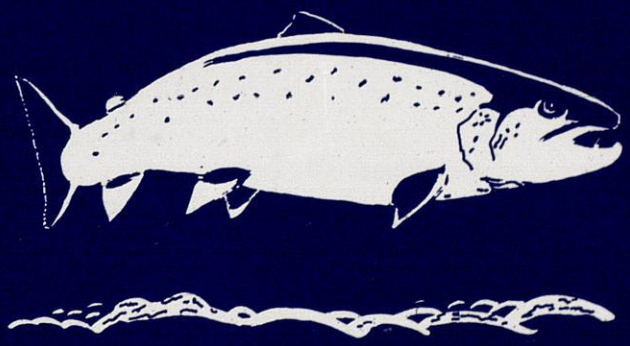
ATLANTIC SALMON TRUST

PROGRESS REPORT

June 1998



The Atlantic Salmon Trust
Moulin, Pitlochry
Perthshire PH16 5JQ
Telephone: Pitlochry (01796) 473439

Patron: HRH The Prince of Wales

COUNCIL OF MANAGEMENT

President:	The Duke of Wellington
Vice Presidents:	Mr. David Clarke
	Sir Ernest Woodroofe
	Dr. Wilfred M. Carter
	The Lord Nickson
	The Lord Moran

ELECTED MEMBERS

Chairman:	Colonel H.F.O. Bewsher
Vice Chairman:	Major General John Hopkinson
Chairman of HSAP:	Dr. D.H. Mills
Mr. G. Bielby	The Lord Onslow of Woking
Lt.Col. R.A. Campbell	The Hon. C.A. Pearson
Mr. Colin Carnie	Mr. C. Robinson
Mr. J.R. Carr	Dr. D.J. Solomon
Mr. R.M. Clerk	Mr. H. Straker
The Hon. Mrs. Jean Cormack	Mr. C.S.R. Stroyan
Mr. A. Douglas Miller	Mr. D. Turner
The Earl of Eglinton & Winton	Mr. O. Vigfusson
Mr. M. Larby	Mrs. Anne Voss-Bark
Mrs. E. Macdonald Buchanan	Mr. A. Wallace
Mr. J. McGrigor	Dr. K. Whelan
Rear Admiral D.J. Mackenzie	Mr. R. Williamson
Mr. E. Mountain	Mrs. Margit Worsham
Mrs. Judith Nicol	

OFFICERS OF THE COUNCIL

Director:	Mr. Jeremy Read
Deputy Director/Secretary:	Mr. Tim Hoggarth
Treasurer:	Mr. Peter Tomlin

INVITED REPRESENTATIVES OF OTHER ORGANISATIONS

ASF (USA)	Mr. J.F. Cullman 3rd
ASF (CANADA)	Mr. L.G. Rolland
AIDSA	Madame S. Tissier
ASDSFB	Miss Jean Matterson
COUNTRYSIDE ALLIANCE	(A Representative)
FISHMONGERS' COMPANY	The Rt.Hon. Viscount Leverhulme
	Mr. John Bennett
RASA	Mr. Richard Buck
S&TA	Mr. T.A.F. Barnes
SPEY TRUST	(A Representative)
WESTCOUNTRY RIVERS TRUST	Mr. Michael Martin

HONORARY SCIENTIFIC ADVISORY PANEL

D.H. Mills, M.Sc., Ph.D., F.I.F.M., F.L.S. (Chairman)
W.J. Ayton, B.Sc., M.Sc., F.I.F.M.
J. Browne, M.Sc. (Department of the Marine, Dublin)
M.M. Halliday, Ph.D. (Joseph Johnston & Sons Ltd.)
G.J.A. Kennedy, B.Sc., D. Phil. (Department of Agriculture for Northern Ireland)
E.D. Le Cren, M.A., M.S., F.I.Biol., F.I.F.M.
J. Solbé, M.B.E., D.Sc., C.Biol., F.I.Biol., F.I.F.M. (Unilever Research)
D. Solomon, B.Sc., Ph.D., M.I.Biol., M.I.F.M.
J.L. Webster, B.Sc., Ph.D., C.Biol., M.I.Biol. (Scottish Salmon Growers Association)
K. Whelan, B.Sc., Ph.D. (Salmon Research Agency of Ireland, Inc.)
Professor Noel P. Wilkins (Department of Zoology, National University of Ireland)
John Webb, BSc., MSc. (AST Biologist)

Observers:

N. Milner, B.Sc., Ph.D. (Environment Agency)
A representative of the Scottish Office Agriculture, Environment & Fisheries Department
E.C.E. Potter, B.A., M.A. (The Centre for Environment, Fisheries & Aquaculture Science)
A. Wallace (Salmon Fisheries Co-ordinator)

INTERNATIONAL CONSERVATION ORGANISATIONS WITH WHICH THE TRUST IS IN CONTACT

France:	Association Internationale de Défense du Saumon Atlantique
Belgium:	Belgian Anglers Club
Spain:	Asturian Fishing Association of Oviedo
Germany:	Lachs-und Meerforellen-Sozietat
U.S.A:	Restoration of Atlantic Salmon in America Inc.
Canada and U.S.A:	Atlantic Salmon Federation
Ireland:	Federation of Irish Salmon & Sea Trout Anglers

Registered Charity No. 252742

CONTENTS

Council of Management	**Front Cover**
Honorary Scientific Advisory Panel	1
Contents	2
Chairman's Introduction	3
Director's Remarks	5
The International Atlantic Salmon Accord	6
Support of Research Projects by the AST	19
Erratum	21
AST Advisory Service	22
The National Salmon and Trout Fisheries Centre, Cardiff	23
The Fish in Art	26
The Eden Rivers Trust	27
The Westcountry Rivers Trust	29
The New Research Ship ***SCOTIA***	33
Constant Monitoring of Water Quality	36
Hybridisation between Escaped Farmed Salmon and Brown Trout	38
Report from the Salmon Fisheries Co-ordinator	40
NASF (UK) Report	43
AST Biologist's Report	44
Review of Scientific Literature on Salmon	47
The Tay Salmon Fisheries since the 18th Century	58

CHAIRMAN'S INTRODUCTION

There can no longer be any doubt that salmon stocks are in severe decline. The North Atlantic Salmon Conservation Organisation (NASCO) annual Council meeting, which I attended at the beginning of June, heard numerous reports of low catches last year. Salmon stocks throughout the North Atlantic are now at an unprecedentedly low level. Of major concern is the fact that the scientific assessment indicates that the situation for multi sea winter stocks in our area is especially serious. NASCO was advised in the most forthright terms that the exploitation rate, particularly in fisheries harvesting populations destined for different rivers, needs to be significantly reduced. As far as the English North East and Irish drift net fisheries are concerned, the message to both Governments could not be clearer.

Notwithstanding the lack of purposeful action up to now, there are indications that the severity of the situation in this country is being realised. A joint assessment recently published by the Environment Agency and the Centre for Environment, Fisheries and Aquaculture Science (previously the MAFF Fisheries Laboratory, Lowestoft), states bleakly "The majority of salmon stocks in England and Wales appear to be in a depleted state". Also the Fisheries Minister, Elliott Morley, has told Lord Moran that his and other departments are considering what additional measures can be taken to protect these stocks. It is to be hoped that this consideration will take place urgently.

The Freshwater Fisheries Review Group set up by Dr Cunningham will clearly be involved in proposing any legislative action. So as to manage the Trust's input to its work, a working party has been set up under the Vice Chairman. The Trust is also represented on Lord Moran's Committee which is co-ordinating similar work by angling organisations.

It was against the background of the severe decline that the Trust took the opportunity at NASCO to launch the International Atlantic Salmon Accord. This was a document put together by the Trust and the Atlantic Salmon Federation (ASF), and agreed by Non Government Organisations (NGOs) from the majority of North Atlantic countries. The Accord, which stemmed from a resolution at last September's Galway Symposium, and to which I referred in the last Progress Report, sets out in simple straightforward terms the problems facing the wild salmon and the actions needed to combat them. It aims to meet the needs of the different countries and the different salmon management regimes from North America to Scandinavia - which perhaps explains the "mid-Atlantic" flavour to some of the text! To ensure it has maximum impact, the Accord has been kept deliberately short, the reasoning behind its recommendations being contained in an accompanying Appendix. Both are printed elsewhere in this Progress Report. Although well received at NASCO, this is only the first step; NGOs will now seek the Accord's endorsement - and hopefully its early implementation - by their own Governments, as the basis on which action must be taken if the wild salmon is to be saved for future generations. In this regard, I have already written to British Ministers on behalf of the Trust.

NASCO also took firm decisions on two other subjects. It agreed to adopt the Precautionary Approach, an expression which means many things to many people, but which in this case has, in simple terms, two major components:

- that nothing should be done which could have an irreversible effect on natural stocks.

- that action to deal with obvious problems should not be delayed while waiting for the last detail of scientific evidence.

Both of these are of great significance in the current situation. NASCO has set out an Action Plan to bring the Precautionary Approach to bear in salmon management, and we shall be urging our own Government to follow its principles constructively.

The second subject on which NASCO was refreshingly firm was that of salmon farming. In 1994 the NASCO nations agreed a Resolution to minimise impacts from salmon aquaculture on wild salmon stocks (the "Oslo Resolution"). A working group report on the implementation of the provisions of this Resolution was strongly critical of the lack of progress in significant aspects, such as reductions in disease and parasite problems, the control of escapees, and the need to give emphasis to wild salmon protection zones. The Council strongly encouraged the signatories to the NASCO Convention to implement the Oslo Resolution more fully. Sadly, neither the Resolution nor these recommendations are legally binding, but the moral pressure on Governments is clearly increasing.

In our own salmon farming context, there are signs of the beginnings of movement towards an acceptance of environmental responsibility. The Scottish Salmon Growers' Association has published a guide to the application of Environmental Assessment in the siting and operation of salmon farms. In more immediately practical terms, it has launched a sea lice control strategy which calls for simultaneous treatment of all farms in an area in the early spring, when the female lice are most vulnerable, and has publicly accepted that this would be of benefit to wild fish. The Trust is pushing for the implementation of this strategy to take place in consultation with fishery interests, particularly the West Highland Fishery Trusts. On the broader front, we remain convinced of the need for an independent regulatory authority to oversee all aspects of salmon farming. This has been emphasised by the recent outbreak of Infectious Salmon Anaemia, a disease new to the United Kingdom, in five farms on the West Coast. Although there is no record in other countries of the disease affecting wild fish, the risk has to be assumed, and it is essential that the source of the outbreak should be identified to avoid any repetition.

It has been a busy six months since the publication of the last Report, but there has been some useful progress, albeit there is still a long way to go.

H F O BEWSHER

*****

DIRECTOR'S REMARKS

I echo with feeling the Chairman's description of the last six months. At a time when there has been steadily increasing evidence of the depressing state of salmon stocks, it has been particularly important to seek a common approach with other groups concerned about the future of the wild fish. The support achieved for the launch of the International Salmon Accord at NASCO has been encouraging, and it emphasises the need to make common cause in ensuring a constructive and beneficial outcome from the work of the Freshwater Fisheries Review Group in respect of salmon in England and Wales. The Trust will seek particularly to secure appropriate consistency between the recommendations of this Group and the measures proposed for Scotland by Lord Nickson's Salmon Strategy Task Force.

It is timely that the first of no less than three Blue Books newly published by the Trust should be a review of Salmon Fisheries in England and Wales. This has been written by Warwick Ayton, a long time member of the Trust's Honorary Scientific Advisory Panel, and lately Fisheries Officer of the Welsh Region of the Environment Agency. It follows the previous reviews of salmon fisheries in Ireland and Scotland, and provides a comprehensive description of current salmon fisheries and their historical background.

The next Blue Book in the new list is a survey of the Industrial Fishery for Sandeels, which follows a study financed by the Trust. It describes the fishery and its conduct, and assesses its potential damage to salmon, especially during the early part of their migration as post-smolts. It is recommended reading, in view of the concern raised by the fishery in the context of current losses of salmon at sea, and of the need for its effective regulation, which is a long way from being achieved.

Thirdly, we are publishing the Proceedings of a seminar on developments in Fish Counters. This was held jointly in Perth last year by the Atlantic Salmon Trust and the Institute of Fisheries Management (Scotland). This offers new insights into recent developments in counting techniques and their application.

At a time when some question the need for science, this Report confidently sets out a summary of the criteria used in deciding on support for practical salmon research projects. It also announces the availability of the services of our Biologist, John Webb, to give initial advice to Associations and Boards who are contemplating survey, monitoring or enhancement projects.

I have to announce a correction to the dates announced in the last Progress Report for the appearance of the Trust's display caravan. The dates given for the CLA Game Fair at Stratfield Saye (24-26 July) are correct, but the Highland Fair at Moy is now being held on 7 and 8 August. I will hope to meet a goodly number of our Supporters at these events.

J B D READ

THE INTERNATIONAL ATLANTIC SALMON ACCORD

A CALL TO ACTION TO SAVE THE ATLANTIC SALMON

The Aim

Wild Atlantic salmon populations throughout the North Atlantic are at their lowest levels in recorded history. The International Atlantic Salmon Accord seeks concerted action to reverse this decline by:

- Optimising the number of Atlantic salmon spawning in their native rivers

  and

- Optimising their survival in freshwater and sea ecosystems

Where optimum targets cannot yet be specified, or their achievement accurately measured, the aim must be to maximise numbers.

Saving the Salmon – The Solution

Conservation action to address seven major issues that affect the salmon during its lifecycle:

1. Inadequate in-river production

2. The impact of aquaculture

3. The impact of fisheries targeted against other species

4. Low marine survival

5. The impact of mixed-population fisheries

6. Predation

7. In-river exploitation and management

Underlying Conservation Strategies

Co-operative efforts:	Integrated and coordinated action to restore the quality of the Atlantic salmon's freshwater and sea ecosystems is needed from all countries which produce or harvest wild salmon.
Precautionary approach:	Governments must encourage and adopt conservation measures even where supporting data is not yet complete.
Reduction of mortality:	Harvesting of salmon outside their natal rivers must be eliminated. River fisheries must allow adequate spawning escapement.
Research coordination:	International research effort and funding is required to understand the direct and indirect impacts of the ocean ecosystem upon Atlantic salmon.

Recommendations

Issue 1 – Inadequate in-river production

- Remove or prevent obstructions or install adequate fish passage
- Prevent pollution
- Control the use of water to maintain adequate flow rates and river levels
- Initiate and continue habitat restoration and enhancement
- Develop catchment (watershed) salmon management and enhancement policies

Issue 2 – The impact of aquaculture

- Develop and enforce strict environmental assessment procedures for new and existing aquaculture sites
- Specify and enforce permitted effluent and sea lice density levels
- Exclude new aquaculture sites detrimental to wild salmon and sea trout
- Develop strategies to remove existing detrimental sites
- Minimise genetic and other biological interactions between farmed and wild salmon
- Advance technology to reduce harmful effluent, deter escapes and control disease and parasites

Issue 3 – The impact of fisheries targeted against other species

- Institute precautionary management regimes for industrial fishing in the Atlantic salmon's forage areas
- Research the impacts of industrial fishing on the salmon and its marine ecosystem
- Research the impact on salmon of pelagic fishing for human consumption

Issue 4 – Low marine survival

- Develop and implement tracking technologies, ocean surveys and monitoring to determine salmon movements and feeding at sea
- Research the direct and indirect impacts of the ocean ecosystem on Atlantic salmon
- Use this data to develop better predictive models of salmon abundance, in order to facilitate proactive management

Issue 5 – Impact of mixed-population fisheries

- Negotiate permanent closure of mixed-population fisheries in territorial waters with fair compensation
- Negotiate permanent closure of the commercial salmon fisheries of Greenland and Faroe Islands through compensation, or the development of alternative fisheries
- Implement an international surveillance system to detect and prosecute unauthorised fishing for Atlantic salmon in international waters

Issue 6 – Predation

- Document the effects of bird and mammal predation in rivers, estuaries and the open sea, and develop optimum practicable means of controlling damage
- In the interim, permit appropriate local or regional measures based on fair assessment of damage

Issue 7 – In-river exploitation and management

- Develop and implement catchment (watershed) salmon management
- Manage salmon exploitation on an environmentally sustainable basis
- Conduct population and migration assessment to guide management
- Implement precautionary regulation of exploitation where needed
- Develop live release as a management tool

THE INTERNATIONAL ATLANTIC SALMON ACCORD

APPENDIX

THE ISSUES – BACKGROUND AND FACTORS FOR IMPROVEMENT

ISSUE 1 - INADEQUATE IN-RIVER PRODUCTION

Background

1. Threats. Freshwater rivers and streams are the production areas for Atlantic salmon. Long-term survival of salmon populations is threatened by anything that:

- prevents returning salmon from reaching their spawning areas
- prevents eggs from hatching or juveniles from surviving to the smolt stage, or
- prevents migrating smolts from reaching the open ocean.

