

**IONTAOBHAS TAIGHDE BRADAN na h-EIREANN
IONCORPORTHÁ**

(THE SALMON RESEARCH TRUST OF IRELAND INCORPORATED)

Sponsored by Arthur Guinness Son & Co. Ltd. and
the Minister for Fisheries

**ANNUAL REPORT
No. XXII**

REPORT FOR THE YEAR ENDED 31st DECEMBER, 1977.

COMMITTEE OF MANAGEMENT

SIR RICHARD V. H. LEVINGE, BART., M.B.E. SENATOR DR. T. K. WHITAKER	}	<i>as Nominees of the Chairman of Arthur Guinness Son & Co. Ltd.</i>
W. M. HUTTON DR. T. R. MOORE		
C. D. RYAN	}	<i>as Nominees for the Minister for Fisheries.</i>
MISS EILEEN TWOMEY		
MAJOR C. W. ROBERTS A. E. J. WENT, D.Sc. (<i>Hon Consultant</i>) (<i>Chairman</i>)	}	<i>Elective Members.</i>

R. G. MALLET, F.C.A., F.C.I.S.	<i>Secretary</i>	
D. J. PIGGINS, Ph.D., B.Sc.	<i>Director</i>	
J. P. LAWRIE, B.Sc.	<i>Biologist</i>	
C. J. McGRATH, B.E., A.M.I.C.E.I	<i>Consultant Engineer</i>	
A. NIXON T. LAVELLE M. DAVITT P. MULCHRONE M. HUGHES	}	<i>Field Assistants</i>

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Laboratory—FARRAN LABORATORY, AND FIELD STATION,
NEWPORT, CO. MAYO.

REPORT FOR THE YEAR ENDED 31st DECEMBER, 1977.

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D. J. PIGGINS.

SECTION A : General

FOREWORD

The Committee of Management presents hereunder its report on the work of the Trust for the year 1977:

Because he is now permanently resident in Great Britain, Sir Richard V. H. Levinge, Bart., who had been a member of the Committee of Management since the foundation of the Trust, decided to retire as from 31 December, 1977. Much of the success of the Trust during its formative years was due to the planning and foresight of Sir Richard. The Committee of Management would, therefore, wish to pay tribute to him for his invaluable contribution to the development and welfare of the Trust over the 22 years he was associated with it, firstly as an active member of the Committee of Management and as chairman from 1972 to 1977. The Trust wishes Sir Richard every happiness in his retirement.

During 1977 the Trust learnt with great regret of the death of Dr. Charles King Mill, a founder member of the Trust and chairman from 1960 to 1972. Dr. Mill's enthusiasm was an inspiration to all involved in the work of the Trust and he also made important contributions to the development of the Trust during the years he was a member of the Committee of Management and later chairman. The Trust wishes to express its sincere sympathy to Dr. Mill's family on their loss.

During 1977 the work of the Trust proceeded satisfactorily on the general lines adopted in previous years and significant advances were made in several fields, including the saltwater rearing project for both salmon and rainbow trout and the trials with single cell protein in the diet of young salmon to offset increasing costs and the decreasing availability of fishmeal.

The new Visitor Display area, completed in July, has proved a great attraction to visitors from home and abroad and the Trust's best thanks are due to An Bord Failte Eireann (Irish Tourist Board) for a grant towards the cost of providing this much needed facility.

A. E. J. Went

SECTION A

1. COMMITTEE OF MANAGEMENT

Senator Dr. T. K. Whitaker was elected a member of the Trust in April and was nominated by Sir Richard Levinge to be his alternate on the Committee of Management in the event of his unavoidable absence. Dr. A. E. J. Went was elected chairman of the Trust for 1977, Sir Richard Levinge having indicated that he did not wish to continue in this office. Senator Dr. T. K. Whitaker was nominated by the Chairman of A. Guinness Son & Co. Ltd. to the Committee of Management from 1 January, 1978.

2. PERSONNEL

The permanent staff remained unchanged during 1977 but Mr. Gerard

McNeela was appointed second night-watchman at the Salmon Leap during the summer. Miss Rachel Piggins (Trinity College, Dublin) and Mr. Jeremy Hackett (University College, Galway) were employed as Temporary Scientific Assistants at the Laboratory and sea-cage sites respectively during the summer.

Mr. T. M. Murphy, MVB, MVSc, MRCVS completed his work at the Laboratory in February while holding a Fellowship awarded by the Atlantic Salmon Research Trust. Mr. Murphy returned to the Unit of Aquatic Pathobiology at the University of Stirling to work up his results and write his doctoral thesis on studies on precocious maturity in male Atlantic salmon parr.

All three sessions (March, May and August) of the Training Course sponsored by the Atlantic Salmon Research Trust were attended by Miss D. M. Cotter and Mr. A. J. Turner. The third trainee, Mr. D. P. McCartan, was unable to attend the March session, but was present in May and August. MM Michel Richard and Pierre Carpentier also attended the March session, sponsored by the Fish Physiology Laboratory, Jouy-en-Josas, France and M. Carpentier returned for the May session.

Mr. David Baird relinquished, with effect from April 1, the studentship established by the Department of Fisheries for the study of the elver and eel population of the Burrishoole river system. The preliminary results obtained from the first six months work have been deposited with the Department and the studentship is to be re-advertised in mid-1978.

3. INSTALLATIONS

The Visitor Display Area was completed by early July and proved a considerable attraction during the tourist season, as well as relieving the stress caused by disturbance to the fish maintained in the experimental rearing installations. One large indoor aquarium tank, divided into four sections, contains salmon parr, brown trout, rainbow trout and eels, respectively. Various wall displays illustrate life-histories, migrations and scale-reading, whilst rainbow trout in two outdoor tanks can be fed by visitors with pellets from a vending machine. The Display Area was constructed with the aid of a grant from Bord Failte Eireann to which the Trust expresses its grateful appreciation.

An elver trap was constructed by the staff of Burrishoole Fishery on the right bank of the Mill Race, some 10m upstream of the outfall of the rearing tanks. The trap was completed in mid-June, some two weeks after the main run of elvers had passed upstream but preliminary indications of trapping efficiency were favourable. The trap was designed by Mr. C. J. McGrath, Inspector and Engineer, Department of Fisheries.

A fish food store, behind the present laboratory/hatchery complex, was completed and in service at the end of the year. The store is vermin-proof and can hold up to 5 tonnes of fish food pellets on timber racks.

The smaller of the two smolt release ponds which also serves as a holding

pond for silver eels in the autumn, was floored with concrete in early August, by the staff of Burrishoole Fishery.

4. METEOROLOGICAL DATA

Rainfall was slightly above average in 1977, at 1579.7mm (62.2"), some 115% of the average for the years 1972 to 1976. There was a prolonged drought period from mid-May to late June, when there were 28 days without rain. The highest daily rainfall recorded for the year of 32.4mm, was on June 30. The months of October and November were very wet, when the total rainfall of 456.9mm was considerably more than has been recorded during the equivalent period since records commenced at Furnace, in 1960.

Low water conditions existed in the Mill Race from mid-May to the end of June, and for a total of 54 days during July, August and September. Thereafter, the Mill Race maintained adequate or flood levels for the remainder of the year (See Fig. 1). Water temperatures were below normal during the winter, not rising above 5°C until early March and not reaching 10°C until mid-May, some three weeks later than in 1976. The drought period in late May and early June resulted in a peak of 18°C, followed by a further peak of 20°C in early July, measured as the water temperature at midnight. There were diurnal variations of up to 4°C, at that time. The water temperature was maintained above 15°C until the end of August, followed by a slow decline to 10°C by mid-November. Cold frosty weather at that time rapidly reduced the temperature to 5°C but this increased to 7.5°C by the end of the year.

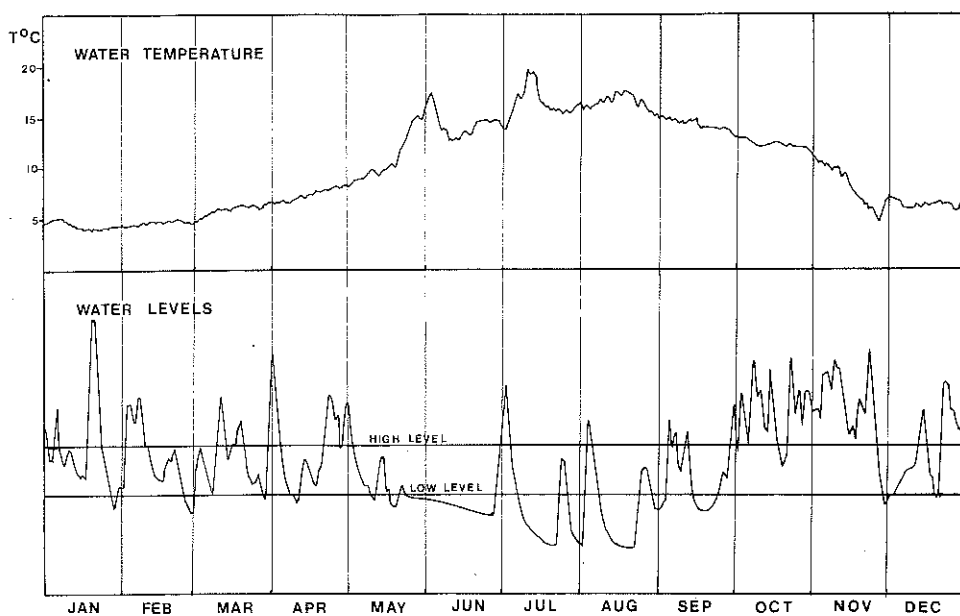


Fig. 1. Water temperatures and water heights in the Mill Race, 1977.

