982	% Recapture
Burrishoole	1754	120	6.8
Connemara	1090	63	5.8
Total	2844	183	6.4

There appears to be little difference in recapture rates in the year of release between the two stocks.

(ii) Behaviour of reared sea trout.

Unlike wild sea trout which ascend through the traps in the summer and do not descend until late winter or early spring, reared sea trout moved through the traps in both directions during October and November. This behaviour, which is also found in reared salmon, is probably due to the reared sea trout being imprinted to water from the Furnace rearing station. Of the fish which had retained their tags, 28 were recorded twice and 7 three times, in different traps. This greatly underestimates the extent of up and downstream movement since trout of less than 30cm in length can easily pass through the upstream screens. Indeed, about half of the first recaptures were made in the downstream traps.

One hundred and thirty six fish, which had retained their tags, were classified as finnock or brown/slob trout on the basis of appearance. Of these, 62% were finnock, but the remainder had not migrated to sea. It might appear that the rearing environment had repressed the sea-going urge, since most tagged wild sea trout smolts become finnock. However, these groups may not be comparable since the "decision" to migrate may have been made in wild fish before they appear in the downstream traps, whereas in reared fish all surviving progeny were released. This, of course, assumes that there is no racial distinction between brown and sea trout in the Burrishoole system.

The recaptures of reared trout, excluding those first recorded in the downstream traps were as follows:

Mill Race upstream trap	:	74
Salmon Leap upstream trap	:	4
Furnace rods	:	37
Feeagh rods	:	6
External sources	:	6

It is apparent that these fish made a considerable contribution to rod catches, particularly in L. Furnace, where reared fish represented 15% of the trout catch. Of the six fish listed from external sources, two were caught on the neighbouring Newport river, three came from the River Moy and one from the River Bann, near Derry. All were caught during the summer and might have returned to the Burrishoole system had they not been caught elsewhere. Nall (1930, *The Life of the Sea Trout*, Seeley, Service and Co. Ltd., London) observed similar summer dispersal along the coast and entry into other rivers, in wild Scottish finnock.

(iii) Tag loss.

46% of all reared trout recaptured in 1982 had lost their tags. Consideration of the data show that tag loss is an ongoing process and that it should be taken into account in estimates of total sea trout survival or calculation of finnock/maiden sea trout proportions using external tags.

(iv) Growth of reared sea trout to the finnock stage

Sixty-six reared trout which were recaptured as finnock had, on average, grown from 22.4cm when released as 2+ smolts, to 30cm. The fastest growing individual was 15.5cm as a smolt and 32.5cm in length on recapture as a finnock. In Table 55, the growth of various groups of finnock in 1982 are compared.

Table 55. Growth of various groups of finnock in 1982.

	Mean smolt length	Mean finnock length	% growth	No. in finnock sample
Ranched Reared	22.4	30.0	34	66
Farmed Reared	20.0*	31.2	56	109
Wild — rod caught	19.7	27.8	41	145
Wild — tagged	22.2	28.9	29	14

*Measured prior to moving to sea cage in September, 1981 (see Section B, 10).

As was discussed in Section B, 10, the growth of the farmed fish may not be directly comparable with wild and ranched finnock since their growth was measured over a much longer period. Additionally, the largest and thus possibly fastest growing trout were selected from the reared population for transfer to the sea cage.

It can be seen that the ranched reared finnock had a smaller growth increment than the rod-caught wild finnock. However, the reared fish were externally tagged, which may have repressed growth. In partial confirmation of this, tagged wild smolts grew less well than rod-caught fish.

SECTION D : FISHERY REPORT

1. CATCH DATA

(i) Numbers and average weights of rod catch

The rod catch for the 1982 season (including wild and reared salmon) was as follows:

	SALMON			SEA TROUT		
	No.	Total wt. (lb)	Av. wt. (lb)	No.	Total wt. (lb)	Av. wt. (lb)
Lough Feeagh	33	147.1	4.45	102	97.5	0.96
Lough Furnace	72	321.6	4.59	269	184.6	0.69
Totals	105	468.7	4.46	371	282.1	0.76

Table 56. Number and average weights of rod caught salmon and sea trout 1970-82.