2. Causes. Impediments to salmon production and survival, with direct and indirect effects, include:

- physical loss or degradation of habitats (spawning, nursery or cool-water refugia)
- point and non-point source pollution, including acidification
- water abstraction and diversion
- inappropriate land use or resource extraction within key watersheds or catchments.

3. Primary actions needed. It is critical to:

- develop the knowledge base by researching and monitoring the quality of habitats and the consequent effects on salmonid populations
- create the financial infrastructure to implement restoration and conservation programmes.

4. Hatcheries. A growing body of research indicates that large-scale hatcheries are less effective in conserving and maintaining salmon populations than are the aggressive restoration and enhancement of habitat. In certain situations, however, hatcheries are critical to restoring lost or threatened populations. Given the rise of "micro" fry hatcheries and other innovative population enhancement techniques, clear policies are needed:

- to guide allocation of financial resources
- to provide biological guidance in the appropriate use of hatchery stock in salmon restoration and conservation programmes.
- to exploit kelt reconditioning techniques.

5. Public involvement. Government agencies at all levels are suffering from financial and staffing limitations. Thus it is critical to the long-term success of salmon conservation programmes to enlist an informed and committed core of volunteers within watersheds to assist in all aspects.

Factors for improvement

- Catchment (watershed) Management. All activities affecting salmon stocks and fisheries within a catchment or watershed need to be co-ordinated to make sure that they are complementary and are not in conflict. Where arrangements for this do not exist, the political and financial environments must be created to establish and maintain watershed salmon management entities. In co-operation with government agencies and industry partners, these entities will implement specific habitat restoration, protection and enhancement programmes.
- Access to spawning grounds – Hydropower and dam intervention. Salmon conservation requires that there should be no man-made blockages in key salmon rivers. Wherever barriers cannot be eliminated, there must be the assurance of adequate passage for salmon at all life stages. Natural blockages from fallen trees or animal activity such as beaver dams must also be cleared.
- Water Quality and Flow. Long term agreements must ensure elimination or sufficient reduction of pollutant or other inputs in rivers and streams to below levels that impede salmon reproduction and survival. Where rivers are affected by abstraction or by release of impounded water, base river flow levels and target minimum water levels should be agreed and must be maintained.
- Optimising Salmon Production. Co-operative ongoing research must be designed and funded to yield data guiding techniques for the enhancement of water quality and habitat (including bankside and instream improvement). Projects must be implemented by a mixture of public and private programmes (subsidised where appropriate).
- Control of predation. This is covered as an individual issue later in this paper.
- Stock Enhancement. Guidance on the appropriate use of stock enhancement techniques must be developed and implemented. In particular:
  - Hatcheries: clear policies are necessary to guide the use of public and private hatcheries in river-specific salmon restoration and conservation programmes where natural spawning cannot be ensured.
  - Other stock enhancement techniques: small-scale "streamside" stock enhancement techniques will require adequate population assessment data and funding to guide their use in site-specific restoration or remedial projects.
  - Sea cages in estuaries: Monitoring and assessment of existing programmes for raising river-specific wild salmon in sea cages in estuaries (including examination of the potential foci for sea louse infestation) should yield data and guidance on the efficacy and the appropriateness of this strategy. Where indicated, long-term agreements and funding should be secured to enable its implementation.
- Public Involvement. Education and information campaigns must be funded and directed towards salmon anglers and the non-angling public. These should inform them of the Atlantic salmon crisis, and of the importance of techniques such as catch and release to increase spawning escapement, and should promote public support and involvement in catchment (watershed) management programmes and initiatives.

ISSUE 2 – THE IMPACT OF AQUACULTURE

Background

1. The scale of the problem. The Atlantic salmon aquaculture industry inflicts environmental impacts throughout the North Atlantic. In all North Atlantic countries which have salmon aquaculture industries, there are salmon farms situated in the vicinity of wild salmon rivers The North Atlantic Salmon Conservation Organisation (NASCO) reports that millions of cultured salmon escape into the wild annually. Aquaculture fish are transmitting disease and parasites to wild stocks and eroding their genetic composition.

2. Disease and parasitic infection. In Norway, diseased imported smolts are believed to have infected wild stocks with furunculosis, and the external parasite, *Gyrodactylus salaris*, transmitted from Swedish hatcheries, has decimated juvenile populations in a number of rivers. In Ireland, and on the west coast of Scotland, there has been a virtual collapse of sea trout stocks, associated with massive infestation by sea lice, in many rivers where there are salmon sea-cage installations.

3. Genetic consequences. Salmon aquaculture broodstock programmes select genetic traits for their economic value to the grower, not for survival of the fish in the wild. Genetic change can also occur in fish farm operations, where, because of the relatively benign environment, selection pressure is much less rigorous than in nature. This results in the survival of many individuals who would otherwise have died. If they escape, they will take with them genes maladaptive for survival in a river in which they are not native. Escaped farmed fish have been shown to interbreed successfully with wild fish, with the risk of prejudicing the gene pool of native populations of wild salmon.

4. Competition. Escaped farmed salmon compete for freshwater habitat and food.

5. Pollution. Effluents from aquaculture operations can degrade both fresh and seawater habitats, thereby adversely affecting the ability of local populations of fish and other aquatic organisms to survive.

Factors for Improvement

- Quantification of negative impacts on wild stocks. Documenting and quantifying the effects of aquaculture will provide the necessary information.
- Technological improvements to mitigate negative impacts. It is in the interest of the aquaculture industry, government and conservationists to advance technology to prevent effluent, infection and escapes from affecting the freshwater and ocean environments and ecologies.
- Involving the aquaculture industry. The aquaculture industry is increasingly seen as a polluter despite the economic benefits it generates. It is important that the aquaculture industry should improve its public acceptance by becoming part of the solution. The industry must participate in research to assess damage and in development of technology and the regulatory process to mitigate harmful impacts on the environment and fish stocks.

- Facilitating the transition to environmentally acceptable practices. Once a blueprint for environmentally sustainable aquaculture has been developed, then there must be a practical step-by-step plan, which includes determining financial outlay and sources, to put the blueprint into practical application.

ISSUE 3 – THE IMPACT OF FISHERIES TARGETED FOR OTHER SPECIES

Background

1. Threats. Fisheries targeted against other species may have an effect in one or both of two ways:

- Salmon may be taken as a by-catch in the fishery
- Removal of the target species may affect the food web and thus reduce the nourishment available to salmon.

2. Current knowledge of effects. Knowledge of both aspects may be summarised as follows:

By-catches. There has been little knowledge of the nature and level of by-catches of post-smolt or adult salmon in other commercial fisheries, although there has been suspicion that both fishing of species described as "industrial", and pelagic fishing of species for human consumption, has posed a threat in this respect. Recent research fishing in the Norwegian Sea and off Northwest Scotland, using surface trawling techniques, has resulted in the capture of post-smolts, and has also indicated these post-smolts were exhibiting shoaling behaviour. It is thus possible that developing near-surface fisheries may directly threaten not just a random selection of post-smolts, but a significant proportion of the run from an individual river. This could result in major damage to the year-class from that river.

The salmon food chain. Industrial fisheries, such as those in the North Sea result in the removal of very large quantities of animal biomass, which would otherwise be food for other fish, birds and sea mammals. Initial assessment of the cumulative effect of industrial fisheries has been limited to the major commercial species, which did not consider salmon. It has been estimated that reductions in industrial fishing would result in increases of between 2 and 20% in landings of the species caught for human consumption. The precautionary assumption must be that industrial fishing can be damaging in the marine phases of the salmon and sea trout life cycles.

Factors for improvement

- Research. Research is urgently needed to provide better knowledge of:
  - The movement of salmon at sea, especially post-smolts, and the areas and times of possible interaction with industrial fisheries
  - The effect of industrial fishing on marine ecosystems, especially as regards salmonids
  - The impact upon salmonids of pelagic fisheries for human consumption.

- Precautionary action. There is a need to establish management regimes for industrial fisheries, including:

- Thorough assessments of the impact and potential impact of existing industrial fishing on other species
- Establishment of sensitive areas off limits to industrial fisheries
- Overall reduction of industrial fishing effort
- Measures aimed at eliminating the by-catch from sea fisheries.

ISSUE 4 – LOW MARINE SURVIVAL

Background

1. Changes in the environment. The ocean is a dynamic place, and its environmental conditions, both locally and globally, change naturally in both predictable (e.g. seasonal) and unpredictable ways, involving changes in sea temperature, salinity, winds and ocean currents. Human activities are also causing upheavals in the ocean. Indirectly, the sea is being altered as our use of fossil fuels pushes a cycle of global warming. More directly, ocean ecosystems are being perturbed as we fish out large quantities of sea life from all trophic levels.

2. Population changes. As the ocean changes, so have the valued ecosystem components (like salmon) upon which humans depend. We do not at present have the knowledge to explain the recent low marine survival levels of Atlantic salmon smolts. In the meantime, populations of potential salmon predators like seals are exploding, and the impacts of industrial fishing of fishes and crustaceans at the low end of the food chain remain uncertain.

3. The need for explanations. It is not reasonable to expect to be able to influence ocean conditions in time to address immediate crises. However, we can begin to develop a better understanding of why and how much things are changing, and how they affect salmon and other important species. This will let us develop better predictive models for the abundance of species and the linkages among them and their environment. This knowledge will bring the causes of the present crises much more rapidly into focus, and permit a quicker development of long term remedial strategies.

Factors for improvement

- Co-ordination of efforts and resources: Many countries are maintaining independent scientific salmon research programmes. All countries are short of financial resources, and much greater results might be achieved if studies were co-ordinated and resources shared. Furthermore, with simple adjustments and little to no additional costs, it may be possible to retarget many nation's ongoing oceanographic research programmes to provide the new data on ocean conditions which is needed to help fathom what is striking at the salmon at sea.
- Improvement of our predictive capacities for salmon returns: Models forecasting the returns of salmon to home rivers in 1997 failed badly. These need to be improved to foster sustainable fisheries management. Some critical but unknown variable (or variables) is (are) absent from these models. We need better knowledge of where salmon are in the ocean, and what environmental conditions and food supplies are like, so that we can identify and monitor this critical variable (or variables). Then we can restore our confidence in our models.

- Implementation of a sustainable ecosystem approach to fisheries: Scientists are increasingly recognising the need for an ecosystem approach to fisheries management. The removal of marine species from one trophic level may directly and indirectly impact on other species. Forage fisheries, whose impacts can cascade through the entire ocean food chain, are of particular concern. So are burgeoning potential predator populations like seals. Better understanding and control of these linkages would do much to ensure that we make no further management mistakes.

ISSUE 5 – THE IMPACT OF MIXED-POPULATION FISHERIES

Background

1. The remarkable specificity with which maturing Atlantic salmon return to their natal rivers for spawning is linked with the evolution of traits that adapt salmon to the physical and biological features of their natal river. This is the key to the salmon's survival.

2. Mixed-population salmon fisheries on the salmon's migration routes in the open sea or coastal waters kill salmon from different river systems. Such harvesting cannot target the salmon of specific rivers. It thus has no regard to the health of discrete river stocks; in the worst case it can decimate entire river populations, and at the least it puts additional stress on those that are already suffering. Furthermore, a number of such fisheries affect stocks from one or more other nations.

3. The North Atlantic Salmon Convention allows Greenland and the Faroe Islands to fish Atlantic salmon to annually negotiated quotas. However, in the case of Greenland, the International Council for the Exploration of the Sea (ICES) has indicated that salmon populations reaching the Greenland fishery are presently below the total number required to meet spawning requirements in North American salmon rivers, and should not be harvested. Spawning targets for North Eastern Atlantic rivers have yet to be agreed, but the returning runs of multi sea winter fish in some index rivers have been recognised as being below self-sustaining level.

4. NASCO regulates existing high seas mixed population fisheries, but these, like the sea fisheries still operated closer inshore by some North Atlantic countries, violate the precautionary approach to salmon management.

5. Diplomatic efforts by NASCO have apparently stopped unauthorised fishing for salmon by non-NASCO states in international waters. There have been no sightings of vessels fishing for salmon in international waters since 1994. There are very few surveillance flights over the fishing grounds, and those that do take place cover only a small part of the total area. NASCO reports, moreover, that the fishery mainly takes place at a time of year when there is 24 hours of darkness. It is possible, therefore, that the problem may be continuing undetected.

Factors for Improvement

- Precautionary approach. In general, the precautionary approach recognises that indiscriminate harvesting of mixed salmon populations is a fundamentally scientifically unsound management strategy. There is wide agreement that salmon should be harvested only after they have entered their natal estuary – resource allocation can then be based on the biological dictates required to sustain a healthy salmon run. This agreement should be universal.
- Scientific advice. In particular, ICES has recommended that the mixed population fishery off West Greenland should be closed, because 2 sea-winter populations have fallen below the total number needed for spawning escapement in North American rivers. ICES has also called for a precautionary approach to managing mixed population fisheries, after an alarming downward trend in maturing Northern European stocks.
- The precedence of international salmon conservation over any country's right to a harvest. Management of salmon in the ocean should ensure that conservation requirements are met for all stocks before harvest quotas are established.
- Detection and deterrence of unauthorised catches of Atlantic salmon in the ocean. The techniques and organisation for international co-operation should continue to be developed.

ISSUE 6 – PREDATION

Background

1. Predation on salmon is an emotive subject, since fish-eating birds and seals, both of which enjoy great sympathy in general public opinion, represent two major groups of predators. The Atlantic salmon is itself a predator, since it feeds on other organisms from its early life. Nevertheless, as was pointed out in the report of the NASCO special session on "The Atlantic salmon as predator and prey", there is no room for emotion in the analysis of scientific data and the provision of scientific advice. The same holds good as regards the management action that should be adopted as a result of that advice.

2. The problem of bird and mammal predation on juvenile and adult salmon has been represented to varying degrees in different nations. In both cases, salmon are not the only prey that is a matter of concern. For example, seals consume significant amounts of fish from other commercially exploited marine stocks, while bird predation is seen to have a significant effect on inland stillwater and river trout fisheries and farms, as well as coarse fisheries.

3. There is a large body of evidence on the effects of both bird and seal predation, much of which is cited in the report of the NASCO special session. However, it has not yet been comprehensively presented to national governments. Further research is in progress; a three-year study is being carried out into the effects of bird predation on fisheries in England and Wales, and on possible countermeasures. At the same time, a study on the control of the rapidly expanding cormorant population is under way in Europe. In both cases, conclusions and recommendations are still awaited.

opportunistic feeding. This becomes a serious conservation matter, since (as was suggested in the context of pelagic fishing in Issue 3) an entire run could be significantly damaged. Seals may also present a particular threat to early-running salmon, which enter rivers at a time of low water temperature when their swimming performance is low in comparison.

5. Otters and mink are also known predators in fresh water. Otters have been an endangered species in many rivers, whereas mink have in some cases been inadvertently introduced, and have an undesirable effect on the local ecology. The situation needs to be assessed locally in each case.

6. Firm evidence of the damage caused by predation is essential before any government will support action to control its effect. Further, implementation of the means of control must be practicable in respect of public opinion. It is often argued that predation represents only a small proportion of the damage done to salmon stocks, and that effort should therefore be concentrated on the other factors which can have a damaging effect. Some control regimes also require unrealistically detailed evidence of the extent and quantifiable cause of damage. In the current crisis, each identifiable threat to salmon stocks should be countered, since it is not yet possible to assess accurately the relative effect of the different components.

Factors for Improvement

- Programmes must be intensified and internationally co-ordinated to document the damage done by predators in fresh water, estuaries and at sea
- Optimum practicable means of reducing excessive damage must be developed
- In the interim, predation should be limited by locally or regionally authorised control where significant damage is fairly assessed

ISSUE 7 – IN-RIVER EXPLOITATION AND MANAGEMENT

Background

1. Local management. Fishing for salmon should only take place within rivers and their estuaries, where management can be applied on a river specific basis. Harvest and management regulations for each river must be adapted to its watershed to reflect the health of the salmon populations within that watershed.
For many rivers we do not know the conservation requirements, whether the requirements are being met or the size of any harvestable surplus. State-of-the-art population assessment is available for few rivers, and population estimates are often based on unreliable data.

