Taighde Bradán Éireann Corpraithe

The Salmon Research Agency of Ireland Incorporated

ANNUAL REPORT

NO. 41

Report for the year ended 31st December 1996

The Annual Reports of the Salmon Research Agency

of Ireland Incorporated follow in sequence to those of its predecessor

The Salmon Research Trust of Ireland Incorporated

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COMMITTEE OF MANAGEMENT (1996/97)

Mr. F.S. O Muircheartaigh (Chairman)	
Mr. A. Drugan	
Ms. S. Davey	
Dr. P. Fitzmaurice	
Dr. T.K. Whitaker	As Nominees of the Minister for the Marine
Mr. J.C. O' Dowd	
Mr. A.J. Fox	
Prof. A. Ferguson	Elective Members
Dr. I. Heaney	
Mr. D. de G. Griffith	Attend meetings of the Committee by invitation

CONSULTATIVE COMMITTEE (1996)

J. Diffley	Beltra Co-operative Society
M. Hughes	Newport Anglers Club
C. Moran	Newport Anglers Club
P. Quinn	Clew Bay Oyster Cooperative Society
V. Roche	N.W. Regional Fisheries Board
D. Quigley	Salmara Teo.
K. Thompson	Newport House Hotel

STAFF (1996)

K.F. Whelan, Ph.D., M.I.F.M.	Director
D.M. Cotter, M.Sc.,	Biologist
R. Poole, Ph.D., M.I.F.M.	Biologist
P. McGinnity, Ph.D. M.I.F.M.	Biologist
G. Rogan, M.Sc., Cert. Aq., Dip. I.F.M.	Laboratory Technician
A. Drumm, N.D.E.S.	Laboratory Technician.
G. Marmion, B.A., Dip. L.I.S.	Administrative Officer
P. Hughes	Fishery Manager (May-October)
A. Nixon	Field Assistant (Foreman)
M. Davitt	Driver / Technician
T. Lavelle	Field Assistant
Eilis O' Connor	Secretary
Dr. G. Farrell	Consultant Engineer

CONTRACT STAFF (1996)

D. Cooke, B.A. Mod.	Research Assistant - (EU Genetics Programme)
M. Matthews, Ph.D.	Research Assistant - (EU Hybrid Programme)
T. Gallagher, B.Sc., Cert. & Dip. Aq. Sci.	Research Assistant (Marine OP - Ecology of *A. salmonicida*)
M. Dillane, Cert. & Dip. Aq. Sci.	Technician - (EU Sea Trout Broodstock Programme)
P. Nixon	Field Assistant - (EU Sea Trout Broodstock Programme)
D. Sweeney	Field Assistant - (EU Sea Trout Broodstock Programme)
B. O' Hea, B.Sc., Dip. Aq. Sci.	Field Assistant - (EU Genetics Programme)
E. Murray	Field Assistant - (EU Sea Trout Broodstock Programme)
C. Kelly	Field Assistant
M. Conway	Clerical Assistant

Personnel SRAI 1996/1997

Director

Dr. K. Whelan

Administration

G. Marmion
M. Conway (C)

Fishery

P. Hughes
Asst. F. Manager (temp.)

Tourist Prog.

Visitor Centre Manager

Research

R. Poole

M. Matthews (C)
M. Dillane (C)
D. Sweeney (C)
P. Nixon (C)

D. Cotter

G. Rogan
A. Drumm
M. Davitt
N. Roche (C)
T. Gallagher (C)

P. McGinnity

D. Cooke (C)
M. Müller (Student)

T. Nixon
P. Hughes (C)
B. O'Hea (C)
T. Lavelle

C = Contract Personnel

SALMON RESEARCH AGENCY OF IRELAND

REPORT FOR THE YEAR ENDING 31st DECEMBER 1996

SUMMARY

1. Reports presented to the 1996 NASCO meeting in Gothenburg, Sweden, recorded an Atlantic salmon catch, by all countries in 1995, of 3,480 tonnes. This compared with a catch of 4,002 tonnes in 1994 and a four year average of 4,551 tonnes for the previous five years. In the light of the above advice NASCO agreed a quota of 425 tonnes for the Faroese Fishery for 1996, but could not agree a quota for the West Greenland Fishery. In July the Greenland Home Rule Government set a quota of 174 tonnes for the West Greenland fishery, an increase of 97 tonnes on the 1995 NASCO quota of 77 tonnes.

2. Against this backdrop of declining salmon stocks, the Report of The Irish Salmon Task Force was published in September 1997. The Report of the Task Force recommends a new approach to the management of salmon stocks which includes a shorter season, a shorter fishing week, the introduction of carcass tagging and the imposition of quotas on the commercial salmon catch. The Report also accepts that inevitably:
"the balance of advantage on conservation, environmental and economic grounds should lie increasingly with redirecting salmon stocks from interceptory or commercial exploitation towards recreational fishing".

3. Although these changes in the management regime are to be welcomed, the Agency does not fully agree with the Task Force's analysis of the current commercial fishery, particularly as to its current economic value, nor would they see any prospect of a full recovery of salmon stocks without, at least in the medium term, a severe curtailment in exploitation. In particular they are concerned that the recommended 900 tonnes quota would not have this effect. They would consider that the Task Force did not give enough prominence in its Report to the sustained long-term decline in the economic value of the commercial salmon fishery throughout the North Atlantic.

4. While interceptory netting and habitat degradation must be viewed as major threats to the welfare and long-term survival of Atlantic salmon stocks, there has been increasing concern in recent years regarding the impact of increasing populations of predators, which has resulted from wildlife conservation legislation introduced throughout the Atlantic salmon's natural range.

5. With the continuing increase in the complexity and extent of the Agency's research programmes, funding has proved an even more difficult problem, particularly Government funding. Following the provision of a Supplementary Grant to the Agency in late '96 the Minister of State at the Department of the Marine, Mr Eamon Gilmore T.D., announced in the Dáil that the Agency was to become part of the Marine Institute.

6. Stripping of sea trout broodstock in 1995 yielded a minimum total of 648,200 ova, some 10% higher than the targeted 590,000.

7. The two year study of hybridisation between Atlantic salmon and brown trout was completed during 1996. Hybrid fry were found to be randomly distributed within catchments. Within fish farming areas there was a weak relationship between hybrid frequency and distance from the rivers to the nearest farm. Direct comparisons between control rivers remote from sea cages and rivers in general areas of fish farming showed no significant difference in the hybrid frequencies recorded.

8. The three year EU AIR programme studying "*The genetic consequences of deliberate and inadvertent introductions of non-native salmon to wild stocks*" concluded in January 1996. Salmon of pure farmed origin grew faster and competitively displaced wild fish downstream, but their overall survival in the wild was 20% less than that of native Burrishoole fish. No differences in survival occurred between these groups in the hatchery control. The two hybrid groups (farmed male x wild female & wild male x farmed female) were intermediate in their growth rate between wild and farmed families, but showed a

similar survival rate to that of the pure wild strain. Wild salmon showed a significantly higher rate of male parr maturation than their farmed counterparts and also showed a higher tendency for autumn pre-smolt migration. Using smolts ranched from the hatchery control it was found that salmon of farmed and hybrid parentage could survive at sea, and home successfully to their river of origin. As expected from their grilse parentage, the native salmon returned as one-sea-winter fish while many hybrids, especially those of farmed female x wild male origin returned as 2 SW salmon. Few pure farmed fish have returned, but as these were of 3 and 4 SW parentage they may yet do so in 1997 &'98. Given the survival of pure farmed juveniles to smolt stage (80% of wild survival) together with the high survival of hybrid groups, a sufficient proportion of the salmon population survived to produce long term genetic changes in the native stock.

9. Two additions to the instrumentation on the remote sensing buoy, sited on Lough Feeagh, are planned for 1997. A biomass sensor will measure algal biomass, turbidity and water colour. A transmission system will be installed to facilitate the automatic down-loading of data from the buoy via a phone line.

10. The one-year catchment management project on the Burrishoole and Newport systems was completed in 1996. The project was very successful and provided a generic aquatic resource management package, a sophisticated capability to assimilate complex habitat data, a user friendly MIS/GIS interface and a detailed reference manual. This project was funded by the Marine Institute.

11. The total release of microtagged smolts into L. Furnace amounted to 43,800. The mean weight of smolts at release ranged 60 - 80g.

12. As part of the EU Triploid Programme 10,100 diploid and 10,100 triploid smolts (differentially microtagged and branded) were released on 25th April 1996. In addition 2,100 diploid and 2,200 triploid smolts were transferred to saltwater on April 12th 1996 and released from the cage site on 30th May 1996. These releases form part of the 'environmental impact' component of the EU study, aiming to elucidate the potential for return and interbreeding in diploid and triploid fish of both sexes.

13. In association with Cong, Costello, Delphi and Parteen hatcheries the SRA co-ordinated the sale of 905,000 ova to Germany and Luxembourg for the 'Rhine 2000' Programme.

14. The four year, EU-funded project, to study the comparative biology of diploid and triploid Atlantic salmon in terms of their performance in fresh and sea water culture, behaviour on release, product quality, potential for somatic growth, exercise physiology and disease resistance, continued in 1996. First cycle experimental groups (mixed sex and all-female diploids and triploids) were established in December 1994. All fish were microtagged and branded during February 1996 and 14,000 smolts were transferred to saltwater and 20,200 smolts were released into L. Furnace.

15. In association with University College Galway, the Agency is undertaking a systematic survey of the environment of Lough Feeagh and associated waters for the presence of the fish pathogen *A. salmonicida*, over a two year period. Fish and sediment samples were collected each month and following procedures prepared by all the partners, were sent to UCG for analysis. Bacteriological analysis was performed by the Agency. This project is funded by the Marine Institute.

16. A total of 380 wild grilse (379 grilse and 1 previously spawned grilse) were recorded moving upstream through the permanent traps during the season. The number of spring fish recorded in the upstream traps was 18. The total run of wild grilse was 409, including the Lough Furnace rod catch.

17. A total of 6148 wild smolts were recorded in the downstream trap in 1996. The wild grilse returns showed a decrease from 9.4% in 1995 to 6.8% in 1996. The ova to smolt survival was similar to the previous two years. The return to freshwater of the 994 reared grilse recorded was 3.0%. This was an

increase of 0.9% over that achieved in 1995 (2.1%). Exploitation by nets, on returning Burrishoole reared grilse, was estimated at 81.4%, a decrease of 2.6% over 1995 (84.0%). Overall survival to the coast was 16.8% and to the fishery 3.0%.

18. A total of 197 wild sea trout and a further 68 non-silvered trout migrated upstream through the traps in 1994. Of these, 81 were adults and 116 (58.9%) were finnock. The 1995 smolt run amounted to 1300 smolts. The total run of reared smolts was 2751.

19. The percentage of smolts returning as finnock in the same year has historically ranged from 11.4% to 32.4%. In 1988, it fell below the previous recorded minimum to 8.5% and in 1989 to a minimum of 1.5%. There were increases in 1990 and 1991 to 5.7% and 10.0% respectively. However, in 1992, the survival again fell to 3.7%; the second lowest marine survival recorded to date. There was a recovery in 1993 with an increase in survival to 7.4% and a further increase to 9.9% in 1994. Survival fell to 4.8% in 1995 but rose to 9.1% in 1996. Survival of reared smolts was 2.5%.

20. A total of 295 salmon were caught in the Burrishoole Fishery in 1995. The catch consisted of 119 wild fish and 176 reared fish. Of these, 84 wild fish were returned alive to the water. There was a minimum of 125 sea trout caught, the majority of which were rod caught on Lough Furnace and returned alive.

21. Creel census returns from Ballinlough provided information on 405 angler visits. These anglers caught 760 rainbow trout and 12 brown trout. Anglers fished for 4.4 hours per visit and caught 2.3 trout. The best trout taken was 5lb. A total of eighteen trout over 4lb were taken and many others over 3lb.

1. INTRODUCTION

Reports presented to the 1996 NASCO meeting in Gothenburg, Sweden, reported the Atlantic salmon recorded catch, by all countries in 1995, of 3,480 tonnes. This compared with a catch of 4,002 tonnes in 1994 and a four year average of 4,551 tonnes for the previous five years. Having reviewed all of the available information ICES (International Council for the Exploration of the Seas) provided NASCO with the following advice:

"In view of the apparent decline in pre-fishery estimates to the lowest historically observed level for maturing and non-maturing 1SW salmon in Southern European countries, non-maturing 1SW in Northern European countries and near lowest levels for maturing 1SW salmon in Northern Europe , it appears that these stocks in aggregate may be below minimum biologically acceptable levels (MBAL). The tenuous condition of these stocks is re-inforced by the downward trends in indices of survival from smolts to homewaters, for wild and reared 1SW and 2SW stock components over the past decade and an increase in the proportion of maturing 1SW in the fisheries. These conditions are similar to those of North American stocks. ICES recommends that, except for in-river fisheries or stocks in individual rivers which are above MBAL, measures should be introduced to reduce fishing mortality and increase escapement of salmon in the North East Atlantic, especially for that component which spawns as multi-sea-winter fish".

In the light of the above advice NASCO agreed a quota of 425 tonnes for the Faroese Fishery for 1996, but could not agree a quota for the West Greenland Fishery. In July the Greenland Home Rule Government set a quota of 174 tonnes for the West Greenland fishery, an increase of 97 tonnes on the 1995 NASCO quota of 77 tonnes.

Against this backdrop of declining salmon stocks, the Report of The Irish Salmon Task Force was published in September 1996. The main recommendations of the Task Force were as follows:

1. **Mission Statement: To secure and augment national salmon stocks as a sustainable resource to be managed on a catchment basis for the social and economic benefit of the community within an overall national framework.**

2. **Spring Fish Policy:**
   - **Drift net season to be delayed until the 1st June**
   - **Draft net fisheries should not commence until the middle of May**
   - **Evaluation of a catch and release policy for rod anglers in spring**
   - **Spring fish enhancement in selected fisheries using modern techniques of genetics and husbandry**
   - **Special environmental protection to be afforded to the habitat of spring salmon, particularly the spawning areas.**

3. **Grilse and Summer Salmon Fishery:**
   - **Monofilament net to be legalised**
   - **Depth of net to be increased to 45 meshes**
   - **Cap number of drift net licences at the 1995 levels**
   - **Confine nets to within six miles of the shore**
   - **Netting on a four day week only**
   - **Fishing times to be restricted to 4am to 9pm**
   - **Season to run from 1st June to the 31st August**
   - **Draft nets to be restricted to defined areas**
   - **No further extensions to the commercial or the rod fisheries**
   - **Ban on the sale of rod caught salmon**

5. **Institutional / Organisational Changes:**
   - **Establishment of a National Salmon Management Commission to monitor strategic implementation of the Salmon Management Plan**
   - **Establishment of salmon catchment committees**
   - **Recasting of the Regional Fisheries Boards to make them more representative of the community as a whole**

6. **Control and Management:**
   - **Introduction of a national total allowable catch and a carcass tagging programme. TAC to be set at 900 tonnes in the initial year of implementation, to take account of the assumed level of undeclared catch.**

The Report of the Task Force recommends a new approach to the management of salmon stocks which includes a shorter season, a shorter fishing week, the introduction of carcass tagging and the imposition of quotas on the commercial salmon catch. The Report also accepts that inevitably:
"the balance of advantage on conservation, environmental and economic grounds should lie increasingly with redirecting salmon stocks from interceptory commercial exploitation towards recreational fishing".

To underpin these proposals additional technical research is required, particularly in relation to the targeting of the recreational salmon fishery as a principal source of future game angling revenue. Amongst the areas which need urgent attention are:

- Stock recruitment relationships, in particular quantifying the effect of additional escapement on smolt production and spawning stock levels
- The value of catch and release as a salmon conservation and management tool
- Relative effectiveness of angling under varying levels of stock abundance
- The role of ranching in boosting the value of minor fisheries
- Survival of stocks under varying levels of Total Allowable Catch
- Development of Catchment Management Technology
- Selective enhancement of Multi-Sea-Winter Stocks

The recently announced incorporation of the Salmon Research Agency with the Marine Institute should help to rationalise the overall national approach to salmon and sea trout research and lead to a speedy and effective response to the above national research priorities.

Although these changes in the management regime are to be welcomed, the Agency does not fully agree with the Task Force's analysis of the current commercial fishery, particularly as to its current economic value, nor would they see any prospect of a full recovery of salmon stocks without, at least in the medium term, a severe curtailment in exploitation. In particular they are concerned that the recommended 900 tonnes quota would not have this effect. They would consider that the Task Force did not give enough prominence in its Report to the sustained long-term decline in the economic value of the commercial salmon fishery throughout the North Atlantic.