	Salmon		Sea trout	
	No.	Av. wt. (lb)	No.	Av. wt. (lb)
1970-74	237	4.6	967	0.94
75	228	5.6	686	0.80
76	198	5.4	560	0.95
77	121	4.0	667	0.85
78	40	5.4	479	0.82
79	118 141	4.0 4.9	449 568	0.95 .87
80	59	5.0	455	1.08
81	42	4.4	385	0.88
82	105	4.5	371	0.76
83	130	5.2	250	0.80

(ii) Salmon

105 salmon were caught in 1982 compared with 42 in 1981 and 59 in 1980. In contrast to recent years, and mainly due to the absence of rain until late August which prevented upstream migration, the majority of the fish (72 salmon) were caught on L. Furnace. Of these, 27 (37.4%) were reared fish. As in 1981, the average weight of rod caught salmon was lower than that recorded in previous years.

As stated in *Ann. Rep. XXVI,* it would appear that rod catches of salmon in the Burrishoole river system increase or decrease according to the stock of fish available. An analysis of stock and catch data over the past thirteen years (1970-82) using rank correlation clearly shows a positive correlation between the stock and catch of both wild and reared salmon (wild salmon $r = 0.91$, $p < 0.01$; reared salmon $r = 0.75$, $p < 0.01$).

However, stock is only one factor that may influence catch and a study was carried out to determine the effect of other variables (fishing effort and various weather conditions) on the magnitude of the rod catch of salmon in any one year. Initially, the study was confined to L. Feeagh and the data has been analysed on a monthly basis during the rod fishing season (June to October) over 11 years (1971-81). Preliminary results are outlined below.

Although fishing was not recorded specifically on the Burrishoole Fishery before 1980, full details of individuals catches have been kept since 1971. From these records, it has been possible to estimate the fishing effort on L. Feeagh for each year between 1971 and 1979. A significant correlation exists between fishing effort and catch of salmon on L. Feeagh ($r = 0.79$, $p < 0.01$). As would be expected, fishing effort is also significantly correlated to the stock of fish available ($r = 0.66$, $p < 0.01$).

The effect of climatic conditions on the catch is diffficult to quantify, as even on an hourly basis, significant changes may take place. A number of climatic variables have been recorded on a daily basis over many years. Those relevant to angling include sunshine, cloud cover, rainfall and wind speed. When these factors are compared with fishing success, only those measured over the entire day (sunshine and rainfall) give meaningful results. Catches of salmon are loosely correlated with rainfall ($r = 0.29$), which has obvious beneficial effects on fishing: in the Burrishoole system, heavy rainfall induces salmon to migrate upstream from tidal L. Furnace into freshwater L. Feeagh. Once in freshwater, these new arrivals supplement the stock of salmon already present and result in higher catches. The presence of the fresh fish and high water levels also seems to make the resident salmon more active. Fishing effort is strongly correlated with rainfall ($r = 0.42$, $p < 0.01$) and this will certainly contribute to greater catches of salmon being recorded after periods of heavy rain.

Sunshine is negatively correlated with catch, which is not surprising, since sunshine is normally associated with a weather pattern which is not conducive to good fishing. Fishing effort is also negatively correlated with sunshine ($r = -0.3$, $p < 0.05$).

Analysis of variance is a statistical technique that divides the total variation present in the catch data into separate independent components that may be attributed to one source or another e.g. the effect of each independent variable (stock, fishing effort, climatic conditions) on the dependent variable (catch). When this technique is applied to the catch data available for the Burrishoole system, only one independent variable (fishing effort) is shown to significantly affect the catch.

Thus from the results of this analysis, it would appear that fishing effort is the most important factor in determining the catch of salmon.

(iii) Sea trout

The total catch of 371 sea trout was marginally lower than that recorded in 1981, which was itself the lowest recorded since 1949. This poor catch is a reflection of the very small stock of fish available. To some extent, the unfavourable weather conditions for angling (hot, dry and windless) recorded during July and most of August, were also responsible for poor catches.

The average weight of the rod catch was lower than that recorded in previous years, as a result of the increased proportion of finnock in the catch (see Section C 3, iv, b).

The effect of stock, fishing effort and various weather conditions on the rod catch of sea trout was also investigated as part of the same study outlined above.

In *Ann. Rep. XXVI,* it was stated that no correlation was found to exist between available stock and catch of sea trout on L. Feeagh (1970-81). However, when data was analysed by month, rather than annually, a significant correlation ($r = 0.75$, $p < 0.01$) was found between available stock and catch of sea trout on L. Feeagh (1971-81).