2. Reduction of in-river mortality. At present, in-river mortality must be kept to a minimum to counterbalance the high mortality in the ocean, the cause of which remains unknown. This reduction may be achieved in several ways:

- By varying the fishing season
- By restricting fishing methods to reduce the vulnerability of the salmon (e.g. only permitting fly-fishing

- By varying the fishing season
- By restricting fishing methods to reduce the vulnerability of the salmon (e.g. only permitting fly-fishing
- By enforcing bag limits.
- By encouraging live release.

These methods may be used individually or in conjunction to meet the requirements of each river.

3. Live release. In North American Aboriginal fisheries, the trap net constitutes the preferred conservation-oriented catch method, for it allows selective harvest. In the recreational fishing industry in all rivers, catch and release is a valid management tool and conservation method.

4. Published results of North American research have established that survival after well-executed catch and release in appropriate conditions is high (close to 100% in water below 20°C), and that spawning success and viability of eggs are unaffected in salmon angled and released in the late fall before spawning. Trials in the United Kingdom have confirmed survival to spawning in the testing case of released rod-caught spring fish, which then spent up to nine months in the river before spawning. North American studies indicate that fish hooked and released under warm water conditions are more severely stressed than those released in colder water, and experience some mortality. Salmon hooked and released in soft water also experience increased mortality.

5. An important benefit of catch and release is that it allows the recreational fishery to continue to operate, boosting local economies and financing vital fisheries management programmes. When fishermen are allowed to practice their sport, their commitment to and involvement in saving the resource is maintained.

6. Poaching. Poaching is a problem in many salmon rivers. Despite the hard work of enforcement agencies, which has resulted in increased apprehensions in many regions, poachers continue to catch far too many salmon. Agencies faced with dwindling resources are finding it harder to maintain adequate surveillance on salmon rivers. Anglers, volunteers and conservation groups can and increasingly do assist enforcement agencies to protect salmon rivers through River Watch and guardian programmes.

Factors for improvement

- Catchment (watershed) salmon management. Management must be a science-based co-operative effort involving all interests around the river, led by those who depend on the salmon for a living and whose stewardship will mean that there will be more salmon in the future to sustain a fishery and generate economic benefits.
- Precautionary management. Until adequate population and migration data are available, managers must lean on the side of conservation and eliminate or limit mortality of salmon in rivers. The development of on-going assessment programmes is a critical conservation objective, to ensure that salmon rivers are receiving adequate spawning escapement.

- Components that ensure the success of catchment (watershed) salmon management:
  - Conservation plans based on reliable population assessment data for determining conservation targets
  - Exploitation of a reasonable surplus above conservation levels, on an environmentally sustainable economic basis
  - Precautionary regulation of exploitation, where needed to protect spawning escapements
  - Recognition and development of catch and release as a conservation tool
  - Public education in the need for it, and the techniques to achieve maximum survival
  - Strengthened surveillance and enforcement to curtail poaching
  - Community development and approval of conservation plans (all users involved)

ENDORSEMENT

The following Non Government Organisations have indicated their support for the Accord:

Association Internationale de Défense du Saumon Atlantique

Association of Scottish District Salmon Fishery Boards

Atlantic Salmon Federation

Atlantic Salmon Trust

European Anglers Alliance

Federation of Irish Salmon & Sea Trout Anglers

Institute of Fisheries Management

National Anglers Representative Organisation

Norges Bondelag (Norwedian Farmers Union)

Norske Lakseelver (Norwegian Salmon Rivers)

Salmon & Trout Association

Scottish Anglers National Association

Ulster Angling Federation

*****

SUPPORT OF RESEARCH PROJECTS BY THE AST

The Atlantic Salmon Trust was founded as the Atlantic Salmon *Research* Trust, and the promotion, encouragement and direct support of practical research are still important parts of the Trust's activity. The Honorary Scientific Advisory Panel has recently restated the policy of the Atlantic Salmon Trust for providing direct support to research projects. The principal elements of this policy are as follows:

- In working for the conservation of wild Atlantic salmon and sea trout, the Atlantic Salmon Trust fully recognises the importance of relevant research of high quality, and is committed to the stimulation and support of such research.

- The Trust will encourage applications by organisations or individuals for assistance in carrying out research projects whose object, directly or indirectly, is the conservation and enhancement of wild salmon and sea trout stocks and/or the improvement of salmon and sea trout fisheries management.

- In general, the Trust will not support projects whose results will be of purely local relevance, and will favour those with a potentially wide application.

- The Trust may provide grants to supplement funding by other authorities. Evidence of this primary support will be required. The Trust will give special consideration to the funding of preliminary, exploratory or pilot studies that have the potential to develop into a more substantial project, to be funded from other sources.

- The Trust will also consider applications aimed at expediting the start of suitable projects which might otherwise be delayed, or at the completion of projects where the potential for a small extension to the original research proposal has been identified.

- The preparation for publication of papers arising from completed projects may also be supported, particularly if the work provides practical guidance for the management of salmon fisheries.

The major item of research is the important and continuing DNA project which is being conducted by our Biologist John Webb, in conjunction with the Marine Laboratory Aberdeen. It is regularly described in Progress Reports. It is budgeted for in its own right, and has been supported since its inception by generous sponsorship from the Dulverton and Robertson Trusts. Applications for support of other projects are considered by the Honorary Scientific Advisory Panel in the light of the criteria set out above.

The following brief summary describes the principal projects completed, in hand and approved for support since 1997:

- **An investigation of the possible effects of the discharge of distillery cooling water into salmon rivers, which has been in progress since 1996.** The work is being carried out on behalf of AST by the Spey Research Trust, and is being financed by the Malt Distillers' Association. It is particularly important in the context of new EU legislation on water quality. It involves studying the populations of fish in the River Fiddich, both above and below the distillery, in order to assess whether changes in water temperature are having any effect on growth and eventual survival. Parr have been marked to allow their progress to be monitored and micro-tagged to identify them when they return as adults; a report on the 1997 juvenile survey is in preparation, and the first tagged grilse should be returning this year.

- **A study of the way water flows through salmon redds, with particular respect to the carriage of oxygen and siltation in the redd structure.** This is a three year project being conducted by Lancaster University, which began in 1997. The purpose of the project is to develop a way of being able to predict the potential of different combinations of gravel quality and water flow, with consequent benefit when undertaking habitat improvement.

- **Assistance with a detailed study of the movements, growth and survival of salmon in the River Conon.** This study is exploring a new technique involving the use of Passive Integrated Transponder (PIT) tags – similar to the identification "bugs" which might be used for road toll charges. Unlike micro-tags, these can be read without harming the salmon at various stages of its life. The contribution of the Trust was to supplement existing funding of the detection equipment and effort by purchasing a supply of tags. This allowed work to begin in 1997; it would otherwise have been delayed until this year. An initial report is due shortly. In this instance the Trust was able both to help with the implementation of a technique with a wide potential, and also to expedite the start of a project.

- **Potential effects on salmon of the Industrial Sandeel Fishery.** The Trust financed passage by a scientist on a Danish sandeel fishing vessel in 1996 in order to study the operation of the fishery at close hand. The results, together with those of a subsequent voyage in 1997, are described by Professor Tony Hawkins (Director of the Marine Laboratory Aberdeen), and a member of the Honorary Scientific Advisory Panel in a Blue Book which will appear shortly after the publication of this Progress Report.

- **Tamar 2000.** The Tamar 2000 project to restore the river habitat was described in a recent report on the work of the West Country Rivers Trust. The Atlantic Salmon Trust made a grant in 1997 to assist in the development and implementation of techniques for surveying every farm along the river for pollution sources, with subsequent advice and assistance to farmers in remedying problems. This experience will be of benefit to the development of similar projects on other rivers.

- **Seal predation.** The Trust is planning to support work on the River Conon this year, aimed at confirming whether seals prey on smolts, and if possible estimating the scale of damage. Smolts, which migrate in shoals, are likely to be particularly vulnerable to common seals. Without quantitative information, particularly of the risk to migrating runs, there is little chance of any official action to reduce the toll being taken by continually increasing seal populations.

- **Population studies by the West Coast Fishery Trusts.** The Trust is making a grant to each of the new Trusts to help in the establishment and operation of traps for sea trout smolts and adults. These are needed in conjunction with remedial work in the wake of the sea trout population collapse; it will be essential to be able to assess the effects both of measures to reduce sea lice levels and of possible hatchery enhancement.

- **Impacts of sea lice infestation on sea trout.** Although the effects of heavy lice infestation on prematurely returning smolts have been all too clearly seen, it has been observed in Ireland that sea trout that remain at sea may return as finnock with heavy lice infestation but in good condition. Other sea trout return without lice. The Trust is planning to support a study by Trinity College Dublin and the Salmon Research Agency of Ireland to investigate this; sea trout smolts will be caught both at sea and in upstream traps through the course of this year, and the subsequent condition and progress of both infested and uninfested fish will be monitored. Samples will also be taken in the vicinity of salmon farms, for comparison. No such detailed examination of the whole scope of how lice affect sea trout has yet been carried out; it will be highly relevant to the rehabilitation work mentioned in the context of the previous project, and the techniques demonstrated should be of value in conducting similar studies of post-smolt lice infestation in West Highland rivers, which the Trust will probably assist.

*****

ERRATUM

(December 1997 Progress Report. Swedish International Salmon Seminar Branas/Ransby – 2 to 4 September. Derek Mills)

The last paragraph (on page 11) should read:

It was obvious from the general discussion afterwards that many present were still not convinced by Per Nyberg's arguments. As I flew over the vast expanse of Lake Vänern on my homeward flight I realised that there were as many *problems facing the conservation of the rare stocks of* landlocked salmon as faced our salmon in the north Atlantic and of whose problems I would be hearing at the forthcoming symposium in Ireland.

*****

AST ADVISORY SERVICE

Introduction. Through its Biologist, John Webb, the Trust is able to offer an initial advisory service to District Salmon Fishery Boards and River Associations.

Scope. The Trust's Biologist has 11 years experience of working on United Kingdom rivers, with contacts in this country, Ireland, Norway, Canada and elsewhere. He is able to provide preliminary advice, before detailed planning or implementation of salmon management projects is undertaken, on the following subjects:

- **Salmon biology**
  Basic biological requirements of key species
  Limiting factors
  Survey design
  Sampling protocols
  Scale reading
  Water quality

- **Salmon population management**
  Redd counting
  Stocking methods
  Catch and release policy and techniques
  Fish and egg handling and transport
  Tagging

- **Habitat**
  In-stream and riparian habitat assessment
  In-stream and riparian habitat management techniques

- **Project Management**
  Planning, monitoring and evaluation

- **Costs**
  Project design
  Cost/benefit analysis of possible management actions
  Project maintenance

Conditions. This assistance is not intended to supplant the detailed service available from specialist consultants. It is aimed at providing advice to smaller salmon fishery management organisations, who are considering undertaking enhancement and/or monitoring projects, on the feasibility and potential scope of their proposals, and on the range of professional services that are available to implement specific projects. It will be provided without charge, except for expenses incurred, although a donation in support of the work of the Trust would be appreciated. Advice will be offered in good faith, but it will be appreciated that the Trust cannot take responsibility for its consequences.

Enquiries. To the Atlantic Salmon Trust at Moulin, Pitlochry (01796-473439) or directly to Mr John Webb (01224 295346 – Email address: j.webb@marlab.ac.uk).

THE NATIONAL SALMON AND TROUT FISHERIES CENTRE, CARDIFF

(Nigel Milner)

Modern fisheries management is increasingly a science-based activity. Stock assessment, protection of the fish's environment and control of fishing all require detailed understanding of the processes regulating stocks and of the socio-economic features that characterise the fisheries. Any organisation hoping to manage salmon fisheries properly must have systems in place to provide this strong scientific base. Salmon management in England and Wales is the responsibility of the Environment Agency, which has recently set up a national centre to provide a focus for the science behind the business. This article explains the role and work of the group.

The Environment Agency was set up in 1996 and has wide-ranging duties in the fields of environmental protection and regulation. Fisheries is one function among many, including waste management, radioactivity, water pollution, conservation, water resources, and flood defence. There are eight regions and over 7,000 staff, with more than 500 in the Fisheries function alone, so co-ordination and communication present some challenges. The Centre's principal aim is to provide scientific support for policy development and operational fisheries practice across the regions. Regionally based fisheries scientists are still essential to the fisheries work of the Agency, but now they have centralised specialist assistance and a focus for networked and co-ordinated best practice.

The NSTFC is a small group of eight staff, including two secondment posts, filled by regional staff who wish to spend time on project work. The Centre is based in Cardiff, but two staff work in Buckley, North Wales, running the Dee Stock Assessment Programme. The Centre's annual work programme is divided into five main areas:

- Resource assessment
- Research and development
- Education and liaison
- Best practice development and dissemination
- Policy and strategy development

These are briefly described below.

Resource assessment

Resource Assessment is the single largest activity, covering the collation, interpretation and reporting of stock assessments for salmon and sea trout. Catch return forms, which can sometimes seem to be a frustration to fishermen, provide a vital part of the assessment process. Annual returns from over 30,000 anglers and hundreds of licenced netsmen are entered onto computers between December and February and form the basis of provisional stock assessments which are reported, jointly with colleagues in CEFAS (Centre for Environment, Fisheries and Aquaculture Science), to the ICES (International Council for the Exploration of the Sea) Working Group to support NASCO decisions on high seas salmon fishery regulations. Other data come from a network of counters, traps, tagging programmes and juvenile electro-fishing surveys carried out by Agency staff in the regions.

Large volumes of data are produced through the national monitoring programmes. This is expensive work and to be cost-effective such information must have a clear purpose and be speedily accessible to a wide range of internal and external users. New software systems are in development to handle the management, analysis and reporting of these data through the National Centre. From 1998 the Centre will produce the Agency's national catch statistics report, which will be a definitive annual record of salmon and sea trout data. A national classification scheme is being implemented, which will enable all data to be reported to common formats.

The River Dee Stock Assessment Programme (DSAP) is based on a sampling and tagging programme of salmon and sea trout at Chester Weir fishtrap, complemented by an electronic counter, juvenile surveys and angling log book census. Begun in 1991, the DSAP fulfills a dual monitoring and research role and has become an established part of salmon stock assessment for the British Isles. The practical expertise built up through this programme provides a foundation for advising on such studies elsewhere, and the facilities enable the Centre to test new methods.

Research and development

The NSTFC both manages the Agency's salmonid fisheries R&D programme and carries out a certain amount of research internally. The programme is directed by the Function's business aims, and current priorities include the development of methods to evaluate the socio-economic value of fisheries, the impacts of land use on stream environments, sea trout stock characteristics and the refinement of salmon stock assessment and modelling in the context of spawning targets.

The use of catch statistics figures highly in the Agency's approach to monitoring and assessment of both stocks and fisheries. The translation of catch into the number of eggs laid by salmon requires detailed understanding of factors controlling fishing efficiency, fish and angler behaviour, response to river flows, distribution and movements, return rates etc. The data collection procedures need to be robust enough to meet their intended use. Part of the purpose of the research is to establish just how robust data need to be and to define the risks and uncertainties associated with decision making under different scenarios of accuracy and precision. Moving the emphasis away from fish, fisheries managers also need to respond to the demands and perceptions of fishermen in the context of the diversity, quality and value of fishing opportunity. These socio-economic aspects are emerging as a challenging area for scientists.

Environmental impacts are important constraints on salmonid fisheries and environmental protection is obviously a huge area of work for the Agency. In the case of salmon, minimising the effects of environmental degradation in freshwater is crucially important to maximise the reproductive potential of returning spawners, at a time when changes in the marine environment seem to be reducing their survival and abundance. The impacts of land use, acting through soil erosion and stream siltation, pesticides, flow changes and in some areas acidification are of particular concern at the moment. R&D on these issues is in hand to identify the scope and mechanisms involved, in order to establish sustainable solutions.

Education and liaison

Communication of the principles and ideas governing fisheries management has sometimes been regarded as secondary to the business of "doing" management. This needs to change, and the Agency attaches great importance to open and accountable decision-making. This requires a strong in-house science base as well as well-informed and interested user groups. Liaison, communication and promotion of the Function's science is thus an important role for the Centre, which is achieved through a variety of channels. Articles, leaflets, exhibition material, workshops, seminars, Internet and the scientific literature all play their part in informing professional and lay people. Partnerships and collaboration in fisheries science are essential to avoid unnecessary duplication and to fund progress in these expensive fields. In the case of salmon and sea trout, our links with the Atlantic Salmon Trust are particularly important. The NSTFC provides a route for the Agency's input to such co-operative ventures, by liaising with other funding or research agencies and institutes, such as CEFAS.