5. IRISH FRESHWATER RESEARCH GROUP

The Trust was host to the 12th annual meeting of this Group, held on May 20, at Westport Woods Hotel. The meeting was attended by 87 persons and 31 papers on various aspects of freshwater research in Ireland were presented to the meeting. Summaries (200 words) of these papers were circulated later, to all participants. On the following day, the Trust's installations were opened to any participant who wished to see them.

6. VISITS AND COMMUNICATIONS

The Director attended a meeting of the ICES Working Group on Mariculture held at Brest in May, when the following paper was presented :-

“Rearing salmon and rainbow trout for sea cages” — D. J. Piggins and J. P. Lawrie.

The Director also attended meetings of the Anadromous and Catadromous Fish Committee of the International Council for the Exploration of the Sea, held at Reykjavik in September and of the Salmon and Trout Association Conference at London, in November.

A paper entitled “The saltwater rearing of salmonids in Ireland” by J. P. Lawrie and D. J. Piggins was read by Mr. Lawrie at a conference organised by the Institute of Fisheries Management in Derry in March. Mr. Lawrie also attended the second of a series of meetings organised by the Scottish Marine Biological Association on fish farming, held at Oban in February and a Symposium on the rhythmic activity of fish organised by the Fisheries Society of the British Isles at the University of Stirling in July. Mr. Lawrie also presented a paper on “Smolt Production” to a Seminar on fish farming organised by the Department of Fisheries at Limerick in September.

A summary of results of the salt water rearing project is being prepared, with a view to publication in due course.

7. THEFT OF FISH

The theft of 66 cage-reared salmon and 44 rainbow trout (total weight approximately 100kg) occurred on September 24, from one of the 4.5m ponds in the brackish water rearing installation. The matter was reported to the Garda Siochana and following investigations, two men were charged with the offence and subsequently pleaded guilty, in the District Court. On conviction, they were fined and ordered to pay compensation to the Trust.

SECTION B : SALMONID REARING (contributed by J. P. Lawrie, BSc, Biologist)

(1) GRILSE OVA HATCHED IN 1975

TABLE I

Original stock	122349
Remaining stock at December 31, 1975	36279
No. of 1+ smolts released in April 1976	9743
As : 1152 fish on pre-smolt "high fat" diet, Brand 'O' and adipose fin clip. 6077 fish on pre-smolt "low fat" diet, Brand 'U' and adipose fin clip. 2514 fish transferred to Salt Water Rearing Project for on-rearing in sea-cages, Brands 'U' and 'A' and adipose fin clip, — and adipose fin clip only.	
Remaining 1+ parr, April 1976	24110
Remaining 1+ parr, January 1977	7167
No. of 2+ smolts released, April 1977	7018
As : (i) 5384 Brand 'X' right shoulder and adipose fin clip. (ii) 467 giant smolts (>25cm), Brand 'XX' left shoulder and adipose fin clip. (iii) 1167 transferred to Salt Water Rearing Project for on-rearing in sea-cages, Brand 'X' and adipose fin clip.	

149 fish died over the period January 1 to smolt release in late April 1977. The giant smolts (>25cm) which have in the past given very poor adult returns, usually as pre-grilse, were branded separately and released into Lough Furnace on March 14 some five weeks in advance of the 'normal' population. The mean length of the normal smolts released into Lough Furnace was 165mm.

(2) SALMON AND GRILSE OVA HATCHED IN 1976

TABLE II

Stock at December 31, 1976	56957
Losses in January 1977	181
" " February 1977	179
" " March 1977	4574 (including 3117, inlet pipe blocked)
" " April 1977	815
" " May 1977	5925 (including 1465, inlet pipe blocked)
No. of 1+ smolts produced in May	25409

Marks :

- (i) 11062 Furnace stock, Brand 'O'
adipose fin clip
- (ii) 1009 Cold shock, Brand 'L'
adipose fin clip
- (iii) 9408 Furnace stock transferred to
Saltwater Rearing Project for
on-rearing in sea-cages
- (iv) 887 Carrowmore Spring Salmon stock
transferred to Saltwater Rearing
Project for on-rearing in sea-cages
- (v) 3043 Furnace stock sold to Killary Sea
Cage Operation.

May release of 1+ parr into the Burrishole Fishery 5412

Losses in June 1977	...	...	...	701
" " July 1977	...	...	...	492
" " August 1977	...	...	...	451
" " September 1977	...	...	...	1220
" " October 1977	...	...	...	606
" " November 1977	...	...	...	171
" " December 1977	...	...	...	74

Total mortality 15389

No. of 1+ parr remaining December 31, 1977 10747

Of the 25,409 smolts reared in 1977, 12071 were released into Lough Furnace as 11062 Furnace stock and 1009 Cold-shock treated (See Report XXI, p27 for details). The average length of these fish was 152mm (range 123mm to 189mm) and 154mm (range 13mm to 183mm) respectively, and they constituted 51% of the yearling population. 76 smolts died in the release ponds, the mortalities being mostly attributable to a mild attack of furunculosis and associated fungal infection. General population health however was good and most of the smolts had already left when the release ponds were "flushed out" on May 18.

5412 small grade 1+ parr, mean length 76mm, on May 10 were adipose fin clipped and released into Bunaveela Lough, a headwater of the Burrishoole River system. (See back cover). The remaining 19029 1+ parr were held for on-rearing to the 2+ smolt stage, and a proportion of these fish was used in a dietary experiment. (See Appendix I for details). Furunculosis accounted for most of the losses over the period 18-5-77 to 31-12-77, survival to the latter date being 75%.

Parr
 19029
 5412

 24441

Smolts 25409

(3) SALMON AND GRILSE OVA HATCHED IN 1977

(i) Survival from ova to underyearlings

TABLE III

	Mixed Stock	Carrowmore Spring Salmon	Scottish Stock
Original Stock	94124	5320	11025
Losses in :-			
December	2377	88	—
January	1281	24	—
February	2700	43	856
March	2857	51	197
April	2382	98	2441
May	5575	407	766
June	3589	152	33
July	2178	40	266
August	4456	1911	233
September	1379	651	313
October	2126		111
November	495		14
December	334		99 (including 72 overflow)
Stock remaining			
December 31, 1977 ...	62396	1855*	5696
% Survival to			
December 31, 1977 ...	66.3	—	51.7

*Added to mixed stock, October 1977.

Due to an increased commitment to smolt production for the sea-cage operations, and the resultant lack of pond space, it proved impossible to follow accurately the effect of warming water during early rearing. The unit was used from 21 February, 1977 to 9 May, 1977, supplying some 56000 salmon ova with water 4 to 5°C above ambient water temperature. The effect this had on improved growth was assumed to be similar to that reported in detail in 1975 and 1976. (See Report XX and XXI).

A batch of salmon ova from the River Thurso in Scotland, aimed at increasing the genetic base from which desirable traits for sea cage rearing can be selected, was received on February 10. Due to limited pond space, only 11025 eggs of the 20910 (123 fluid oz at 170/fluid oz) imported from Thurso Fisheries Ltd., were held separately, the remainder being mixed with the Furnace stock.

First feeding of the fry held at ambient water temperatures commenced on April 29, compared with April 10 in 1976. Losses during first feeding of both warmed water and ambient batches of fry were light at 10.6%.

The first of the warmed water fry were moved outside to 2m ponds on April 30 and the hatchery was cleared of fish on July 1. Mortalities during the summer were mainly of weak fry. An eye condition, possibly because of

supersaturation in the warmed hatchery water, resulted in a 48% mortality over the period August — September, in the fry derived from Carrowmore spring salmon. The controlled breeding line was abandoned at this stage, and the remaining 1855 fish added to the Furnace stock.

Grading was carried out on five occasions over the period June — December, and by the end of December, the following grades had been established :-

TABLE IV

	Mixed Stock	Scottish Salmon
1st Grade		
No.	11147	3471
% batch stock	17.9	60.9
Mean length — mm	131	125
2nd Grade		
No.	2935	—
% batch stock	4.7	—
Mean length — mm	115	—
3rd Grade		
No.	48313	2225
% batch stock	77.4	39.1
Mean length — mm	71	76

4. RAINBOW TROUT HATCHED IN 1977

21300 eyed ova (100 fluid oz. at 213/fluid oz.) were purchased from the Fanure Hatchery of the Inland Fisheries Trust Inc. Survival of these fish and of the 10,674 ova stripped from 0+/0+ (freshwater age/saltwater age) broodstock selected from the sea cages, are given in Table V. Lack of pond space prevented separate records being kept throughout the year.

TABLE V

	Sea Cage Stock	Roscrea Stock
Original stock	10674	21300
Losses in :-		
December	353	—
January	575	—
February	1007	512
March	1317	2229
April (including 1613 pipe down)	1924	1094
May		565*
June		106
July		216
August		789
September		786
Stock remaining at end of September	20501	

*Stocks pooled May 1977

The developing ova and the feeding fry of both fish stocks were supplied with warmed water during hatchery rearing (February 22 — May 9) at which stage the majority were moved outside to the 2m ponds. Egg and alevin losses in the ova derived from Sea Cage broodstock were abnormally high at 30.5% and were related to the very small size of the eggs taken from these fish (396/fluid oz). A mortality of apparently healthy feeding fry occurred in April, and accounted for most of the 5.1% losses for this month. Similar losses were noticed in the 1975 and 1976 stocks. Salt treatment (1 — 2% solution for 15 minutes) was effective in reducing the mortality.