As for salmon, a significant correlation exists between fishing effort and catch of sea trout on L. Feeagh ($r = 0.92$, $p < 0.01$). Again, fishing effort is also significantly correlated with the stock of fish available ($r = 0.70$, $p < 0.01$).

Similar weather conditions are conducive to good rod catches of both salmon and sea trout so, as would be expected, the sea trout catch is positively correlated with rain ($r = 0.5$, $p < 0.01$) and negatively correlated with sunshine ($r = -0.21$, N.S.).

Analysis of variance of the catch data for sea trout shows that it is not only fishing effort but also the amount of rain and sunshine that has a significant effect on the catch. This indicates that weather conditions are more important in determining rod catches of sea trout than those of salmon.

2. EXPLOITATION RATES BY ROD FISHING

Only fly-fishing is permitted and records of the rate of exploitation for stocks of wild and reared salmon and sea trout now exist since 1970. Accurate assessments can be made for L. Feeagh but the complication of unknown numbers of sea trout spawning in the streams flowing directly into L. Furnace makes it impossible to attempt reliable estimates of the exploitation rate of sea trout in L. Furnace. 269 sea trout were caught in L. Furnace during 1982, most of which, it can be assumed, were destined to spawn in the L. Furnace tributaries. (See Frontispiece for geography of Burrishoole River system).

For salmon, the maximum rates are accurate, assuming no spawning in L. Furnace tributaries. To arrive at the minimum rates, a tentative correction of 10% has been applied. This is a slight, deliberate over-estimation, as only one stream is used to a minor extent by spawning salmon.

The 1982 rod fishing season for salmon ended on September 30 as in 1981. In 1980, the season ended on September 7, August 31 in 1979 and October 12 in previous years. Thus the exploitation rates of 1970-78 are not directly comparable with those for 1979 onwards.

The 1982 exploitation rate of the total stock of **reared salmon** (12.6%) was high, especially compared with those recorded in 1980 and 1981 (5.5% and 4.4%). This increase was almost entirely caused by good catches of reared grilse on L. Furnace during August. In contrast, only a relatively poor stock of fish migrated late in the season to L. Feeagh, and the exploitation rate of reared grilse on this lough was only 2.6%.

The stock of **sea trout** in L. Feeagh was the smallest yet recorded. Even so, the exploitation rate of 9.2% was an improvement on the past seven years (1975-81).

Table 57. Exploitation rates for rod fishing.

WILD SALMON	1970-74	1975-79	1980	1981	1982	1983
Lough Feeagh						
"Available" fish by end of fishing season	988	644	610	356	407	
Rod catch	86	51	36	15	30	35
Exploitation rate %	8.7	7.9	5.9	4.2	7.4	

WILD SALMON	1970-74	1975-79	1980	1981	1982	1983
Loughs Feeagh and Furnace						
Total stock of wild fish	1282	802	700	407	510	
10% addition for L. Furnace residents	1411	882	771	447	561	
Total catch of wild fish	206	113	50	32	75	
Minimum exploitation rate %	14.6	12.8	6.5	7.2	13.4	
Maximum exploitation rate %	16.1	14.1	7.1	7.9	14.7	

REARED SALMON	1970-74	1975-79	1980	1981	1982	1983
Lough Feeagh						
"Available" fish by end of fishing season	154	122	77	159	115	
Rod catch	4	7	5	4	3	11
Exploitation rate %	2.6	5.7	6.5	2.5	2.6	

REARED SALMON	1970-74	1975-79	1980	1981	1982	1983
Loughs Feeagh and Furnace						
Total stock	261	257	163	228	247	
Total rod catch	32	28	9	10	30	
Exploitation rate %	12.3	10.9	5.5	4.4	12.1	

SEA TROUT	1970-74	1975-79	1980	1981	1982	1983
Lough Feeagh						
"Available" fish by end of fishing season	1983	2518	1450	1218	1113	
Rod catch	318	210	103	67	102	
Exploitation rate %	16.0	8.3	7.1	5.5	9.2	

3. FISHING EFFORT

(i) Boat lettings.

There was an increase in boat lettings in 1982 compared with 1981. Boat lettings with boatmen also increased, although as has been the case since 1980, boats without boatmen continued to provide the largest revenue to the fishery. Weekly lettings continued to decline in 1982.