Best practice development and dissemination

Fisheries management is often a highly technical business, giving great scope for inconsistency of methods and standards in an organisation as large as the Agency. Definition and dissemination of best practice through training workshops and guidance manuals provides a direct, tangible link to regional staff and is supported by a technical advisory service on matters such as stock assessment and the technical basis to Salmon Action Plans. Expertise on a particular subject may lie with staff in regions who have built up considerable skills in specialist topics such as fish counters, fishpass design or acoustic counters for example. The Centre's role is then as a clearing house, by knowing what is going on in scientific developments inside and outside the Agency and being able to place enquiries quickly with those who can help.

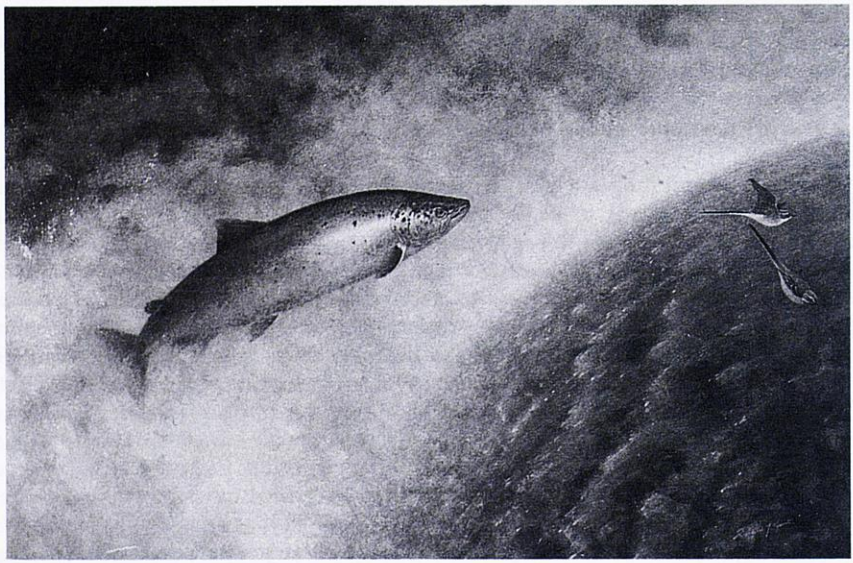
Strategy and policy

Finally, the Agency's future fisheries policies and long term strategy are dependent upon good scientific advice. Current priorities in this area are: development of a national trout strategy, the design of a national fisheries monitoring policy and incorporation of fish genetics into policy that will meet the Agency's aims for sustainable protection of biodiversity. In the immediate future the Centre will also contribute to the Agency's input to the review of fisheries legislation.

Although the programme outlined above is wide ranging, the priority for the NSTFC in its early stages lies in forging links with internal and external customers. This, and establishing sound monitoring and information systems will be the basis for delivering later benefits for the managers and users of sustainable salmonid fisheries.

For further information about the Centre please contact Dr. Nigel Milner at:
National Salmon and Trout Fisheries Centre
Environment Agency
St. Mellon's Business Park Tel: 01222 770088 Fax: 01222 362487
St. Mellons', Cardiff CF3 0LT Internet: nigel.milner@environment-agency.gov.uk

THE FISH IN ART



Richard Smith. "Atlantic Salmon and Grey Wagtail", Acrylic 37½" x 54½"

PAINTINGS - BRONZES - CERAMICS

A contribution from proceeds of sale will be paid to
The Atlantic Salmon Trust

Brochure available on request

THE COTSWOLD WILDLIFE ART GALLERY
LITTLE FARINGDON MILL, LECHLADE, GLOS. GL7 3QQ
Tel: 01367 253060/252754 Fax: 01367 253406 Email: cwag@lfm.co.uk

EDEN RIVERS TRUST

(James Carr)

It was a bad day in March 1993 when a chemical spillage on a farm near Kirkby Stephen (just north of Bowes Moor on the A66 Scotch Corner to Penrith road) caused the death of all fish life in the Eden from there downstream for approximately 20 miles to Penrith. The timing could not have been worse, with juvenile salmon congregating in the river prior to moving downstream and, for the local trout fishermen, a stocking of brown trout recently completed.

The case for damages has been a complex one and has not yet come to court – however many of the riparian owners were members of the Anglers Conservation Association which has generously taken up the case on their behalf. For those that weren't members the question arose as to whether or not they wished to join the action with the consequent exposure to legal fees – this was particularly true of the owners of lower salmon beats whose loss was much less easy to prove than the trout beats which were directly impacted.

After much discussion it was decided that the Lower Eden Owners Association which had a few pounds in its reserves should offer to underwrite all legal expenses for the salmon beats and that in return all the benefit of the claim for both ACA members and others should be channelled back into the good of the river. The obvious vehicle for this was a charitable trust. It was against this background that The Eden Rivers Trust was formed – as events proved its formation and indeed the commencement of its activities were well in advance of any resolution to the pollution claim!

The Trust achieved charitable status in late 1996: unlike in Scotland the English system will not accept 'fishery' trusts as being charitable. It is assumed that such trusts would be funded by riparian owners for their own benefit! Instead the objectives need to be drawn much wider – conservation and education being the key elements. Perhaps this is for the best since it mirrors very closely the changes in emphasis within the Environment Agency between fisheries and conservation generally. Healthy fish populations are surely the ultimate litmus test of a healthy environment!

Our Trustees reflect this broader remit. Our chairman, Andrew Quinn, is the retired Chief Executive of Granada Television; others include a representative from North West Water, our lead sponsor, and from Lowther Estate, one of the leading landowners in the upper catchment. We are also fortunate in having Ian Gregg, a recent incomer to the area who brings with him all his experience on the Tweed.

We have been particularly fortunate in receiving sufficient funds from North West Water to employ a full time Environment Manager – the Eden is a particularly important catchment for the water company since they have significant abstraction rights not only from Ullswater, Hawes Water and the nearby fells but also from the river Gelt rising in the Pennines. Both the Gelt and Lowther sit in the top twenty low flow rivers in England, which indicates the seriousness of the Eden's plight.

Other core funding has been received from a variety of charitable trusts, riparian owners and 'friends' so that the Trustees feel comfortable in committing up to £20,000 per annum for the next three years towards environmental programmes. It is intended that this money should be allocated to projects that can achieve a gearing factor of 3:1 or better: successful applications have been made for Landfilll Tax money, a 5b application is awaiting a decision and small grants have been received from English Nature, Environment Agency, Lake District National Park and others.

Exciting as this is – at least for those involved in the Trust's work – the money is only a pittance in relation to what needs doing. It would be easy to attempt a host of small projects throughout the whole catchment and have nothing visible to show for it: instead we have relied upon the advice given by English Nature and the Environment Agency, following their river survey work for SSSI designation and Salmon Action Plans respectively, to identify specific tributaries that need help and might respond to a more extensive programme. It is particularly pleasing that in one instance we have been able to work on one project with the Environment Agency and to find that the upstream site has been chosen as one of the Regional sites for their recently launched Sustainable Rivers Project.

We are also committed to providing educational programmes for schools and colleges – indeed as a precondition of sponsorship North West Water required 20% of our manager's time to be spent on such programmes. We are fortunate that Alasdair Brock, who joined us full time just over six months ago, is well qualified for and enjoys this particular aspect of his work.

We are a long way behind the West Country Rivers Trust in what has been achieved – but we have made a start. It is also encouraging to see other rivers in the North West adopting similar initiatives: no two rivers are the same and inevitably the structures for setting up active local organisations will also vary.

With the review of fishery legislation now underway it seems likely that the committee will need to consider how the various government agencies should link into local initiatives – whilst undoubtedly the traditional fishery consultatives should have their say, perhaps the real future for those who care about our rivers should be through slightly broader based conservation and education trusts such as the Eden Rivers. Certainly in our experience it is this broader aspect of the Trust that appeals to some of the funding sources which in turn provide the core funding to allow partnerships between a wide variety of bodies working towards a common goal.

In the end we must remember that fish are at the top of the food chain – if everything else is in good order so too will be the fish!

*****

THE WESTCOUNTRY RIVERS TRUST

Tamar 2000 SUPPORT Project Progress Report

(Arlin Rickard, Director, WCRT)

This four-year pathfinder environmental partnership project to restore and rehabilitate the River Tamar is split into two phases. Phase 1 covering the first two years of the project, comes to an end this summer. Phase 2 will take the project through to June 2000.

Causes not just symptoms

An important aspect of the project is the way in which it tackles the causes not just the symptoms of decline in water quality and habitat. Improvements brought about by the project also need to be sustainable. To achieve these aims it is crucially important to fully engage not just the riparian owners but also the farmers within the wider catchment. A large number of the Tamar 2000 environmental targets are linked to demonstrating and delivering economic savings and gains to farmers within the project's holistic farm plans. Fertilisers and farmyard manure are a case in point.

A win, win situation

The majority of farms in the project are showing savings of up to 25% on nitrate fertiliser usage. The savings coming from careful targeting, timing and application of bag fertiliser and the application of correct values to soil N and organic manures in the crop requirement calculation. Coupled with the use of clover in suitable grass leys and focused cropping, grazing and cutting regimes, benefits accrue to both farm profitability and the environment. The substantial cash savings on fertiliser being equivalent to that which previously would have leached from the soil and contributed to the nutrient enrichment of the river.

Farm yard manure, slurry and dirty water suffers from being often referred to as farm waste. This regularly means farmers underestimate its nutrient value as well as the costs associated with its storage and application. Here the project seeks to attach real values to this important farm by-product and reduce handling costs by waste minimisation techniques, in particular concentrating effort on clean and dirty water separation in the farmyard. Advice is then directed to its careful application to reduce run off and maximise take up by the growing crop.

Phosphates have perhaps played a bigger part than nitrates in the eutrophication problems associated with the River Tamar. As with nitrates, soil testing has revealed that on many livestock farms the application of bag phosphate can be dramatically reduced or even cut out altogether. This work, coupled with developing Best Management Practices to reduce loss of topsoil and erosion (phosphates often enter the river attached to soil particles), brings further gains to both farmer and water quality.

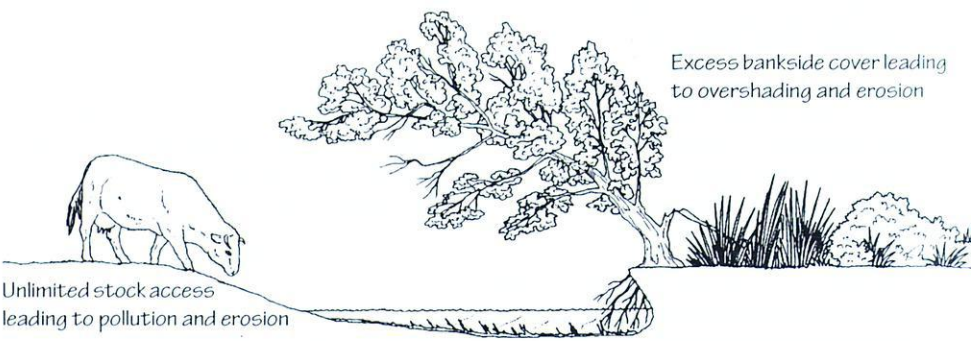
Look upstream to see how the T

. . . reducing soil erosion

The Trust tackles erosion by cattle and sheep by identifying vulnerable stretches of river bank and providing grant aid to farmers for fencing and advice on appropriate stock management.

The exclusion of stock from banks improves river corridors for all wildlife, enhances habitat for adult fish and helps maintain spawning gravels.

This is what we find



Shallow, muddy water, in over-widened channels with few fish. A poor spawning habitat.

. . . reducing diffuse pollution

Excess fertiliser and animal manure can lead to diffuse pollution creating algal blooms and de-oxygenation of water.

By creating Buffer strips along vulnerable water courses and providing advice to farmers in targeted areas the Trust can reduce this problem.

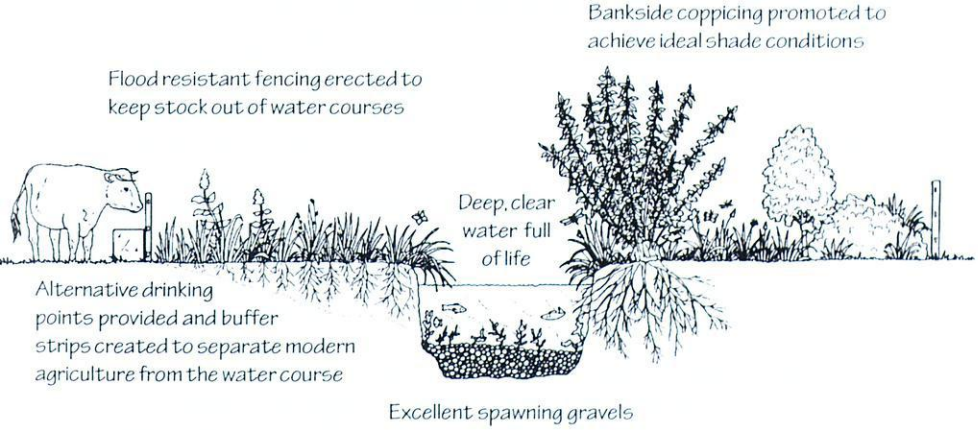
. . . why not cast a lit

...ust can improve your fishing ...

... conserving & restoring wetlands

The Trust adopts a long-term strategy to improve summer flows. Through working with landowners and increasing the awareness of the role that wetlands play in stabalising flows, the Trust aims to increase the area of wetlands in our catchments, so improving summer flows & water quality in a sustainable way.

This is what we leave



... coppicing

The Trust is keen to create appropriate levels of shading throughout the length of a river to provide habitat, cover and food for young and adult fish.

Too much shading leads to loss of bank-side vegetation, too little leads to high water temperatures. In places the Trust promotes bankside planting and river bank fencing, in others the Trust establishes a coppicing regime to achieve the desired levels of shading.

...e something our way.

Habitat restoration

The maintenance and restoration of key wetlands, coupled with the development of buffer zones and the re-vegetation of ditches within management plans, also play an important role in trapping sediment nutrient stripping and de-nitrifiction. Work indicates that the added water storage provided by these wetlands and ditches does offer measurable benefits in the amelioration of flashy flows and reduction of the extreme conditions brought about by flood and drought.

Compelling evidence

Every bit as important, and visibly the most spectacular, is the difference brought about by fencing livestock out of the river corridor, particularly when coupled with river corridor management in the form of coppicing and/or tree planting. Like other organisations before us, the before and after photographs of river corridor restored in this way are compelling evidence of the way in which this vital habitat has been neglected and abused in the past.

Farmers too have been quick to see the advantages to the husbandry of their livestock through fencing off the river in this way and again, with the provision of alternative drinking areas such as pasture pumps, can measure the benefit in cash terms.

The Tamar 2000 SUPPORT Project aims to involve over 500 farmers and riparian owners in the Tamar catchment.

Some outputs to date:

- Over 200 farms visited
- 25 kilometres of fencing erected to protect river corridor and provide buffer zones
- 12 kilometres of ditches under re-vegetation programme for water storage, trapping sediment and nutrient stripping
- 37 sites of accelerated erosion controlled
- 79 salmon spawning gravel areas de-silted
- Obstructions to fish migration removed
- Coppicing and tree planting
- Wetland restoration with monitoring sites established
- Demonstration sites of best practice established

A Phase 1 report for the project is in preparation at this time. A summary will be available in due course.

*****

THE NEW RESEARCH SHIP: *SCOTIA*

(A.D. Hawkins, Fisheries Research Services, Marine Laboratory Aberdeen)

A striking new ship recently entered Aberdeen Harbour to begin life as the main research ship of the city's Marine Laboratory. The ship bears the name *Scotia*, the fourth to carry this illustrious name. *Scotia* is a multi-purpose, diesel-electric vessel designed by Skipsteknisk A/S, of Alesund, Norway and built on the Clyde by Ferguson Shipbuilders Ltd. of Port Glasgow. Seventy metres long, and in a smart blue and white livery, the design combines the essential features of a modern hydrographic research ship with those of a top-line pelagic and demersal trawler.