The Task Force was provided with a detailed economic analysis of the commercial fishery (O' Muircheartaigh, 1996) which concluded that it was currently worth about IR£2 million, a drop of almost IR£10 million, in real terms, since the period 1970/'74. The submission of the Wild Salmon Support Group to the Task Force, showed that spawning stocks were low, particularly in the smaller systems such as the Burrishoole and required urgent and sustained enhancement.

Following consideration of the Task Force Report by the Minister, the Department of the Marine and the Dail Committee on Economic Strategy and Enterprise, it was decided to implement its principal conservation measures for the 1997 season, as a first and necessary step if salmon stocks are to be conserved. These include:

Drift Net Fishery

- Reduction in prescribed maximum number of licences which may be issued by the Regional Fisheries Boards from 847 to 773.
- Reduction in sea area in which salmon fishing is allowed from twelve to six nautical miles from the baselines.
- Deferral of opening date of fishery to 1st June
- Weekend close period extended to three days - Friday to Sunday inclusive
- Introduction of day only fishing between the hours 4am to 9pm
- Use of monofilament netting legalised
- Increase in maximum depth of mesh permitted from 30 meshes deep to 45 meshes.

Draft and Other Net Fisheries

- Revision of prescribed maximum number of licences which may be issued from 604 to 518, draft nets and from 164 to 152, other engines
- Opening date of fishery deferred to 15th May
- Weekend close period extended to three days - Saturday to Monday inclusive

Institutional \ Organisational Changes

- Establishment of catchment management committees
- Formation of consultative group to review a quota regime for the 1998 season

While interceptory netting and habitat degradation must be viewed as major threats to the welfare and long-term survival of Atlantic salmon stocks, there has been increasing concern in recent years regarding the impact of increasing populations of predators, which has resulted from wildlife conservation legislation introduced throughout the Atlantic salmon's natural range. A special session of the NASCO Council was therefore convened to discus in detail: ***"The Atlantic Salmon As Predator And Prey"*** where detailed data were presented on the role of predators in reducing overall salmon survival. During its life cycle, from egg to adult, the salmon is preyed on by some 50 known predators. In addition to the more obvious predators such as seals, predatory fish and the larger fish-eating birds the survival of juvenile salmon can be seriously affected by the smaller fish feeders such as the Kingfisher. This bird is highly selective in its feeding and where they are available, prefers young salmon. It has been estimated that they can eat their own weight (150g) of fish per day and up to 1,600 parr per season. Mergansers and Goosanders have a similar preference for young salmon and collectively these birds can seriously deplete streams of their parr stocks. Not surprisingly the salmon's main predators at sea are seals, sharks and other large predatory fish. There is particular concern regarding the massive growth in seal numbers across the North Atlantic. For example, in the U.K. the number of grey seals has risen from an estimated 30,000 in 1965 to 103,000 in 1992; while in Canada seal populations are increasing by some 5% - 13% per year. With each grey seal requiring on average 6.8kg (15lb) of fish per day it is not surprising that fishery interests are urgently seeking selective seal culls.

1.1 Incorporation of the Agency with the Marine Institute

With the continuing increase in the complexity and extent of the Agency's research programmes, funding has proved an even more difficult problem, particularly Government funding. Following the provision of a supplementary grant to the Agency in late '96 the Minister of State at the Department of the Marine, Mr Eamonn Gilmore T.D., announced in the Dail that the Agency was to become part of the Marine Institute. In his speech the Minister stated:

"The Salmon Research Agency is a national agency under the aegis of the Department of the Marine engaged in research on salmon and sea trout. Over the years the Agency has made valuable contributions to salmon and sea trout research. It has played an important, and too often unappreciated, role in carrying out field research for the Department of the Marine........

While the original role of the Agency was to undertake research on salmonid breeding, rearing techniques and census work on wild populations, its workload has increased significantly in recent years....

The increased subvention (introduced in the Dail today) does not, however, provide a satisfactory long-term solution to the funding requirements of the Agency. Neither does it overcome structural weaknesses in existing arrangements whereby research is conducted by a number of State bodies.....

The whole purpose of setting up the Marine Institute was to integrate marine research carried out by such State bodies under one roof. I have therefore decided in the light of the continuing financial difficulties of the SRA, the long-term interests of its employees and the overriding need to bring about an integrated coherent approach to salmon research generally, that the SRA should, as soon as practicable, become part of the Marine Institute".

The Agency is pleased that in announcing this move the national importance of the Agency's work has been recognised. It now looks to the future with greater assurance that adequate national resources will be available to support both its long-term research programmes and the unique experimental facilities which are under its control.

1.2 Conspectus of Agency's Work

Several major research projects were completed during 1996 and the results are summarised in this year's Annual Report. Papers from all of these programmes have been submitted for publication.

Increasingly the Agency is adopting a catchment-based approach to its environmental and biological research. In this context we are particularly pleased with the success of the project, funded by the Marine Research Measure of the Fisheries Operational Programme, which has resulted in a sophisticated MIS / GIS (Management Information System / Geographical Information System) system, containing powerful mapping and geo-referencing capability. Within the context of the Burrishoole and Newport systems this technology has quantified many physical parameters within the catchments (eg. length of rivers and streams, acreage of afforested land, acreage of over-grazed land, geology, gradient etc.).

It is now possible to superimpose on these data biological information, providing a quantitative index of fish habitat. Through the provision of this generic software and a detailed Procedures Manual the technology is now available to all other fisheries and environmental agencies.

Work was also completed on the major EU-funded project which studied the genetic consequences of interactions between non-native and native salmon stocks. The results of this project have, for the first time, experimentally confirmed the risks posed to genetic diversity by the interbreeding of native and fish farm stocks. The high survival of pure farmed juveniles to the smolt stage, together with the high survival of hybrid groups, showed that longterm genetic changes in the native stock could result.

During the second year of the EU-funded Hybrid programme, the first extensive survey of the frequency of salmon-trout hybridisation in Ireland was completed, encompasing 11 salmonid fisheries throughout the country. Hybrid frequencies were found to be uniformly low (generally <2%) with no evidence of significantly elevated hybridisation rates in rivers situated near salmon-farming activity. Interestingly, canthaxanthin, a synthetic carotenoid pigment used widely in the aquaculture industry as an artificial colorant, was detected in salmon and trout fry from a number of Irish river systems which are remote from salmon farming activity, highlighting the need for further research into this area before carotenoid pigment analysis can be reliably used as a marker for farmed salmon.

The Agency's core research into the biology of the Burrishoole salmonid and eel stocks continued during the past year. The returns of significant numbers of large 2SW farm x wild hybrids in the ranched stock indicates that modern genetic and husbandry techniques could be used to enhance runs of wild MSW stocks, which are currently at an all time low. Over the coming years the Agency will be experimenting with a range of such stocks in order to develop appropriate protocols for such enhancement programmes.

The Agency's sea trout enhancement programme again exceeded target ova production, with the collection of 1.6 million ova from the reared broodstock. We currently have almost 6,000 adult sea trout on hand and hope to cap production at the 1.5 million ova level for the next two years.

The incorporation of the Agency with the Marine Institute should provide an even greater national focus on the importance of its work and hopefully result in more structured support for its experimental research work, particularly its invaluable long-term core research and monitoring programmes.

1.3 General Review of Salmon and Sea Trout Research

The following is a general outline of research being carried out by other Agencies and Universities:

The Marine Institute's Fisheries Research Centre continued the national micro-tagging programme. It involves national co-operation with the Regional Fisheries Boards, the Salmon Research Agency, the Electricity Supply Board (ESB) and several private fishery owners in the west of Ireland. In the past year 300,000 hatchery-reared smolts and over 5,000 wild salmon smolts were tagged with coded microtags.

The FRC carry out a tag recovery programme in all of the major salmon landing ports in Ireland, and over 50% of the nationally declared catch is examined each season. Over 103,000 salmon were examined for the presence of tags in the past year. Nearly 5,000 tags were recovered from fish which were tagged and released in 1994 / 5. Approximately 5.5% of the national catch comprised of salmon released as hatchery smolts, while 3.4% of the catch comprised microtagged fish.

Survival to the coast from hatchery smolt releases was 11.5% in 1995 while the return rate to the rivers was 1.8%. Homewater exploitation by commercial nets was estimated at 84%, a higher rate than that reported over the previous eight years. Survival to the coast and to the river for wild stocks has been estimated at 12.1% and 3.8% respectively in recent years.

As part of the recommendations of the Salmon Task Force, the FRC initiated a comprehensive review of spawning target methodologies and models for the implementation of Total Allowable Catches and Quotas.

A comprehensive rivers database on approximately 700 rivers has been set up, which will eventually include information on spawning habitat area, nursery areas, stock size and spawning targets. These combined spawning estimates will form the basis of setting regional catches and quotas.

Preliminary work was initiated by the FRC on a telemetry programme for the River Liffey, using coded acoustic transmitter tags developed by LOTEK of Canada. The study investigates the behaviour of adult salmon in relation to a thermal / domestic sewage effluent entering the River Liffey at Poolbeg. Facilities for trapping, holding and tagging of adult salmon were prepared at Islandbridge in co-operation with the ESB and the Eastern Regional Fisheries Board. The basic elements of this programme are:

- A study of the movements and behaviour of the returning adult salmon and migrating juvenile salmon in relation to (1) the thermal effluent generated by the ESB oil / gas generating station in the River Liffey estuary and (2) the hydro-generating station further upstream at Leixlip
- Examination of the timing of the upstream migration and the extent of movement within the system
- Estimation of the size of the total run of adults and juveniles.

A study of the physiology and smoltification was completed by University College Dublin and the FRC in 1996. Species included wild salmon and sea trout and hatchery reared salmon, sea trout and rainbow trout. Results from these experiments did not support the hypothesis that the collapse in sea trout stocks in the west of Ireland was primarily due to osmoregulatory dysfunction in migration smolts. The study has also shown fundamental differences between the various salmonid species in the smoltification process and subsequent physiology while at sea.

The Central Fisheries Board continued its major physical rehabilitation programmes on the Moy, Brosna and Mask / Corrib catchments. Extensive pre- and post - stocking surveys were carried out in a range of sea trout fisheries, in addition to assessments of the physical improvements required. The Board is responsible for the Tourism Angling Measure of the Fisheries Operational Programme and in this regard provided funding for a wide range of programmes, including both State and private sector initiatives.

The Central Fisheries Board co-ordinates the collection of sea trout samples from a wide range of fisheries each spring and in conjunction with the Western Regional Fisheries Board carried out basic research into the biology of sea trout particularly on fisheries such as the Erriff, Gowla and Invermore.

The Electricity Supply Board continued its salmon management programmes on the Shannon, Erne and Lee catchments. During 1996 the River Shannon and its tributaries were stocked with 88,000 unfed Multi-Sea-Winter (MSW) fry and 1.2 million 1-Sea-Winter (1SW) unfed fry. In addition 51,000 smolts of MSW parentage and 110,000 of 1SW parentage were released.

The fish counter at Ardnacrusha recorded a total of 1,462 salmon in 1996, of which 1,107 were wild and 304 reared. Adult and juvenile assessments of Shannon tributaries were also carried out. The estimated rod catch of salmon and grilse from the Lower Shannon Fisheries was 2,340 of which 23% were of reared origin.

On the River Erne the adult trap at Cathleen Falls was upgraded and new smolt traps and fish counter / video system were installed. Escapement upstream was 720 salmon and 619 ranched fish were retained as broodstock. The estuarine nets caught 851 salmon of which some 40% were of ranched origin.

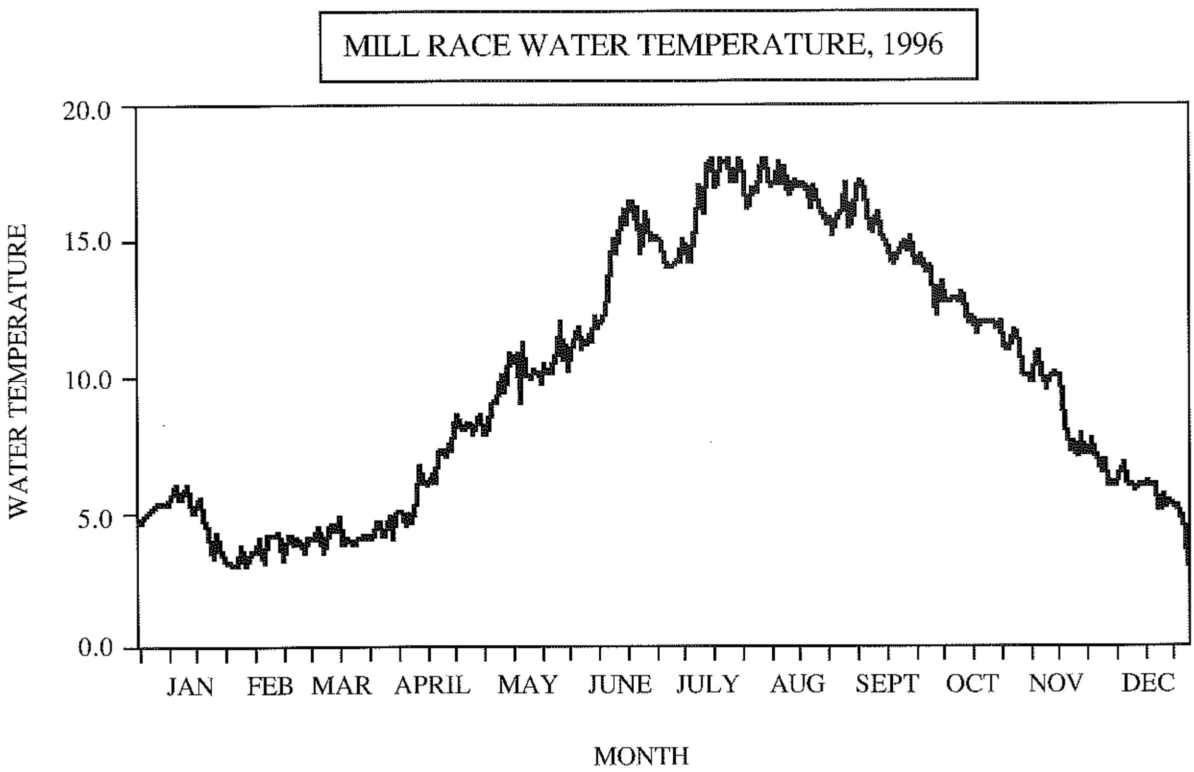
In conjunction with the FRC a new Geographical Information System is being developed to assist with the management of the Erne system. The objective of the first phase of the programme is to quantify the spawning potential of the catchment.

An estimated 400,000 unfed fry were planted in the Lee catchment during 1996. In addition 74,000 smolts were released.

A modified generation protocol was put in place at both Carrigadrohid and Inniscarra Dams in 1996 to assist wild smolt escapement. A proportion of smolts descended via the fish-pass at Carrigadrohid and in 1996, some 515 smolts were recorded using a v-channel and Vaki bioscanner attached to the smolt trap. Operations of the River Sullane smolt trap upstream of Macroom continued for a four month period, during which 3,827 smolts were intercepted.

In addition to co-operative projects involving the Agency, which are outlined in this report, other University projects on-going at present include: population genetics of wild salmon stocks, comparative parasitology of stocked and wild salmonids; environmental impact of afforestation and hillside erosion on salmonid bearing catchments; the development of a vaccine for sea lice; eel stock assessment; river and stream ecology and the population dynamics of salmonid populations.

Fig. 1.


