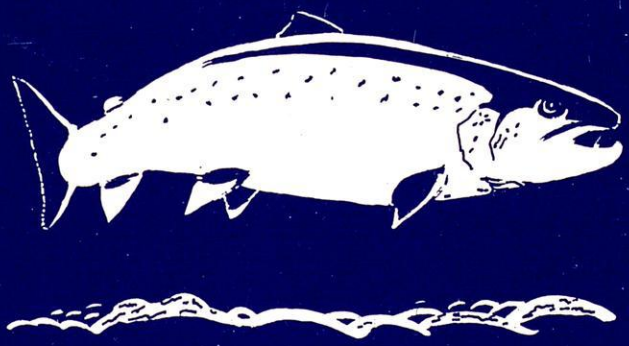
ATLANTIC SALMON TRUST

PROGRESS REPORT

June 1999



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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

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CONTENTS

CHAIRMAN'S INTRODUCTION

The last six months have shown a degree of progress on a number of important fronts. Following the approach made to the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) at the end of last year by the Trust, the ASDSFB (now called the Association of Salmon Fishery Boards) and the Association of West Coast Fisheries Trusts (AWCFT) about the collapse of salmon and sea trout stocks on the West Highland Coast, the Chairmen of the three organisations met with the Fisheries Secretary early in the New Year to ascertain what could be done to try to remedy the present serious situation. It was clear that little was likely to be achieved without Ministerial backing and the co-operation and involvement of the fish farming industry. Following further meetings both with the Chairman of the Scottish Salmon Growers Association (SSGA) and then with SOAEFD, the Minister agreed in April to set up a Working Group "to develop and promote actions to restore and maintain healthy stocks of wild and farmed fish, including the initiation of measures for the regeneration of the most seriously depleted wild stocks." The SSGA will be an integral part of the Group, together with the Trust, the ASFB and the AWCFT, under Scottish Office chairmanship. Others will be co-opted as necessary. The terms of reference, which are set out elsewhere in these pages, were swiftly agreed and the first working meeting took place in early June.

It is of course much too early to predict what the Group will be able to achieve but it is reassuring to find that there is a genuine willingness on all sides to work together. I should however emphasise that it is the purpose of the Group to initiate actions to try to rectify the present disastrous situation; it has not been set up just to produce a report.

In so far as England and Wales are concerned, I explained in the December Progress Report that the Trust had submitted its views to the Review Group examining Freshwater Fisheries in these two countries. While our Deputy Director was co-opted to the Moran Committee, which sought to deliver the collective views of some fourteen fishing and fishery organisations, the Trust has nevertheless made its own views known to the Group through the Committee set up last year under the Vice-Chairman. In a recent letter, the Vice-Chairman addressed inter alia the important aspects of institutional arrangements and funding. Professor Lynda Warren, the Chairman of the Review Group, has welcomed both the Trust's initial submission and the follow-up letter for their clarity of content and their precision in identifying critical issues. A more detailed report appears elsewhere in these pages, but the Group has now completed the gathering and hearing of evidence and is scheduled to report to Ministers in the autumn.

A particular aspect on which the Trust has focused is that of the North East drift nets. The continued existence of this highly damaging mixed stock fishery remains a major stumbling block to North Atlantic Salmon Fund endeavours to obtain agreement over the interceptory fisheries off Greenland and the Faroes. Following discussion with the Chairman of NASF (UK) last autumn, it was agreed that a comprehensive paper should be prepared on all interceptory netting to be sent to the Review Group and subsequently to Government. This paper was prepared by Ian Gregg, formerly Chairman of the Tweed Commissioners, and both the Trust and NASF (UK) are greatly indebted to him for all the hard work he has undertaken over several months and the substantial research involved in putting it together. To date the paper has been sent to the Review Group in so far as it affects their deliberations, and also to other interested fishery, management and conservation organisations. In due course it will be sent to Government in England, Wales and Scotland. A summary of the paper's conclusions appears elsewhere in this Report.

Following publication of the Environment Agency's draft proposals last November, the Trust has been active in the ensuing consultations concerning the introduction of bye-laws designed to protect spring fish in England and Wales, and was influential in the eventual relaxation of the provisions concerning hook size and gape. The new bye-laws were in due course introduced in the spring and are reviewable in five year's time. While regarded as controversial in several quarters, it is very much to be hoped that these measures will be successful in sparing the maximum number of spring fish to spawn.