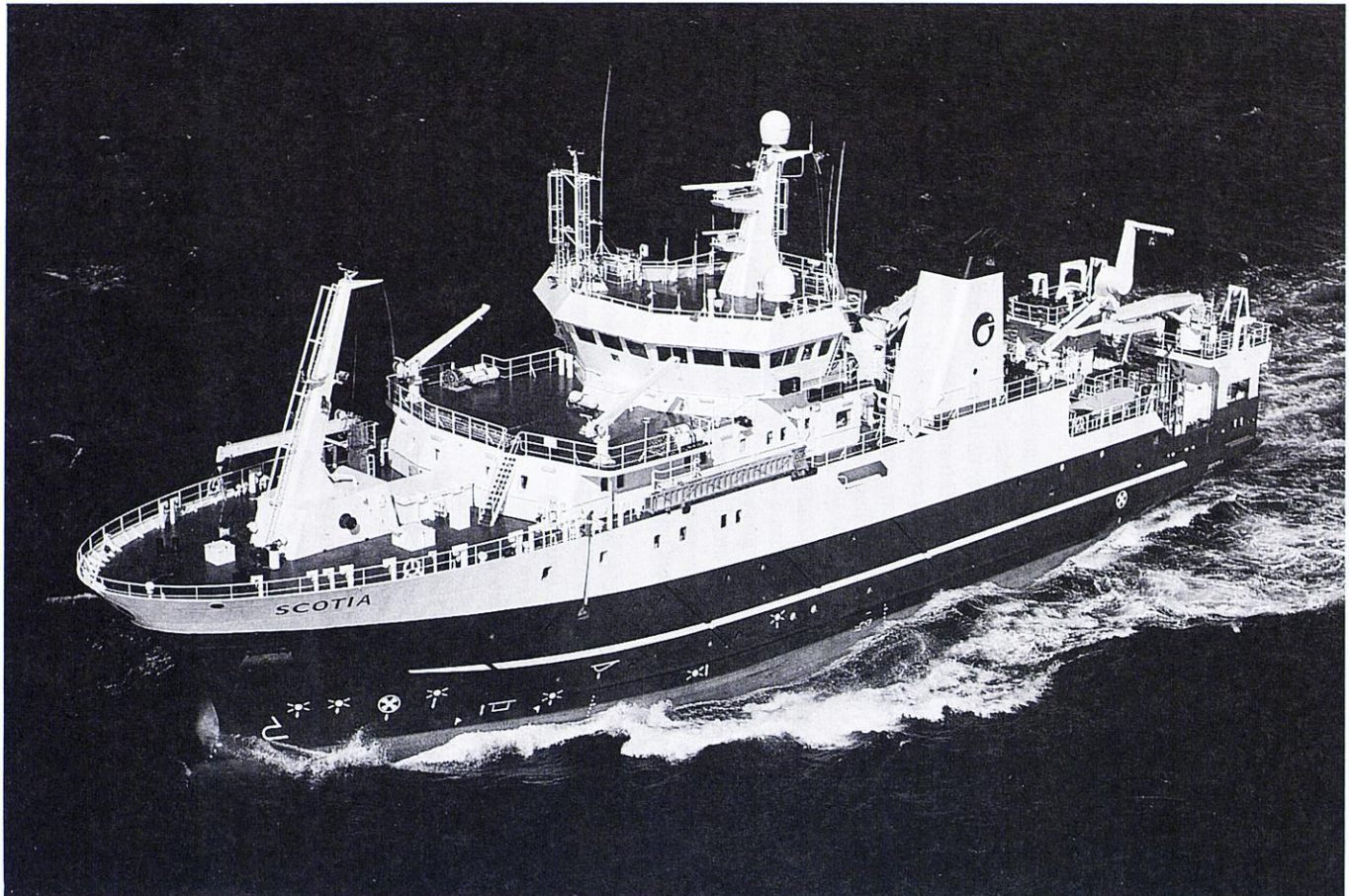
The Marine Laboratory, in Victoria Road Torry, is part of The Scottish Office. Its main function is to monitor the fish stocks on which Scottish fishermen depend. But it is also responsible for investigating the general state of the seas around Scotland. The new ship will carry out routine surveys of fish and shellfish stocks and in addition will sample the seas for evidence of pollution around the Scottish coast. It will provide emergency monitoring in the event of major oil spills, and will also take part in a range of international marine research programmes in the North Atlantic, including studies of salmon on the high seas.

The *Scotia* is designed to have an endurance of 30 days, and is expected to operate at sea for up to 290 days per year. The ship has a very flexible propulsion system, powered by three diesel engines, coupled to electrical generators supplying power to two electric motors on a common drive shaft. With all three diesel generators running there is sufficient power to tow a large pelagic trawl for mackerel in winter conditions. But the vessel is also able to travel between survey positions at 11 knots using only one diesel generator for economy.

The ship is also very manoeuvrable, as she has to operate close to fixed seabed positions and around structures like oil platforms. Her station-keeping abilities are maintained by a combination of the single screw main power drive, an articulated rudder, an omni-directional bow thruster, and a tunnel stern thruster, steered by a dynamic position fixing system operating through satellites above the earth.

The high central bridge of the ship allows all-round visibility. A fully instrumented autotrawl system facilitates fishing operations, allowing the tension in the trawl warps to be constantly monitored and reducing the potential for damage to the net. The trawl-deck is visible both from the bridge and from a trawl control cabin at the aft end of the trawl deck. To enable the vessel to move quickly from one fishing gear to another a series of small hydraulic winches are fitted, so that trawl doors can be changed easily and safely. The two main trawl winches are situated below decks and are supplemented by two net drums above deck, and an auxiliary drum below deck – allowing net repairs to be carried out under cover.

Although the ship is fitted with a stern ramp for trawling, hydraulically operated ramp covers can be put in place, enabling hydrographic work to be carried out from a floor directly over the stern. A gamma frame allows equipment to be picked up from the deck and lowered over the stern and replaces the less versatile A-frame or simple davit of earlier ships. *Scotia* also has several large cranes and tension-compensated low pressure hydraulic winches to deploy, tow and recover scientific equipment. These specialised cranes allow instrument packages to be locked to the crane tips close to the sea surface, greatly reducing the potential for damage.


SCOTIA

A drop keel can be lowered three metres beneath the hull of the ship, carrying acoustic transducers for echosounding and measuring ocean currents. The drop keel allows the systems to operate well away from the turbulence and entrained air close to the hull. The ship itself is very quiet, as much of the machinery is placed on resilient mounts, while the hydraulic systems operate under low pressure with large diameter pipework and bends of large radius.

Perhaps the most radical feature of the new *Scotia* is a system for locating container laboratories within the main body of the ship. Up to nine containers, five full-size and four half-size, can be loaded below decks and coupled to an umbilical system carrying a full range of services. The laboratories can be adapted and fitted out on shore, at the Marine Laboratory, and a different combination loaded for each cruise, minimising turn-around time in port.

The new *Scotia* maintains all the features of her predecessors. The first *Scotia* was a wooden sailing ship, a converted whaler, which took part in the National Antarctic Expedition of 1902 to 1904 to the Southern Ocean. Under the leadership of William Bruce, a distinguished polar explorer, the first permanent scientific station was established in Antarctica. The *Scotia* expedition also added substantially to knowledge of the outline of the Antarctic continent and to the bathymetry of the Weddell and Scotia Seas – the latter named after the ship itself.

In 1948, the Marine Laboratory acquired the second ship to bear the name *Scotia*, an ex-Admiralty minesweeper, which was converted to serve as a research ship. This ship ranged widely across the North Atlantic, carrying out a programme of hydrographic surveys across the Faroe Shetland Channel, and venturing to Greenland in the north and Rockall to the west. This *Scotia* carried out pioneering studies of the drifting plants and animals (including fish larvae) that populate the seas around Scotland. It was shown that water masses of different origin were characterised by 'indicator' organisms which could be used to follow the movements of these water masses of differing fertility, temperature and salinity as they moved around Scotland, and from the North Atlantic into the North Sea.

In turn, the steamship *Scotia* was replaced by a purpose built diesel-electric research ship in 1971. That ship, the predecessor of the new vessel, began her life as a hospital ship in the seas off Iceland, during the 'Second Cod War'. One of her first research cruises, however, was to West Greenland, where new investigations were beginning into the growing sea fishery there for Atlantic salmon. Later in her life, in the late 1990s, *Scotia* returned to the study of salmon through investigations into migrating salmon post-smolts to the west of Shetland.

The new *Scotia* will be operated for the Marine Laboratory by Marr Vessel Management Ltd. It carries a crew of 17, and can accommodate up to 12 scientific staff. The new ship is designed to operate in cold and inhospitable seas, carrying the most advanced scientific sampling systems. Her role will take her from the Bay of Biscay to the waters around Rockall and in the Faroe Shetland Channel. She is set to maintain a proud tradition of service for the Marine Laboratory and The Scottish Office.

*****

CONSTANT MONITORING OF WATER QUALITY

(by Chris Puhr, University of Durham, reproduced with kind permission from the Progress Report of the West Galloway Fisheries Trust, July 1997.)

A satisfactory quality of water is an essential requirement for all aquatic life, including fish, with salmonids being especially sensitive to downgrading of this water quality.

While in West Galloway Fisheries Trust's (WGFT) core rivers a lack of urbanisation in the catchment means there is little direct industrial pollution, with agricultural effluents usually affecting only relatively small, localised areas, it is disappointing that large areas of the headwaters of these rivers are, on the whole, fishless. WGFT and others believe that the evidence suggests that acidification is seriously influencing water quality in these areas, caused by the high acid deposition rates to the region and the often base poor underlying geologies present. This problem is exacerbated by the scavenging effect of coniferous forests which are more efficient at accumulating acidifying pollutants than other vegetation types.

In order to contribute rationally to the debate on surface water acidification and to be able to lobby statutory bodes about our concerns WGFT purchased constant monitoring equipment which was installed on the Rivers Bladnoch and Luce in 1991. In 1992 further apparatus was installed on the Water of Fleet and subsequently in 1996 additional equipment was placed in the River Cree following discussions with the Macaulay Land Use Research Institute (MLURI). WGFT now record accurately and continuously pH, stage height (an index of water flow) and temperature throughout the year at these sites.

The equipment is powered by rechargeable solar batteries and records information every 20 minutes. In this way a great deal of data is generated and every 2 weeks WGFT visit each site to download this information to disc and recalibrate the probes to ensure the continued accuracy of the records taken. To check further the functioning of the probes water samples are collected to be analysed by SEPA. These checks have confirmed the accuracy of the data collected.

This network of recording stations allows WGFT to monitor water quality (in terms of pH) accurately throughout the year. Minimum pH levels are of obvious concern although the actual period of time pH remains depressed before recovery to acceptable levels is perhaps more important in influencing the survival of juvenile salmonids.

WGFT have found that during dry periods (normally summer months) pH values on monitored rivers rise steadily often exceeding pH.6. At this pH salmonid fish species are able to survive. However, during flood events (typically in autumn/winter) a combination of wet and dry deposition results in a rapid decrease in pH (increase in acidity) to levels where salmonid survival is less likely.

During 1996 pH values of less than pH.4 were recorded at all 4 sites. Additionally, these low pH values were found to remain depressed for extended periods with the Bladnoch site having a pH value of less than 5 for all of October, November and December 1996.

The pH values recorded mean that all of the rivers monitored regularly fail the EC Freshwater Fisheries Directive in terms of pH requirements for salmonid fish. At the levels recorded it is very likely that acidification is the major factor in making these areas fishless with the sensitive egg and alevin stages being particularly affected through the malfunction of hatching enzymes causing a failure to hatch. Alevins can also suffer problems in the processes associated with the development of organs such as the brain and spleen.

Additionally, harmful aluminium concentrations can be elevated by decreased pH values which can impact upon the biological communities present in the water course, including all lifestages of salmon and trout. It is estimated that a continued increase of between 5 and 50% in the mortality of the egg and fry life stages is likely eventually to cause the extinction of an affected salmonid population.

Other work by WGFT shows a lack of juvenile salmonids present in electrofishing surveys, a lack of overwinter survival of hatchery reared fry when introduced to these areas, and has confirmed the inability of salmonid eggs to develop and hatch viable alevins in these reaches.

In recent years a number of protocols have been negotiated and implemented which reduce the amount of industrial and other emissions released to the atmosphere which increase acid deposition levels. These measures are welcomed by WGFT but at the present time we are unable to detect an improvement in water quality and salmonid populations following these reductions. The headwaters of our rivers remain acidified, juvenile salmonid populations remain impoverished or absent, egg survival is poor and the rod and line fisheries of the river are suffering economically as a result. WGFT will continue to monitor water quality despite its implications in terms of use of resources (one man month and in excess of 3000 miles are allocated annually) and will continue to contribute to the debate regarding emissions and the appropriateness of continued coniferous plantings and re-plantings on acid sensitive geologies. These are issues which will not disappear quickly and estimations as to when water courses are likely to recover chemically remain uncertain. The point at which biological recovery is likely is even more difficult to determine with any degree of confidence but is unlikely until well into the 21st century.

In the meantime WGFT hope to maintain remnant salmonid populations in carefully selected areas of these headwaters through hatchery operations and to influence policy makers in the assessment of land use issues likely to influence the acidification problem. WGFT regard this work as of fundamental importance to the area and hope, by ensuring the issue of acidification remains high on the agenda of relevant bodies, that progress can be made which will assist the biological recovery of our rivers in the future.

*****

HYBRIDISATION BETWEEN ESCAPED FARMED ATLANTIC SALMON (SALMO SALAR) AND BROWN TROUT (SALMO TRUTTA)

-

Frequency, distribution, behavioural mechanisms and effects on fitness.

(John Webb, AST Biologist)

In 1991, a study by the Freshwater Fisheries Laboratory, Pitlochry and the Atlantic Salmon Trust on 16 rivers in Scotland showed that in 14 of the systems surveyed there were salmon fry that could be demonstrated to be the result of spawning by escaped farmed female salmon. Furthermore, among these fish, there was a disproportionately high number of hybrids between salmon and trout; rates of hybridisation between salmon and trout were higher for female escapees than for wild fish. This observation was supported by subsequent independent studies carried out in rivers in Norway where elevated levels of hybrids were detected in those rivers with a history of spawning by escaped farmed salmon or in rivers that discharged into areas where cage rearing of salmon was being carried out.

These findings led to the setting up of a EU supported collaborative study (Contract no. AIR3 CT94 2484) between the four research groups based in Norway (NINA), Belfast University, Aberdeen (FRS/AST) and Ireland (SRAI). The study was designed to look at the frequency of occurrence survival and reproductive function of hybrids and their progeny. Using a wide range of field sampling, behavioural and genetic techniques the four teams of workers conducted a series of investigations to quantify hybridisation in 'unspoiled' rivers and in rivers that had a record of high proportions of escaped farmed fish, to identify the mechanisms of hybridisation and assess the performance of hybrids at various stages of their life cycle. The project ran for a period of two years and some of the key findings were as follows:

Samples of swim-up fry were obtained by electro fishing from a selection of salmon rivers free from aquaculture effects in Scotland, Ireland and Norway. Ten rivers yielded a baseline frequency of hybrids at 0.6% (range 0.0-4.7%). Samples taken in four rivers in Scotland and Norway, for which intrusion of escaped farmed salmon was known, produced 3.7% F1 (first generation) hybrids (range 0.4-7.0%) and 1% post F1 (ie. Second or later generation) hybrids.

DNA analysis indicated that with the exception of a single specimen obtained from the River Tweed, all these hybrids were the result of spawning between male brown trout and female salmon. Among samples taken from the rivers Kerry, Dionard (Scotland) and Os (Norway), other fish were detected that could have been the result of spawning between hybrid adults and pure bred fish – so called post-F1 hybrids. Indeed, in the Kerry and the Dionard fish were detected with a genetic background that suggested that introgression to salmon had occurred although it was not possible to deduce whether this had been the result of a cross between a hybrid and a pure species or a cross between two different F1 hybrid parents.

In another part of the study, a range of behavioural studies were conducted in Norway using wild and farmed salmon and large brown trout to examine the behavioural mechanisms that lead to or prevent hybridisation. Mature male parr of both species are known to participate in spawnings among adult fish. As a consequence, of particular interest was the behaviour of mature trout parr at spawning as they are considered to be one of the most likely routes of hybridisation.

There were clear differences in the spawning behaviour of salmon and trout. Only 7% of the salmon spawnings were observed to involve parr. Furthermore, farmed female salmon were observed to have more parr involved in their spawnings than wild females. Farmed salmon were less successful at defending their spawnings from involvement by parr than were wild salmon and had a higher frequency of their eggs fertilised by parr (45% *vs* 7-11% in spawnings with wild salmon). Indeed, a lower frequency of wounding incurred by parr in the absence of wild salmon suggests that farmed salmon are less vigorous or successful at driving parr of either species from the spawning area.

Natural and semi-natural redds of wild salmon and ranched salmon from wild parents were also investigated to estimate the contribution that parr (of either species) had made to the final spawning. In wild redds, the percentage contribution ranged from 0-55.1% (mean, 32.2%). In redds produced by ranched salmon the range of parr contributions was higher, between 42 and 64% (mean 56.8%).