Growth during late spring and early summer was not as good as in previous years. Initially, this was ascribed to the higher stocking densities employed, but following a mortality in the 0+/0+ sea cages rainbow trout which was diagnosed as proliferative kidney disease, microscopic inspection of the 1977 fry stock revealed a similar condition (80% incidence at 18 September, 1977). Grading was carried out in June and September and the total stock remaining at the end of September (20501) was transferred to brackish water ponds for further on-rearing, and acclimatisation prior to cage rearing in the sea.

5. NORWEGIAN RAINBOW TROUT

1000 0+ parr, average weight 20.2gm (derived from Norwegian broodstock) were obtained from Glenties Hatchery of the Department of Fisheries on December 13. It is hoped to transfer these fish to the brackish water rearing unit in early 1978 for saltwater acclimatisation prior to transfer to the sea cages.

6. OVA LAID DOWN IN 1977

(i) Grilse ova from Lough Furnace

52 females and 31 males taken over the period September 19 — December 22 were held to December 2 in the freshwater broodstock pond. They were then transferred to one of the 4.5 metres square, partially covered brackish water rearing ponds, and supplied with 10‰ salt water until December 14, when it was reduced to 4‰ and held at that level until the end of the year. The fish were injected with Terramycin (injectable grade) at capture, and at every subsequent handling. Five fish, two of which were female kelts, died over the period December 10 to 31.

The first female was stripped on November 30, 11 days earlier than the first fish in 1976, and stripping was completed by 11 January, 1978; the eggs taken on that day being included in the fecundity values given in Table VI for convenience.

TABLE VI

No. of female fish	52
No. of fluid oz produced	1200.5
No. of ova produced	189220
No. of ova per fish	3639
No. of ova per litre	5573 (158/fluid oz)
Average weight of fish	2.3 kg (5.06 lb)
No. of ova per kg weight	1582

The size of the ova varied between 4232 and 6807 per litre (120 and 193 per fluid oz) as measured after they had been allowed to swell in water for at least 30 minutes.

(ii) Cage Salmon ova

229 2+ /1+ cage reared salmon were transferred from the sea cages on August 25 and 27 to one of the brackish water rearing ponds (13‰). All the fish were injected with Terramycin at transfer. 26 fish died over the period August 26 — September 19, there being no further mortalities until stripping commenced (December 10). 66 fish were stolen from the pond on September 24, (see Section A for details), and the remaining 138 fish (54 females, 84 males) were transferred to the freshwater holding pond. The fish were returned to the brackish water rearing unit on November 29 and held in 8‰ saltwater until December 31.

The first female was stripped on December 10, and stripping was completed by January 23, 1978. Fecundity values are given in Table VII, the eggs stripped in January 1978 being included for convenience.

TABLE VII

No. of female fish	54
No. of fluid oz produced	676
No. of ova produced	101340
No. of ova per fish	1877
No. of ova per litre	5149 (146/fluid oz)
Average weight of fish	1.37 kg (3.0 lb)
No. of ova per kg weight	1370

The size of the ova varied between 4761 and 5820 per litre (135 and 165 per fluid oz) as measured after they had been allowed to swell in water at least 30 minutes.

(iii) Rainbow trout ova

126, 0+/0+ rainbow trout were selected as broodstock, transferred from the sea cages on July 28 and August 27 and held under the same conditions detailed above for the sea cage salmon broodstock. 44 fish were stolen from the pond on September 24 (see Section A for details) but otherwise no losses occurred until stripping commenced on December 10. Projected ova requirements for 1978 were met from 18 of the 37 hen fish available for stripping. Fecundity values are given in Table VIII.

TABLE VIII

No. of female fish	18
No. of fluid oz produced	170
No. of ova produced	59037
No. of ova per fish	3280
No. of ova per litre	12027 (341/fluid oz)
Average weight of fish	1.21 kg (2.7 lb)
No. of ova per kg weight	2711

The ova were very small in size, varying between 11181 and 12909 per litre (317 and 366 per fluid oz) as measured after they had been allowed to swell in water for at least 30 minutes.

(iv) Hybrid crosses

Since it was thought that hybrid crosses might prove useful for sea cage rearing, the following experiments were carried out :-

A. Rainbow trout female x sea trout male :

The ova from a single 0+/0+ rainbow trout hen taken from the sea cages was crossed with the milt of a wild sea trout male. The 3938 eggs (11 fluid oz at 358 per fluid oz) were stripped on December 16.

B. Ranched salmon female x rainbow trout male :

The ova from a single ranched salmon hen were crossed with the milt of a 0+/0+ cage rainbow trout male. The 4439 eggs (23 fluid oz at 193 per fluid oz) were stripped on December 23.

C. Rainbow trout female x cage salmon male :

The ova from a single 0+/0+ cage rainbow trout hen were crossed with the milt of a cage salmon male. The 5312 eggs (16 fluid oz at 332 per fluid oz) were stripped on December 23.

7. REARING OPERATIONS IN BRACKISH AND SALT WATER

(i) Salmon

Growth of the 1529 2+/0+ (freshwater age/saltwater age) and 1345 1+/0+ (corrected figure) fish from January 1 to March 15 was poor, a result of the low water temperatures experienced during this period. Thereafter growth increased, reaching a peak in late May, but not attaining the same rapid rate achieved in the corresponding period for 1976. Losses for the period January 1 to August 31 were light at 1.6% and there was no recurrence of the kill of apparently healthy fish experienced in June/July 1976. Macroscopic examination of the kidneys of fish sampled around this period revealed a low level incidence of proliferative kidney disease, and it may be that a somewhat more advanced condition was responsible for the kill in 1976. Total survival of the two groups of fish (2+ smolts and 1+ smolts) from transfer to marketing was 80.1% and 57.0% respectively. 212 fish were retained for breeding purposes and transferred to the brackish water rearing unit on August 25 and 27. (See 5 (iii) for details). A total of 2593kg (5808 lb) of cage reared salmon was marketed over the period May 8 to August 6.

The 10510 smolts transferred to the sea cages over the period May 24 — 27 comprised the following groups :-

- (i) 1167 2+ smolts (brand mark 'X' and adipose fin clip). Acclimatised to 8‰ salt water over the period April 3 to May 24.
- (ii) 515 (corrected from the 887 fish transferred to the brackish water rearing unit, 372 fish having escaped through a faulty pond outflow screen) 1+ Carrowmore spring salmon stock. Acclimatised to 6.5‰ salt water over the period April 3 to May 24. (No mark, no fin clips).
- (iii) 4781 1+ smolts (corrected from 5138 fish; 257 parr). Acclimatised to 9‰ salt water over the period April 3 to May 26.
- (iv) 4047 1+ smolts (corrected from 4270 fish; 223 parr), no mark, no fin clip. Transferred directly from fresh water to sea water.

Post transfer losses of the four groups were 69.5%, 28.7%, 2.9% and 14.5% respectively. A prophylactic dose of Terramycin was administered to all the smolts for the five day prior and subsequent to transfer excepting Group (i), and this may explain the high level of mortalities in this population. Summer growth was good although an outbreak of vibriosis in Groups (iii) and (iv) above, associated with high water temperatures in mid-August resulted in a mortality of 6.2%. By December 7, the average weights of the fish in the four groupings were: (i) 602 gm, (ii) 497 gm and both (iii) and (iv) 686 gm. These may be compared with an overall average weight of 500 gm on November 3, 1976.

(ii) Rainbow Trout

There was a 5.8% post transfer mortality in the 2300 (corrected from 2222) 0+ rainbow trout smolts transferred to the sea cages in October 1976. Growth over the period November to March was poor, due to the unusually low water temperatures, and normal during April and May. 1814 fish weighing 915.3 kg (2050 lb) were culled over the period May 16 to September 9, the average weight of the fish held until early September before sale being 934 gm. A kill similar to that described in the Report-XXI 1976 (p. 31) but of lesser magnitude occurred over the period June — July and was responsible for 6.6% loss of the total stock. Microscopic analysis of samples of infected fish by Mr. T. M. Murphy, MVB, MVSc, MRCVS revealed gross calcification of the kidney, and renal calcinosis was diagnosed. Further microscopic examination of infected parr in the stock laid down in December 1976 revealed symptoms more closely related to those of proliferative kidney disease.

43 fish were killed for biological examination over the period December 1976 — August 1977, and 126 selected broodstock were transferred to the brackish water rearing unit on July 28 and August 27 (see 5 (iii) for details).

Pumped brackish water (8‰ salinity) was supplied to approximately 80% of the 20501 0+ rainbow trout parr transferred to the brackish water rearing unit on September 31. Losses during October totalled 7100, 5579 of these being due H₂S poisoning when the surface buoy was severed from the intake pipe during a gale and water was drawn from the bed of the Lough. Most of the fish lost were large grade that were about to be transferred to the sea cages. Following repair of the intake, the remaining 13401 were held in 8‰ salt water, and 3362 of these fish (top grade, mean weight 48 gm) were transferred to the sea cages on November 26 and December 2. Post transfer losses were low at 0.3%. The total stock remaining in the brackish water ponds at December 31, 1977 was 9945, 94 fish having died over the period November — December.