No such blanket measures have been introduced in Scotland. Instead it is to be hoped that the new Scottish Parliament will be persuaded to grant additional powers to DSFBs to enable them, where appropriate, to introduce whatever measures they consider necessary to protect the fragile spring component of the stock in their own river systems. For the moment, the voluntary measures of restraint imposed on many Scottish rivers appear to be working reasonably well.

H F O BEWSHER

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DIRECTOR'S NOTES

These notes are being completed just after the annual meeting of the North Atlantic Salmon Conservation Organisation (NASCO), which was held for the first time in the Republic of Ireland, at Westport, County Mayo, which is near the Salmon Research Agency. It is therefore appropriate that this Progress Report contains an account of the content and recommendations of a Seminar on "Managing Ireland's Spring Salmon," which was organised last autumn by Dr Ken Whelan, Director of the Agency and a Member of the Trust's Council of Management and Honorary Scientific Advisory Panel. It makes interesting reading in the context of the much-discussed action taken in the United Kingdom for the conservation of spring fish. Ken Whelan also contributes a brief up-dating report on the Irish situation, which shows encouraging improvements in some rivers. Some similar improvements have been noted on this side of the water, but there is clearly no room for complacency. Discussions at NASCO were overshadowed by very gloomy scientific assessments of salmon stocks, especially of multi sea winter fish, on both sides of the Atlantic. In the face of dire predictions for North American spawning runs, the Greenland fishery was restricted for two years to a catch for internal consumption only (about 20 tons). Contrary to some recent reports, it appears that Greenland did not export any of last year's catch, which was around that level, and the prohibition will remain in force. Although an unrealistically large quota has again been allocated to the Faroes, it is hoped that, as for last year, only a small research fishery will actually take place.

Given the current problems, I make no apology for the fairly sober content of a large part of this Report. I believe that supporters of the Trust will wish to be informed of the various enquiries and initiatives that are currently in hand. Besides the Irish seminar, this issue includes:

> A report on the final stages of the Review Group on Salmon and Freshwater Fisheries in England and Wales.

The terms of reference of the Tripartite Working Group on the West Highland sea trout and salmon problems.

A summary of the conclusions and recommendations of the paper on Interceptory Exploitation.

The principles underlying a "consensus paper" initiated by the Worldwide Fund for Nature on the need to develop policies for the conservation and management of all freshwater fish species in Scotland, which has been endorsed by the Trust, in conjunction with other conservation and fishery management organisations.

The research projects currently being supported by the Trust are again described, and the next issue will contain a summary of results obtained by last year's projects. Our biologist contributes his regular report, and we are reprinting the announcement of his availability to give initial advice to Associations and Boards who are contemplating survey, monitoring or enhancement projects. For those interested in the conservation of broodstock, our Vice Chairman introduces a novel method of retaining fish without the use of a potentially damaging keep net.

I would like to draw readers' attention to the notice of publication of the Proceedings of the workshop on problems facing salmon in the sea, reported in the December issue. Dr Derek Mills has succeeded in arranging for it to be published by Fishing News Books, under the title "Ocean Lives of Atlantic Salmon". This has the welcome result of relieving us of all publishing costs. The standard price of this impressive book, which will appear in November, is expected to be a rather daunting £59.50, but supporters of the Trust will be able to order copies through this office at a 50% discount. I should also like to point out that, as usual, we enclose a Covenant Form and Banker's Order with each copy of the Progress Report, for the convenience of readers who are not already subscribers. In these expensive times, it would be of great benefit if everyone who has already "signed up" could use this form to enlist an additional supporter for our work.

I hope that many of you will visit our display caravan at the Scone Fair (3-4 July), the CLA Game Fair at Harewood House (30 July-1 August) or the Highland Field Sports Fair, Moy (6-7 August).