Though the early part of the study had demonstrated that hybrids did occur in wild populations, very little was known of their survival in a hatchery and in the wild. Consequently, the survival of artificially produced hybrids was compared in the hatchery and the wild. Rearing and release experiments showed F1 hybrids to be intermediate between the parental species in morphological, ecological and behavioural traits. The hybrids survived in both fresh and sea water. Indeed, survival of F1 hybrids was quite high in both environments. However, survival among backcrossed F2 groups (F1 hybrid backcrossed with a pure trout or salmon) was shown to be very low, and only occasionally did the backcrosses survive after first feeding. After the F3 backcross stage however, viability was restored.

In conclusion, the results of this research suggest that hybridisation between salmon and trout may increase following escapes of farmed salmon and deliberate releases of cultured fish, and that such hybridisation may have important ecological and genetic consequences for wild populations.

*****

REPORT FROM THE SALMON FISHERIES CO-ORDINATOR

(Andrew Wallace)

There have been a number of interesting developments on the West Coast over the last few months, one of the most encouraging of which has been the appearance of the Trusts' first annual reports. 1997 was the first full year of work for the new West Coast Trusts and these reports, which have been prepared over the winter, are a testament to the vast amount of work that has taken place thus far and on which the biologists will be building this season. Whilst much of the work is still preparatory in nature it is clear from the reports that a comprehensive basic inventory of the catchments and their problems has now been prepared and this will allow problem areas and priority issues to be isolated and worked on with increasing efficiency. These reports are available to members of the Trusts, and those who are interested in their work going on in any one area should contact the relevant Trust whose addresses have been listed below.

Another development of interest is the possible expansion of the Awe Fisheries Trust into the South Argyll area. This area includes rivers like the Eachaig, Fyne, Add, Euchar and Creran which are currently not covered by the Trust network. On June 8th there was a public meeting held in Inverary to discuss such an expansion and over the next few months a steering group will look into the feasibility of raising further funds in this area to provide a second biologist for an expanded Awe and South Argyll Fisheries Trust. This will give reasonable coverage throughout a large and geographically complex area. If anybody is interested in this expansion, then further information can be obtained from the Awe Fisheries Trust biologist, Dr. Colin Bull (address below).

Continuing on the theme of Trust development, a steering group has now been formed and a draft proposal prepared exploring the potential of setting up a Clyde River Foundation in conjunction with the angling clubs in Strathclyde and the River Clyde Fisheries Management Trust. A lot of preparatory work has been done over the last 2 years and there seems to be sufficient enthusiasm to take the idea on to the next stage. It is hoped, after a fairly extensive consultation process, that this proposal might become a reality next year. The idea is to capitalise on the enormous amount of voluntary work already being done on the Clyde by angling clubs, and this will hopefully be brought about through the appointment of a co-ordinator who could provide 'on site' fisheries management and research advice, help raise funds for project development and ensure that the Clyde plays a role in the various national fisheries initiatives that are taking place in Scotland. The Clyde has the considerable benefit of being a river both into which salmon seem to be returning in growing numbers and which has a vast commercial catchment for sponsorship. A similar project in the Forth catchment is also being considered although this is very much in the first stages of discussion.

One of the principal responsibilities of the West Coast Trusts is collecting fisheries and related data, of which there has been a scarcity on the West. To most, data is dull stuff and seems perhaps to be less of a priority in a world in which West Coast sea-trout stocks continue to bump along the bottom and salmon stocks appear not to be doing much better. The problem is that without good data, presented in a form which policy-makers will understand and pay heed to, there can be little hope of influencing the apparent ambivalence of such policy-makers to the problems on the West Coast. The Scottish Office continues to stand by the statement that salmon and sea-trout stocks on the West Coast are experiencing no more serious a decline

than those on the East Coast – a fact that even their own statistics refute. But it is in the face of this sort of attitude that the need for cast iron data and the highest quality information becomes essential, even if it is expensive and time consuming to gather. Those amongst us whose patience is being severely tried on the issue of the crisis affecting West Coast rivers should be reassured that the West Coast Trusts are not gathering this information simply to satisfy their own curiosity but hope shortly (and to some extent they have started already) to put such information to good practical use. This will start to deliver benefits locally, hopefully in the not too distant future, but equally exciting is the prospect of being able to combine the work of all these fisheries management organisations from around Scotland, including the Scottish Office's own laboratories, with the ultimate aim of being able to target this information collectively at specific high priority problems, in a way which will undoubtedly be much more difficult for those who are responsible for such issues to ignore.

To assist in this the Scottish Fisheries Co-ordination Centre (SFCC) has been established, which currently consists of 12 partners. These include the 6 West Coast Trusts, the Conon Fishery Board, Spey Research Trust, Tay Foundation and Tweed Foundation who, with the Freshwater Fisheries Laboratory at Faskally and the University of Durham (providing Information Technology support), are starting to co-ordinate the way in which fisheries data are collected, collated, analysed and ultimately used. Each of these partners pays an annual subscription to the SFCC which entitles them to the services of the centre.

There are a number of strands to this project, the first being the development of a standard data-base for recording fisheries data. The partner Trusts, whose combined areas now cover about half Scotland in conjunction with the Freshwater Fisheries Laboratory are now collecting electro-fishing and habitat data to agreed protocols that they have developed amongst themselves. This project is being extremely effectively developed and co-ordinated by Chris Puhr whose work has been sponsored by Scottish Hydro-Electric.

This database will be continuously developed and refined and twice yearly training sessions are organised to ensure that the correct techniques for data gathering and recording are being adhered to. But of perhaps greater interest is how these data might be used once collected. The SFCC is currently developing a Geographical Information System (GIS) which will allow fisheries data to be related to other data-sets such as land use, hydrological, geological and digital terrain data. Such a system relies heavily on high quality data – the simple equation being that if you put rubbish into such a system, you get rubbish out. But with rigorous standards being developed and adhered to the hope is that a dedicated fisheries GIS system will provide a level of support for fisheries biologists and managers which will save time, money and allow, in time, for the development of models which could greatly assist management decisions.

Whilst the SFCC currently involves 10 trusts, the intention is to develop the project to include other catchments and possibly other organisations who have direct or indirect interests in fisheries and habitat data. The project is very much in its infancy but progress to date has been good and the SFCC hopes to be able to provide a fisheries GIS service to the partners this summer. Provision is also being made for making the software, training and data collection protocols available to other fisheries management organisations who might want to participate in this project at a lower level.

Those wishing to find out more about the SFCC and its work should contact me on 0131 558 8858 and it might be possible to arrange for a demonstration of the GIS project to any interested fishery boards. There will be regular news through the AST Progress Reports, and through the Salmon Fisheries Co-ordinator's Quarterly Reports which give a short summary of important initiatives and news in the Scottish salmon arena. If you wish to be put on the mailing list for these reports please contact the same number.

West Coast Fisheries Trusts – Contacts

Western Isles – Mark Bilsby, Creed Lodge, Marybank, Stornoway, Isle of Lewis HS2 9JN Tel/fax: 01851 701526, Email: m.bilsby@btinternet.com

West Sutherland – Dr. Shona Marshall, Gardener's Cottage, Scourie, by Lairg, Sutherland IV27 4SX Tel/fax: 01971 502259, Email: shona@wsft.demon.co.uk

Wester Ross – Dr. James Butler, Rose Cottage, Eilean Darach Estate, by Garve, Wester Ross IV23 2QN Tel/fax: 01854 633349, Email: James@wrftrust.demon.co.uk

Lochaber – Dr. Jon Watt, Arieniskill Cottage, Lochailort, Inverness-shire PH38 4LZ Tel/fax: 01687 470350, Email: ldftrust@zetnet.co.uk

Loch Awe – Dr. Colin Bull, The Ardchonnel Old Schoolhouse, Eredine, by Dalmally, Argyll PA33 1BW Tel/fax: 01866 844293, Email: c.bull@zetnet.co.uk

West Galloway – Callum Sinclair, 12a Victoria Street, Newton Stewart DG8 6BT Tel: 01671 403011, Fax: 402248

*****

NORTH ATLANTIC SALMON FUND (UK) REPORT

(By the Secretary)

At the June meeting of the North Atlantic Salmon Conservation Organisation (NASCO) there was a dramatic change in the regulation of high seas commercial salmon fishing. For the first time, no quota was allocated to the West Greenland commercial fishery, primarily because of the desperately low forecast of the state of salmon of North American origin in relation to the spawning targets for Canadian and US rivers. There is still no overall spawning target for European rivers, but the scientific advice was that exploitation of these stocks should be significantly reduced. Given these two arguments, the result was that salmon fishing off West Greenland in 1998 will only be allowed for local consumption (previously assessed at 20 tons, or about 7,400 fish). This adds incentive for the Greenlanders to agree to Orri Vigfusson's offers to reach a deal for a long-term closure, in return for compensation payments and assistance to switch to other fisheries. Orri has previously had encouraging meetings with fishermen and government representatives in Greenland, and there are good grounds for optimism.

The Faroes fishery remains closed, as it has done since 1991 under Orri Vigfusson's original agreement, and the latest scientific assessment is that its closure increased the returns to European waters in 1997 by 6-12%. This is significant, in a year when catches were at an all time low, they might have been even lower without the closure of this fishery.

The NASF (UK) campaign for 1998 is proceeding well. It was given a splendid boost by a dinner held in Aberdeen in April at The Marcliffe at Pitfodels, which was generously hosted by its owner, Mr Stewart Spence, and raised over £65,000. NASF(UK) was honoured that His Royal Highness The Prince of Wales had agreed to attend the dinner, and his enthusiastic support for Orri Vigfusson's unique initiative to preserve the diminishing stocks of wild Atlantic salmon was a great encouragement to all.

These funds, raised from generous private benefactors, will augment the significant and vital support from Scottish District Salmon Fishery Boards and from River Associations and Angling Clubs in England, Wales and Northern Ireland. However, the prospect of longer-term agreements means that there can be no let-up in the fund-raising effort. Details can be obtained from the Registered Office of the North Atlantic Salmon Fund (UK) at:

Brodies WS
15 Atholl Crescent
Edinburgh
EH3 8HA

*****

DNA fingerprinting studies

Lifetime fitness among spring salmon and early running grilse

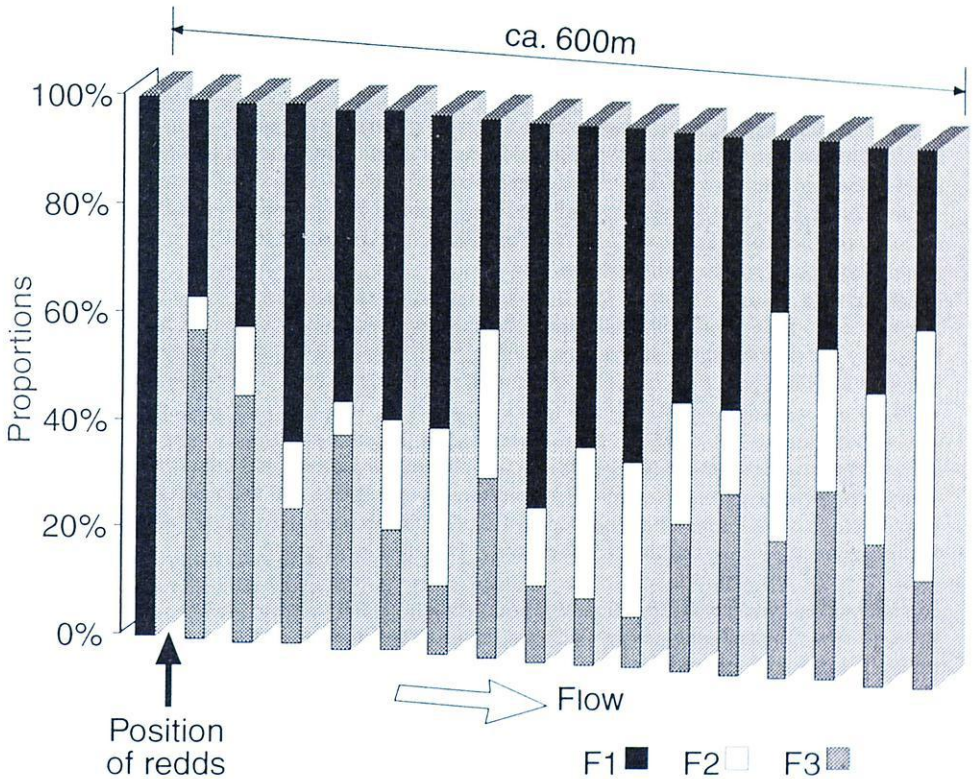
The research project at the Baddoch burn is progressing well and as planned (for a detailed description, see the December 1997 AST Progress Report). Sampling of all the migrating parr and smolts captured at the fixed smolt trap is continuing. Like last year, the mild weather saw some smolts begin leaving the burn during February. However, it was late March before the more normal larger daily catches were made – coinciding with snow melt and rain induced spates and the darker nights associated with a new moon. To investigate whether the time at which fish leave their home streams affects their subsequent return rates as adults, we have batch tagged each monthly group of migrants. Of particular interest is the relative performance of those fish that begin leaving the burn very early in the spring (February-March), compared with the main component of the run that leave in April, May and early June. By early May, approximately 1400 fish had been caught. All have been sampled for scales, micro-tagged, fin-clipped and released.

Sampling of migrants will continue up to the end of the smolt run and scale reading and DNA analysis of the samples obtained last autumn and this spring will be carried out over the summer months.

The distribution of different families of 0-group salmon in common areas of natural stream habitat

Laboratory analysis of samples obtained from 0-group salmon fry dispersal study has now been completed. Each of the three family groups of fish was derived from the same number of eggs (3000), placed in a single artificial redd. All the eggs were fertilised on the same day to ensure a common hatch date. In early September, samples of the resultant fry were obtained throughout the length of the study area by electro-fishing – corresponding to the end of the first summer period of distribution from the redd, density dependent mortality and growth.

The diagram opposite shows the distribution of three families of 0-group salmon fry captured in contiguous sectors throughout a common area of stream habitat as revealed from the DNA analysis. The frequency and distribution of fry throughout the available rearing habitat differed significantly. One family (F1) generally contributes more than one third of the fish in each section, whilst another generally contributes less than one third. Indeed, the study shows that in most sections sampled, one family is greater than the proportions that might be expected (ie. greater than one third). The other two families (F2 and F3) increase and decrease as we move downstream. Finally, near the bottom of the main study area, the proportions of each of the three families are approximately one third.


ca. 600m
100%
80%
60%
40%
20%
0%
Proportions
Position
of redds
Flow
F1
F2
F3

Although this data represents something of a single 'snapshot' of the ongoing process of distribution, growth and competition among young salmon in the first year of their free swimming lives, these preliminary findings are important as they suggest different families of salmon fry colonise common areas of habitat differently – a process that is probably driven by competition. Further analysis will be carried out on this data to explore the effects of habitat quality on the local fry densities and their growth. In addition, the effects of single isolated redds on the distribution of fry derived from larger redd groupings will be investigated.

Meetings and publications

In March I gave a presentation on catch and release and live fish handling to members of the River Findhorn DSFB, proprietors and ghillies. The presentation will be repeated at the invitation of the Conon DSFB at a meeting in late May.

In early April, I attended a meeting of the EA and representatives of the Taw and Torridge fishing associations to discuss future option for water quality monitoring, juvenile population assessment and management and riparian habitat management. Later in the month I gave a short presentation to the members of the Dee Salmon Improvement Association on my research on the River Dee with particular emphasis on the management of juvenile salmon populations that generate spring salmon.

A paper entitled 'Escaped farmed salmon in Scotland: temporal and spatial trends in their frequency and occurrence' that was presented at the ICES/NASCO Symposium in Bath earlier this year has been published in the ICES Journal of Marine Science, volume 54, pages 1216-1220.

A Fisheries Research Report entitled 'Catch and release: the survival and behaviour of Atlantic salmon angled and returned to the Aberdeenshire Dee, in spring and early summer' has been completed and will be published in June. Copies will be obtainable from the FRS Marine Laboratory in Aberdeen and the FRS Freshwater Fisheries in Pitlochry.

A paper entitled 'Patterns of run timing in adult Atlantic salmon (*Salmo salar* L.,) returning to Scottish rivers – some new perspectives and management implications' that was presented at the Fifth Atlantic Salmon Symposium in Galway, in September of last year has been submitted for publication.

*****

REVIEW OF SCIENTIFIC LITERATURE ON SALMON

(with acknowledgements to Dr. Peter Hutchinson, NASCO and Dr. Derek Mills)

1. Eggs

Egg survival and timing of hatch in two Scottish Atlantic salmon stocks.
M.J. Donaghy, E. Verspoor. 1997. Journal of Fish Biology, 51 (1). 211-214.