Table 58. Boat lettings (number of boat days).

	Let by week	Let by day	With boatman	Without boatman	Total boat days let
1979	96	74	172	Not applicable	172
80	73	119	76	116	192
81	57	103	46	114	160
82	32	155	67	120	187
83	72	144	65	151	216

(ii) Effort data.

Table 59. Effort data.

	L. Furnace: Rod hours	L. Furnace: Boats /day	L. Feeagh: Rod hours	L. Feeagh: Boats /day	Overall boat utilisation rate	Total rod hours
1979	1928*	0.8*	1272*	1.1*	1.9*	3476*
1980	2542	1.7	1149	0.7	2.4	3691
1981	2042	1.5	836	0.6	2.1	2878
1982	2672	1.5	1240	0.7	2.1	3912

*estimated

(iii) Fishing success.

In Table 60, the catch data is incorporated with the fishing effort to give an estimate of fishing success: number of rod days to catch one fish.

Table 60. Catch per unit effort (rod days per fish). better as fish per rod-day?

Year	L. Furnace: SALMON	L. Furnace: SEA TROUT	L. Feeagh: SALMON	L. Feeagh: SEA TROUT
1980	14.8	0.9	3.5	1.3
1981	11.1	0.8	5.5	1.6
1982	4.1	1.4	4.2	1.5

1. It was assumed that each boat contained 2 people fishing for 8 hours per day unless known otherwise.
2. Fishing by Newport Anglers' Club is included. It was assumed that Club fishermen fished for four hours on week days and eight hours on Sunday.

The most noticeable change in 1982 was the increased catch of salmon per unit effort of fishing recorded for L. Furnace. This was brought about by low water conditions until late August, referred to previously. Despite unsuitable angling conditions (lack of wind, high water temperatures and salinity, etc.) certain tidal conditions on L. Furnace appeared to result in high catches of grilse. Sea trout did not react in a similar manner and this is reflected in the very low catch per unit effort recorded. Catch per unit effort of both species on L. Feeagh was similar in 1982 to that recorded in previous years.

4. EELS

(i) Silver eels.

The catch of 4234 silver eels in 1982 conforms well with the five-year averages for 1971-75 and 1976-80. The total was not a complete count since the Mill Race trap was recorded as overflowing on October 15 and the fine mesh screens on the fish fence had to be lifted during high floods, for short periods. As usual, almost 75% of the catch was made at the Salmon Leap trap.

Table 61. Timing of the silver eel run.

	Salmon Leap	Mill Race	Totals
August	173 (from 20/8)	—	173
September	435	35	470
October	1935	823	2758
November	500	258	758
December	60	15	75

Two batches of silver eels were sample-weighed before sale, with the following results:-

Date	Number	Total weight	Av. weight
October 22	3126 eels	441.1 kg	141 g
November 22	884 eels	151.4 kg	171 g

There was further evidence of larger eels migrating later in the season, during 1982. For example, 313 specimens sampled on October 18 from early-running eels, had an average weight of 143g whilst 242 eels caught on October 19, 20 and 21 had an average weight of 162g. As noted above, the average weight had increased to 171g by November 22. The average weight over the entire run improved to 148g in 1982 compared with 131g in 1981.

Table 62. Catches and average weights.

1971-75	4465	84 g
1976-80	4023	115 g
1981	4702	131 g
1982	4234	148 g
1983		176

(ii) Elvers.

Both permanent elver traps on the Mill Race were operating from early May but catches were very poor. It appears that water levels in the Mill Race can influence catches markedly, as well as other variables such as water flow in the traps, cover for climbing medium, etc. The elver migration was normal, however, and large numbers were attracted up the waste-water channel of the rearing ponds. These were caught in a small mobile trap but died suddenly, after about 10 days captivity. Ichthyothyriasis was diagnosed on many of the dead and dying elvers. Elvers are captured for restocking more productive waters; silver eels are small in size and number in the Burrishoole river system.

SECTION E : BIOCHEMICAL GENETICS

1. Introduction.

In the branch of biochemical genetics discussed below, the technique called electrophoresis is used to separate the soluble proteins extracted from tissues such as skeletal muscle, liver, heart, brain or eye. Particular enzymes or other specific proteins are localised using specific stains and appear as coloured bands on the starch or polyacrylamide gel medium. The majority of specific proteins isolated by electrophoresis are identical in all members of a species and are termed monomorphic. However, some proteins are polymorphic, that is different forms of the protein exist in different members of a species. By counting alternative patterns in a sufficiently large sample of individuals, it is possible to calculate gene frequencies. Different populations may have statistically significant differences in gene frequencies if they do not interbreed. When used in stock discrimination, this method has the advantage that the characters studied are uninfluenced by environmental variation.