MILL RACE WATER TEMPERATURE, 1996
20.0
15.0
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WATER TEMPERATURE
JAN
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APRIL
MAY
JUNE
JULY
AUG
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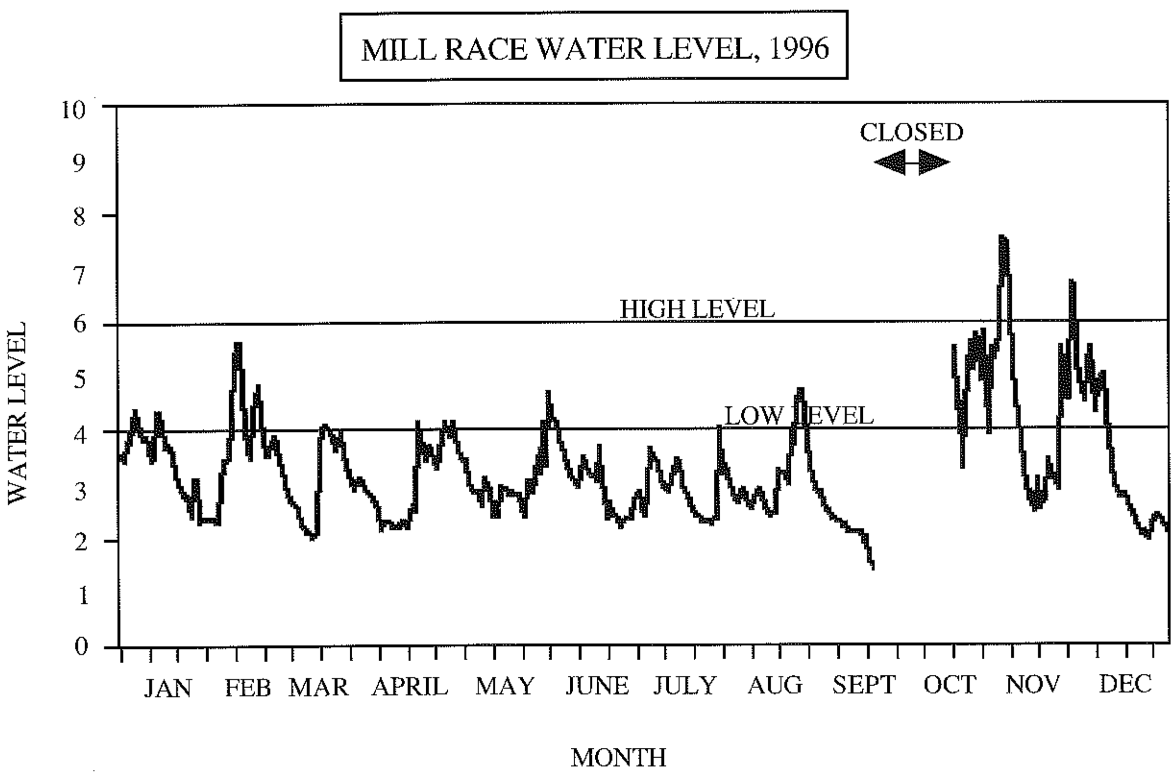
MONTH

Fig. 2.


MILL RACE WATER LEVEL, 1996
CLOSED
HIGH LEVEL
LOW LEVEL
10
9
8
7
6
5
4
3
2
1
0
WATER LEVEL
JAN
FEB
MAR
APRIL
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
MONTH

1.4 Meteorological Data

Daily meteorological data were collected during 1996 and are included in the monthly weather bulletin issued by the National Meteorological Office. The entire weather station was stolen in November 1993, which led to a seven day gap in the records for that period.

The monthly rainfall figures for 1993, 1994, 1995 and 1996 are given in Table 1, along with the annual totals for 1977 to 1996. Months of high rainfall in 1996 were February, October and November. The total rainfall was 1286.6 mm in 1996, the driest year since 1977.

Table 1: Monthly rainfall totals (mm) for 1993, 1994, 1995 and 1996 and the annual totals for 1977 to 1996. * Seven days missing data.

Month	1993	1994	1995	1996	Year	Total
January	220.2	245.5	220.9	70.0	1977	1579.7
February	64.4	113.0	163.8	187.0	1978	1592.2
March	89.7	267.5	192.2	76.5	1979	1653.3
April	124.7	164.6	63.6	89.1	1980	1792.1
May	155.2	88.3	84.2	91.6	1981	1646.8
June	109.6	119.6	34.6	56.2	1982	1609.6
July	120.9	91.9	130.4	98.8	1983	1495.9
August	85.1	109.3	10.7	108.8	1984	1556.6
September	100.9	80.5	102.7	69.4	1985	1584.1
October	53.7	90.3	178.3	210.1	1986	1886.9
November	26.5*	136.6	136.7	135.7	1987	1373.6
December	322.5	250.0	64.4	93.4	1988	1715.2
					1989	1583.9
					1990	1805.9
					1991	1549.6
					1992	1771.1
					1993	1473.4
					1994	1757.1
					1995	1382.5
					1996	1286.6

Water levels were relatively low all year with the exception of early February, late October, late November and early December. Only one high flood occurred in late October. The Mill Race was closed between 23 September and 17 October for pipelines.

The pattern of water temperatures was similar to 1995. Water temperature fell to a minimum of 3.0^{o}C in February. The temperature increased from February through to a peak of 16.4^{o}C on the 21 June. It dropped slightly in July and rose to a new peak of 18^{o}C on 19 July. There was a steady drop in temperature from the end of August through to the end of December.

2. SEA TROUT

2.1 Sea Trout Broodstock Programme

Since 1989, many sea trout stocks in the Galway/south Mayo region had declined to a critical level and urgent action was needed to save the genetic integrity of these stocks. A full description of the sea trout broodstock programme initiated in 1991 was given in the 1995 Annual Report.

In 1993, the Department of the Marine and the Salmon Research Agency initiated the Connemara Broodstock bank, based on the Burrishoole Reconditioning Programme and the Norwegian Gene Bank concept, in an attempt to collect, ongrow and protect a core broodstock of native sea trout in a fully marine situation. While it was not feasible to collect sea trout from all the fisheries, it was decided to commence with a manageable number of donor fisheries. The fisheries chosen were: Burrishoole, Erriff, Costello and Crumlin. The basic aim of the programme is to build up these four stocks, thereby allowing for a net donation of ova/fish to other, less healthy, stocks in the future. The first phase incorporates two separate but related strategies: the ongrowing to maturation of F1 sea trout parr/smolts and reconditioning and ongrowing wild sea trout kelts and finnock. This programme received initial funding in 1993 from Udarás na Gaeltachta and is now fully supported by the EU Tourism Operational Programme for Inland Fisheries since 1994.

Progress in 1996

All stocks performed well during 1996 with no significant problems occurring. The loss of the 200 adult broodstock in the autumn of 1995 did not significantly impact on the effectiveness of the overall programme as the majority were very large old males or females with questionable reproductive quality, which had been held for experimental purposes.

Stripping in 1995 yielded a minimum total of 648,200 ova, some 10% higher than the targeted 590,000.

The broodstock were transferred to the sea cages in Clew Bay during March and April 1996. Few mortalities were recorded, except for a small proportion of mature males which failed to re-adapt to the saline conditions. Unlike the previous summer (1995) temperatures were normal and no rearing difficulties related to high temperatures occurred. In July and August 1996 the fish were returned to the freshwater sites (L. Pollaghowly, L. Skahagadranton, L. Furnace). Stripping commenced in November 1996 and was completed by the end of January, with a total green ova yield of 1.6 million.

2.2 Hybridisation Between Atlantic Salmon and Brown Trout (See App. II)

The rapid growth in aquaculture of Atlantic salmon (*Salmo salar*) in north-western Europe since the 1970's has given rise to concerns regarding the biological consequences of fish farm escapes on wild salmonid stocks. Recent studies in western Scotland indicate that inter-hybridisation between escaped farmed female salmon and brown trout (*S. trutta)* occurs more frequently than in pure wild stocks.

The aim of this project was to quantify and understand more fully the effects of hybridisation between Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta)* particularly as it relates to escapees from the aquaculture industry.

In this study a combination of genetic and carotenoid pigment analysis was used to test the hypothesis that offspring of escaped farmed female Atlantic salmon contain higher frequencies of salmon-trout F1 hybrids than the progeny of wild salmon. Canthaxanthin, an artificial flesh colourant which is still used widely in commercial salmon feed in Ireland, provided a discriminatory marker for the determination of fry derived from farmed female salmon.

The general prevalence of canthaxanthin in Irish donor rivers was unexpected. Carotenoid pigment analysis of wild salmon ova taken from the Leannan, Crana, Owenmore and Burrishoole systems showed canthaxanthin to be absent in all cases confirming wild salmon females do not carry the pigment. However, HPLC analysis of adult resident trout from six catchments throughout Ireland indicated canthaxanthin to be present in each of the systems examined with many individuals showing trace levels of the pigment. The source of canthaxanthin in Irish rivers and the means by which emergent salmon fry accumulate detectable levels of canthaxanthin so soon after first feeding, warrants further investigation if carotenoid screening is to be used in future studies of this kind.

Table 2: Numbers of sea trout ova distributed from the SRA to sea trout hatcheries for on-rearing and planting out.

FISHERY	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*
B'SHOOLE	17,363	100,267	92,282	27,031	20,004	48,037
OWENGARVE				12,000	15,000	70,000
ERRIFF	4,593		23,007	27,181	7,950	123,942
COSTELLO			29,898	30,000	36,087	73,082
GOWLA			28,844	64,599	54,804	119,062
KYLEMORE				13,190	67,000	100,420
CRUMLIN				28,266	85,130	102,397
INVERBEG				15,201	63,272	41,497
INVERMORE						41,497
B'NAHINCH			4,026	92,045	94,735	111,286
SCREEBE					59,000	43,988
NEWPORT						100,000
CLIFDEN						61,076
CULFIN						113,215
DELPHI						77,215
TOTAL	21,956	100,267	178,057	309,513	502,982	1,226,714

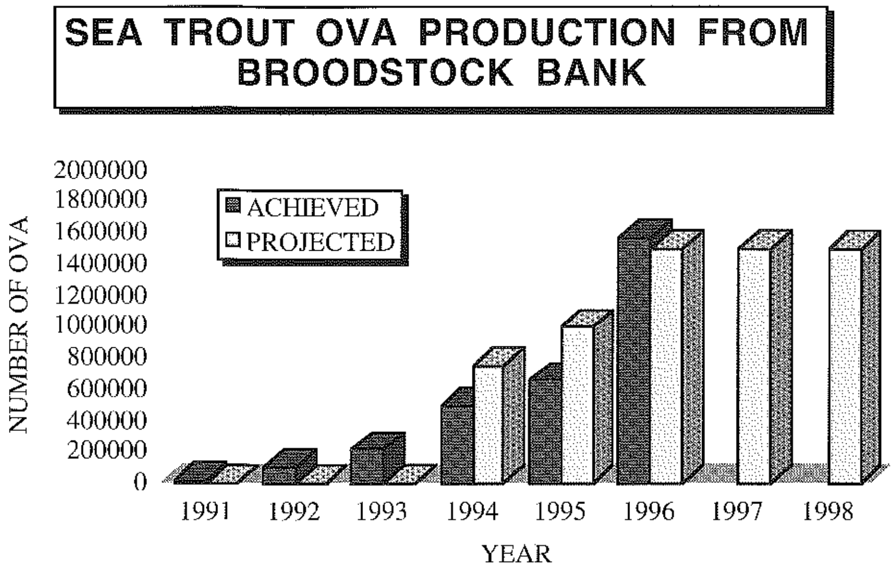
Table 3: Green ova produced from each donor stock

STOCK	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*
B'SHOOLE	17,977	99,696	138,508	157,558	110,203	594,736
ERRIFF	4,853	-	25,901	34,786	8,514	297,988
COSTELLO	-	-	37,437	234,348	317,278	403,577
CRUMLIN	-	-	-	49,168	223,419	270,224
TOTAL	22,830	99,696	201,846	475,860	659,414	1,566,525

Table 4: Stocks on Hand 1997

BURRISHOOLE	**2050**	**4+, 3+, 2+**
ERRIFF	**1000**	**3+**
COSTELLO	**1592**	**2+ to 8+**
CRUMLIN	**1287**	**3+, 1+**
TOTAL:	**5929**	

Fig. 3.



3. GENETIC STUDIES

3.1 Introduction

The three year EU AIR programme studying "*The genetic consequences of deliberate and inadvertent introductions of non-native salmon to wild stocks*" concluded in January 1996. The project brought together the expertise of fishery and molecular scientists from The Salmon Research Agency of Ireland, Queens University Belfast, University College Cork, The Scottish Office of Agriculture and Fisheries Department, the University of Oviedo Spain and the Xunta Galicia, Spain.

The initial stages of this project involved a study on a selected number of rivers in Co. Donegal which are known to occasionally receive runs of escaped farmed salmon. These studies established that farmed escaped salmon breed in the wild, with each other and with wild fish, and that the resultant juveniles survive. Consequently, the main aim of the project was to establish the relative survival and performance of these juveniles and to assess the possible impact of these non-native fish competing and interbreeding with native stocks.

3.2 Methods

A significant portion of the project was based on a control stretch of the Srahrevagh River, in the Burrishoole system, bound at the upper end by a series of impassable waterfalls and at the lower end by a unique, custom designed, trapping system. The study involved the introduction of eyed ova from four full and half-sib family groups (comprising 60 families in 1993 and 44 in 1994) of native, farmed and hybrid salmon in the controlled stretch of river. The offspring of these crosses were trapped as they migrated from the experimental stretch at all stages from fry to smolt. Further samples were obtained by electrofishing of 0+ and 1+ salmon. Muscle tissue from these salmon were subjected to DNA profiling, based on composite genotypes at seven minisatellite loci, to determine their parentage. The survival and growth of these genetically distinct stocks have been analysed and a number of publications detailing the results of experiments are currently in press. A sub set of these families were also reared in the SRAI hatchery to provide a domestically reared control population.

3.3 Results

Salmon of pure farmed origin grew faster and competitively displaced wild fish downstream, but their overall survival in the wild was 20% less than that of native Burrishoole fish. No differences in survival occurred between these groups in the hatchery control. The two hybrid groups (farmed male x wild female & wild male x farmed female) were intermediate in their growth rate between wild and farmed families, but showed a similar survival rate to that of the pure wild strain. Wild salmon showed a significantly higher rate of male parr maturation than their farmed counterparts and also showed a higher tendency for autumn pre-smolt migration. Using smolts ranched from the hatchery control it was found that salmon of farmed and hybrid parentage could survive at sea, and home successfully to their river of origin. As expected from their grilse parentage, the native salmon returned as one-sea-winter fish while many hybrids, especially those of farmed female x wild male origin returned as 2 SW salmon. Few pure farmed fish have returned, but as these were of 3 and 4 SW parentage they may yet do so in 1997 &'98.

3.4 Conclusions

Given the survival of pure farmed juveniles to smolt stage (80% of wild survival) together with the high survival of hybrid groups, a sufficient proportion of the salmon population survived to produce long term genetic changes in the native stock. Notably, such changes affect high heritability traits such as growth, sea age at maturity and male parr maturity. While some of these changes may be seen as desirable from an angling management standpoint, in specific circumstances they are likely to reduce the fitness and productivity of native salmon populations. Furthermore, as most farm stocks used in Europe are from few sources and often have reduced genetic variability, escapes of farmed salmon are likely to reduce natural inter- and intra- population variability. This will inevitably reduce the long-term adaptability of individual populations and thereby lower their survival chances when faced with environmental change.

4. ENVIRONMENTAL STUDIES

4.1 Remote Sensing

The EU-LIFE project: *The development of an automated network of water quality monitoring stations in a series of European lakes*, is on-going. To date the collection of data from the buoy moored on Lough Feeagh has proved very satisfactory. As outlined in the 1995 Annual Report the unit monitors a wide range of parameters on an on-going basis.

Two important advantages of the LIFE instrument package are its remote operation and user determined sampling interval. At present, hourly readings on all parameters are recorded by the logger on the buoy though in most cases these readings comprise sums or averages of readings taken each minute. The resulting data sets have a much greater resolution than equivalent data gathered manually. For example, detailed examination of the results from the thermister chain (which records temperature at 12 depths) has demonstrated the existence of internal waves (seiches) in the region of the thermocline which have a rather irregular periodicity. The influence of high wind events on the thermal structure of the lake can also be seen.

Interesting comparisons can also be made between the weather station on the buoy and the weather at the laboratory (about 2 km away). The maximum daily air temperature was typically up to 4°C higher at the laboratory than at the buoy whereas minimum daily air temperature was higher at the buoy by about 1°C (data for June to September 1996). These comparisons demonstrate the moderating influence of the lake on air temperature over the water surface.

Two important additions to the buoy instrumentation are scheduled for July 1997. The first is a novel 'biomass' sensor which is currently under development at the laboratories of the Institute of Freshwater Ecology

(Cumbira, UK) and is deseigned to measure algal biomass, turbidity and water colour. The second is a transmission system which will allow users to download data automatically from the buoy via a radio link and phone line. These two additions effectively complete the installation under the LIFE programme.

4.2 GIS and Catchment Management (See Appendix I)

A one year project entitled " *The Development of a Suite of Protocols and State of The Art Tools for River Catchment (Watershed) Management*" was initiated in February 1996 and concluded in February 1997. This project was essentially an enabling proposal designed to facilitate the development of a catchment management strategy which will allow for resource development without jeopardising the potential of the fishery resource.

The project has resulted in the following recommendations regarding habitat classification:

- habitat classification should be geographically referenced and encompass the full river or stream basin. It should be based on a hierarchical structure which reflects differing biotopes and habitat types
- it should include in detail all physical attributes of the watercourse, which relate to its geomorphology
- the classification should facilitate the imposition of biological indices of habitat quality onto the physical data within the GIS

The project has delivered an integrated aquatic resource management package of habitat methodology, a sophisticated habitat acquisition capability and a user friendly MIS/GIS interface.

5. SALMONID REARING

5.1 Salmon Stocks 1995

Growth and survival was good in all stocks. Stress testing was carried out in March and April and tests proved negative for *A. salmonicida* .