Atlantic salmon eggs from the rivers Oykel and Shin were monitored in three rivers and in culture. Significant mortality, attributable to low pH, was found for both stocks in the River Oykel though it was eightfold higher for the non-native Shin eggs. Shin eggs hatched earlier at all three wild sites but hatched later in culture. The observations are consistent with genotype-environment interactions for pH sensitivity and developmental rate.

2. Parr

Evidence for adaptive matching of appetite in juvenile Atlantic salmon *(Salmo salar)* with regular seasonal rhythms of food availability.
A.L. Simpson, J.E. Thorpe. 1997. Aquaculture 151 (1-4). 411-414.

Appetite of Atlantic salmon parr fed to excess peaked in May on rising ambient temperature, and declined sharply over the summer months despite appropriate temperatures for feeding and growth. In parallel samples from the river supplying the tanks with water, the numbers of optimally sized drifting prey decreased steadily from June to August. It is concluded that the observed reduction in appetite of the parr was an adaptation to decreasing prey availability in the natural habitat at this time.

Interhabitat migration of juvenile Atlantic salmon in a Newfoundland river system, Canada.
J. Erkinaro, R.J. Gibson. 1997. Journal of Fish Biology 51 (2). 373-388.

Migrations of juvenile Atlantic salmon between habitats (both fluvial and lacustrine) were studied in a Newfoundland river system from May through September. Salmon parr showed poor site fidelity in fluvial habitats, and high rates of migration, especially in spring-early summer. Most habitat shifts were upstream from fluvial habitats to a lake at the head of a small tributary. In September, 10% of the salmon parr caught in the lake (n=275) had been marked in the main stem of the river or in the tributary stream (total n=641). The abundance of parr in the lake increased in May-June, then decined gradually to September. Most of the lacustrine immigrants were 1+ parr. Mature males were found amongst the autumnal emigrants. Salmon parr in the lake grew larger than those in the river, and lacustrine smolts captured in the lake were larger than those caught at the mouth of the river.

Spatial strategies of wild Atlantic salmon parr: Exploration and settlement in unfamiliar areas.
J.D. Armstrong, V.A. Braithwaite, F.A. Huntingford. 1997. Journal of Animal Ecology 66 (2). 203-211.

Relationships between distributions of animals and the resources they use can be expected to depend critically on the mobility of individual animals within populations. However, there is little information on the movements of individuals within populations of animals in most natural aquatic systems, so it is difficult to model accurately the processes that underlie their distributions. Aspects of the processes involved in the colonisation of vacant areas by stream-resident Atlantic salmon *Salmo salar*, (69-114mm length) were measured under near-natural conditions. In five separate trials over summer months, groups of salmon were introduced into enclosed 30-m long sections of stream, each comprising three distinct 10-m long regions of habitat. The subsequent movements of each individual fish within the enclosures were monitored remotely and continuously using a passive integrated transponder (PIT) tracking system. Considerable variation was observed between the activity of different individual salmon. Some of the fish (range between trials, 3-33%) settled into localised home ranges without moving between regions, 10-38% of the fish moved within two regions, and 37-87% of the salmon moved through all three regions of their enclosure. A fraction (0-20%) of some of the populations was particularly mobile and never settled but continued to move throughout all three regions of the enclosure. Within the scale of this current study, it would appear that, for territorial animals such as salmon parr, certain members of the population will settle in new territories after very little exploration of their new environment. The propensity to explore was independent of habitat type, but was directly proportional to the size of the fish. The time from release until 50% of fish in populations settled (excluding the mobile fraction) ranged from 0-3 to 2-4 days. Activity levels were particularly high and initial movements by fish were directed upstream in trial 1, early in the summer, perhaps reflecting upstream migration by salmon parr within the population of the burn at this time.

3. Smolts

The seaward movement of Atlantic salmon smolts in the Usk estuary, Wales, as inferred from power station catches.
M.W. Aprahamian, G.O. Jones. 1997. Journal of Fish Biology 50 (2). 442-444.

The greatest numbers of Atlantic salmon smolts were caught at Uskmouth power station during the day on the flood tide and the least on an ebbing night tide. Catch rates during the day on an ebb tide and at night on a flood tide represented an intermediate state. The results, together with tracking data, suggest that salmon smolts prefer to migrate seaward through the lower Usk estuary during the night on an ebbing tide.

Juvenile recruitment and smolt output of brown trout (*Salmon trutta* L.) and Atlantic salmon (*Salmo salar* L.) from a lacustrine system in western Ireland.
M.A. Matthews, W.R. Poole, M.G. Dillane, K.F. Whelan. 1997. Fisheries Research (Amsterdam) 31 (1-2). 19-37.

A combination of electrofishing of feeder streams and shore seine netting of two lakes in a salmonid fishery in Burrishoole, western Ireland provided evidence of extensive use of lacustrine habitat by juvenile Atlantic salmon and brown trout. Mean densities of 0.024 trout and 0.002 salmon m^{-2} were recorded in Lough Bunaveela (46 ha), and 0.010 trout m^{-2} and 0.010 salmon m^{-2} in Lough Feeagh (410 ha). Appearance of 0+ salmon and trout in summer seine net catches indicated early downstream movement of fry from inlet streams to lake inshore areas which also provided nursery habitat for older age classes. Total trap records of salmon and sea trout smolts migrating from the Burrishoole catchment since 1970 were used to provide one of the first published estimates of smolt production from a lacustrine catchment in temperate Europe. Trout and salmon smolt output from Burrishoole was shown to have declined by about 50% since records began. Current levels of production are estimated at about 4 sea trout smolts ha^{-1} (0.4 kg ha^{-1}) and about 13 salmon smolts ha^{-1} (0.3 kg ha^{-1}).

4. Post-Smolts

Records of post-smolt Atlantic salmon, *Salmo salar* L., in the Faroe-Shetland Channel in June 1996.
R.G.J. Shelton, W.R. Turrell, A. MacDonald, I.S. McLaren, N.T. Nicoll. 1997.
Fisheries Research (Amsterdam) 31 (1-2). 159-162.

Atlantic salmon spawn and undergo their early development in fresh water but typically make most of their growth in the sea. In the British Isles the freshwater phase may last from 1 year to, exceptionally, 5 years. The young salmon enter the sea in the spring. Because their numbers are restricted by the extent of suitable rearing habitat in fresh water, salmon are relatively uncommon fishes in the sea and records of their occurrence, other than at sites of directed fisheries have, until recently, been infrequent. Here we report on the capture of 167 post-smolt salmon caught in five trawl hauls during June 1996 in the surface waters of the Faroe-Shetland Channel. A combination of age-structure (based on scale readings) and tag-return data suggests a relatively southern origin for most of the fish. The large numbers of fish caught in two hauls and the results of analysing the tag returns suggest that post-smolt salmon form schools in the open sea. All tagged fish were of hatchery origin, suggesting that hatchery-reared fish have ocean migrations similar to wild fish, at least for part of their life at sea. Hydrographic observations obtained before and during the trawls suggest that the fish were concentrated within a persistent, narrow northward flowing slope current located along the northwest European continental shelf edge.

5. Adults

Upstream migration of adult Atlantic salmon past a fish counter weir in the Aberdenshire Dee, Scotland.
I.P. Smith, A.D.F. Johnstone, G.W. Smith. 1997. Journal of Fish Biolog;y 51 (2). 266-274.

During their upstream migration through the lower reaches of the Aberdeenshire Dee, Scotland, radio-tagged adult Atlantic salmon passed a Crump weir-based fish counter without substantial delay over a range of river flows and water temperatures. Tagged salmon were detected sequentially by automatic listening stations placed along the river and were detected at the counter site for a median time of 18 min, compared with a median time of 5 min before the weir was built. One fish out of 16 spent 6.7 h in the vicinity of the weir, but such migratory pauses also occurred before the weir existed. The results suggest that the number of salmon crossing the counter per unit time is a function of the number of fish present downstream and their tendency to migrate upstream, without being limited by their ability to surmount the weir. The apparent slight delay at the weir is probably insignificant in terms of the overall progress of riverine migration and in the context of using counter records to relate salmon movements to environmental variables.

Tidal and diel timing of river entry by adult Atlantic salmon returning to the Aberdeenshire Dee, Scotland.
I.P. Smith, G.W. Smith. 1997. Journal of Fish Biology 50 (3). 463-474.

The timing of salmon migration from the estuary of the Aberdeenshire Dee into the river in relation to tidal phase and time of day was studied by combined acoustic and radio-tracking of individual fish and by analysing records of untagged fish from a resistivity fish counter 0.8 km upstream from the tidal limit. Up-estuary movements that led to river entry were predominantly nocturnal and tended to occur during the ebb tide. Penetration into the non-tidal reaches of the river also tended to occur at night, but the timing of salmon movements was no longer significantly associated with tidal phase. The tracking data suggested that the reduction in the strength of the association between salmon migration and tidal phase resulted from variability in rates of progress from the estuary to the river. This variability may have been random, or related to changes in migratory behaviour during entry to fresh water. A simulation of upstream progress by groups of salmon illustrated the decay of the relationship between salmon movements and tidal phase and the advance of the average tidal phase of observed salmon movements with increasing distance of the observation point from where movements were initiated. The magnitude of these effects depended on the average rate of upstream progress and variability in the rate of progress, being greatest when upstream progress was slow and variable. These results highlight a limitation of point observations of migration with regard to identifying environmental stimuli for migration and quantifying their effects.

6. Habitat Management

Evaluation of habitat improvement and restoration initiatives for salmonids in Newfoundland, Canada.
D.A. Scruton, K.D. Clarke, T.C. Anderson, A.S. Hoddinott, M.C. Van Zyll De Jong, K. Houston. 1997. Canadian Manuscript Report of Fisheries and Aquatic Sciences 0 (2413). I-V, 1-35.

Declining Atlantic salmon stocks, which forced the closure of the commercial salmon fishery on the island of Newfoundland in 1992, coupled with the increasing economic importance of the recreational salmonid fishery, has resulted in two major Federal-Provincial agreements over the past decade aimed at rebuilding the salmonid stocks of the Province. These agreements, the Newfoundland Inshore Fisheries Development Agreement (NIFDA), from 1988-1992, and the Cooperation Agreement of Salmonid Enhancement and Conservation (CASEC), from 1992 to 1997, included habitat improvement and restoration as a major strategy and supported a total of 142 projects at a total cost of 3.0 million dollars. It was recognised that a proportion of these projects should undergo scientific evaluation to provide information on the effectiveness and transferability of techniques and to assist in developing region-specific criteria to guide publically sponsored habitat initiatives. This report provides an overview of these evaluations, as selected case studies, including projects involving restoration of habitat degraded by historic forest harvesting (Joe Farrell's Brook and Pamehac Brook), removal of a natural migration barrier (Dead Wolf Brook), and the addition of spawning gravel to increase juvenile salmonid production (Northeast Placentia River). Results of a series of experiments in a controlled flow channel (Noel Paul's Brook) to investigate the effect of several habitat alterations on salmonid populations under Newfoundland conditions are discussed. Generally, the projects evaluated have been successful in increasing salmonid abundance and/or production. Results have highlighted the importance of hydrological and biological considerations to habitat improvement and restoration initiatives and recommendations are made for future projects.

7. Kelt Reconditioning

Stocking experiments using progeny of freshwater-reconditioned Atlantic salmon, *Salmo salar* L.
I.J.J. Moffett, G.J.A. Kennedy, W.W. Crozier. 1997. Fisheries Management and Ecology 4 (5). 385-390.

The progeny of salmon, *Salmo salar* L., kelts reconditioned in fresh water for one and two years were stocked in the spring as swim-up fry into good salmonid habitat in 1993 and 1994. Survival to the first summer was compared with that of control groups. There was no significant difference ($P > 0.4$) between the average number of reconditioned kelt and control fry caught per five-minute semi-quantitative electric fishing for the two years. Transformation of semi quantitative electric fishing results showed that average survival rates were about 24% and 30% for reconditioned kelt progeny and their controls, respectively, in 1993, and about 34% for both groups in 1994.

8. Tags

Field trials of marking stream salmonids by dye injection and coded-wire-tagging.
C. Dussault, M.A. Rodriguez. 1997. North American Journal of Fisheries Management 17 (2). 451-456.

In the summers of 1993 and 1994, we conducted trials in natural streams to assess the performance of dye marks and full-length coded wire tags (CWTs) when used simultaneously. Brook trout, *Salvelinus fontinalis*, and juvenile Atlantic salmon, *Salmo salar*, (fork length > or = 55mm) were marked with jet injection of Alcian Blue dye (in the base of the pectoral, pelvic, or caudal fins) and CWT (snout implant). All Alcian Blue marks remained clearly visible for at least 4 weeks. After 8 weeks, 3.1% of brook trout and 11.4% of Atlantic salmon had lost at least one mark. Although loss rates did not differ significantly among marking locations, 86% of mark losses were from the caudal fin. Marking in pelvic or pectoral fin locations induced high mortality in smaller fish. Dye retention was low for individuals recaptured 10-14 months after injection, presumably because interannual growth caused dilution of the mark. Loss rates of CWT in summer were 2.5% for brook trout and 8.4% for Atlantic salmon; for either species, loss rates did not differ significantly among size-classes. Marked fish did not differ from unmarked fish in growth or condition in summer.

A comparison of five external marks for Atlantic salmon, *Salmo salar* L.
I.J.J. Moffett, W.W. Crozier, G.J.A. Kennedy. 1997. Fisheries Management and Ecology 4 (1). 49-53.

Five external marks (Panjet, visible implant tag, hot brand, anal finclip and fluorescent pigment) were compared for retention and effect on marine survival in Atlantic salmon, *Salmo salar* L., ranching experiments aimed at complementing coded wire tagging. Only fluorescent pigment marks and Panjet marks were found to be effective, with retention rates of 76.9% and 90.0% respectively, after one year at sea. The Panjet was the only mark to significantly reduce marine survival ($P < 0.001$) compared with controls.

9. Genetics

Microsatellite loci reveal highly significant genetic differentiation among Atlantic salmon (*Salmo salar* L.) stocks from the east coast of Canada.
S.K.J. McConnel, D.E. Ruzzanate, P.T. O'Reilly, L. Hamilton, J.M. Wright. 1997. Molecular Ecology 6 (11). 1075-1089.

Allele frequency data from eight microsatellite loci provide evidence of highly significant genetic differentiation among stocks of Atlantic salmon *Salmo salar* L. from the Bay of Fundy, eastern and north-western Nova Scotia and Newfoundland. Estimates of genetic structure (R-ST and theta) among samples from geographical regions for which more than one stock was sampled. Samples from the Bay of Fundy taken from stocks which are phenotypically and behaviourally diverse showed particularly high levels of genetic structure. Rogers' allele sharing and $(\text{delta-mu})^{-2}$ distances also revealed significant diffferences among stock samples and were significantly correlated (Rogers' and $(\text{delta-mu})^{-2}$) with sea distance

between rivers. Results suggest that stocks of Atlantic salmon in eastern Canada are highly diverse genetically and that this should be an important consideration in any management programme for stocks in the area.

Genetic divergence and interactions in the wild among native, farmed and hybrid Atlantic salmon.
S. Einum, I.A. Fleming. 1997. Journal of Fish Biology 50 (3). 634-651.

There is concern that the progeny resulting from the spawnings of escaped farmed Atlantic salmon may compete with and disrupt native salmon populations. This study compared, both in the hatchery and in the wild, fitness-related traits and examined interactions among farmed, native and hybrid 0+ parr derived from controlled crosses and reared under common conditions. The farmed salmon were seventh-generation fish from the principal commercial strain in Norway and native salmon were from the rives Imsa and Lone, Norway. In the hatchery, farmed salmon were more aggressive than both native populations and tended to dominate them in pairwise contests. Farmed salmon were also more prone to risk, leaving cover sooner after a simulated predator attack, and had higher growth rates than native fish. Interbreeding between farmed and native fish generally resulted in intermediate expression of the above traits. There was, however, evidence of hybrid vigour in Lone/farmed crosses which were able to dominate both pure Lone and farmed parr in pairwise contests. In the wild, observations of habitat use and diet suggested that the populations compete for territory and food, and both farmed fish and hybrids expressed higher growth rates than native fish. Our results suggest that these innate differences in behaviour and growth, that probably are linked closely to fitness, will threaten native populations through competition and disruption of local adaptations.

Applications of single locus minisatellite DNA probes to the study of Atlantic salmon (*Salmo salar* L.) population genetics.
J. Perez, P. Moran, A.M. Pendas, E. Garcia-Vazquez. 1997. Journal of Heredity 88 (1). 79-82.