J B D READ

THE SALMON AND FRESHWATER FISHERIES REVIEW GROUP

A CONTINUATION ARTICLE

(Deputy Director)

The deliberations of the Review Group up to the end of November were covered in the December Progress Report. The final 1998 evidence gathering session was held in London on 10th and 11th December and addressed Factors Affecting Habitats. The Trust elected not to offer evidence separately but was content to have its views incorporated in the Moran Committee's submission, with the Deputy Director forming part of its representative panel fielding oral questions from the Review Group. As was to be expected, evidence concentrated on the problems associated with improving water quality and flow and all the issues pertinent to habitat restoration and enhancement. It was comforting that almost without exception the major presenting bodies, namely the Atlantic Salmon Trust with the Moran Committee, the Environment Agency (EA), the National Farmers Union and, in particular, the Anglers' Conservation Association (ACA) had all identified similar issues. The presentation by Victoria Beale from the ACA was quite outstanding, effectively bringing together all the areas addressed by previous speakers and earning her a generous and well-deserved tribute from the Review Group.

During the review of Fish Populations on 8th February, the AST and Moran Committee's evidence had been very similar to that presented by the EA and the RSPB. The Deputy Director had drafted the majority of the section covering predation whilst Mark Hatcher, the Moran Committee's secretary, had concentrated on obstructions, barriers and barrages. Of particular note, for the first time, the RSPB publicly stated that there were occasions when the culling of fish eating birds might be justified. However the Countryside Commission for Wales and English Nature had jointly produced very negative contributions which appeared to be flawed both factually and in the recommendations. Regarding predation, they wished both to make policy and to act as the executive body when issuing licences. They made it very clear that if this situation were to arise, it was most unlikely that any licences would be issued whilst they were empowered to make both the appropriate recommendations and decisions. Fortunately, it did not appear that their evidence had carried much weight with the Review Group. The Moran Committee asked if it could be permitted to submit an additional paper addressing bird predation to the Review Group. This was because it had originally been hoped that the MAFF/DETR joint three year study into piscivorous birds would be published in time for the Review Group to take note of its contents, plus any observations on its recommendations by interested Non Government Organisations. However, in reply to a question by Lord Moran in the House of Lords, Lord Donoughue (Parliamentary Secretary MAFF) had said it was not expected that the report would be released until the Autumn of 1999. The Review Group's Chairman had agreed to this request providing that it had been made public before her Committee was dissolved. With this in mind, a supplementary paper addressing Bird Predation was submitted by the Moran Committee in May. Once again the Deputy Director had drafted a significant element of its contents.

Whilst the Review Group had considered Coarse, Still Water Trout and Eel Fisheries in January and Fisheries and Recreation issues in March, the final major hearing of interest to the AST was held on 21st and 22nd April when Institutional Arrangements and Funding were discussed. From the outset, it became clear that this was going to be a contentious subject.

The best the Trust could hope to achieve was a consensus which met its interests from a conservation stand-point. In the final analysis, the Trust's proposals for funding arrangements received concerted support. However, inevitably there had been differing views regarding institutional arrangements. The Moran Committee encountered similar difficulties when attempting to meet the aspirations of all its member organisations and it was only after the consideration of four very differing drafts that a co-ordinated paper could be submitted to the Review Group. As a result the Vice-Chairman and his sub-committee agreed that it was essential for the Trust to submits its own views in addition to those incorporated in the Moran Committee's submission. These were included in a short paper drafted by the Vice-Chairman addressing issues considered by the Trust to be of particular importance in the conservation of the wild Atlantic salmon resource. His views and recommendations were:

International and National Management. While NASCO, advised by ICES, provides an international forum within which the conservation of salmon can be discussed, there is no European inter-governmental organisation in which the policy for the conservation and management of the European salmon resource can be agreed. The result is that co-ordination and implementation of active management policies is lacking, as also is joint research into the general decline in the salmon stocks which provide an important financial input to a number of European states. The Trust requests the Review Group to recommend to Government **the setting up of a formal inter-governmental organisation of those European states which benefit from the wild salmon resource, with the object of co-ordinating the management of the resource and associated research.**

Conflicting Ministerial Responsibilities. From the submissions the Review Group has received the single most important factor to emerge must be the ability of our water environment to support an abundant population of fish species. It is clear from the work of the Trust over the years that a major factor in the decline of the wild salmon population is the degradation of river environments. Much of this has been caused by changing land use brought about by the farming and forestry grant system which has encouraged practices detrimental to river environments. These grants have been administered by MAFF, while at the same time funds are provided by DETR to redress some of the damage. There would appear to be grounds for examining the responsibilities of these two ministries in relation to river environments. On balance it seems to us that there would be advantages in having fisheries under the same Ministry as the environment on which they depend. We support the Moran Committee's recommendations **for a transfer of the responsibility for fisheries within the Ministerial system.**