5.2 Ranching

The total release of microtagged smolts into L. Furnace amounted to 43,800. The mean weight of smolts at release ranged 60 - 80g.

23,600 Burrishoole grilse stock were released as three groups on 18th April and 9th May 1996. One group was vaccinated with AVL Furovac as part of an ongoing study to assess the impact of vaccination on return rates of adult salmon.

As part of the EU Triploid Programme 10,100 diploid and 10,100 triploid smolts (differentially microtagged and branded) were released on 25th April 1996. In addition 2,100 diploid and 2,200 triploid smolts were transferred to saltwater on April 12th 1996 and released from the cage site on 30th May 1996. These releases form part of the 'environmental impact' component of the EU study, aiming to elucidate the potential for return and interbreeding in diploid and triploid fish of both sexes.

5.3 Aquaculture

42,000 vaccinated salmon smolts, averaging 60 - 80g, were transferred to sea cages on 19th March 1996.

4,100 diploid and 5,600 triploid salmon smolts, averaging 50 - 55g, were transferred to saltwater on 4th April as part of the 'comparative performance' component of the EU Triploid Programme. Unfortunately, due to accidental damage to the cage, the majority of fish were lost in June. The escape will, however, provide additional information on the migratory behaviour of escapees, through the national microtagging programme. The small numbers remaining were on-grown for use in hormonal studies of diploid and triploid salmon.

5.4 Salmon Stocks 1996

Four distinct groups of fish were reared during 1996: Burrishoole stock, Scottish 2SW stock and diploid / triploid Burrishoole and all-female Scottish 2SW stocks for the EU Triploid Programme.

Growth and survival was good in all groups. Grading was carried out during August and September and one formalin treatment was administered in September to control parasites. The majority of pre-smolts destined for transfer to sea cages in 1997 were vaccinated with AVL Furovac in November. Stocks of salmon pre-smolts on hands in December 1996 were 28,300 Burrishoole ranching stocks (average weight 45 - 55g) 27,000 Scottish 2SW stock (35-45g), 24,200 EU Burrishoole stock and 32,600 EU Scottish 2SW stock.

5.5 Rainbow Trout 1996

168,500 rainbow trout fry were reared on contract between February and June. 164,000 were transferred to freshwater in June and 2,800 were stocked into Ballinlough during September and November. 1,300 were retained for stocking in 1997.

5.6 Salmon Stocks 1997 (Grilse ova laid down in 1996)

132 hens were stripped in late November and December, producing an estimated 593,000 green ova. The average fecundity value was 4,500 per hen.

Broodstock condition was good throughout the holding period. Fish were tested by the Department of the Marine in December and salmon ova certified disease free. 183 fish were cored for microtags and 70 kelts were released into L. Furnace. Ova quality and survival was good.

In association with Cong, Costello, Delphi and Parteen hatcheries the SRA co-ordinated the sale of 905,000 ova to Germany and Luxembourg for the 'Rhine 2000' Programme. Ova distribution is detailed in Table 5.

Table 5: Ova Supplies 1996 / 1997

Export Orders:

Germany	875,000 (348,000 SRA)
Luxembourg	30,000
Denmark	100,000 (SRA)

Total Export 1.005 million

SRA Home Orders: 50,000

SRA Retained: 70,000

5.7 EU Triploid Programme

The project aims to evaluate the comparative biology of diploid and triploid Atlantic salmon in terms of their performance in fresh and sea water culture, behaviour on release, product quality, potential for somatic growth, exercise physiology and disease resistance.

The Agency has been contracted by UCG to assess the comparative performance of diploids and triploids as cultured stocks and the environmental impact of triploid salmon through tagging and release studies.

First cycle experimental groups (mixed sex and all-female diploids and triploids) were established in December 1994. All fish were microtagged and branded during February 1996 and 14,000 smolts were transferred to saltwater and 20,200 smolts were released into L. Furnace.

Second cycle groups, established in December 1995, consisted of mixed sex diploid and triploid grilse stock and all-female Scottish diploid and triploid 2SW stock. Growth and survival was good in all groups during the year and similar trends in performance were noted between first and second cycle fish. Irish grilse stocks will be used for the environmental impact study and Scottish stocks to assess comparative performance in saltwater.

The second annual meeting of partners took place in September 1996 and the project is reported to be proceeding satisfactorily. To date, few differences of commercial significance have emerged in freshwater performance, but the greatest comparative differences are likely to emerge during the seawater rearing phase, particularly as the diploids mature and the triploid females do not. First returns of smolts released in 1996 are expected during 1997 and will be monitored via the National Tag Recovery Programme and from direct returns to the Burrishoole Fishery.

5.8 Smoltification Study

An M.Sc. study in the Department of Biological Sciences, D.I.T., which aims to characterise smolting in wild and reared stocks of sea trout and Atlantic salmon, continued in 1996. In addition, diploid and triploid salmon were sampled, as part of the EU triploid programme, to establish if there are differences in smolting arising from triploidisation.

Samples were taken from January to May 1996 and are undergoing analysis for Na+K+ATPase and thyroid hormones thyroxine (T4) and $3,5,3^{1}$-triiodo-L-thyronine (T3).

5.9 The Ecology of *Aeromonas salmonicida*

In association with University College Galway, this Marine Institute funded project details a systematic survey of the environment of Lough Feeagh and associated waters for the presence of the fish pathogen, *A. salmonicida*, over a two year period. The pathogen detection methods include bacteriological, immunological (ELISA) and genetical (DNA probe / PCR) techniques.

Fish and sediment samples were collected each month and following procedures prepared by all the partners, were sent to UCG for analysis. Bacteriological analysis was performed by the SRA. The future plan of research is to continue analysing samples throughout a second year to establish if patterns emerge from the data.

6. FISH CENSUS PROGRAMME

6.1 Wild Salmon and Grilse

A total of 380 wild grilse (379 grilse and 1 previously spawned grilse) were recorded moving upstream through the permanent traps during the season. The run commenced in April and was completed in November. The total run is below the 1990 - 95 average (430) and contrasts with the average run of 1,145 in 1970 - 74.

The number of spring fish recorded was 18. Although this is an increase from the previous year (15) it is still low despite the suspension of the North Atlantic high seas fisheries.

The retained rod catch of wild grilse on Lough Furnace was 29 fish. Therefore, the total wild grilse return, including the Furnace rod catch and the upstream count, was 409.

Table 6: Wild salmon and grilse

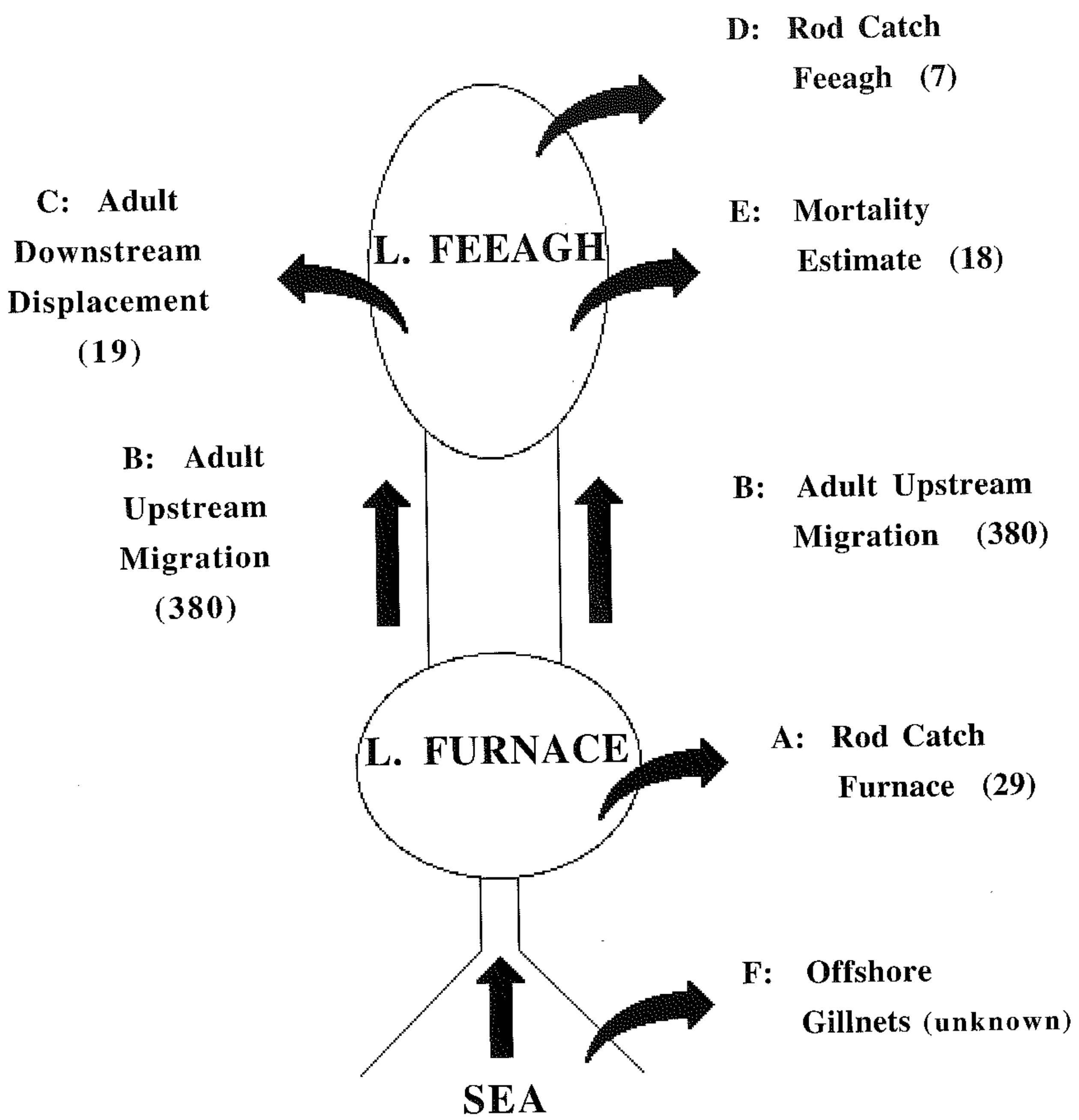
Year	Total Salmon	Total Grilse
1970-74	14	1145
1975-79	36	703
1980-84	35	449
1985-89	22	492
1990-94	16	421
1995	15	565
1996	18	409

Table 7: Wild salmon smolt run

1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
5376	3817	6354	5968	3794	6926	5429	5971	5998	6148*

* 5854 smolt released to sea.

ADULT WILD GRILSE 1996

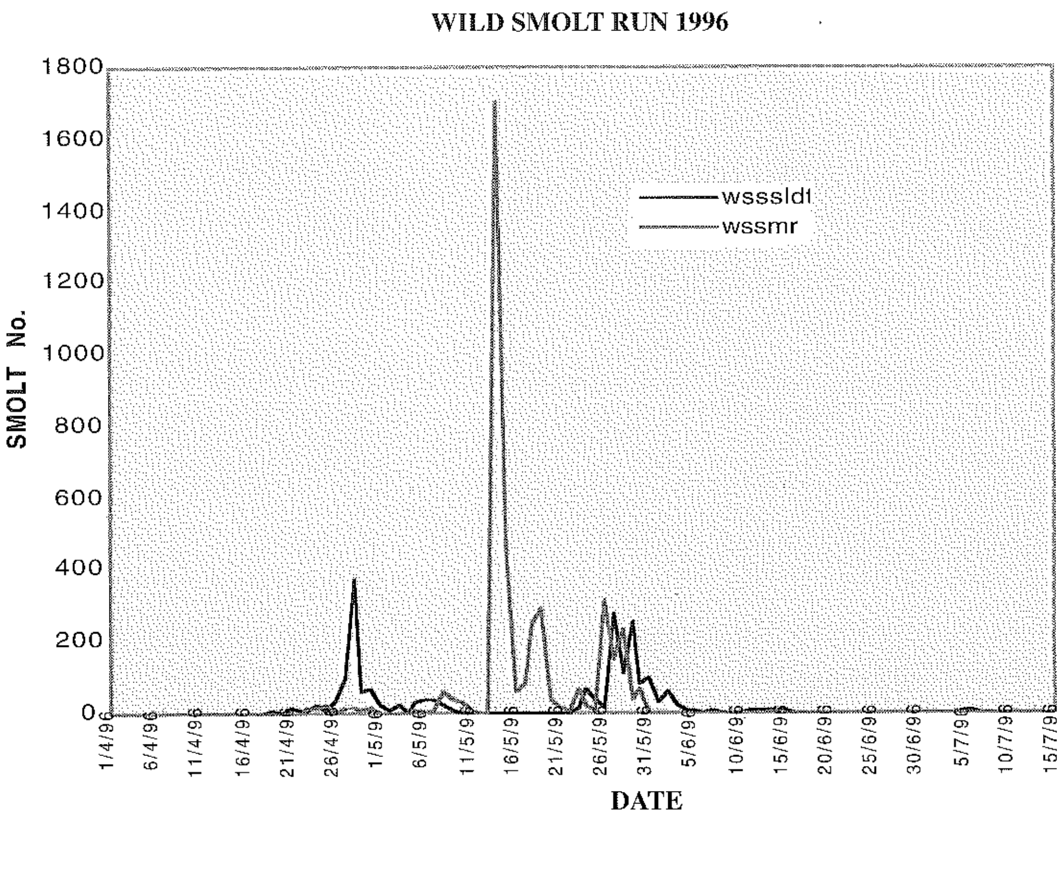


Adult survival to coast	unknown
Adult survival to Burrishoole	409
Wild grilse spawning stock	337

The wild salmon smolt run commenced on 15 April. The total number of smolts recorded moving downstream was 6148 of which 2065 were recorded in the Salmon Leap and 4083 in the Mill Race. A high level of mortalities was recorded in the traps due to low water conditions and due to the overlap of the sea trout smolt run. This appeared to have a detrimental effect on the salmon, possibly because of harassment and predation by the larger sea trout smolts. The total number of smolts released downstream was 5854. This was similar to the 1995 wild smolt run of 5998 smolts.

Water levels were generally low during the period of the smolt run. On the 14 May the weir board on the Mill Race was intermittently removed in an effort to move smolts downstream. This resulted in the downstream movement of 1703 smolts on the 14 May, (Fig. 5)

Fig. 5.



wsssldt = wild salmon smolt Salmon Leap downstream trap
wssmr = wild salmon smolt Mill Race downstream trap

6.2 Net Marked fish

The incidence of net marks on grilse returning during 1996 was low. Of the total upstream migration of salmon 4.7% reared and 5.3% wild fish were recorded with net marks.

Although some fish had bite and/or claw marks the incidence of these was much lower than recorded during 1995.

6.3 Spawning Stock

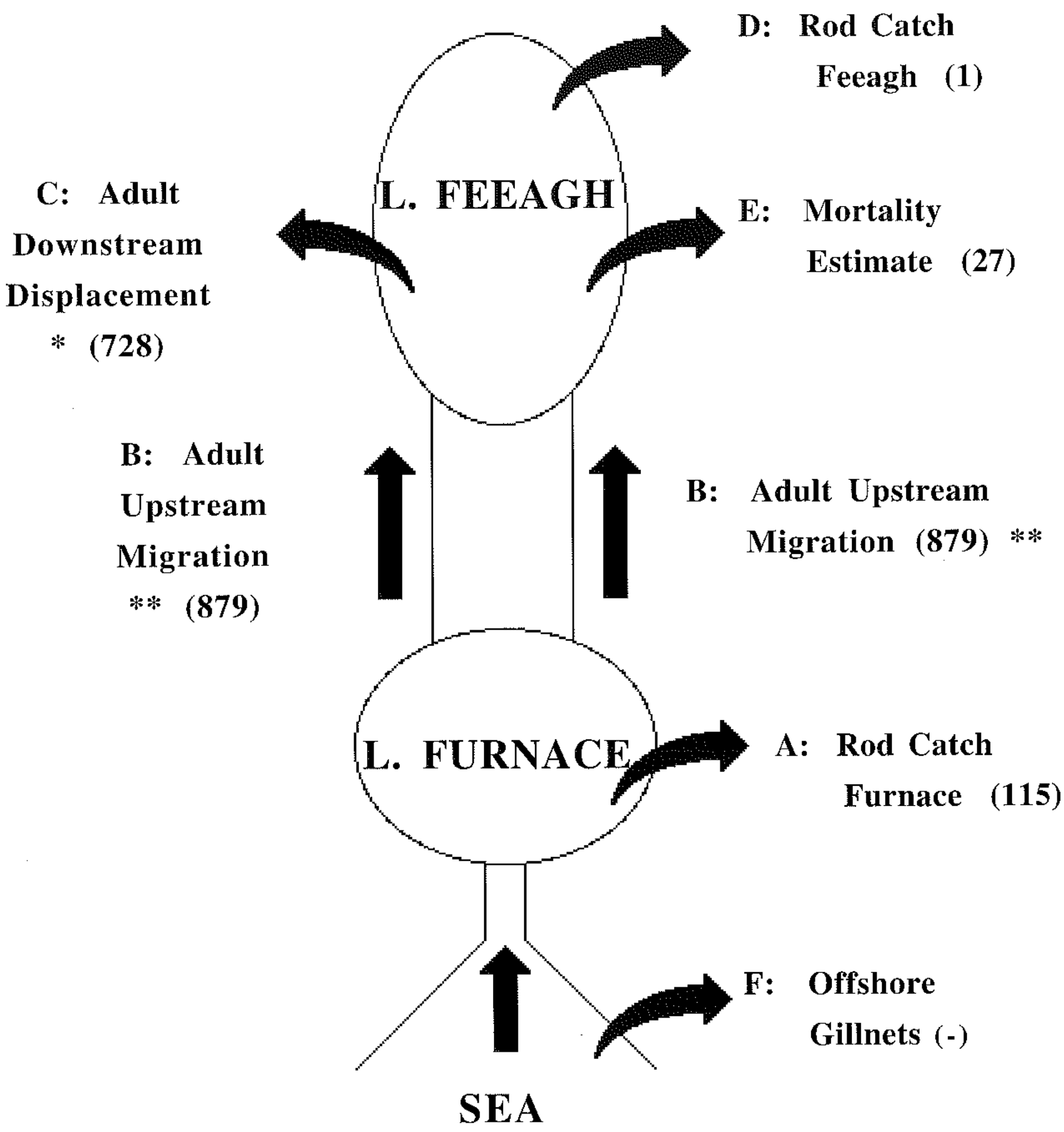
The total spawning stock in 1996 comprised 594 wild and reared salmon as against an average of 578 for the years 1990-95.