2. Atlantic salmon *(Salmo salar)*

a) Genetic variation throughout the range of the salmon.

In a continuation of the study described in *Ann. Rep. XXVI,* Section E, 2c, samples of more than 100 salmon parr from rivers in Ireland, Norway and Canada have been assayed for five polymorphic enzyme loci *(Idh-3,* Aat_s*-2,* Me_m*-2,* Mdh_s*-3* and *Sdh-1).* These rivers were the Munster Blackwater, Bandon, Carrowniskey, Burrishoole and Moy in Ireland; the Alta in Norway and the N.W. Miramichi and Salmonier in eastern Canada. In addition, samples are currently being analysed from Ellidar river in southwest Iceland and the North Esk, Dee and Spey in Scotland.

Some initial results of this study are presented diagrammatically in Fig. III.

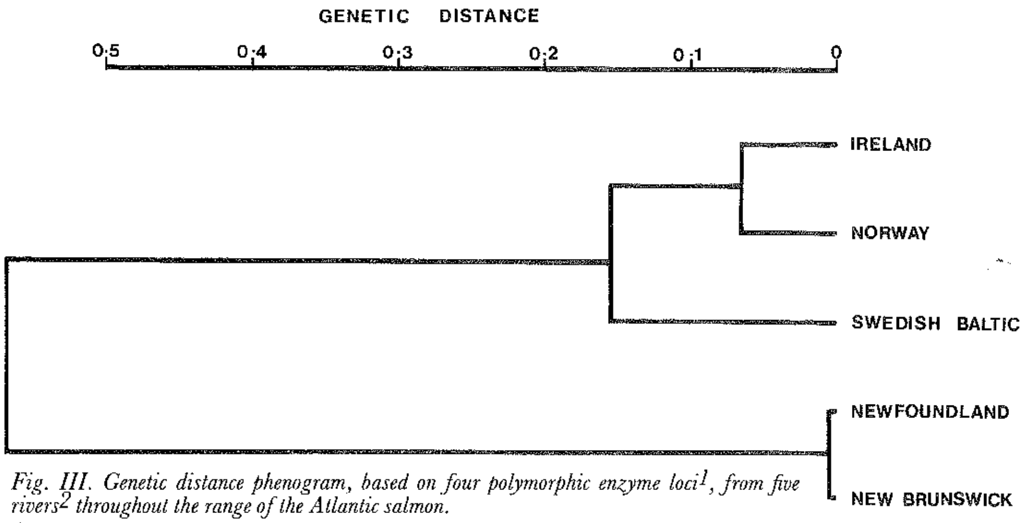


Fig. III. Genetic distance phenogram, based on four polymorphic enzyme loci[1]*, from five rivers*[2] *throughout the range of the Atlantic salmon.*

[1] *Loci mentioned above without* Idh-3

[2] *The rivers are:- Ireland, Munster Blackwater; Norway, Alta; Swedish Baltic, Torne (data from Stahl, 1982,* Ecol. Bull., 34, *95-106. "Fish Gene Pools". Ryman, N (ed.), Stockholm); Newfoundland, Salmonier and New Brunswick, Miramichi.*

In this diagram, termed a phenogram, gene frequency differences at four of the polymorphic enzyme loci mentioned above between salmon from rivers in Ireland, Norway, eastern Sweden and eastern Canada, are expressed as genetic distances (Nei, 1972. *Amer. Natur., 106,* 283-292). Increased genetic distance implies greater gene frequency differences and thus a more distant relationship. It can be seen that salmon from rivers in Newfoundland and New Brunswick are very closely related. Riverine populations from southern Ireland and north western Norway are also fairly closely related, whereas a population from the Baltic is only distantly related to either of the eastern Atlantic populations. Finally, it is clear that a major dichotomy exists between salmon from either side of the Atlantic.