3000 0+ rainbow trout (mean weight 75gm) purchased from Erbel Ltd. (Dingle) were transferred directly from the transporter to the sea cages on December 8. A small proportion of these fish had inflated swim bladders as a result of oxygen supersaturation during transfer from Dingle. These fish made up the greater part of the 4.7% post transfer losses.

SECTION C : CENSUS WORK ON FISH MOVEMENTS

1. WILD SALMON

(i) UPSTREAM MOVEMENTS

(a) Timing and numbers

Due to lower water temperatures in the spring, compared with 1976, the first spring fish did not run through the traps until late April, after the water temperature had reached 7.5°C. Two fish were counted in April, followed by seven in May, although 3 of these latter fish died or were moribund due to UDN. Similarly, of 3 further spring fish counted in June, 1 died and 1 showed the early stages of UDN infection. It is unlikely that any of this early stock survived to spawn since it should be assumed that all were exposed to UDN infection. This spring and early summer outbreak of UDN has been a feature of the past three years and seems to be linked with the increased stress produced by low water conditions and rapidly increasing water temperatures.

No infection was observed in the remaining run of two-sea-winter fish (16 in July, 3 in August, 10 in September and 2 in October) the total of 43 being slightly lower than those for 1975 and 1976 but significantly larger than those for the years 1970 to 1974. (See Table IX).

Despite low water levels there was a small run of wild grilse through the Mill Race trap in June, but no significant numbers were counted through until the first major flood in early July, followed by a smaller rise in water levels at the end of the month. This pattern repeated itself in August but only half as many fish ran through the traps as in July, suggesting that stocks entering Lough Furnace from the sea during August were relatively small. This was confirmed by the increased numbers of fish running in September, following cessation of activity by coastal nets at the end of August. The sustained high water levels throughout October virtually cleared out the grilse stock of Lough Furnace and only 3 further grilse were counted upstream during November and December. Some 58% of the total run was counted through the Salmon Leap trap, although in September, the Mill Race count was only one third that of the Salmon Leap.

The overall escapement of grilse to Lough Feeagh, at 607, was less than in any year since full records became available in 1970. This figure is the more disquieting in that it represents the survival from the largest smolt run yet recorded (see Section C. ii (a)) so that whilst fresh water production has been maintained at a satisfactory level, return to the river from the sea is decreasing, the most obvious cause being overfishing by coastal drift nets.

Table IX shows the comparative escapements of salmon and grilse through the traps for the past eight years :-

TABLE IX

Year	Mill Race		Salmon Leap		Total	
	Salmon	Grilse	Salmon	Grilse	Salmon	Grilse
1970	0	468	0	620	0	1088
71	4	354	0	386	4	740
72	3	1024	18	345	21	1369
73	15	954	8	722	23	1676
74	14	351	11	504	25	855
75	15	308	37	516	52	824
76	10	257	40	540	50	797
77	12	253	31	354	43	607

Table X shows the monthly percentages of the combined total run of grilse through the traps, compared with the five-year average for the 1970-74 and the actual figures for 1975 and 1976. Figures in parentheses for 1977 are the actual monthly counts of grilse.

TABLE X

	1970 - 74	1975	1976	1977
May	—	—	4.8	—
June	5.8	13.7	41.8	2.0 (12)
July	18.9	8.6	13.7	35.2 (214)
August	26.8	7.0	—	16.6 (101)
September	25.5	49.9	13.8	32.0 (194)
October	17.6	19.7	22.3	13.7 (83)
November	4.8	0.7	3.0	0.5 (3)
December	0.6	0.4	0.6	—

(b) Net-marked grilse

None of the 12 grilse seen in the Mill Race trap in June was net-marked but in July 24% of the fish in both traps were marked to greater or lesser degrees. In August, 10% of the grilse were marked and 5% in the first half of September. The legal closing date for local drift nets is August 31. One fish noted with a fresh net-mark in October had probably fallen foul of an illegal net.

(c) Spawning escapement

The spawning escapement in 1977 was subject to some mortality from UDN, as noted in Section 1. (i) a above, where 10 two-sea-winter fish are assumed to have died from this cause. Grilse were not affected by early summer UDN in 1977.

As noted in Report XXI the spawning escapement for 1976 was increased by the planting of 45000 early-feeding fry from the Burrishoole Fishery hatchery in the spring of 1977. To take this into account, the spawning escapement is assumed to have been increased by 11 females. In addition, 5412 yearlings which were surplus to requirements, were planted out on May 10, 1977 by the Trust. At

a mean length of 76mm, the survivors of this planting can be expected to migrate as 2+ smolts in 1978 :-

TABLE XI

	Wild grilse	Wild salmon	Reared fish
Counted through traps	607	43	96
Rodcatch, Lough Feeagh	46	0	0
Taken for hatchery use	0	0	83
Mortality from UDN	0	10	0
Escapement	561	33	13
Total potential spawning stock:	607		

The comparative figures for previous years are as follows :-

TABLE XII

	Maximum escapement	Reared fish component
1970	1136	200
71	609	584
72	1654	1277
73	1522	1495
74	708	700
75	842	795
76	736	721
77	607	594

Thus, the escapement for 1977 is the lowest yet recorded but is of the same order as that for 1971, which resulted in the low smolt production figure for 1974. It seems likely, therefore, that smolt production may be low in 1980 and for this reason, all early feeding fry which are surplus to requirements in the Trust's hatchery programme will be planted out in the Burrishoole river system in 1978.

(d) Survival from brood year ova to smolts and grilse

The count of wild grilse in 1977 represents those fish which were derived from the 1973 brood year. The spawning escapement for that year (shown in Table XII above) was 1522, but included only 27 grilse derived from reared smolts, the majority having been used in hatchery operations. Thus the maximum escapement was 1522 and the minimum (subtracting the reared fish component) was 1495. A range of 50 to 55% females in this escapement and a range of 4000 to 4115 ova per female was used in the calculations to give average and minimum values for ova deposition during the winter of 1973/74. (For original data pertaining to these estimates, see *Report XIX (1974) Section 7 (a) v.*)

The resultant grilse total is the trap-count of upstream-migrating fish, with the addition of rod-caught wild grilse from Lough Furnace and the subtraction of previously-spawned fish.

TABLE XIII

Survival from ova to grilse

Spawning escapement	1495 to 1522
No. of females	748 to 837
Ova deposition	2,992,000 to 3,444,000
No. of smolts produced	16,136
Survival rate (ova to smolt)	0.54 to 0.47%
Survival (smolts to grilse)	4.2%
No. of returning grilse	668
Survival to grilse per 1000 ova	0.22 to 0.19
Survival to grilse per grilse female	0.89 to 0.80

Comparable estimates are now available from four brood year-classes :-

TABLE XIV

Brood year class	Survival rates ova to smolts	Survival rates to grilse per 1000 ova	Survival rate to grilse per grilse female
1970	0.44 — 0.63%	0.36 — 0.52	1.48 — 2.06
1971	0.72 — 0.89%	0.67 — 0.76	2.83 — 3.29
1972	0.39 — 0.57%	0.24 — 0.35	0.97 — 1.39
1973	0.47 — 0.54%	0.19 — 0.22	0.80 — 0.89

Note that the values for survival from ova to smolts for the 1973 brood year-class fall well within those previously experienced, so that it seems unlikely that the planting out of 2000 yearlings in 1975 had any significant effect on the smolt production in 1976. This was confirmed by the recapture of only one grilse from this planting in 1977.

The values for survival from ova to grilse and from female grilse parent to grilse offspring show a disquieting downward trend. To have a self sustaining population each female grilse parent must produce at least two surviving grilse offspring but this value is now less than one, indicating a progressive attrition of stocks, relatable to lowered survival in the sea, which must give cause for grave concern.

(ii) DOWNSTREAM MOVEMENTS

(a) Smolts : Timing and numbers

Very occasional salmon smolts appeared in the traps during the first half of April but no significant numbers were recorded until the last week of the month, when the water temperature had reached 8°C. A total of 1311 smolts was recorded for April, this being considerably lower than normal for this period. Smolts ran steadily throughout May but never in large numbers and migration had ceased at the Salmon Leap by May 20, due to low water levels. Only some 4500 smolts were counted in all, during May, with a further 325 at the Mill Race by mid-June and another 100 very late smolts at the Salmon Leap in early July. Only 28 downstream-migrating parr were counted during autumn.

The overall total of 6323 salmon smolts was the lowest yet recorded and can be related firstly, to the low spawning escapement in 1974, since the calculated survival rates from ova to smolts of 0.39 — 0.45% are comparable with those of the 1972 brood year-class. However, these values fall below the average for the brood year-class from 1970-73 and this can be attributed to the summer drought of 1976, which must have had a damaging effect on the 1+ salmon parr in the nursery streams.

No signs of disease were seen among the salmon smolts.