The reared component of the total spawning stock comprised 40.2% as compared to 21.7% the previous year. The increased reared proportion was a result both of a poor return of wild fish during 1996 and of the fact that the collection for broodstock was carried out after the majority of reared fish had migrated into Lough Feeagh. This delay resulted from construction work on the water supply.

Table 8: Spawning escapement 1970 - 1996

	Maximum spawning escapement	Wild fish component	Reared component
1970-74	1126	986	140
1975-79	725	683	42
1980-84	474	430	44
1985-89	662	428	232
1990-94	603	348	254
1995	478	376	102
1996	594	355	239

ADULT REARED GRILSE 1996



Adult survival to coast	3606
Adult survival to Burrishoole	994
Reared grilse spawning stock	239

* Includes broodstock & cull
** Grilse and previous spawners

6.4 Reared Salmon

Exploitation by nets if NCFM is included	81.4%[1]
Survival to coast	16.8%[1]
Survival to river	3.0%

The percentage of coastal exploitation of Burrishoole stock increased from a low of 51.6% in 1989 to 70.8% in 1992 and 84% in 1995. The exploitation level in 1996, however, decreased marginally to 81.4%.

[1] (Ó Maoiléidigh, Browne, Cullen, McDermott, Bond, McLaughlin, Rogan, ICES North Atlantic Salmon Working Group Working Paper 97/6).

The majority of recaptures in the coastal fishery during 1996 were in the Galway / Limerick area. The percentage exploitation of Burrishoole fish in the Galway / Limerick area has increased during the 1990s whereas exploitation in the Donegal area decreased.

The weight range for reared salmon was 1.8 - 4.6kg with an average weight of 2.7kg, (n = 115).

The sex ratio of reared grilse in the upstream traps was 1.3 : 1.0 (male : female).

Table 9: Total stock of reared grilse and salmon

Year	1970-74	1975-79	1980-84	1985-89	1990-94	1995	1996
	261	257	184	948	858	809	1012

6.5 Return rate of wild and reared grilse

The returning reared grilse in 1996 were derived from 32,997 Burrishoole smolts. There was a total of 994 reared grilse recorded giving a return rate of 3.0% to freshwater. This was an increase from 2.1% in 1995 and similar to the return rate of 3.4% recorded in 1994. The fact that the reared return rate has shown an increase in 1996, whereas the wild return rate decreased from 9.4% to 6.8%, would indicate that the poor condition of the wild smolts migrating in 1995 resulted in poor adult survival, whereas reared smolts released under more favourable conditions showed a good survival rate.

6.6 Ova to smolt survival

The ova to smolt survival ranged from 0.54 - 0.48. This was similar to the previous year. The survival of grilse per grilse female was 1.5, **well below the minimum level of 2 which is required to provide for a self-sustaining population.**

Table 10: Ova to smolt survival 1970 to 1992

Brood year class	% Survival rates ova to smolt	Survival rates to grilse per grilse female spawner
1970-79	0.48 - 0.62	1.4 - 1.7
1975-79	0.63 - 0.73	1.5 - 1.6
1980-84	0.61 - 0.69	1.7 - 1.9
1985-89	0.45 - 0.44	1.4 - 1.5
1990	0.54 - 0.47	2.0 - 1.8
1991	0.53 - 0.47	2.0 - 1.8
1992	0.54 - 0.48	1.3 - 1.5

6.7 Recaptures of Reared 2SW

A total of 17 reared 2SW fish were recorded in the upstream traps during 1996.

6.8 Smolt Release 1996

There was a total of 23,627 smolts of Burrishoole origin consisting three microtag groups, released during 1996. All of the smolts were released into Lough Furnace and were released as an early and normal release. Normal release is taken as the period of the main wild smolt run, reared smolts were released 22 days prior to the normal release period to determine the effects of release date on return rate.

In addition to Burrishoole smolts released at Burrishoole an additional 20,200 smolts were also released into Lough Furnace for the EU triploid programme.

Table 11: Burrishoole smolts released in 1996

Release Date	18/4/96	9/5/96	9/5/96
Release Site	Furnace	Furnace	Furnace
No. Released	7,716	7,961	7,950
Weight (g)	61.0	71.1	68.9
Length (cm)	17.6	18.5	18.1
Condition Factor	1.1	1.1	1.2
Microtag Code	18/47/58	18/47/59	18/47/60

7. WILD SEA TROUT

The sea trout research and monitoring programmes were continued in 1996.

7.1 Upstream Movements: Timing and Numbers

A total of 197 wild sea trout and a further 68 non-silvered trout migrated upstream through the traps in 1996. Of these, 81 were adults and 116 (58.9%) were finnock. This showed little change over the previous six years. The numbers are compared with other years in Table 12. Of the total run of migratory trout (265), 25.7% were non-silvered. For the purposes of this report, the non-silvered trout are not included with the sea trout. Table 12 shows clearly that the numbers of sea trout in the early 1990s have not recovered in the Burrishoole and have shown a ten-fold drop since the 1970s.

Table 12: Annual runs of sea trout recorded in the traps.

YEAR	MILL RACE	SALMON LEAP	TOTAL	Amended Total
1970-74	1365	762	2127	
1975-79	829	1775	2604	
1980-84	458	780	1238	1719 *
1985-89	386	590	978	
1990-94	134	90	242	
1985	479	976	1465	
1986	277	1110	1387	
1987	528	422	950	
1988	497	366	863	
1989	147	77	225	
1990	101	54	155	
1991	180	162	342	
1992	123	28	151	
1993	130	43	173	
1994	136	74	210	
1995	90	90	180	
1996	112	85	197	

* See Table 34, Ann. Rep. XXX (1985); p. 43.

The timing of the sea trout run in 1996 and in previous years, expressed in monthly percentages, is given in Table 13. The highest proportion of sea trout, both finnock and adults, moved upstream in July and August. This pattern was similar to the previous four years. The low water levels in August and September prevented fish from migrating, but many of these apparently migrated in October, after the angling season had closed.

Table 13: Timing of the Burrishoole sea trout run (in monthly percentages).

	1970-'79	1980-'84	1985-'89	1990-'94	1994	1995	1996
MAY	-	0.2	0.5	0.1	-	2.8	2.0
JUNE	13.1	24.6	9.4	8.4	7.6	8.9	3.1
JULY	54.4	44.9	62.2	55.0	44.3	48.3	36.5
AUGUST	15.8	10.3	18.4	16.5	20.0	1.1	35.5
SEPTEMBER	7.6	14.8	3.7	8.5	4.3	5.0	3.1
OCTOBER	6.4	3.5	4.1	7.9	10.9	27.2	15.2
NOVEMBER	2.4	1.5	1.5	2.9	10.5	6.7	3.6
DECEMBER	0.3	0.2	0.2	0.7	2.4	-	1.0

Figure 6 shows the length distributions for the 1990 to 1996 upstream migrating sea trout. There was little increase in the number of finnock in 1996 and a slight drop in the 1 sea-winter and subsequent age groups. Once again, little improvement in the structure of the Burrishoole sea trout stock was evident in 1996.

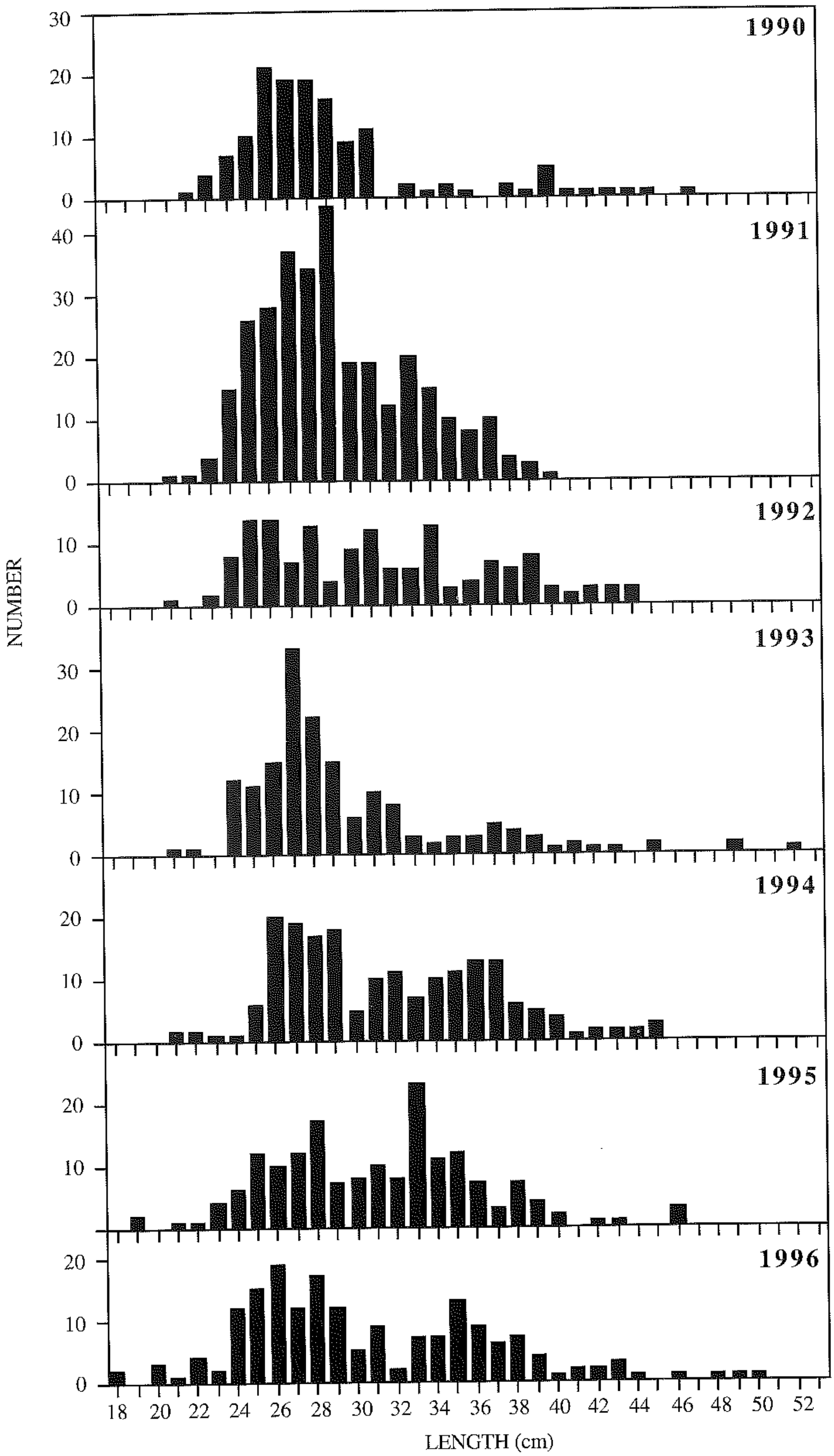


Fig. 6. Length frequency distributions for the upstream migrating silvered trout for 1990 to 1996.

7.2 Spawning Escapement

With the continuation of the catch and release bye-law into the 1996 fishing season, no sea trout were killed on L. Feeagh in 1996. Using the upstream fish counts through the traps, the total maximum spawning escapement of migratory trout to the L. Feeagh catchment was 265, of which 68 were non-silvered sea trout. The total spawning stock consisted of 43.8% finnock. In normal finnock populations, only some 20% to 30% mature and their overall contribution to egg deposition is minimal. It is the one and two sea year maiden sea trout that contribute the bulk of the ova to a sea trout catchment. In the case of the Burrishoole, it has been calculated that 1+ sea winter maidens contribute 31% of the overall ova deposited.

Table 14: Annual spawning escapement of migratory trout into freshwater.

	1970-'79	1980-'84	1985-'89	1990-'94	1994	1995	1996
Max. Escap,	2090	1146	906	231	276	249	265
Revised		1622					

7.3 Reared Adults

NUMBER

This was the third year that a return of finnock occurred derived from the sea trout rearing programme. A total return of 103 tagged or marked trout was recorded in the upstream traps in 1996. Some 49% of the reared fish were returning as 0+ sea age finnock from the reared smolt run. A further 15% were 'one year sea age' derived from the 1995 smolt migration, 2% older trout and 34% were unsilvered trout.

LENGTH

Figure 7 shows the length distribution for the reared sea trout returning to the upstream traps in 1996. These ranged in length from 19.1 cm to 43 cm. There was a mode of 26 cm for the finnock and a length range from 19.1 cm to about 30.0 cm.

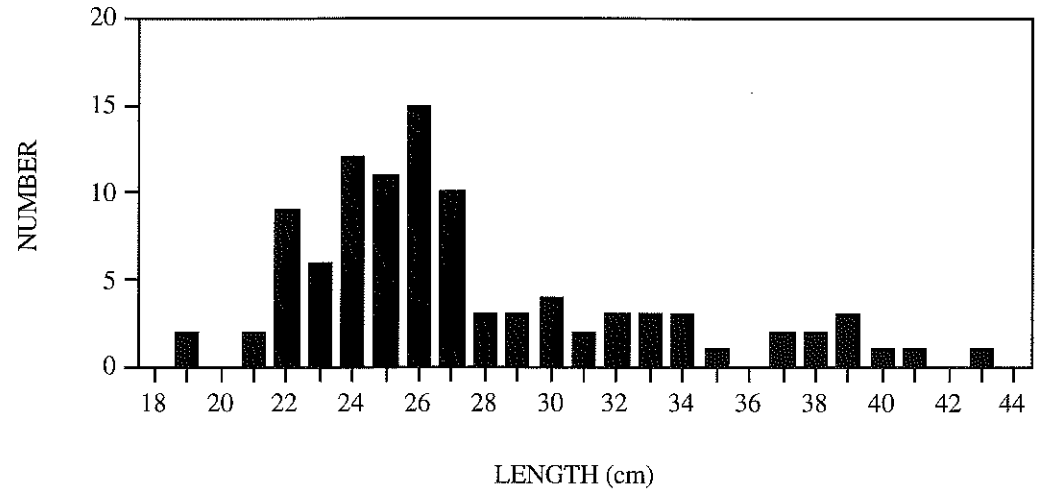


Fig. 7. Length frequency distribution for reared sea trout returning in 1996 (n=100).

7.4 Downstream Movements, Sea Trout Smolts

Table 15: Monthly numbers of Burrishoole sea trout smolts recorded through the traps.

	Salmon Leap	Mill Race	Total	%
January	1	0	1	0.1
February	15	2	17	1.3
March	28	0	28	2.2
April	660	58	718	55.2
May	354	73	427	32.8
June	103	1	104	8.0
July	2	0	2	0.2
August	2	1	3	0.2
Total	1165	135	1300	
Number Released			1279	

The 1996 smolt run amounted to 1300 wild smolts, of which 1279 were released to the wild. This was a decrease of some 500 smolts on 1995 and was similar to that of 1994 (Table 16).