b) Electrophoretic analysis of salmon from the Faroes commercial catch

Three methods have proved useful in the stock discrimination of mixed oceanic fisheries for salmon. These are tagging, analysis of scale characteristics and electrophoretic analysis. Of these methods, tagging using either external tags or coded-wire micro-tags, is by far the most labour-intensive. In the case of the oceanic fishery at West Greenland, which expanded rapidly in the late 1960's, the latter methods proved successful and in 1976 gave very similar results (Payne and Cross, 1977. *ICES Anadromous and Catadromous Fish Committee,* C.M. 1977/M:10). In fact, scale analysis is now used each year to calculate stock composition at West Greenland. The commercial catch at West Greenland consists of a mixture of salmon from Europe and North America and it is the annual continental proportions of this mixture that is of interest. The extent of genetic distance between Europe and North American salmon is evident in Figure III. The differences in scale characteristics between salmon from the two continents are also large.

An oceanic fishery for salmon has recently developed off the Faroes Islands. Preliminary tag recaptures suggested that only European fish were involved, mostly from Norway and Scotland. Since it was important to determine the contribution of each country within Europe to this fishery, samples were collected from the 1981/82 Faroes catch to test the discriminatory ability of analyses of electrophoretically-detectable traits and scale characteristics. Electrophoretic analysis was undertaken at the SRTI laboratory, using the five polymorphic enzyme loci mentioned above. More than 200 fish were analysed. It was found that there was not a significant deficit of heterozygotes at any locus, when compared with the expectations of the Hardy Weinberg equilibrium. This meant that there were not large differences in gene frequencies between the various populations in the sample. In contrast, there was a highly significant heterozygote deficit at two loci in the samples from West Greenland discussed above. Consideration of the phenogram (Figure III) shows that the genetic distance over four enzyme loci between salmon populations from the south of Ireland and north west of Norway — extremes of the European range — is only 1/10th of the distance between populations from Europe and North America. Thus the genetic method may not be applicable in the present case though this conclusion can not be confirmed until tests are carried out on material from the 1982/83 Faroes commercial catch. It should be noted that whilst the sample number can be increased and several samples can be taken throughout the fishing season, it is not at present possible to increase the number of loci assayed. This is because the five loci mentioned above were the only ones found to be strongly polymorphic in a survey of 59 protein loci (Cross and Ward, 1980. *Genet. Res. Camb., 36* 147-165).

3. **Brown trout and sea trout** *(Salmo trutta)*

An account of the methodology and initial findings of this investigation was given in *Ann. Rep. XXVI.* In 1982, sea trout smolts were again taken from the downstream traps and resident brown trout were caught in L. Feeagh. These will be analysed at a number of polymorphic loci to see whether gene frequencies are constant over time. In addition, two samples of brown trout were taken from above impassable waterfalls on the Burrishoole system. A sample of sea trout was also caught in the nearby Newport river. Analyses of these samples will indicate the extent of genetic variation which exists in *S. trutta* in this area.

APPENDIX I

A study of the growth of the trout *(Salmo trutta L.)* **in the Burrishoole system.** By Arthur E. Neiland.

This project was submitted as a thesis, in partial fulfilment of a B.Sc (Hons.) degree in biology at the University of Stirling, Scotland.

Introduction and methodology.

The growth of brown trout in L. Feeagh (area: 430ha, altitude: 30m, max. depth: 45m) was studied together with that of trout in two feeder streams: the Cottage River (length: 3.2km, altitude of source: 548m) and the Shrahrevagh River (length: 4km, altitude of source: 424m). Both streams have a waterfall on their respective courses, representing an impassable barrier to trout migrating upstream, above which the samples were taken. Data from sea trout smolts caught in the downstream traps at the outflow of L. Feeagh in 1982, and from brown trout sampled in the lough in 1961 were also analysed.

Fork lengths and weights of all samples of fish were measured and scale samples were read for back calculations of mean length at age. When possible, sex and maturity determinations were made, with supplementary data being provided by samples taken at a later date.

Results.

Age composition.

Both the 1961 and 1982 sample from L. Feeagh showed a dominance of 2+ and 3+ year old trout, with no fish older than 5+ years. The Cottage River and Shrahrevagh River samples were dominated by 1+ and 2+ fish, with no fish older than 3+. The sea trout smolt sample consisted of 2+ and 3+ fish only, with the former being dominant in number.

Scale radius — body length relationships.