(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 total stock is calculated from the count of wild grilse through the traps, plus the rod-catch of wild grilse on Lough Furnace and the trap catch of wild two-sea-winter fish in the following year. Table XV shows these values for the years 1970 to 1977 and the relevant survival rates from the smolt stage :-

TABLE XV

	Trap Count	Furnace Rod-catch	2 SW Fish	Total	Relevant Smolt total	% survival
1970	1088	236	5	1329	12—14000	9.5—11.0*
71	740	49	21	810	14637	5.5
72	1369	144	23	1536	13915	11.0
73	1676	92	25	1793	14081	12.7
74	855	78	52	985	11282	8.7
75	824	104	50	978	9972	9.8
76	797	88	41	926	14650	6.3
77	599	69	N/A	676	16136	4.2**

* Smolt count not accurate in 1969

** Survival to grilse only

As noted earlier, the survival of smolts to the grilse stage showed a marked decline in 1976/77, when the value of 4.2% is the lowest yet recorded and is less than half the average value for the years 1971-75.

(c) Tagging of wild smolts

When it became apparent that the smolt production was poor no wild smolts were tagged during 1977. One fish, tagged as a 15.0 cm smolt on May 25, 1976 was recaptured as a grilse of 2½ lb. (1.14 kg) in the Cumberagh River, Co. Kerry, in early October, 1977.

(d) Sampling of wild smolts

In order to confirm the age structure and condition factor of the wild smolt population, nine samples of 20 smolts were taken at 3 or 4 day intervals from late April. The fish were anaesthetised, measured to the nearest mm, weighed

to the nearest gm and a small sample of scales removed from the shoulder. They were allowed to recover from the anaesthetic for several hours and then resume their downstream-migration. The scales were read under a microscope and five age categories were distinguished, viz 1+, 2., 2+, 3., and 3+. In the following table, these age categories have been reduced to the three year-classes, with percentage composition and the average length, weight and condition factor given for each sample.

TABLE XVI

Group	% smolt age composition			Av. Length	Av. Weight	C.F.
	1	2	3			
1	10	75	15	137.1	25.7	0.99
2	20	75	5	134.7	23.5	0.96
3	10	80	10	139.2	25.4	0.94
4	5	90	5	141.4	26.5	0.94
5	0	90	10	141.3	24.8	0.88
6	0	100	0	137.6	27.1	1.04
7	5	95	0	143.5	27.1	0.92
8	15	80	5	141.7	29.9	1.05
9	15	80	5	151.6	34.3	0.98
Means	9	85	6	140.9	27	0.97

Although the samples were too small for total confidence there would appear to be a tendency for the older smolts to run earliest and for the average size of smolts to increase as the season progressed. The condition factor (coefficient of condition) was fairly uniform over the sampling period, with an average value of 0.97.

(e) Salmon kelts

TABLE XVII

Counted through traps	
December 1976	11
January 1977	49
February	21
March	99
April	31
May	1
Total	212 (comprising 171 females and 41 males)

The proportion of kelts judged healthy enough for tagging rose to 78% (165/212) in 1977, compared with 68% in 1976. Male kelts were more numerous at 19% of the total run and 15% of all kelts were lightly marked with fungus at tagging. The spawning escapement in 1976 was estimated at 725, the survival to the kelt stage in 1977 increasing to 29%. Comparable data for the years 1974 to 1977 are given in Table XVIII.

TABLE XVIII

	1974	1975	1976	1977
% Healthy kelts in kelt run	64	72	68	78
% Males in kelt population	9	23	14	19
% Lightly marked	40	16	20	15
% Survival from escapement	29	33	23	29
% Recaptures in 1st year	7.3	7.0	6.7	7.3

The high water levels in winter and early spring are reflected in the high proportion of the trap catch (75%) of all kelts at the Salmon Leap.

Recaptures of tagged kelts totalled 12 in 1977, or 7.3% of which 8 were recorded in the traps and 4 from coastal drift nets. As in 1975 and 1976 two recaptures were obtained from nets well south of the home river (Aran Island, Galway Bay and off the Cliffs of Moher, Co. Clare). This southerly deflection of the return migration was brought to light by return of tags from the drift nets which have operated in this area since 1972. The remaining two coastal net recaptures came from Achill Island, Co. Mayo and Killala Bay, Co. Mayo.

The 8 female previously-spawned grilse constituted 2.6% of the estimated female grilse escapement, their mean growth increment in the sea was 7.2 cm and the absence period in the sea averaged 177 days.

There was one example of a long-absence previously spawned grilse recorded in 1977 :-

Tagged as grilse kelt :	March 7, 1976;	length 64 cm, female
Recaptured :	July 1, 1977;	length 78 cm, female

The recapture rate of the tagged grilse kelts in 1976 was omitted, inadvertently, from Report XXI (1976). It was 6.7% and the above recapture increases this survival rate to second spawning to 7.4%.

(f) Ulcerative Dermal Necrosis (Salmon Disease)

1976/1977 spawning season

The appearance of the majority of infected salmon kelts in the downstream traps was delayed in 1977, when the proportion of affected fish was higher than normal in February. However, the overall incidence of infection among kelts declined again in the 1976/77 season. Table XIX shows the timing of appearance of infected kelts in the traps and the degree to which the monthly total was infected, in percentages, compared with the results for the past two seasons and the five-year average for 1970 to 1974 :-

TABLE XIX

	1970-74	1974/75	1975/76	1976/77
November	6	0	0	0
December	46	94	56	36
January	70	76	68	73
February	19	14	18	43
March	2	7	1	3
April	1	2	0	0

Table XX compares the severity of UDN infection amongst the total stock, over the past eight seasons.

TABLE XX
% of infected fish in total kelt run

1969-70	21
1970-71	21
1971-72	32
1972-73	37
1973-74	57
1974-75	41
1975-76	38
1976-77	25

1977/78 season

As noted in Section C.1 (i) above, UDN was observed amongst upstream-migrating two-sea-winter fish in May and early June, when 4 dead and 1 marked fish were noted in the traps. No infection was observed among the grilse, which did not move upstream in any numbers until July.

The early kelt run in December comprised 8 fish of which 1 was moribund and 7 were marked.

Broodstock (total 83) were maintained without loss in a fresh water holding pond from mid-September to early December. Each fish was injected with oxytetracycline at transfer from the traps to the pond. After a further transfer (and injection) from the fresh water to brackish water pond in early December, one female fish died with fungal infection, probably associated with UDN.

2. REARED SALMON

(i) Upstream movements

It has been noted in earlier years that when the survival rate of the wild smolts to the grilse stage is poor, that of reared smolts is also affected, usually to a much more pronounced degree. This was the case in the return of grilse in 1977 from the release of reared smolts in 1976, when the overall recapture rate of 0.63% was the lowest experienced for over 12 years. It is possible, however, that the quality of the smolts at release has deteriorated, in that furunculosis is known to be present in the population each year, and more recently, a condition resembling proliferative kidney disease was noted. In one instance of transfer of reared smolts to cages in salt water, the 2+ smolts involved had shown no mortality for three months prior to transfer, but the stress of a change to an hyperosmotic environment caused an outbreak of furunculosis, presumed latent in fresh water, resulting in 70% mortality. The kidney condition is not thought to be due to *Corynebacterium* species but may have its origin in diet and/or altered water chemistry. This condition has been under investigation during the past year. The possibility of undetected deterioration in smolt quality tends to be confirmed by the relatively better performance of 1+ smolts in the sea during 1976-77, when 2+ smolts normally survive from 2 to 4 times better than 1+.

As in 1976, some recaptures were made in the home river of post-smolts which escaped from sea cages. One of these had escaped from the original sea cage site in Clew Bay and had spent from October 1975 to July 1977 in the sea, returning as a small summer fish, derived from a 1+ smolt, weighing about 3.9kg (8½lb). The remaining two had escaped from the Doughill site, during measuring or sampling operations, since no major escapes have occurred from this site. These fish returned as late-running grilse, one of normal size (2.5kg), the other being much smaller, at about 1 kg.

One recapture as a grilse was made from a batch of 2000 1+ parr, released in fresh water during August, 1975, and three recaptures as small spring fish were noted from the 7480 1+ smolts released in 1975, in addition to the 120 grilse already recorded from this batch.

There were 7 previously-spawned grilse among the 110 recaptures in 1977, 3 of which still bore the Floy tags attached in the summer of 1976. 6 of the 7 previous-spawners were derived from 2+ smolts, released in 1975.

Table XXI below, shows the various batches of smolts and the recaptures, from releases in 1975 and 1976.

TABLE XXI

	Smolt age	Year of Release	Number Released	Brand	Return as —		% Recapture
					G	2SW	
1.	1+	1975	1653	X	20	1	1.27
2.	1+	1975	2870	—	41	2	1.50
3.	1+	1975	4610	Y	79	1	1.74
4.	1+	1976	1268	O	16	N/A	1.26
5.	1+	1976	6077	U	42	N/A	0.69
6.	2+	1976	2598	K	17	N/A	0.65
7.	2+	1976	5315	T	21	N/A	0.40

Handwritten notes in original table:
 Groups 1-3: } 9133
 Groups 4-5: } 67345
 Groups 1-3: } 144
 Groups 4-7: } 6.79

It is interesting to note that the recapture rates in groups 4 and 6 above, which were 1+ and 2+ smolts fed on a high fat (14%) diet for 66 days prior to release, were higher than in groups 5 and 7, which were similar fish maintained on a diet with normal (7.5%) fat content.

The 110 recaptures were made up in the following ways :-

Mill Race trap	54
Salmon Leap trap	42
Furnace rods	6
Outside nets	8

Three of the outside net recaptures were made off Achill Island by drift nets, one came from the North Mayo drift nets and four from a draft net operating in the joint estuary of Newport and Burrishoole rivers.