The main smolt run in 1996 occurred in two main peaks related to increases in water level.

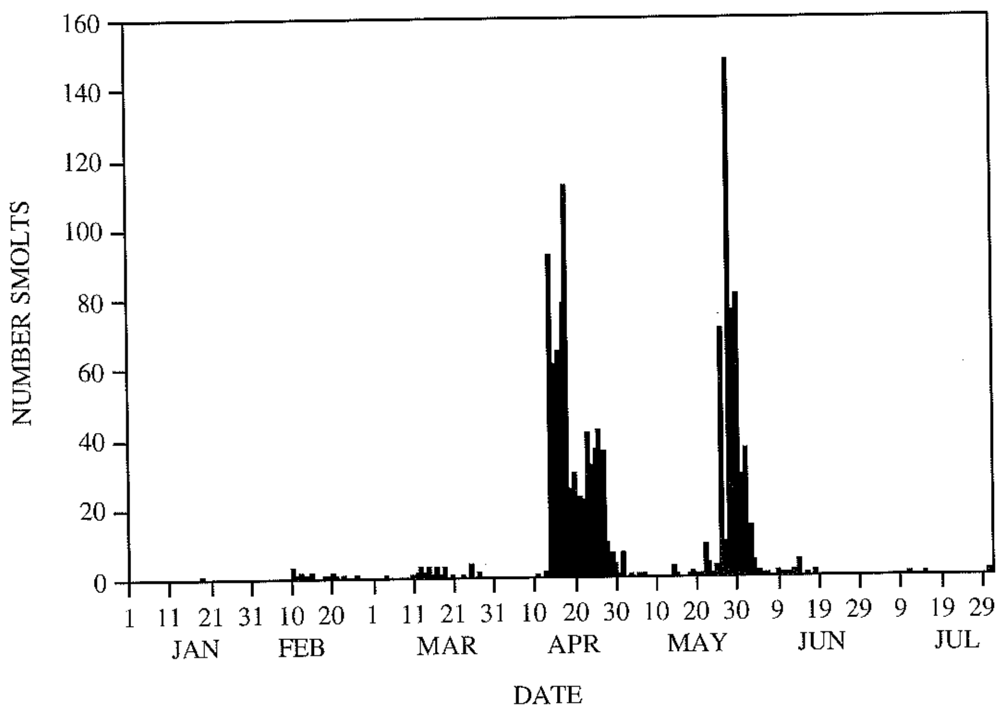


Fig. 8. Timing of the Burrishoole 1996 wild smolt migration.

Table 16: Annual wild sea trout smolt numbers in Burrishoole for 1970 to 1996.

	1970-79	1980-84	1985-89	1990	1991	1992	1993	1994	1995	1996
Number	4176	4038	4119	2063	2530	1936	1720	1127	1821	1300

LENGTH

The length distribution for the 1996 wild sea trout smolts is given in Figure 9. The wild smolts had an average length of 21.9 cm a range of 15.7 cm to 30.8 cm, with a modal length of 22 cm. The 1996 mean smolt length was significantly longer (P=0.0001) than that of 1995. This was probably due to an increase in three year old smolts derived from the stocking of fry into L. Feeagh in 1993.

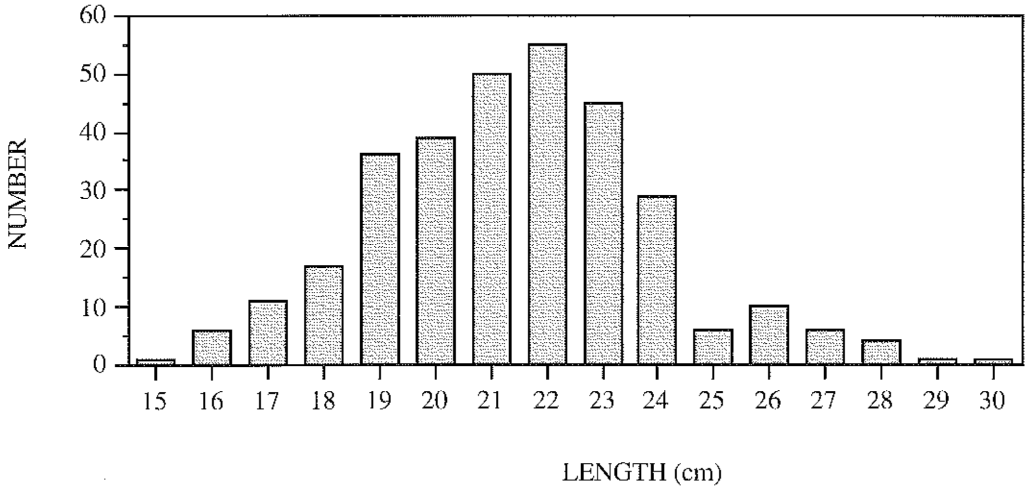


Fig. 9. Length distribution for smolts in the Burrishoole system, 1996 (n=317).

7.5 Reared Smolts

NUMBER

Sea trout parr have now been stocked into L. Feeagh, as 0+ autumn parr and 1+ spring parr, since 1993 (Table 17). These fish are the progeny of the reconditioned broodstock collected from the catchment in 1991 and 1992. To date, eight such stockings have taken place. Predominantly two and three year old smolts, derived from these stocked parr, have been counted through the traps since spring 1994 (Table 18).

A total of 2751 smolts from released parr were counted through the traps in 1996; 2705 of these were released downstream. All reared smolts were measured and identified where possible using elastomer marks and micro-tags.

Of the parr released in 1993 and 1994, a total smolting rate of 11.0% was achieved (Table 18). This included four year classes of smolts from stockings carried out at three different times of the year. As these fish were micro-tagged it was not possible to separate the different age classes making up the separate annual runs of smolts. Of the 1994/'95 releases of elastomer marked fish, a total smolting rate as 1+ and 2+ year old smolts of 12.9% was recorded; additional three year old smolts are expected in 1997.

Table 17: Details of sea trout progeny released in the Burrishoole catchment.

Release Date	Number Released	Age	Tag	Details
Spring 1993	6463	1+	M. Tag	L. Feeagh Release
Autumn 1993	3089	0+	M. Tag	L. Feeagh Release
Spring 1994	8609	1+	M. Tag	L. Feeagh Release
Spring 1994	982	1+	M. Tag /Caudal PJ	L. Avoher Release
Autumn 1994	7114	0+	Elastomer L. Eye Yellow	L. Feeagh Release Large Grade
Spring 1995	8234	1+	Elastomer R. Eye Yellow	L. Feeagh Release All-Female Progeny
Spring 1995	8566	1+	Elastomer L. Eye Red	L. Feeagh Release Medium/Large Grade
Spring 1996	4705	1+	Elastomer R. Eye Red	L. Feeagh Release

M. Tag = Micro Tag PJ = Panjet L. Eye = Left Eye R. Eye = Right Eye

Table 18: Number and age of parr released, number of smolts counted each year and smolting rate (%). Age class of smolt given in italics. Estimated number of additional unmarked (tag loss) fish are included in parentheses.

Release Date	Number	Age	Mark	Number Counted as Smolts 1993	1994	1995	1996	% Smolting[1]
				1+	*2+*	*3+*	*4+*	
Spring 1993	6,463	1+	M. Tag	202	893	-[2]	-[2]	16.9%
					1+	*2+*	*3+*	
Aut. 1993	3,089	0+	M. Tag	-	4			
Spring 1994	8,609	1+	M. Tag	-	15	683	171	
Spring 1994	982	1+	Caudal	-	0	14	1	1.5%
Total '93/'94[3]	19,143			202	908	697 (91)	172 (29)	11.0%
						1+	*2+*	
Aut. 1994	7,114	0+	L. Y.	-	-	98 (3)	588 (97)	11.0%
Spring 1995	8,234	1+	R. Y.	-	-	373 (12)	692 (115)	14.5%
Spring 1995	8,566	1+	L. R.	-	-	178 (6)	799 (132)	13.0%
Total '94/'95[3]	23,914					649 (21)	2079 (344)	12.9%
							1+	
Spring 1996	4705	1+	R. R.	-	-	-	110 (18)	2.7%

[1] Not including autumn parr migrants
[2] Included in '93/'94 data
[3] Includes estimate of tag loss fish

M. Tag = Micro Tag
L. Y. = Left Yellow Elastomer
R. Y. = Right Yellow Elastomer
R.R. = Right Red Elastomer

The reared smolts migrated downstream in a series of peaks, with two major peaks of migration in mid-April and late May (Fig. 10). This pattern was identical to that observed for the wild smolts.

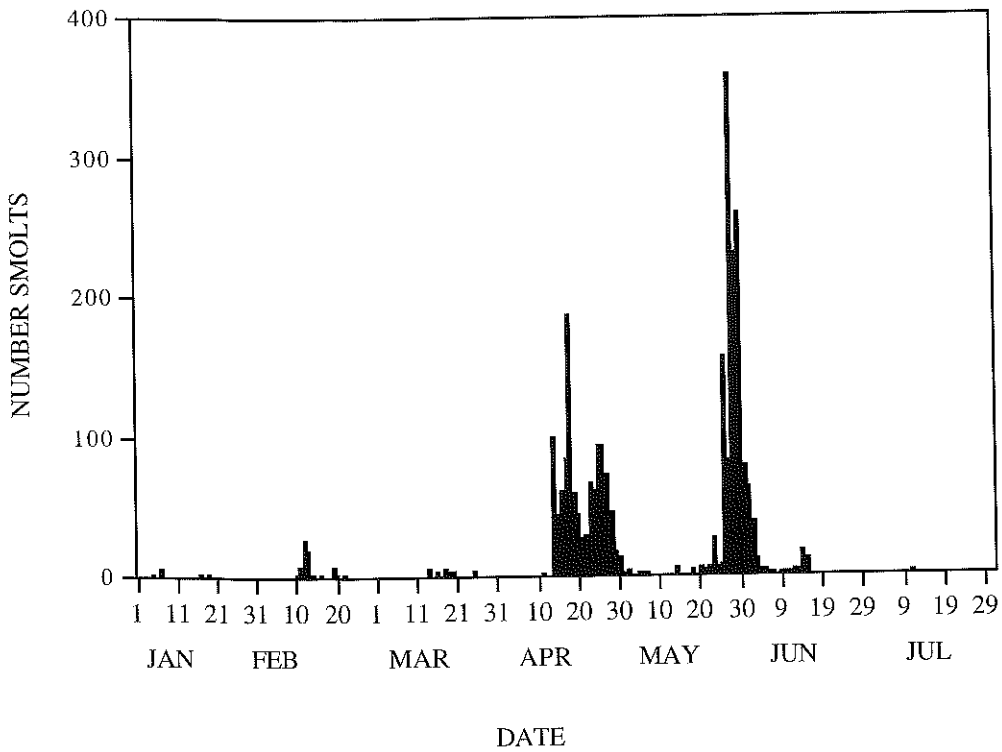


Fig. 10. Timing of the Burrishoole 1996 reared smolt migration.

LENGTH

The length distribution for the 1996 reared sea trout smolts is given in Figure 11. The reared smolts had an average length of 21.9 cm (n = 2751) a range of 13.6 cm to 32.9 cm, and a modal length of 21 cm. The mean and modal length of the reared smolts are similar to those for the wild smolts.

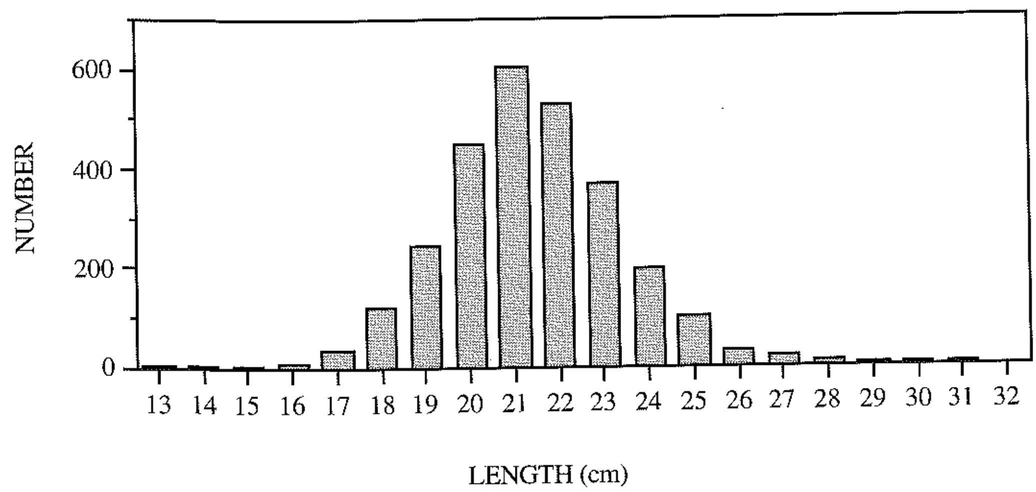


Fig. 11. Length distribution for reared smolts in the Burrishoole system, 1996 (n=2751).

7.6 Autumn Migrating Smolts

These are juvenile trout (*Salmo trutta* L.) which generally move downstream through the traps from August to December. It is not clear whether these are true sea trout or part of the resident trout stock, should a difference exist.

A total of 777 trout entered the traps between August and December 1996 (Table 19). The percentage of 0+ trout that migrated in 1996 from the beginning of August to the end of December was 34.0% (Table 20). It is not known exactly what proportion of the 0+ trout are trapped because the downstream trap grids are not so fine as to prevent some from escaping.

Table 19: Numbers of migrating autumn juvenile trout in the Burrishoole fish traps, to the end of December 1996.

	Salmon Leap		Mill Race		Total	
	0+	1+	0+	1+	0+	1+
August	3	3	2	3	5	6
September	4	15	0	1	4	16
October	197	334	2	5	199	339
November	16	76	15	15	31	91
December	23	55	2	6	25	61
Total	243	483	21	30	264	513
Overall Total						777

Table 20: Percentage of 0+ juvenile trout amongst trapped autumn migrating trout.

1982	50.0
1983	N/A
1984	55.8
1985	30.3
1986	16.1
1987	35.3
1988	60.9
1989	37.2
1990	35.2
1991	26.0
1992	38.2
1993	27.6
1994	16.8
1995	25.3
1996	34.0

7.7 Total Recruitment

The 0+ autumn trout will not be large enough to become sea trout smolts in the following spring. The remainder, predominantly 1+ years old, could contribute to the overall recruitment of sea-run trout the following year. The exact proportion of 1+ autumn trout that become smolts in any given year is not known.

It is only since 1982 that the proportion of 0+ trout amongst the autumn migration has been estimated. Thus, the figures for total recruitment up to this time are over-estimated (Table 21).

Table 27: Estimates of total migrant trout recruitment up to 1981.

YEAR	SMOLT TOTAL	AUTUMN TROUT (preceding year)	TOTAL RECRUITMENT
1970-74	4450	2870	6746
1975-79	4314	3186	7489
1980	2337	2351	4688
1981	6710	2631	9341

From 1982, total recruitment was calculated by adding the number of sea trout smolts produced in any one year to the total of 1+ autumn trout the previous year (Table 22). The assumption is made that all the 1+ autumn trout will become sea trout smolts and that no 0+ trout from the two years previous will be recruited as smolts.

Table 22: Estimates of total migrant trout recruitment from 1982.

YEAR	SMOLT TOTAL	AUTUMN TROUT 1+ & Older (preceding year)	TOTAL RECRUITMENT
1982	3907	1300*	5207*
1983	4852	1109	5961
1984	2383	1200*	3583*
1985	4238	611	4894
1986	3454	1472	4926
1987	3371	1726	5097
1988	4290	949	5239
1989	3179	556	3735
1990	2022	634*	2656*
1991	2137	636	2773
1992	1936	234	2170
1993	1720	183	1903
1994	1127	306	1433
1995	1821	282	2103
1996	1300	336	1636

* estimated

7.8 Marine Survival

WILD

An estimate of sea trout survival to first return to freshwater can be more accurately calculated by the use of trap census data rather than rod catch returns of tagged or marked fish. Small numbers of stray fish are captured in other systems and it is not known whether these fish would have returned to their natal systems to spawn. Finnock are known to wander between river systems and are therefore not as reliable for assessing survival.

The pattern of marine survival found is similar whether the number of smolts is used or the combined total recruitment of smolts and autumn 1+ trout. The percentage of smolts that return as finnock in the same year historically ranged from 11.4% to 32.4% (Fig. 12). In 1988 it fell below the previous recorded minimum to 8.5% and in 1989 to a minimum of 1.5%. Subsequently, there have been increases in 1990, 1991, 1993 and 1994. However, in 1992, the survival fell to 3.7% and in 1995 it also fell to 4.8%. In 1996 the percentage return as finnock rose to 9.1% from 4.8% in 1995.