Regression analysis of the relationship between scale radius and fork length of the trout indicated logarithmic linear relationships. The slopes of the regression lines were positive, and all passed close to the origin. On the basis of these relationships, proportionality was assumed between length increase and scale radius increase.

Back calculations of length and growth rates.

From analysis of back calculations of mean length at age, using the Student's t-test, there was found to be no significant difference between growth rates of trout sampled from L. Feeagh in 1961 and 1982. There was also no significant difference between trout growth in the Cottage River and the Shrahrevagh River. However, comparison of the stream samples and the 1982 L. Feeagh sample, showed a much higher growth rate in the lough after 1 year; the L2 (growth from end of the first to the end of the second year) and L3 values of the lough trout being significantly higher. For the L. Feeagh samples there was a particularly large increase in length from L1 to L2.

The sea trout smolts showed no significant difference in growth rate when compared to the brown trout in the streams and lough, except at the L3 stage, when the value was significantly lower compared to the lough trout.

Expression of the growth of the trout in the form of growth curves, specific growth rates and annual increments of growth histograms confirmed these comparisons, along with use of the von Bertalanffy's growth model (both graphical and computer models). The L-infinity (or ultimate length) parameter in the latter model, was highest for the L. Feeagh brown trout, and lowest for the stream trout, with the sea trout smolts having an intermediate value between the two. The Cottage River brown trout had a higher L-infinity value than the Shrahrevagh River fish.

Length — weight relationship.

Regression analysis of Log_e length against Log_e weight showed a strong linear relationship with a positive slope in all five samples. Determinations of mean condition factors indicated that fish of all ages in all the samples were in good condition (C.F. > 1.0). The condition factor tended to decrease from age 1+ to 3+ in all cases, increasing after 3+ in the lough. The 2+ and 3+ sea trout smolts had a lower mean condition factor than brown trout in either the lough or streams.

Sex and maturity determinations.

From limited sampling in L. Feeagh, between October and December, 1982, brown trout were found to be capable of maturing at 2+ and certainly at 3+, having reached a minimum length of 24cm for males and 22cm for females.

Conclusions.

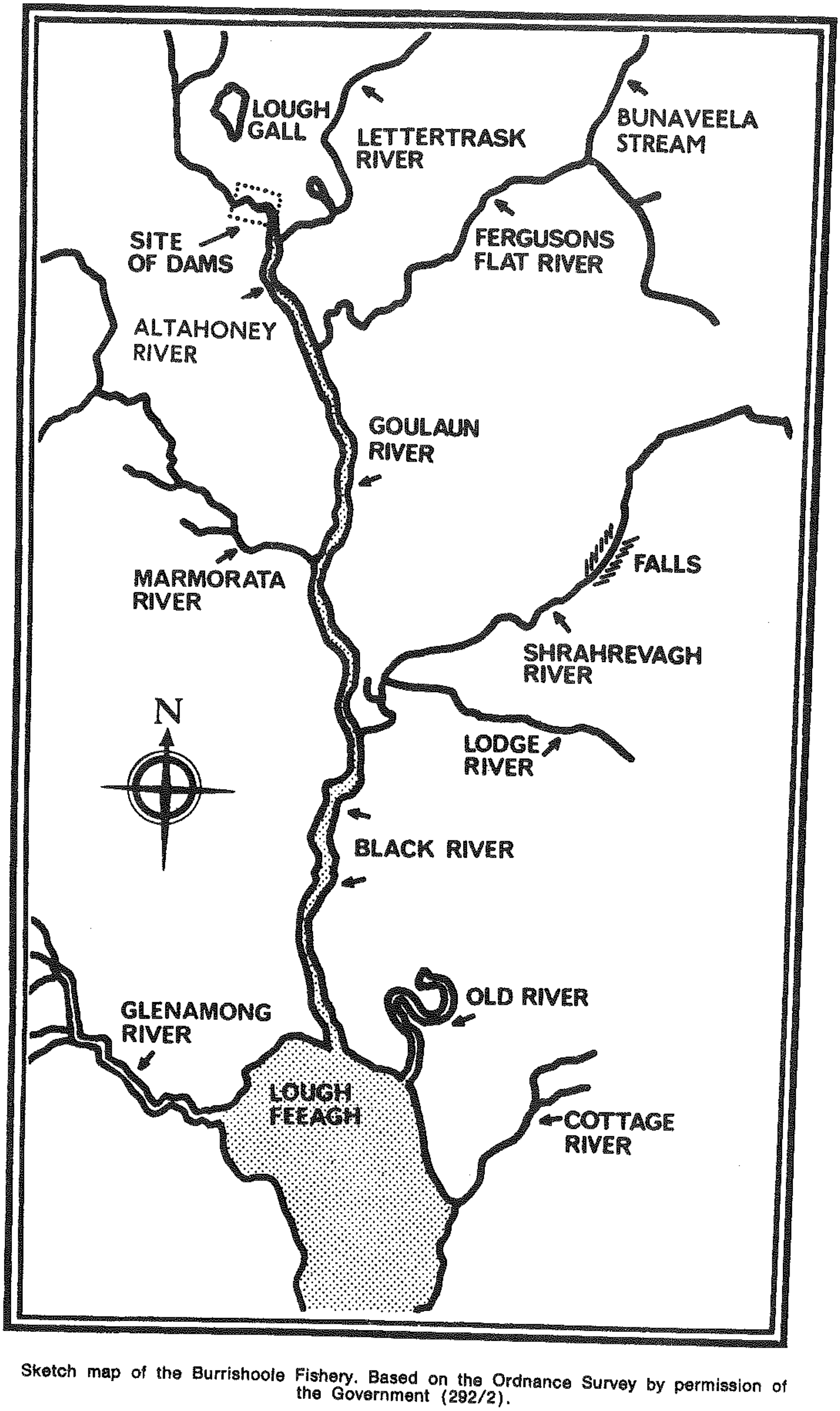
1. It appears that in the Burrishoole system all trout spend at least their first year in the spawning streams. 0+ trout were not found in L. Feeagh.