Rod-caught recaptures fell to a very low level in 1977, when the 6 fish caught on Lough Furnace represented only 8% of the total catch on that lake and

6% of the incoming stock of reared fish. No reared fish were caught on Lough Feeagh but broodstock was retained from the trap catches from mid-September onwards, so that relatively few reared fish were available for anglers on Lough Feeagh. Only 11 reared fish had been counted through the traps by the end of August, so that this paucity of early-running stock was largely responsible for poor rod catches on both lakes.

Of the 96 fish passed through the traps, 83 were used in hatchery operations, being retained either on their initial upstream migration or as they left Lough Feeagh, migrating downstream, in their usual attempts to home on their rearing point, mid-way Loughs Feeagh and Furnace. As in the past three years, the proportion of reared fish using the Salmon Leap passage to Lough Feeagh was 44%, compared with less than 10% in the years 1970 to 1973.

There were no recaptures of pre-grilse in 1977, nor of fish which had suffered compaction of the distal vertebrae, giving a "stumpy" appearance. Legibility of brand marks was again poor, with about 50% of the returning fish having indistinct or missing brands.

The average size of returning grilse at 60.4cm, was smaller than usual, in common with the wild grilse in 1977. For the first time, the grilse derived from 1+ smolts were larger (60.7cm) than those from 2+ smolts (59.9cm). There were occasional fish of good size, however, reaching 74.5cm and weighing approximately 4.2kg (9½lb). The sex ratio of grilse from 1+ smolts was exactly 50:50 and that from 2+ smolts was 52:48 (females to males).

The reared grilse were, as usual, later in their appearance in the traps than wild fish, with 80% of the total being recorded in September and October. The following table compares the monthly proportions of the runs of wild and reared grilse, through the traps :-

TABLE XXII

	Wild fish %	Reared fish %
June	2.0	—
July	25.2	5.2
August	16.6	6.3
September	32.0	39.6
October	13.7	41.7
November	0.5	3.1
December	—	4.1

The relative survival rates of smolts released in 1976 may be compared with those of previous years in Table XXIII below, where post-smolt escapes from sea cages have been excluded :-

TABLE XXIII

Year	Smolts released	Number recaptured	% 2+ smolts	% 1+ smolts
1966	9764	62	0.62	0.83
67	10256	194	1.87	1.09
68	14260	490	4.41	2.91
69	17317	654	5.20	4.02
70	16637	312	3.64	1.25
71	10219	136	1.27	1.65
72	10237	682	7.00	4.08
73	7906	117	1.55	0.85
74	5479	60	1.10	1.08
75	10206	354	4.18	0.80
76	15674	253	1.62	1.60
77	15258	96	0.48	0.79

Note that these figures relate to the return of reared grilse to the river and make no allowance for the contribution of reared grilse to commercial fishermen, where fin-clip and brand marks would pass unnoticed in the catch.

Excluding previous spawners, these fish can be divided into the following categories :-

Smolt parentage	Returned as grilse	2 SW fish *	Pregrilse
2SW	183 (87%)	27 (13%)	0
Grilse	3046 (98.3%)	54 (1.7%)	5
2SW x grilse	147 (96.1%)	6 (3.9%)	0

* Includes both small spring and small summer fish.

(ii) Downstream movements

All reared smolts were transferred to release ponds prior to the main emigration of wild smolts. 2+ smolts were branded in December 1976 and 1+ smolts from early April. Marks used in 1977 were :-

2+ Grilse smolts	5384	Adipose fin clip + Brand	X (right shoulder)
2+ Grilse smolts	467	Adipose fin clip + Brand	XX (left shoulder)
1+ Grilse smolts	11062	Adipose fin clip + Brand	⊖
1+ Grilse smolts	1009	Adipose fin clip + Brand	L

Sea cage stocks were 1167 2+ grilse parentage smolts, 9408 1+ grilse parentage smolts and 887 2SW parentage 1+ smolts.

3. SEA TROUT

(i) Upstream movements

(a) Timing and numbers

The total sea trout run of 2212 was only 66% of the 1976 level, this being related to the decreased survival to the kelt stage from the estimated spawning escapement in 1976. (See Section ii(c)). Fresh-run sea trout were relatively late

in their appearance in the traps in 1977, due largely to the low water conditions during June. The bulk of the sea trout run occurred during July and the first finnock (0+ sea years) appeared during the period July 4 to 7. Accurate records were kept of the proportion of finnock in the run, these being 50% in July and 44% in August, through both traps. The proportion of finnock (724) in the total run of sea trout (2212) was 33%, distinctly less than the estimated 45% in 1976. This in turn, can be related to the smaller production of sea trout smolts in 1977 and autumn-migrating trout in 1976. (See Section ii a and b). No finnock were observed in the sea trout trap catch in September.

The totals for upstream migrating sea trout, counted through the traps from 1970 onward, are as follows :-

TABLE XXIV

Year	Mill Race	Salmon Leap	Total
1970	885	359	1244
71	889	518	1407
72	1799	426	2225
73	1596	1248	2844
74	1658	1271	2929
75	1651	1697	3348
76	894	2408	3302
77	731	1481	2212

The total for 1977 can be seen to be smaller than any years since 1971 and the preponderance of trap captures at the Salmon Leap, noted in 1976, was continued in 1977. The sea trout run showed a reduced proportion in June, due to low water levels and where almost one-third of the run was recorded from August onwards in earlier years, only 16% was recorded in the same period in 1977. In the following table, the monthly proportions of the 1977 run may be compared with those from the five-year average for 1970 — 74 and those for 1975 and 1976 :-

TABLE XXV

	1970-74	1975	1976	1977
May	—	—	0.2	—
June	14.3	13.4	31.4	3.6
July	50.5	56.5	56.2	80.2
August	14.1	12.1	—	7.0
September	8.9	9.7	5.0	5.7
October	8.4	6.0	6.6	3.0
November	3.3	2.2	0.5	0.5
December	0.5	0.1	0.1	—

(b) Net-marked fish

Some 10% of the early run of the larger sea trout in July showed net marks of varying severity and these persisted, to a lesser degree (2%) in August. These were not seen with any frequency until 1976 and may well be related to a known increase in illegal netting in the sea, particularly in Clew Bay.

(c) Spawning escapement

TABLE XXVI

Counted through traps	2212
Rod catch on Lough Feeagh	231
Escapement	1981

The rod catch showed an improvement over the past two years but did not recover to the values for 1970 to 1974. In consequence, the estimated spawning escapement was slightly larger than those recorded for 1970 to 1972, but below those of 1973 to 1976 :-

TABLE XXVII

Year	Estimated spawning escapement
1970	1017
71	1249
72	1883
73	2391
74	2519
75	3118
76	3117
77	1981

(ii) Downstream movements

(a) Sea trout smolts

Sea trout smolts started their downstream migration in mid-March but the peak of the run did not occur until late April and early May. Only 30% of the run was caught at the Mill Race and the total of 3889 was below the average of 4435 for the preceeding seven years. Since this decrease cannot be related to poor spawning escapements in the relevant broodstock years, it would appear that this fall-off in production might be related more to the effects of the drought in 1976. The downstream run of autumn migrating juvenile trout in 1976 was about normal so that part of the decrease in sea trout numbers in 1977 can be explained by the shortfall in smolts resulting in fewer finnock.

Table XXVIII gives the sea trout smolt totals for the years 1970 to 1977 :-

TABLE XXVIII

1970	3228
71	2961
72	5465
73	6071
74	4527
75	3587
76	5207
77	3889

(b) Autumn-migrating juvenile trout

These fish are 1+ and 2+ trout, showing a definite downstream migration pattern in the autumn and known to contribute, at least in part, to the finnock and

sea trout production of succeeding years. The total run increased slightly in 1977, at 3506, with the usual preponderance in October :-

TABLE XXIX

	Mill Race	Salmon Leap	Totals
September	86	513	599
October	508	1529	2037
November	178	511	689
December	63	118	181
Totals	835	2671	3506

For comparison, Table XXX gives the annual totals of autumn-migrating juvenile trout, since 1970 :-

TABLE XXX

1970	3128
71	3620
72	2124
73	2606
74	2703
75	4171
76	2947
77	3506

(c) Sea trout kelts

It was noticeable that the kelt run in 1977 was later than in 1976, with the peak reverting to the usual period of early April. Table XXXI gives the timing of the kelt run, the fish divided into "large" (over 30cm) and small classes, roughly delimiting finnock from older fish :-

TABLE XXXI

Month	Large	Small	Total	"Marked"
November 76	162	48	210	21
December	181	62	243	19
January 77	64	56	120	5
February	55	32	87	1
March	231	115	346	2
April	380	337	717	1
May	12	32	44	0
June	1	2	3	0
Totals	1086	684	1770	49 (2.8%)

The proportion of "marked" fish (those exhibiting some degree of fungus infection) showed a marked decline from the figure of 6.7% in 1976, so that disease would not seem to be a major factor in the lowered survival rate from the fresh fish to the kelt stage. As shown in the following table, this poor survival was evident in both finnock and larger sea trout.

TABLE XXXII

	1976	1977
Total kelts	2335 (75%)	1770 (57%)
Total escapement	3118	3117
Large sea trout escapement	2183	1714
Sea trout kelts	1716 (79%)	1086 (63%)
Finnock escapement	935	1403
Finnock kelts	619 (66%)	684 (49%)

The survival was slightly worse among the larger sea trout but there was an overall reduction of some 25% in the values for 1977, compared with 1976 and earlier years, involving a loss of about 500 sea trout whilst in fresh water.