The total survival of smolts to the first return to freshwater as finnock, in the same year and one year old sea trout in the following year (always an over-estimate as a proportion of finnock re-entering freshwater in year 1 return as sea trout in year 2 (Mills et al, 1990)) also shows a drop in survival from 1987 to 1989 (Fig. 12).

Historically, the total survival to first return ranged from 19% to 66%. This collapsed to 1.8% in 1989 but rose to 12.1% in 1990. However, little further improvement was recorded in 1991 (12.8%). Marine survival fell to the second lowest level in 1992 but returned to 13.1% for the 1993 year class of smolts. There was a further increase in 1994 to 18.2% but a drop in 1995 to 8.1%.

REARED TROUT

Percent return and marine survival data for the reared trout are given only for smolt to finnock and one sea winter returns. The data including autumn downstream migrants and upstream unsilvered trout are not included in the analysis.

Of the 897 reared two year old smolts which migrated downstream in the spring of 1994, 69 returned to the traps between June and November of that year as finnock and a further 30 returned in 1995 as one sea winter fish. This gives a percent return as finnock of 7.7% and a total survival of 11.0% - lower than the 18.2% total survival (finnock and 1SW) for the wild smolts.

Of the estimated 762 reared two and three year old micro-tagged smolts which migrated downstream in the spring of 1995, 15 returned to the traps between June and November of that year. This gives a percent return of 2.0% - lower than the 4.8% return for the wild smolts. A further 14 returned in 1996 as one sea winter fish giving a total marine survival of 3.8%.

Of the estimated 686 reared one-year-old elastomer marked, 'smolts' which migrated downstream in the spring of 1995, 5 returned to the traps between June and November of that year. This gives a percent return of 0.7%. No further recaptures were recorded in 1996.

Of the estimated 201 reared three and four year old micro-tagged smolts which migrated downstream in the spring of 1996, 14 returned to the traps between June and November of that year. This gives a percent return of 7.0%.

Of the estimated 2423 reared two year old, elastomer marked smolts, which migrated downstream in the spring of 1996, 61 returned to the traps between June and November of that year giving a percent return of 2.5%. None of the 110 marked one year olds returned as finnock. This poor return of one year old 'smolt' in both 1995 and 1996 confirms the difficulty, encountered in the past at the SRTI, of producing 'S1' sea trout smolts.

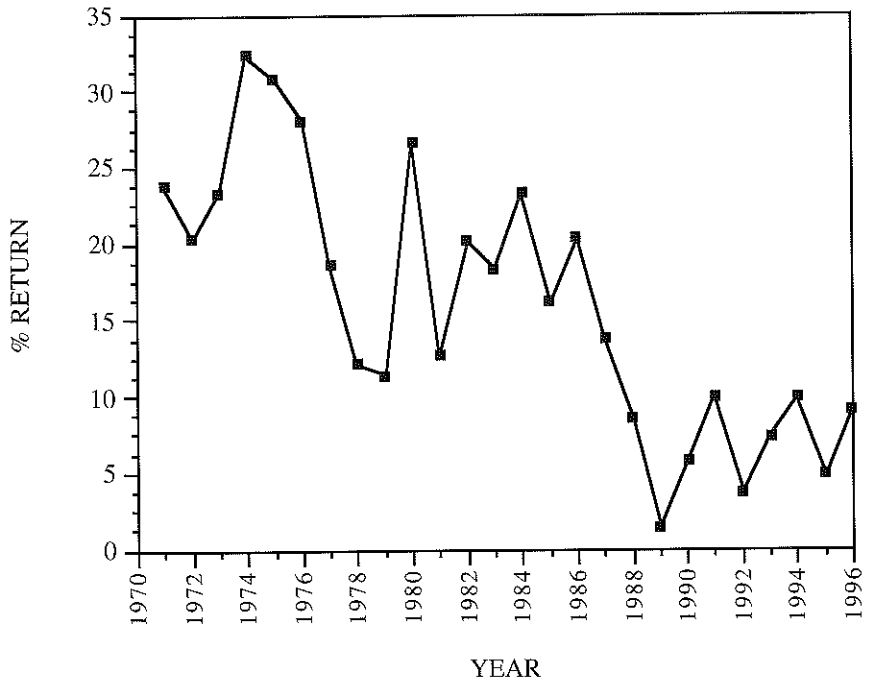


Fig. 12. Annual percentage return of smolts returning as finnock to the Burrishoole system.

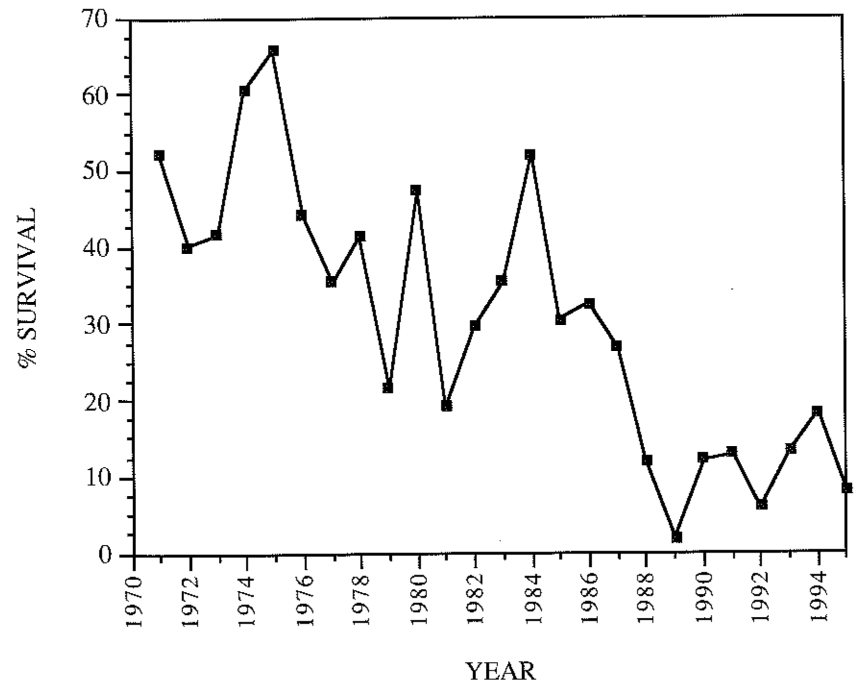


Fig. 13. Annual marine survival of smolts to first return (as finnock and 1+ sea trout) to the Burrishoole system.

Table 23: Percentage return of sea trout smolts as finnock and 1SW maidens

Year	% Survival Smolt to Finnock	% Survival Smolt to 1st Return
1971	23.78	52.35
1972	20.35	40.13
1973	23.42	41.76
1974	32.36	60.46
1975	30.78	65.77
1976	28.10	44.06
1977	18.62	35.51
1978	12.13	41.27
1979	11.40	21.46
1980	26.57	47.33
1981	12.65	18.99
1982	20.12	29.51
1983	18.30	35.47
1984	23.25	52.04
1985	16.16	30.37
1986	20.35	32.46
1987	13.76	26.73
1988	8.53	11.86
1989	1.48	1.77
1990	5.70	12.09
1991	9.97	12.82
1992	3.73	5.84
1993	7.40	13.12
1994	9.90	18.19
1995	4.79	8.10
1996	9.07	

7.9 Sea Trout Kelts

Table 24: Timing and numbers of sea trout kelts for the 1995/1996 season.

Month	Large	Small	Total
October	3	10	13
November	6	30	36
December	17	24	41
January	8	15	23
February	9	17	26
March	5	14	19
April	29	43	72
May	0	0	0
Total	77	153	230

The freshwater survival of kelts is given in Table 24. In some years, the number of kelts migrating downstream has exceeded the number of upstream migrants. This occurred in the early '80s when the screen allowed finnock to escape. This was rectified. More recently, the difficulty in separating small finnock and large smolts has led once again to a discrepancy as shown in Table 25.

Since 1987, only one survival rate has been given for all sizes as it has been shown that a proportion (at least 33%) of the sea trout population may overwinter in freshwater. These fish do not spawn and continue to grow. There is also the additional complication of larger smolts and reduced sea growth mentioned above. Thus the comparisons of the proportion of fish in different year classes between the upstream migrants of one year and the downstream migrants of the next are invalidated.

Table 25: Annual survival rate to sea trout kelt, as % of the upstream escapement of the previous year.

Year	Larger (> 30.0 cm)	Small (< 30.0 cm)
1976	79	66
1977	63	45
1978	50	66
1979	33	107*
1980	50	82
1981	44	345*
1982	53	203*
1983	63	177*
1984	74	210*
1985	70	98
1986	66	72
1987	58.7% (combined)	
1988	65.5% "	
1989	68.7% "	
1990	79.0% " *	
1991	98.7% " *	
1992	89.5% " *	
1993	96.7% " *	
1994	104.6% " *	
1995	96.2% " *	
1996	127.7% " *	

* Years when the number of finnock kelts counted downstream exceeded the number counted upstream during the previous season.

8. EEL STUDIES

8.1 Silver Eels

Silver eel trapping was continued in 1996. Few eels were trapped in July and August except on a small flood at the end of August. The main run commenced on the 27 September. The total run amounted to 2251, which was almost half the catch recorded in 1995. Water levels were satisfactory in October and November but dropped to low levels in December. The largest proportion of eels (64%) were trapped in October (Table 26).

Table 26: Timing and numbers of the 1996 silver eel run.

	Salmon Leap	Mill Race	Total	%
July	4	1	5	0.2
August	95	19	114	5.1
September	457	2	459	20.4
October	1428	17	1445	64.2
November	170	31	201	8.9
December	26	1	27	1.2
Total	2180	71	2251	

In 1996, 97% of the total catch was made in the Salmon Leap trap. The Mill Race trap was closed between the 23 September and the 17 October for re-construction work. As 75% of the total catch at the Salmon Leap was made during this period it is possible that the closure of the Mill Race may have reduced the overall catch of eels.

Sub - sampling of 1172 by batch weight gave a mean weight of 184g (Table 27).

Table 27: Comparative data for the silver eel runs since 1971

YEARS	NUMBER	AV. WT. (gm)
1971 - '75	4465	84
1976 - '80	4023	115
1981 - '85	2678	171
1986 - '90	11658	196
1986	1856	194
1987	2713	195
1988	3283	206
1989[1]	685	254
1990	3121	176
1991	266	246
1992	523	186
1993	181	260
1994	468	220
1995	2003	225
1996[2]	1172	184

1 Incomplete due to flooding

2 Incomplete due to closure of Mill Race trap for re-construction

9. FISHERY REPORT

9.1 Catch Data

9.1.1 Numbers and Average weight of Rod Catch

A total of 295 salmon were caught in the Burrishoole Fishery in 1996. The catch consisted of 119 wild fish and 176 reared fish. To conserve wild fish numbers 84 of the 119 wild fish were returned alive to the water.

A total of 125 sea trout were caught and returned 96% were rod caught on Lough Furnace.

9.2 Salmon

Due to the low return rate of wild fish during 1996 anglers were requested to return wild fish alive to the water. As a further measure to conserve wild stocks fishing on Feeagh ceased in July.

The reared fish component of the rod catch consisted of both native Burrishoole fish and returns from an experimental group of multi sea winter parentage smolts. The latter group consisted of 31% of the total reared rod catch. Some of these fish returned as two-sea-winter fish and had an average weight of 6.7kg and an average length of 85.7cm. The largest reared fish caught during 1996 was 90cm and weighed 8.6kg, a new record for the fishery.

9.3 Rod Fishing Exploitation Rates

The maximum angling success for wild fish in the Burrishoole system at 28.3% was similar to the previous year. The angling success on Lough Feeagh for wild salmon dropped from 12.8% in 1995 to 5.9% in 1996. The exploitation of reared fish on Lough Feeagh also shows a drop from 6.1% to 1.3%. Due to the closure of fishing on Lough Feeagh the exploitation rates are not directly comparable with previous years. Exploitation was calculated to the end of July rather than September as in recent years.

9.4 Angling Success

The majority of angling effort occurred on Lough Furnace (98.9%), as Lough Feeagh was only fished for a two week period during July.

Water levels were low for much of the fishing season resulting in poor fishing conditions. The overall catch per unit effort for salmon on Lough Furnace decreased from 0.35 in 1995 to 0.22 in 1996. Although the catch per unit effort on Lough Feeagh shows an increase from the previous year it is not directly comparable with previous years due to the very short fishing period on Feeagh during 1996.

The catch per unit effort for sea trout on Lough Furnace shows a decrease from 0.23 in 1995 to 0.10 in 1996. Although the numbers of sea trout recorded in the upstream traps was similar in both years the poorer fishing conditions in 1996 may account for the reduced catch per unit effort.

Table 28: Catch per unit effort (CPUE) and effort per unit catch (EPUC) for the Burrishoole Fishery

YEAR	L. FURNACE				L. FEEAGH			
	SALMON		SEA TROUT		SALMON		SEA TROUT	
	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC
80-84	0.13	9.92	0.85	1.35	0.23	4.47	0.63	2.10
85-89	0.24	4.89	0.46	5.09	0.24	4.57	0.29	70.30
90-95	0.20	6.10	0.17	16.80	0.20	5.40	0.10	14.00
96	0.22	4.40	0.10	10.50	0.83	1.20	0.30	2.90

9.5 Managed Fisheries

Catch statistics for Ballinlough show that 405 anglers visited the fishery and returned a catch of 760 rainbows and 12 brown trout. The average weight was 800g ($1^3/_4$lb) and anglers caught 2.3 fish per visit and fished on average for 4.4 hours. A total of eighteen trout over 1.8kg (4lb) were taken and many others over 1.4kg (3lb).

Unfortunately, due to unforeseen problems, it was not possible to construct the new roadway, parking area and floating jetty at Ballinlough in '96. All of the problems have now been surmounted and we hope to commence construction in spring '97.

Clogher Lough was once again little fished. However, it fished exceptionally well in April / May, with many anglers taking bags of 12 to 14 wild trout in an evening. The Clogher trout average 150g - 210g (6oz - 8oz), with many fish of 450g (1lb) or greater.

§**Table 29:** Rod Fishing Exploitation Rates (1970-1995)

	1970 -74	1975 -79	1980 -84	1985 -89	1990-94	1995	1996
WILD SALMON							
Lough Feeagh							
"Available" fish by end of fishing season	988	644	431	493	400	235*	167
Total rod catch	86	51	27	43	35	30	11
Rod catch retained	-	-	-	-	-	29	8
Angling success %[1]	-	-	-	-	-	12.8	6.6
Exploitation rate %[2]	8.7	7.9	6.6	8.1	8.8	12.3	4.8
WILD SALMON							
Loughs Feeagh & Furnace							
Total stock of wild fish	1282	802	496	548	449	475	406
+ 10% addition for L. Furnace population	1411	882	543	603	494	523	447
Total catch of wild fish	206	113	55	84	70	141	119
Rod catch retained	-	-	-	-	-	114	35
Max. angling success %	-	-	-	-	-	29.7	29.3
Min. exploitation rate	14.6	12.8	10.7	13.7	14.2	21.8	7.8
Max. exploitation rate	16.1	14.1	11.6	15.1	15.6	24.0	8.6
REARED SALMON	1970 -74	1975 -79	1980 -84	1985 -89	1990 -94	1995	1996
Lough Feeagh							
"Available" fish by end of fishing season	154	122	109	659	606	49	150*
Rod catch	4	7	5	43	25	3	1.0
Exploitation rate %	2.6	5.7	2.6	6.3	4.1	6. 1	0.7
Loughs Feeagh & Furnace							
Total stock	261	257	184	948	858	889	1032
Total rod catch	32	28	24	117	108	185	176
Exploitation rate %	12.3	10.9	12.7	12.1	12.6	20.8	17.1
WILD SEA TROUT							
Lough Feeagh							
"Available" fish by end of fishing season	1983	2518	1193	919	196	108	82*
Rod catch	318	210	78	74	31	6	5
Exploitation rate %	16.0	8.3	6.8	6.4	15.8	5.6	6.1

1 % Angling Success - % of the rod catch.

2 % Exploitation - % of the retained catch

* Angling on Feeagh for two weeks only in July

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GLOSSARY

Allele: One of two or more alternative forms of a gene, each possessing a unique nucleotide sequence.

Allozymes: Alternative enzyme forms encoded by different alleles at the same gene locus.

Alevin: First free-swimming stage after hatching from the egg, having a yolk-sac which contains food supply for the first few weeks.

Aquaculture: The culture or husbandry of aquatic fauna other than in research, in hobby aquaria, or in governmental enhancement activities.

Commercial ranching: The release of a fish species from a culture facility to range freely in the ocean for harvest and for profit.

Competition: Demand by two or more organisms or kinds of organisms at the same time for some environmental resource in excess of the available supply.