Local Management. The Trust strongly supports the principle of catchment management and applauds the Environment Agency on the production of Local Environment Action Plans which in turn incorporate Salmon Action Plans. However, we believe that those with a self interest in salmon fisheries (owners, anglers) should have a greater say in their management. We consider that there is scope for the EA to be more accountable for its activity at catchment level, and to this end we would like to see a more formalised Board or Committee structure set up at the level of catchments or groups of small catchments, to provide a forum in which to ascertain available resources, agree priorities and annual work plans, and assess results. Raising of funds for local initiatives could also fall within their remit. We support the Moran Committee's request to the Review Group to **recommend a more formalised structure at catchment level to which the EA would be accountable for local fisheries management.**

Funding. Degradation of the water environment is a major cause of the decline in salmonid fisheries. Over the period of this decline the funding available for fisheries and habitat

restoration has considerably reduced in real terms despite increasing pressures on the environment. The present scale of funding is totally inadequate to restore salmonid fisheries to their original state, let alone maintain and improve them. While it is only fair that beneficiaries of fisheries (owners, anglers and rural business) should contribute to their maintenance and improvement, it is however not acceptable that they should have to pay for the restoration of habitats damaged by others. We consider that water users should contribute directly to habitat restoration. **With the Moran Committee, we consider that there are strong grounds for an environmental levy to be raised on water bills of both commercial and private users."**

The 21st-22nd April Hearing, attended by both the Vice-Chairman and the Deputy Director, effectively completed the formal gathering of national evidence by the Review Group, other than a final general subject session in Fishmongers' Hall on 23rd April, which mainly concentrated on local issues in the Thames region. The Review Group expects to publish its recommendations in the Autumn. Having received widely differing views from the many bodies and individuals submitting evidence over the last eight months, this will be no easy task for the Chairman and her Group members. We wish them well in their endeavours and eagerly await the publication of their report.

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THE WEST HIGHLAND INITIATIVE

The Tripartite Working Group which has been set up includes fishery management, angling and salmon conservation interests, together with representatives of the salmon farming industry and of the Scottish Office, under the chairmanship of the Fisheries Secretary. Its Terms of Reference are as follows:

Having regard to the serious decline in wild salmon and sea trout stocks in the west of Scotland and to the sustainability of the salmon aquaculture industry:

1. To develop and promote the implementation of measures for the restoration and maintenance of healthy stocks of wild and farmed fish, including:
   - Environmental standards and husbandry practices
   - The availability and implementation of effective medicinal treatments.
   - Fallowing and rotation strategies
   - Location of sites

2. To develop and promote the initiation of measures for the regeneration of wild salmon and sea trout stocks, including:
   - Identification of the river systems which are of highest priority, in terms of imperilled sea trout and salmon stocks.
   - The design of procedures to develop restoration projects for these systems.
   - Preparation of a broodstock programme to hold stocks from fragile systems until restorative action is possible.

3. To propose arrangements at a local and national level for taking forward the foregoing, and to ensure that the results of this work are reflected in the development of Local Authority fish farm planning guidelines and Framework Plans.

INTERCEPTORY EXPLOITATION OF SALMON

The paper jointly prepared by the Atlantic Salmon Trust and the North Atlantic Salmon Fund (UK) argues for the ending of interceptory netting around the United Kingdom, and makes initial proposals for the means of achieving this, with fair compensation for those concerned. The summary reproduced below appears at the beginning of the paper.

INTRODUCTION

The Aim of the paper is:

To set out the case for the complete cessation of interceptory exploitation of wild salmon, with a view to making recommendations for UK action.

Interceptory Fisheries may be defined as those that catch fish at any point outside the river of origin.

SUMMARY OF DISCUSSION

Conservation. It is widely agreed and extensively documented that the exploitation of the wild salmon outside its river of origin represents bad management practice. This view is further reinforced by:

- The dramatic decline of wild salmon stocks over the last 25 years, a decline that is unlikely to be halted without determined action.
- The vulnerability of the salmon to exploitation on the high seas, due to its habit of feeding close to the surface.

Economic Factors. It is well documented that the exploitation of salmon by rods makes a far greater contribution to the economy than does exploitation by nets, both in terms of employment and in income to the Exchequer. Low stocks and low prices due to competition from farmed salmon have substantially reduced the economic viability of net fisheries as well as the contribution they are able to make to local economies.