In the absence of disease or climatic conditions as major factors, it would seem that the lowered survival rate must be due to some form of predation, of which illegal fishing is perhaps the most likely.

The proportion of small fish (38.6%) in the 1977 kelt total confirms the estimate of 45% finnock in the upstream-migrating sea trout in 1976.

The tagging of sea trout kelts was discontinued in 1976 but some further results were obtained from the 1974/75 taggings, in 1977. There were 59 tagged fish among the kelts recaptured in 1977 and of these, 5 were caught as fresh fish in the summer. It is likely that the 1978 run will be almost completely free of tagged fish, so that sea trout kelt tagging could be resumed in 1979. In addition, one recapture was made from a batch of Swedish sea trout smolts, released as 2+ fish in 1974. Scale reading disclosed that it had returned first, as a maiden 1+ fish in 1975, and had spawned twice, returning for a third spawning in 1977, measuring 46.2cm (18.2"), weighing approximately 1kg (2.12lb). This is the normal growth rate for native Irish fish, whilst the Swedish stocks in their native rivers might be expected to weigh perhaps four times heavier.

4. EXPLOITATION RATES BY ROD FISHING

Records now exist of the rate of exploitation of stocks of wild and reared salmon and sea trout by rod fishing (confined to fly only) since 1970. Accurate assessments can be made for Lough Feeagh but the complication of unknown numbers of sea trout spawning in the streams flowing directly into Lough Furnace makes it impossible to attempt reliable estimates of the exploitation rate of sea trout in Lough Furnace. It should be noted that 436 sea trout were caught in Lough Furnace during 1977, most of which it can be assumed were destined to spawn in the Lough Furnace tributaries. (See Frontispiece map for geography of Burrishoole River system).

For salmon, the maximum rates are accurate, since they assume no spawning in Lough Furnace tributaries, but to arrive at the minimum rates, a tentative correction of 10% has been applied, which is a slight, deliberate over-estimation, as only one stream is involved and used only to a minor extent by spawning salmon.

Salmon derived from reared smolts are treated separately in Table XXXIII below, which gives the comparative values for the years 1975 to 1977, and the five-year average for 1970 to 1974.

TABLE XXXIII

WILD SALMON

Lough Feeagh

	1970-74	1975	1976	1977
"Available" fish by October 12	987	776	709	573
Rod catch	87	54	68	46
Exploitation rate %	11.3	7.0	9.6	8.0

WILD SALMON

Loughs Feeagh and Furnace

Total stock of wild fish	1265	928	885	668
10% addition for L. Furnace residents	1392	1021	973	735
Total of wild fish	205	161	156	115
Minimum exploitation rate %	14.7	15.8	16.0	15.6
Maximum exploitation rate %	16.2	17.3	17.6	17.2

REARED SALMON

Lough Feeagh

"Available" fish by October 12	154	190	95	30
Rod catch	4	18	9	0
Exploitation rate %	2.6	9.5	9.5	0

REARED SALMON

Loughs Feeagh and Furnace

Total stock	261	280	262	102
Total rod catch	32	67	42	6
Exploitation rate %	12.3	24.0	16.0	5.9

SEA TROUT

Lough Feeagh

"Available" fish by October 12	1983	3173	3236	2169
Rod catch	318	230	185	231
Exploitation rate %	16.0	7.2	5.2	10.7

SUMMARY

Despite spells of dry, warm weather in both July and August, the exploitation rate for the rod catch of wild grilse from the total stock remained very similar to that of other years. The low rod catch, in terms of numbers, is merely a reflection of the much decreased stock, as the run was only slightly more than half that of the five-year average for 1970 to 1974.

Sea trout catches in Lough Feeagh improved in terms of the exploitation rate but did not regain the level of 16.0%, which was the average over the period 1970 to 74.

The exploitation rates for reared salmon were poor in 1977, due to the very small run in June, July and August, coupled with the fact that broodstock was retained from the traps from mid-September, when it became apparent that ova for the hatchery and restocking programmes were likely to be in short supply. Catches of reared fish constituted only 8% of the Lough Furnace catch and 5% of the overall catch, compared with 27% and 22% respectively, in 1976.

The rod catch figures for the 1977 season (including wild and reared salmon) were as follows :-

	No.	Salmon		No.	Sea Trout	
		Total	Average		Total	Average
		Weight (lb)			Weight (lb)	
Lough Feeagh	46	225	4.89	231	189	0.82
Lough Furnace	75	377	5.02	436	380	0.87
Totals	121	602	4.98	667	569	0.85

The average weights of both salmon and sea trout were lower than in 1976 and for the first time since 1974, the average weight of rod-caught salmon fell below 5lb. For comparison, the catch figures, with average weights where available, are given in Table XXXIV below, for the period 1970 to 1977 :-

TABLE XXXIV

	Salmon		Sea Trout	
	No.	Av. Wt. (lb)	No.	Av. Wt. (lb)
1970	354	N/A	1155	N/A
71	93	5.09	504	0.87
72	335	N/A	839	N/A
73	190	N/A	1045	N/A
74	214	4.07	1292	1.00
75	228	5.62	686	0.80
76	198	5.41	560	0.95
77	121	4.98	667	0.85

5. SILVER EELS

The catch of silver eels in 1977⁷ at 5362 increased by some 20% over the figure for 1976. Over 70% of the catch was made in October, during a period of sustained high water levels. Following improvements to the holding pond a more accurate record of weight was obtained in 1977. The average weight of eels sold was 103 gm (3.6 oz), compared with an average weight of 70 gm in 1964 which was the first occasion on which the Mill Race trap catch was sample-weighed. The total weight of the eel catch in 1977 was 555kg.

Details of the run are as follows :

	Mill Race	Salmon Leap	Totals
September	170	737	907
October	825	3019	3844
November	193	392	585
December	3	23	26
Totals	1191	4171	5362

Comparative figures for previous years were :-

1971	2924	} 5 year average : 4465
72	3144	
73	5087	
74	4642	
75	6530	
76	4595	
77	5362	

APPENDIX I

REPLACEMENT OF FISHMEAL BY SINGLE-CELL PROTEIN IN A DIET FOR YEARLING ATLANTIC SALMON (*SALMO SALAR*).

D. J. Piggins

INTRODUCTION

In view of probable increasing costs and decreasing availability of fishmeal for salmonid diets, considerable attention is being given to possible replacements. One such replacement is single-cell protein (SCP), derived by the action of yeasts or bacteria on a variety of hydrocarbon substrates. The protein used in this experiment was "PRUTEEN", produced by I.C.I., from the action of *Methylophilis* bacteria on methanol, with the addition of ammonia and nutrient salts. Bacterial SCP has higher crude protein and sulphur-containing aminoacids levels than yeast SCP and earlier experimental work (1, 2) has shown that complete or partial replacement of fishmeal by Pruteen in rainbow trout diets had no deleterious effects on growth.

MATERIALS AND METHODS

A total of 8387 yearling Atlantic salmon in four batches (Controls : 1868, 2002. Experimentals : 1856, 2661) were used in this experiment, the average lengths of the groups ranging from 96 to 115mm, weighing 12 to 18gm. The fish were held in 2 x 6m and 2 x 4.5m ponds, at flow rates of 132 and 114 litres/min respectively, corresponding to 6.8 and 6.2 litres per sq.m pond surface.

Population densities at the start and finish of the experimental period were :-

Controls	:	1.24kg/sq.m rising to 2.61kg/sq.m
Experimentals	:	1.55kg/sq.m rising to 3.24kg/sq.m

Note that the control density was only 80% of the experimental density at both the start and finish of the experiment.

The experiment took place over the period July 2 to October 4, 1977, a duration of 94 days. Water temperatures ranged from 12.5 to 19.0°C over this period, at an average of 15.5°C. (See Fig 1).

Sample batches of 100 fish from each of the 4 groups were measured individually to the nearest mm and weighed in groups of 5 to the nearest gm at monthly intervals over the experimental period. Fish were anaesthetised in MS 222 for these measurements.

Pruteen was supplied by ICI Billingham and was made up into an experiment diet by Messrs. Wm. Craig Ltd., Kilrea, Co. Derry. The diet was formulated on the basis of complete replacement of fishmeal by Pruteen, to the following specifications (formulation supplied by Mr. Wm. Craig) :-

Pruteen	400kg
Cod Liver Oil	20
Limestone	35
Dicalc. phosphate	16
Premix (Vits & TE's)	12.5
High fat Calf Milk powder	25
Meat & Bone meal	100
Soya bean meal	40
Wheat-feed	340

Analysis of this diet and the control diet (BP Nutrition Ltd.) were carried out by ICI Billingham, who supplied the following figures :-

Analysis (% of DM)

	BP Nutrition Control	40% 'Pruteen'
Crude Protein	48.75	46.25
Ash	12.0	14.1
Total P	1.8	2.2
% Ca	2.6	3.4
% K	1.1	0.62
% Na	0.59	1.2
% Cl	1.1	1.3
ppm Fe	430	410

Fatty Acids

C 8	0.01	0.04
C10	0.01	0.01
C12	0.12	0.10
C14	0.17	0.20
C16:0	1.70	2.00
C16:1	0.15	1.20
C18:0	0.37	0.30
C18:1	2.35	1.00
C18:2	4.50	1.20
C18:3	0.70	0.17
C22-24	0.01	0.01

Aminoacids

	BP Nutrition Control	40% 'Pruteen'
Lysine	3.38	2.80
Methionine	1.30	1.01
Aspartic Acid	4.17	3.86
Threonine	1.96	2.00
Serine	2.11	1.84
Glutamic Acid	6.82	6.19
Proline	2.74	2.16
Glycine	3.04	2.68
Alanine	3.24	3.30
Valine	2.73	2.35
Isoleucine	1.60	1.99
Leucine	3.94	3.26
Tyrosine	1.35	1.36
Phenylalanine	2.05	1.70
Histidine	1.59	1.00
Arginine	2.72	2.70

Note that the two diets are not strictly isocaloric, in terms of crude protein. It can be seen that of the 16 aminoacids analysed, only 4 (threonine, alanine, isoleucine and tyrosine) show higher values in the experimental diet, but of the four essential aminoacids which are said to be in lower concentration in bacterial SCP than in fishmeal (isoleucine, leucine, valine and phenylalanine) only phenylalanine falls below the level of dietary requirements for sockeye salmon (1).