Five single-locus minisatellite probes (SLPs) derived from *Salmon salar* have been used to describe genetic variability of Atlantic salmon in a Spanish river (Esva). A total of 202 individuals (48 juveniles and 154 returning adults) were analysed in 1992 and 1993. The five loci were highly polymorphic, with the number of different alleles per locus ranging from 4 to 10. In adult samples, allele polymorphism was demonstrated to be independent of both sex and sea returning age. Between-generation stability in frequencies for the different alleles was measured comparing samples from consecutive generations. Results indicated the utility of SLPs for the study of Atlantic salmon population genetics.

The effect of *Gyrodactylus salaris* (Monogenea) on the epidermis of Atlantic salmon, *Salmo salar*, parr in the River Batnfjordselva, Norway.
C. Appleby, T.A. Mo, I-L Aase. 1997. Journal of Parasitology 83 (6). 1173-1174.

Skin morphology of Atlantic salmon, *Salmo salar*, parr infected with *Gyrodactylus salaris* was examined for 3 years in the river Batnfjordselva in Norway and compared to that of uninfected salmon parr from a neighbouring river. The epidermis of the infected population had more cell layers and was thicker than the epidermis of parr from the uninfected population. The number of mucous cells did not differ, and no seasonal changes in morphology of the epidermis were detected in either rivers. Intensity of *G. salaris* did not correlate to epidermal thickness, epidermal cell layers, or mucous cell concentration.

Population dynamics of *Gyrodactylus salaris* (Monogenea) infecting Atlantic salmon, *Salmo salar*, Parr in the river Batnfjordselva, Norway.
C. Appleby, T.A. Mo. 1997. Journal of Parasitology 83 (1). 23-30.

Population dynamics of *Gyrodactylus salaris* on 5 year classes of Atlantic salmon, *Salmo salar*, in the river Batnfjordselva in Norway was studied from April 1991 to June 1994. Prevalence was 100% on all year classes throughout the study period, except for a marked decline in winter and spring of 1992. Median abundance generally increased during summer and peaked in September/October at levels between 400 and 1,300 parasites. The lowest number of parasites was observed during winter and spring. The seasonal dynamics in the first year of the study differed markedly from the remainder of the study; abundance peaked already in June/July on 1+ and 2+ fish the first year, but decreased throughout summer and peaked again in autumn. A collapse in the *G. salaris* population was observed in the winter of 1991/1992, with prevalence being 0-40% on all year classes. Parr aged 2 years harboured significantly fewer parasites than younger parr during the winter months. Parasite intensity on precocious males was significantly higher than on sexually immature males and females. *Gyrodactylus salaris* was found on the fins (76%), gill filaments (15%), and head/body (9%). During the last 2 years of the study the gills were increasingly infected, with 40% of the parasites found on gills in some samples.

Salinity tolerance of *Gyrodactylus salaris* (Platyhelminthes, Monogenea): Laboratory studies.
A.Soleng, T.A. Bakke. 1997. Canadian Journal of Fisheries and Aquatic Sciences 54 (8). 1837-1845.

The salinity tolerance of the freshwater monogenean *Gyrodactylus salaris*, infecting Atlantic salmon (*Salmo salar*) parr, was studied experimentally. Following direct transfer of infected fish from fresh water to 5.0 parts per million salinity, parasite population growth increased at the same rate as in freshwater and was positively correlated with temperature (1.4, 6.0, and

12.0 degree C). In 7.5 parts per million salinity the populations declined and became extinct after a maximum of 56 days, without any significant difference between 6.0 and 12.0 degree C. However, some infra-populations demonstrated short periods of growth. At higher salinities (10.0, 15.0, 20.0, and 33.0 parts per million) the survival time decreased, and there was a negative correlation between survival time and temperature (1.4, 6.0, and 12.0 degree C). When transferred directly to sea water (33.0 parts per thousand) the parasites became opaque and ceased moving after a few minutes. There was no difference in parasite survival time between direct and gradual transfer from fresh water to 7.5 and 10.0 parts per million except for one infra-population which demonstrated population growth from day 22 after some fluctuations following gradual transfer to 7.5 parts per million. The present findings support the hypothesis of brackish water dispersal of *G. salaris* with infected fish migrating between rivers in fjord systems.

11. Salmon Farming

The incidence of reared Atlantic salmon (*Salmo salar* L.) of fish farm origin at West Greenland.
L.P. Hansen, D.G. Reddin, R.A. Lund.1997. ICES Journal of Marine Science 54 (1). 152-155.

The proportion of escaped farmed Atlantic salmon in the commercial fishery at West Greenland was estimated using samples of fish caught with drift-nets in the commercial fishery in 1991 and 1992. Identification of reared fish was carried out using scale analysis. Despite the fact that large numbers of salmon escape from fish farms around the North Atlantic, the proportion of farmed fish in this fishery was low, 1.1% in 1991 and 1.4% in 1992, and much lower than in the area of the Faroese fishery in the east Atlantic. The low number of fish farm escapees at Greenland is surprising since large numbers of farmed salmon are produced in countries from which most of the wild salmon that occur at West Greenland originate.

Endurance of farmed and sea-ranched Atlantic salmon *Salmo salar* L. at spawning.
E.B. Thorstad, B. Finstad, F. Okland, R.S. McKinley, R.K Booth. 1997. Aquaculture Research 28 (8). 635-640.

Endurance of farmed and sea-ranched Atlantic salmon *Salmo salar* L. males was analysed during spawning time. The fish were endurance tested at different swimming speeds (1.6-2.1 ms^{-1}) in forced swim trials. The sea-ranched males (51-65cm, n = 20) fatigued significantly earlier than the farmed males (59-72cm, n = 20), although the sea-ranched males were significantly smaller than the farmed males. When the size difference between the two groups were corrected for, no significant difference in the endurance of the two groups was found. Farmed salmon had a significantly higher fat content in white muscle (4.7%) than sea-ranched salmon (1.1%).

The feeding response of diploid and triploid Atlantic salmon and brook trout.
R.A. O'Keefe, T.J. Benfey. 1997. Journal of Fish Biology 51 (5). 989-997.

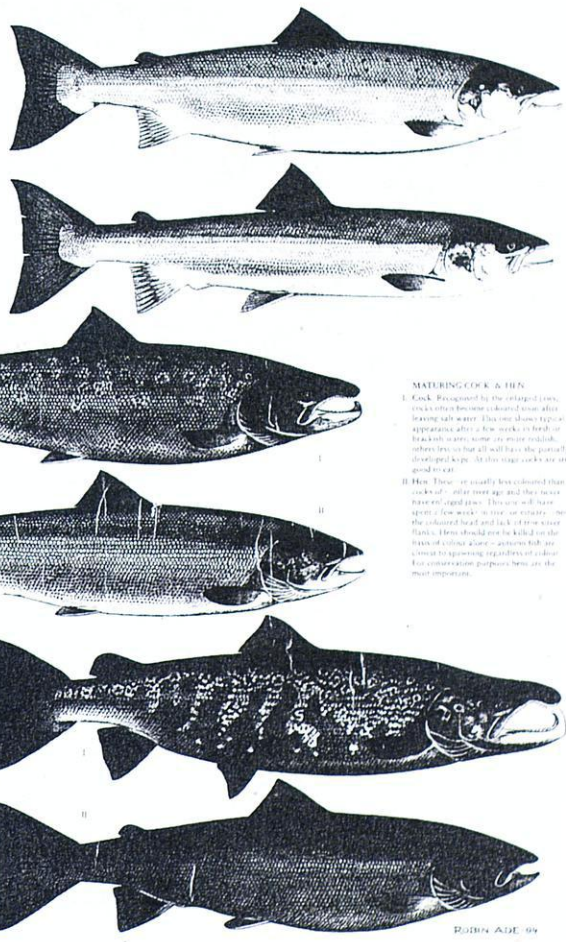
Pair and group experiments were conducted to determine whether differences exist in feeding success between juvenile diploid and triploid salmonids in a competitive situation. In the pair experiments, 22 pairs (one diploid and one triploid) of size-matched Quebec-strain brook trout *Salvelinus fontinalis* (7.2-46.3g) were fed an unlimited number of pellets three times a day for 5 days. Dominance was assigned to the fish which ate the most pellets within each pair. In the group experiments, groups of three diploid and three triploid size-matched fish were fed a restricted ration three times a day for 5 days. Hierarchical rank within the group was assigned based on the number of pellets consumed by each fish. The group experiment was repeated 10 times with Atlantic salmon, *Salmo salar*, (5-1-62.7g), Quebec-strain book trout (11.8-110.8g), and large UNB-strain brook trout (18.2-33.0g), and 12 times with smaller UNB-strain brook trout (0.6-2.0g). A statistically significant difference in rank between ploidies was found only for the smaller UNB-strain brook trout in the group experiments, with diploids dominant over triploids. This suggests that there may be a difference in competitive feeding success between diploid and triploid brook trout early in development, but that this difference diminishes as the fish grow.

Saltwater performance of triploid Atlantic salmon *Salmo salar* L. X brown trout *Salmo trutta* L. hybrids.
P.F. Galbraith, G.H. Thorgaard. 1997. Aquaculture Research 28 (1). 1-8.

Survival and growth in a saltwater net-pen of sexually immature triploid Atlantic salmon *Salmo salar* L. times brown trout *Salmo trutta* L. hybrids was comparable to that of immature diploid Atlantic salmon. Following 17 months of freshwater rearing, the experimental fish were individually tagged and transferred to a saltwater net-pen where they were raised communally for 376 days. Initial and final average weights were 158 and 760g per fish for the diploid Atlantic salmon and 209 and 1010g per fish for the triploid hybrids; weights for the hybrids were significantly larger in both cases (alpha = 0.05). Survival from transfer to harvest was 3% for the Atlantic salmon and 48% for the hybrids. Average specific growth rate of fish which survived to harvest was 0.422% day-1 for Atlantic salmon and 0.41% day-1 for hybrids; these values were not significantly different. No significant differences were observed in average condition factor and dressout percentage between crosses. Average gonadal weights and gonadosomatic indices were not significantly different for male diploid Atlantic salmon, female triploid hybrids and male triploid hybrids, but were significantly greater for female Atlantic salmon.

*****

SALMON *a fisherman's guide* RECOGNITION



FRESH RUN SALMON

Recognised by the pristine condition and bright silver flanks. Fish straight from salt water have lousy, easily detached scales and many carry sea lice which drop off within a few days. Hen salmon (illustrated) have a fine shape on the lower jaw but unlike cocks they retain normal head proportions when in the river. Fresh run salmon make the best eating.

KELT

Kelts are salmon which have spawned. Usually identified by the fish shape, distended vent and presence of "gill maggots" on the red gill filaments, they are often encountered by anglers in spring when they regain a silvery appearance and can be mistaken for fresh run Springers. Kelts must be returned unharmed to the water.

MATURING COCK & HEN

I. Cock. Recognised by the enlarged jaws, cocks often become coloured soon after leaving salt water. This one shows typical appearance after a few weeks in fresh or brackish water; some are more reddish, others less so but all will have the partially developed kype. At this stage cocks are still good to eat.

II. Hen. These are usually less coloured than cocks of similar river age and they never have enlarged jaws. This one will have spent a few weeks in river or estuary – note the coloured head and lack of true silver flanks. Hens should not be killed on the basis of colour alone – anyone with any interest in spawning regardless of colour for conservation purposes hens are the most important.

COCK & HEN IN BREEDING DRESS

I. Cock. The combination of "tartan" colours is typical although shades vary – the fully developed kype, used in fighting rivals, is the most consistent indicator of maturity. Condition can be gauged by viewing from above (fig.I) – if the back is still thick a fish is in better condition (and more likely to be edible) than a thin "kipper", which, unless it is a first salmon, is better returned.

fig.I

II. Hen. This is a summer fish – Springers are often darker by spawning time while late entrants may still be silver flanked. Fully mature hens have soft, swollen bellies and spawning is imminent if they also have protruding vents.

ROBIN ADE '99

SALMON & SEA TROUT

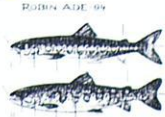
Salmon II can be distinguished from large Sea Trout (II) by a more streamlined shape, concave tail, slimmer tail wrist, upper jaw reaching not further than rear of eye, few if any black spots below lateral line. (Pre 15 usually 11-13) scales counted obliquely forward from adipose fin to lateral line – Image Point 12-14

GRILSE & SALMON

Grilse or one sea winter salmon, which comprise most of the annual rod catch are silver salmon returning from one sea winter salmon except by early stocking. They are smaller on average (c. 5lb. in May, 7-8lb. in July, but grilse entering rivers in September score about 8-10lb. and in October 12-15lb. Salmon usually weigh over 8lb. Most are 2SW fish, those returning in spring average 8-10lbs, in summer 12-14lbs, in autumn 14-16lbs. Salmon tend to double in weight during each full spawning period (May – Oct) spent in sea.

SALMON & TROUT PARR

Salmon Parr (I) are normally distinguished from young Brown/Sea Trout (II) by the more streamlined shape, deeply forked tail, larger pectoral fin. Look in orange or adipose fin, smaller mouth, sharper snout. Only 1-4 spots on gill cover, often very large spots, well defined parr marks.



Posters available @ £4 (incl.p&p), jigsaws @ £6.50 (incl.p&p), postcards @ 75p.

ATLANTIC SALMON TRUST PUBLICATIONS

		£
Atlantic Salmon: Planning for the Future (Proceedings of the 3rd International Atlantic Salmon Symposium, Biarritz, 1986)	edited by D. Mills & D. Piggins	45.00
The Biology of the Sea Trout (Summary of a Symposium held at Plas Menai, 24-26 October 1984)	E.D. Le Cren	1.50
Salmon Stocks: A Genetic Perspective	N.P. Wilkins	1.50
Report of a Workshop on Salmon Stock Enhancement	E.D. Le Cren	1.50
Salmonid Enhancement in North America	D.J. Solomon	2.00
Salmon in Iceland	Thor Gudjonsson & D. Mills	1.00
A Report on a Visit to the Faroes	D. Mills & N. Smart	1.00
Atlantic Salmon Facts	D. Mills & G. Hadoke	f.o.c
The Atlantic Salmon in Spain	C.G. de Leaniz, A.D. Hawkins, D. Hay & J.J. Martinez	2.50
Salmon in Norway	L. Hansen & G. Bielby	2.00
The Automatic Counter – a Tool for the Management of Salmon Fisheries (Report of a Workshop held at Montrose, 15-16 September 1987)	A. Holden	1.50
A Review of Irish Salmon and Salmon Fisheries	K. Vickers	1.50
Water Schemes – Safeguarding of Fisheries (Report of Lancaster Workshop)	J. Gregory	2.50
Genetics and the Management of the Atlantic Salmon	T. Cross	2.50
Fish Movement in Relation to Freshwater Flow and Quality	N.J. Milner	2.50
Acidification of Freshwaters: The Threat and its Mitigation	R. North	3.00

Strategies for the Rehabilitation of Salmon Rivers (Proceedings of a joint Conference Held at the Linnean Society in November 1990)	D. Mills	5.00
Salmon Fisheries in Scotland	R. Williamson	3.00
The Measurement and Evaluation of the Exploitation of Atlantic Salmon	D.J. Solomon & E.C.E. Potter	3.00
Salmon in the Sea and New Enhancement Strategies (Proceedings of the 4th International Atlantic Salmon Symposium, St. Andrews, New Brunswick, June 1992)	edited by D. Mills	30.00
Surveying and Tracking Salmon in the Sea	E.C.E. Potter & A. Moore	3.00
Problems with Sea Trout and Salmon in the Western Highlands	edited by R.G.J. Shelton	3.00
Automatic Salmon Counting Technologies - A Contemporary Review	G.A. Fewings	3.50
Salmon in the Dee Catchment: The Scientific Basis for Management (Proceedings of a one day meeting held at Glen Tanar House, 13 October 1994)	A. Youngson	3.50
Spring Salmon	A. Youngson	3.00
Enhancement of Spring Salmon (Proceedings of a one day Conference held at the Linnean Society of London 26 January 1996)	edited by D. Mills	12.00
Water Quality for Salmon and Trout (second, revised edition)	J. Solbé	3.50
Salmon Fisheries in England & Wales	W. Ayton	3.50
The Industrial Fishery for Sandeels	A.D. Hawkins J. Christie & K. Coull	3.00
Fish Counters (Proceedings of an AST/IFM Seminar held in Perth on 4 April 1997)	edited by A.V. Holden & G. Struthers	3.00

Printed by Woods of Perth (Printers) Ltd., 3/5 Mill Street, Perth PH1 5JB — Telephone (01738) 622244