2. Growth during the first year of trout destined to remain in the streams or migrate to L. Feeagh or to the sea was identical. Subsequently, trout from L. Feeagh grew faster than those remaining in the streams.

3. Growth in both streams and L. Feeagh was slow and typical of Irish oligotrophic rivers and lakes.

GLOSSARY

Alevin	First free-swimming stage after hatching from the egg, having a yolk-sac which contains food supply for the first few weeks.
Coded-wire tag	Microscopic particle of binary-coded wire, injected into nasal cartilage of smolts. The particle is magnetised for later detection.
Condition factor	The relationship between length and weight of fish, giving a measure of fatness. Values above unity (1.00) reflect increased fatness.
Costia	Small, motile protozoan parasite of gills and skin surfaces.
Dip	Direct immersion of fish in buffered vaccine.
Eyed ova	Eggs with embryo inside egg shell, having visible eye-pigment.
Finnock	Sea trout which return to fresh water in the same year as they left as smolts.
Fish family	First generation offspring of one mating pair.
Fry	Free-swimming stage after yolk-sac has been used up.
Furunculosis	Bacterial disease of salmonid fish.
Gene	Section of nucleic acid carrying heritable information.
Gene frequencies	The proportion of alternative genes at a locus.
Genetic distance	A measure of the difference between samples calculated from gene frequencies.
Glass eel	Unpigmented elever, before migration into fresh water.
Grilse	Salmon which spends only 1 winter in the sea before returning to fresh water.
Heterozygote	Where two different forms of a gene are present at a locus.
H.I. — Hyperosmotic Infiltration	Achieving the uptake of vaccine by immersing fish in an hypertonic salt solution before immersion in the buffered vaccine.
Imprinting	The process in which the distinctive odour of the natal river is learnt by the salmon smolt, enabling specific homing as an adult.
Locus	An area in which one maternal and one paternal gene occurs on a pair of chromosomes.
Ova	Eggs.
Panjet	Instrument which uses compressed air to inject substances subcutaneously.
Parr	Juvenile salmon before smolt transformation.
Phenotype	Physical expression of an organism's genotype.
Salmonid	This term embraces all species of the genus *Salmo*, including salmon, sea trout, brown trout and rainbow trout.
Sea trout	Migratory trout, spending 2 or more months in the sea each year after migration.
2-sea-winter fish	Salmon, including spring and summer fish, but excluding grilse.
Smolt	Juvenile stage at which salmon and sea trout migrate to salt water.
UDN	Ulcerative Dermal Necrosis — skin condition of adult salmon, often leading to death.



Sketch map of the Burrishoole Fishery. Based on the Ordnance Survey by permission of the Government (292/2).