Mr. A. G. Kidd of ICI Protein Department (personal communication) commented that the overall aminoacid levels were slightly lower in the experimental diet, as a function of the lower crude protein level but that the levels of methionine, lysine and arginine could be assumed to be above the minimal required. Similarly, both calcium and phosphorus levels are elevated in the experimental diet but the Ca/P ratio remained similar in the two diets. The sodium level in the analysis was expected to rise with the use of Pruteen but was higher than envisaged.

There was an expected change in the fatty acid spectrum also, with an increase in C16 and decrease in C18 components, compared with the control diet. Total fatty acid levels, determined chromatographically, showed the control diet at 10.1% to be 60% higher than the experimental diet, with the probability that absolute values, determined by chloroform/methanol extraction, would be higher for both diets.

Owing to die-plate difficulties, the experimental diet consisted of 5mm diameter pellets, compared with the 3mm diameter control diet pellets. The experimental diet was also of harder consistency and paler colour than the control diet and this gave rise to initial problems in acceptance of the pellets by the experimental fish and in dispensing the pellets without blockages through the water-wheel automatic feeders used for all four batches of fish.

Recent work (3) has shown optimum pellet diameters to be 2.2 to 2.6% of the fork length of the fish. At the onset of the experiment in the case of the experimental diet, this figure was 4.6% compared with 2.9% for the control diet. At the close, the respective values were 3.6% and 2.2%.

RESULTS

(i) Growth

Overall growth was very similar in both controls and experimentals over the 3 months feeding, where the controls increased in length by 26.5% and in weight by 132%, compared with the experimentals at 26.0% and 138%, respectively.

However, there was an initial lag in growth rate on the part of the experimental fish, for the reasons detailed above, as may be seen from Table I and Fig. 1. The results shown in Fig. 1 for Group A during the first month may have been affected by sampling errors.

In gross terms the fish were doubling their weight in about 2 months, which is normal during the summer for this size range of Atlantic salmon.

TABLE I

	Experimentals				Controls			
	Group A		B		C		D	
	L	W	L	W	L	W	L	W
Start	111	16	106	15	115	18	96	12
Month 1	111	19	111	18	122	24	108	16
Month 2	127	29	123	25	132	32	120	24
Month 3	140	40	134	34	138	37	131	31

L = Length in mm
W = Weight in gm

The Coefficient of Condition was calculated from the formula

$$\frac{W(\text{gm}) \times 100}{L^3(\text{cm})}$$

and shows each group to have become progressively fatter over the experiment, although Group B of the experimental fish show the effect least, being relatively fat at the start of the experiment. (See Table II).

TABLE II

	Experimentals		Controls	
	Group A	B	C	D
Start	1.17	1.37	1.18	1.08
Month 1	1.39	1.32	1.32	1.27
Month 2	1.42	1.34	1.39	1.39
Month 3	1.46	1.41	1.47	1.38

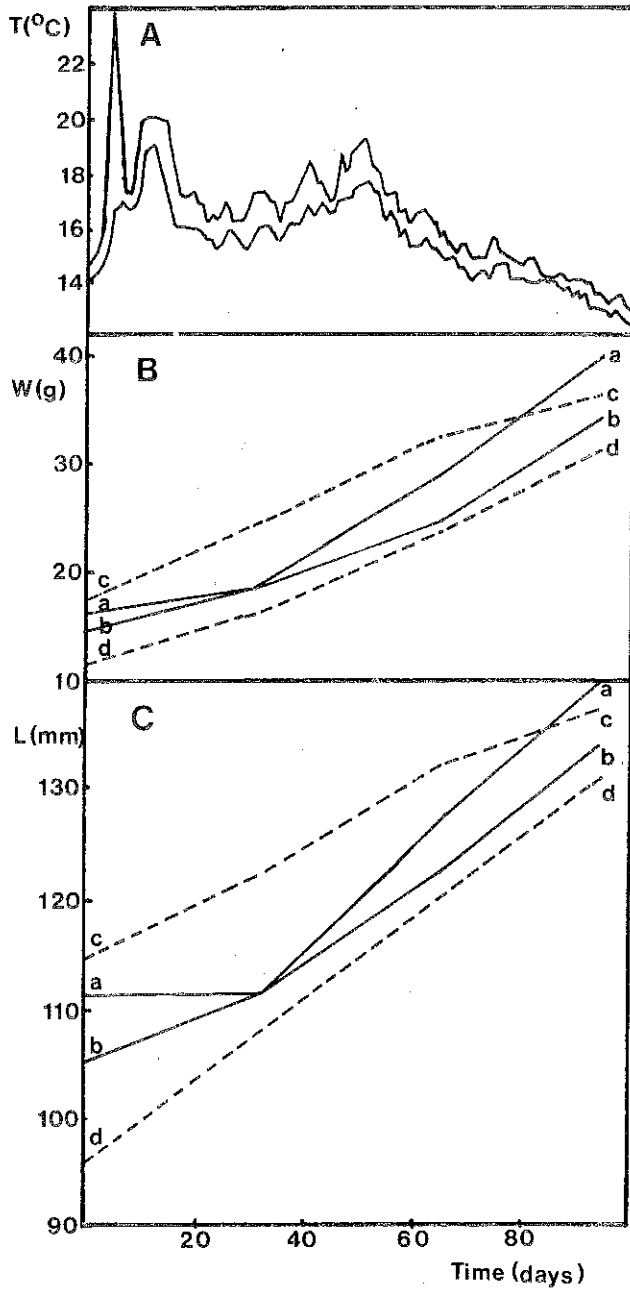


Fig 1.

- A. Diurnal range in water temperatures over the experimental period.
- B. Growth in weight.
- C. Growth in length.

Groups a and b ----- Test fish.
 Groups c and d ——— Control fish.

(ii) Conversion Rates

Conversion rates were calculated for combined groups of controls and experimentals for each month of the experiment as total weight of food supplied over the period, divided by the live weight gain. Live weight gain was calculated from the average weight gain over the period multiplied by the number of fish known to be present, after subtracting mortality figures. Conversion rates are shown in Table III.

	Month	Weight of food fed (kg)	Live weight gain (kg)	Conversion rates
CONTROLS	1	34.500	20.078	1.72 : 1
	2	37.820	28.928	1.31 : 1
	3	32.263	21.050	1.53 : 1
	Total	104.583	70.056	1.49 : 1
EXPERIMENTALS	1	40.300	11.897	3.39 : 1
	2	44.200	35.334	1.25 : 1
	3	41.250	40.460	1.02 : 1
	Total	125.750	87.691	1.43 : 1

Whilst the conversion rates for the control group remained relatively uniform over the 3 months the experimental group was obviously wasting food during the early, non-acceptance period. During the final month of feeding the Pruteen diet, the experimental fish achieved a highly efficient conversion rate, although the possibility of weight gain through water uptake on a relatively high-salt diet should not be overlooked.

(iii) Mortality rates

Daily records of mortalities in the four ponds were maintained throughout the experimental period and the % losses at the end of each month are shown in Table IV :-

	Experimentals		Controls	
	A	B	C	D
Month 1	6.38	2.26	0.75	2.85
2	7.98	0.55	4.20	4.35
3	4.01	0.22	4.28	1.93
Overall	11.4		8.9	

Although there were slightly more losses amongst the experimental fish as a whole, this is not considered to be a result of diet since the losses were confined almost entirely to one group. This group (A) had a low level furunculosis infection at the onset and had to receive terramycin treatment (coating on the pellets) towards the end of the first and second months of the trial.

Gross macroscopic examination of dissected specimens of both groups at the close of the experiment revealed no noticeable abnormalities among the Pruteen fed fish compared with the controls. Kidney specimens were preserved for later histological examination.

SUMMARY

This simple feeding trial confirms that fishmeal can be completely replaced by bacterial SCP (Pruteen) in a diet for young Atlantic salmon, without any deleterious effects on growth and mortality over a period of three months. It is hoped to make a further trial, when the deficiencies of size and constitution of the experimental diet would be made good and the experiment would continue over an entire year, or more, incorporating the period of smolt transformation. This would enable possible long-term effects of essential aminoacid deficiencies to become apparent and would test the ability of the smolts fed on this diet to withstand the stress of transfer to sea water.

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