Condition Factor: The relationship between length and weight of fish, giving a measure of fatness. Values above unity (1.00) reflect increased fatness.

Containment: Characteristics of a facility which has an approved design which minimizes operator error to cause escape of fish, or unauthorized persons to release contained fish.

C.P.U.E. Catch per unit of effort - e.g. fish per rod day or netting hour.

Diversity: All of the variations in an individual population or species.

Enhancement: The enlargement or increase in number of individuals in a population by providing access to more or improved habitats or by using fish culture facility production capability.

Eyed ova: Eggs with embryo inside egg shell, having visible eye pigment.

Exotic: See introduced species.

Finnock: Sea trout which return to freshwater in the same year as they left as smolts.

Fish culture facility: Any fish culture station, hatchery, rearing pond, net pen, or container holding, rearing, or releasing salmonids.

Fry: Free-swimming stage after yolk-sac has been used up.

Furunculosis: Bacterial disease of salmonid fish.

Gamete: Mature germ cell (sperm or egg) possessing a haploid chromosome set and capable of formation of a new individual by fusion with another gamete.

Genetics: A branch of biology that deals with the heredity and variation of organisms and with the mechanisms by which these are effected.

GIS: Geographical Informations Systems (GIS) are interactive computer mapping and database systems which support the creation, storage, analysis and mapping of environmental information. Sources of information include terrain detail, hydrology, water quality, landuse, habitats, geology and other geographically distributed phenomena. Within a GIS, data on different themes are stored as different layers and integrated with each other in a variety of manners to reveal where particular situations occur.

Grilse: Salmon which spends only one winter in the sea before returning to freshwater.

Imprinting: The process in which the distinctive odour of the natal river is learned by the salmon smolt, enabling specific homing as an adult.

Indigenous: Existing and having originated naturally in a particular region or environment.

Introduced species: Any finfish species intentionally or accidentally transported or released by man into an environment outside its native or natural range.

Isolation: Means restricted movement of fish and fish pathogens within a facility by means of physical barriers, on-site sanitary procedures and separate water supply and drain systems and cultural equipment.

Kelt: Adult salmon which has spawned, recovered (mended) and is migrating out to sea.

Mariculture: Aquaculture in sea water.

Microtag: Microscopic particle of binary-coded wire, injected into the nasal cartilage of smolts. The particle is magnetised for later detection.

MIS: Management Information Systems (See GIS above)

Native: See non-indigenous

NCFM: Non-catch Fishing Mortality: an estimate of illegal and/or unreported catch, in and out of the fishing season.

Niche: A site or habitat supplying the sum of the physical and biotic life-controlling factors necessary for the successful existence of a finfish in a given habitat.

Non-indigenous: Not originating or occurring naturally in a particular environment; introduced outside its native or natural range.

Novel: See non-indigenous.

Osmoregulation: Control of osmotic pressure within an organism so as to guarantee that body fluids are neither too dilute or concentrated.

Ova: eggs.

Panjet: Instrument which uses compressed air to inject substances subcutaneously.

Parr: Juvenile salmon before smolt transformation.

Population: A group of organisms of a species occupying a specific geographic area.

Raising factor: The figure by which the recorded return of microtags has to be multiplied, to estimate the actual numbers of microtagged fish in the total catch.

Ranching: See commercial ranching

Rehabilitation: The rebuilding of a diminished population of a finfish species, using a remnant reproducing nucleus, toward the level that its environment is now capable of supporting.

Restoration: The re-establishment of a finfish species in waters occupied in historical times.

Salmonid: All species and hybrids of the Family Salmonidae.

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.

S1 and S2 smolts: One-year-old and two-years-old smolts, respectively.

Species: A group of interbreeding natural populations that are reproductively isolated from other groups.

Stock: Population of organisms sharing a common gene pool which is sufficiently discrete to warrant consideration as a self-perpetuating system which can be managed.

Strain: A group of individuals with a common ancestry that exhibits genetic, physiological, or morphological differences from other groups as a result of husbandry practices.

Transfer: The deliberate or accidental movement of a species between waters within its native or natural geographic range, usually with the result that a viable population results in the new locations.

Transferred species: Any finfish intentionally or accidentally transported and released within its native or natural geographic range.

Triploid: A sterile fish having three sets of chromosomes instead of the normal two.

UDN: Ulcerative Dermal Necrosis - skin condition and ulceration of adult salmon, often leading to death.

APPENDIX I

GIS AND CATCHMENT MANAGEMENT

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Introduction

A one year project entitled " *The Development of a Suite of Protocols and State of The Art Tools for River Catchment (Watershed) Management*" was initiated in February 1996 and concluded in February 1997. The project was funded under contract IR.95.MR.023 of the Marine Research Measure (Operational Programme for Fisheries 1994 - 1999), administered by the Marine Institute, and part funded by the European Union's Regional Development Fund.

This project was essentially an enabling proposal designed to facilitate the development of a catchment management strategy which will allow for resource development without jeopardising the potential of the fishery resource.

Background

A central problem in the sustainable development of freshwater fisheries is the absence of tools and strategies to identify and manage the principle threats which affect individual watershed systems.

The aim of this project was to develop a suite of protocols (guidelines) and state of the art tools for fishery managers and those responsible for catchment resource management and development. Such protocols and tools will be particularly relevant to those responsible for the implementation of the National Development Plan (1994 - 1999) as it relates to angling tourism, the findings of the Salmon Task Force and the EU Habitats Directive.

Protocols include the elaboration of guidelines for the acquisition of habitat information (including the use of the Global Positioning System to record for accurate location, use of digital photographic imagery techniques for storing data, etc.); the evaluation of criteria for risk assessment and the inclusion of these in a management information system (MIS) incorporating a Geographic Information System (GIS) mapping and analytical facility.

The project made use of the Newport and Burrishoole fisheries (Co. Mayo) as its source of data as (i) many data on these fisheries are readily available and (ii) a broad range of the catchment management issues to be addressed are evident in these catchments (iii) they represented a manageable scale for prototype development. The resultant GIS/MIS package is generic in nature and provides a model for demonstration and use in other river catchments.

Objectives

To develop suitable protocols / tools for habitat information acquisition and criteria for risk assessment to ensure the sustainable development of river catchments and their fisheries.

To provide a user friendly and low cost Management Information System (MIS), incorporating Geographical Information System (GIS) mapping and analytical facility, which can be used by fishery managers for resource management and development.

To enhance the performance of the State Sector Agencies (CFB/RFB's/FRC/EPA/SRAI) in the management and development of freshwater fishery resources by facilitating its access to state of the art MIS/ GIS technology.

Methodology

The project was undertaken and objectives achieved through a series of tasks or Work Packages

- Review of literature and international best practice including visits to the United States, Canada and the UK.
- Evaluation of aquatic habitat inventory methodology
- Technical evaluation and installation of appropriate GPS technology
- Application of aquatic habitat inventory techniques to the Burrishoole and Newport River catchments
- Capture of existing datasets in GIS format
- Quantification of the fishery asset
- Identification and evaluation of risk assessment criteria
- Development of a user friendly MIS/GIS interface including input from local steering group

Results

The project has resulted in the following recommendations regarding habitat classification:

- habitat classification should be geographically - referenced and encompass the full river or stream basin. It should be based on a hierarchical structure which reflects differing biotopes and habitat types
- it should include in detail all physical attributes of the watercourse, which relate to its geomorphology
- the classification should facilitate the imposition of biological indices of habitat quality onto the physical data within the GIS

Remote sensing, using aerial photography and orthophotographic (a form of sophisticated aerial photography) maps, can be used in conjunction with proximate habitat analysis or as a preliminary survey technique. Bankfull width and flood plain extent should also be delineated.

The global positioning system used in the project provides a powerful mapping and geo-referencing capability. The quality of the data collected has surpassed all expectations. The MIS/GIS system has been successfully interrogated to yield valuable analysis of a wide range of factors which limit salmonid productivity in the Burrishoole and Newport River catchments eg overgrazing, afforestation, stream bank erosion.

The project has delivered an integrated aquatic resource management package of habitat methodology, a sophisticated habitat acquisition capability and a user friendly MIS/GIS interface. The aquatic habitat inventory methodology and the technological protocols are described and referenced in a comprehensive Procedures Manual under the headings - Survey strategy; Creating a Data Dictionary; Aquatic Habitat Inventory Methods; Downloading GPS Rover Files Onto P-Finder©; Correcting Rover Files and Incorporating Rover Files Onto GIS.

Developing partnership

The close working partnership between the partners has ensured the transfer of state-of-the-art technology from the third level sector partner (NRDC) to the State sector (SRAI). The SRAI has now an established MIS / GIS for fishery resource management. This will form the basis for further development and implementation of management techniques in conjunction with other agencies responsible for fishery and / or river management. It will also provide a framework for the broad scale promotion and dissemination of sustainable management strategies through the organisation of seminars, workshops and training courses.

To ensure that protocols and tools developed during the project were appropriate and usable, a Steering Committee, representing a cross section of interested parties, was set up to liaise with and advise the main project team. Organisations represented on the steering committee included: Mayo County Council; the Central and Regional Fisheries Boards; Angling Groups; Fishery Owners; the Environmental Protection Agency; Irish Farmers Association; Coillte; Newport Development Association and Teagasc.

APPENDIX II

HYBRIDISATION BETWEEN ATLANTIC SALMON AND BROWN TROUT

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SUMMARY

The rapid growth in aquaculture of Atlantic salmon (*Salmo salar*) in north-western Europe since the 1970's has given rise to concerns regarding the biological consequences of fish farm escapes on wild salmonid stocks. Recent studies in western Scotland indicate that inter-hybridisation between escaped farmed female salmon and brown trout (*S. trutta)* occurs more frequently than in pure wild stocks.

The aim of this project was to quantify and understand more fully the effects of hybridisation between Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta)* particularly as it relates to escapees from the aquaculture industry.

A major component of the Hybrid programme involved an investigation into the parental structure of salmon redds formed by wild and by ranched grilse. Genetic analysis of eyed ova and alevins taken from wild salmon redds in the upper Burrishoole catchment and from ranched redds located in prepared gravel beds at the Salmon Leap and Mill Race traps showed no difference in the numbers of precocious parr participating in spawning events (3-5 parr per redd). However, fertilisation by precocious parr accounted for a mean of 56.8% of the ova examined from ranched redds, significantly higher than recorded for redds of wild salmon (Annual Report, 1995). Further trials carried out in 1996, confirmed a significantly higher rate of fertilisation for precocious parr within ranched redds, although the difference between wild and ranched redds was less marked.

Spring 1996 also saw the culmination of the first extensive survey of the frequency of salmon-trout F1 hybrids in Ireland. In this study a combination of genetic and carotenoid pigment analysis was used to test the hypothesis that offspring of escaped farmed female Atlantic salmon contain higher frequencies of salmon-trout F1 hybrids than the progeny of wild salmon. Canthaxanthin, an artificial flesh colourant which is still used widely in commercial salmon feed in Ireland, provided a discriminatory marker for the determination of fry derived from farmed female salmon.

Recently emerged salmonid fry were collected from April to June 1994 and 1995 by electrofishing of several spawning sites within 11 western Ireland rivers situated near commercial salmon rearing sites. A total of 3,698 unsorted salmonid fry were collected and analysed using allozyme and DNA analysis. Hybrid and pure-species groups were determined using species-specific variation at the glucosphosphate isomerase enzyme loci *GPi-1,2** and *Gpi-3**.

47 salmon-trout F1 hybrids were identified from 3,698 salmonid fry analysed (1.3%). Hybrid fry were present in 7 of the 11 catchments examined with overall frequencies ranging from 0.7% to 3.1%. Rivers sampled in both 1995 and 1996 showed a decrease in the frequency of hybrids between the two years. Mitochondrial DNA analysis identified salmon as the maternal species in all cases.

Detailed mini-satellite DNA analysis was carried out on samples from the Crana and Leannan Rivers where specific markers have been developed to identify the presence of a non-native cultured strain of Atlantic salmon. Analysis of 499 salmonid fry collected from the R. Crana in 1995 showed two salmon fry to possess the B haplotype, which is characteristic of the non-native cultured strain. 503 salmonid fry collected from the R. Leannan in 1994 and 1995 failed to show the presence of this haplotype indicating few farmed escape female salmon to have spawned in these rivers over the two years.

Random samples of salmon fry ($n \simeq 50$) taken from seven catchments in 1996 were screened for the presence of canthaxanthin using thin-layer chromatography (TLC). Canthaxanthin was recorded at trace levels (<5 % of total carotenoid pigment content) in all locations, ranging in frequency from 18% of the fry examined in the R. Owenmore to 75% of fry in the Melvin system. A total of only six salmon fry (1.7%) contained canthaxanthin pigment loads significantly above the trace level, indicating progeny of demonstrably farmed escaped females to be scarce.

None of the 18 hybrid fry collected in 1996 contained the high levels of canthaxanthin indicative of progeny of farmed escaped female salmon. Canthaxanthin was detected at trace levels (<5%) in five of the 18 hybrid fry (28%). Statistical analysis of the frequency of occurrence of canthaxanthin contained in hybrid fry compared to that in putative wild fry showed no significant difference (Chi-square; $P>0.1$) regardless of whether or not salmon and hybrid fry containing trace levels of canthaxanthin were included as putative progeny of farm escaped salmon.

Hybrid fry were randomly distributed within catchments. No consistent pattern emerged in the distribution of hybrid fry within the catchments between years. Within fish farming areas, there was a weak relationship (Spearman Rank; $P<0.1$, $r = 0.46$) between hybrid frequency and distance from the river estuary to the nearest farm. However, no hybrid fry were detected in some rivers situated in the proximity of fish farms. Direct comparison between control rivers remote from sea cages and rivers in general areas of fish farming showed no significant difference in hybrid frequencies recorded (Mann-Whitney U; $P>0.1$).

The general prevalence of canthaxanthin in Irish donor rivers was unexpected. Carotenoid pigment analysis of wild salmon ova taken from the Leannan, Crana, Owenmore and Burrishoole systems showed canthaxanthin to be absent in all cases confirming wild salmon females do not carry the pigment. However, HPLC analysis of adult resident trout from six catchments throughout Ireland indicated canthaxanthin to be present in each of the systems examined with many individuals showing trace levels of the pigment. Therefore it seems likely that the trace levels of canthaxanthin found in some recently emergent salmonid fry was probably attained during first feeding.

The source of canthaxanthin in Irish rivers and the means in which emergent salmon fry accumulate detectable levels of canthaxanthin so soon after first feeding warrants further investigation if carotenoid screening is to be used in future studies of this kind.

APPENDIX III

NATURALLY OCCURRING *TRYPANOSOMA GRANULOSUM* INFECTIONS IN THE EUROPEAN EEL, *ANGUILLA ANGUILLA* FROM COUNTY MAYO, WESTERN IRELAND

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Trypanosoma granulosum (Order:Kinetoplastida) is a pleomorphic protozoan parasite found in the peripheral blood of the European eel. Natural infections, transmitted by fish-feeding leeches appear to be widespread and are apparently symptomless. Boon (1990), however, found that infections in small eels in Lake Ijssel, Netherlands, were associated with a significant decrease of % haematocrit and suggested the importance of trypanosomiasis in eels may be underestimated.

The infection is characterized by a one-peak parasitaemia with a prepatent, patent and chronic phase. Trypanosome morphs of different sizes are thought to coincide with the stages of infection (Letch, 1980).

The present field study was designed to assess seasonal fluctuations of prevalence and parasitaemia of the infection in a wild eel population. In addition, hosts were examined for pathological changes due to the presence of the parasite. The overall size distribution and seasonal changes of trypanosome morph sizes were investigated.

Between January and November 1995 four sites in the Burrishoole catchment were sampled on a bi-monthly basis. These included the north western and eastern shores of Lough Feeagh, the Lodge and the Black Rivers. Following anaesthetization of the animals blood samples were taken. Prevalence (ie the percentage of eels infected) was determined using the haematocrit centrifuge technique (HCT). Intensities of infection were estimated by examining dried and fixed blood smears. Percentage haematocrit was recorded as an indication for anaemia. All eels were left to recover in running water before being released back into the wild.

Prevalence was consistently high in eels from both lake sites, lower and more variable in the two stream sites. Parasitaemia was generally low and the distribution highly skewed. Individuals carrying medium and high infections were most common in late summer and autumn. Although percentage packed cell volume was consistently higher in uninfected fish, the differences were not significant. Seasonal fluctuations of haematocrit seemed less pronounced in animals free from patent infections.

The size distribution of trypanosomes found in the blood was bimodal. Seasonal changes of trypanosome morph sizes indicated that parasitaemia did not increase immediately following infection, but was delayed until water temperatures increased during the summer months.

The results of this study are to be published in the Journal of Fish Diseases.

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