Salmon Management. By far the greatest contribution, in terms of cost and time, to conservation and management, is made by salmon rod fisheries.

SUMMARY OF CONCLUSIONS & RECOMMENDATIONS

- The exploitation of salmon outside their river of origin is universally accepted as contrary to sound management, primarily on the grounds that it does not discriminate between separate self sustaining populations and makes monitoring and management difficult or impossible. Every modern report on the management of Atlantic Salmon stocks condemns the practice.

- Salmon catches in Scotland and in England and Wales have fallen disastrously in recent years and many important river systems are now considered to have insufficient salmon to stock themselves adequately.

- Those responsible for salmon management have in recent years taken major steps to improve management practices, including introducing measures to reduce exploitation and to improve habitat. Their management plans will be seriously undermined unless interceptory exploitation is ended across the whole UK.

- By continuing such exploitation, the UK is damaging its reputation in environmental and conservation terms and seriously undermining its ability to influence other countries to stop such exploitation.

- Rod fishing makes a much greater contribution to fragile rural economies and to funding management and conservation, than does commercial fishing.

- Salmon are an important part of our natural heritage which should be preserved for future generations to enjoy.

- The North East Coast Salmon Fishery is predominantly a drift net fishery and highly interceptory. In most years it accounts for more than 50% of the total of all salmon caught in England and Wales.

- The Scottish fixed engine catch is interceptory and accounts for over 30% of the total of all salmon caught in Scotland.

- The position is even more extreme in Ireland where the drift net fishery accounts for 70% of all salmon caught. A significant proportion of these salmon is from UK rivers.

- These situations cannot be accepted if we wish to manage this important and complex industry in a modern and professional way.

- **In England and Wales licences should be phased out over the next 3 years.**

- **In Scotland rights should be compulsorily purchased in 5 years if no voluntary agreement has been reached before then.**

- **Government must be prepared to legislate and make a financial contribution to costs. Catchments/rivers that benefit must contribute.**

ANGLING FOR CHANGE

INTRODUCTION

On 14 April, a Consensus Statement initiated by WWF Scotland was formally agreed in Edinburgh by representatives of a broad range of interested groups. Besides the Atlantic Salmon Trust, it was signed by:

The Association of Salmon Fishery Boards
The Association of Scottish Stillwater Fisheries
The Association of West Coast Fisheries Trusts
The Institute of Fisheries Management (Scottish Branch)
The Salmon and Trout Association
The Scottish Anglers' National Association
The Scottish Federation of Coarse Anglers
Scottish Wildlife and Countryside Link

Its purpose is "to demonstrate the strong consensus in favour of developing policies for the sound management and sustainable exploitation of freshwater fish (both migratory and resident) in Scotland".

The basic principles which should govern such policies, and the conclusion of the statement are set out below. The full document may be obtained from WWF Scotland, 8 The Square, Aberfeldy, Perthshire PH15 2DD.

PRINCIPLES

Any new scheme should cover all of Scotland.
Comment: The present piecemeal approach leads to problems ranging from declining stocks, increase in disease and parasites, to the spread of alien fish species; and at times to no management at all.

All species of freshwater fish in Scotland should be covered by any new scheme.
Comment: Special attention should be given to native species, especially those of economic importance. In the case of migratory species, co-ordination of high seas management, particularly in domestic waters is of concern. There is some debate over the definition of native species of freshwater fish. Any new policy should seek to define the terms 'native', 'naturalised' and 'alien'. In any case, all species, native or alien, of economic or cultural value, rare or common, require management.

Any new scheme must take account of all types of fishing.
Comment: There is a range of fish species and anglers' interests in Scotland. In some catchments, game fishing for Salmon and Sea Trout will dominate, while in other areas angling for Brown Trout or coarse fish will have importance. The interests of private and commercial stillwater fisheries must also be respected.

Management should be local and vested in catchment-based fishery boards and their associated trusts.
Comment: This builds upon the present movement towards these already taking place through the formation of successful, science-based Fishery Trusts and foundations and the discussion about amalgamation of smaller Boards.

There is a requirement for an appropriate form of central support for local management, research, and data collection.
Comment: Local expertise and policies based on local conditions should be the dominating factors and any central focus should serve and not direct the Fishery Boards and Trusts. Central support is required for national aspects of management, such as the provision of national statistics and other data, advice on legislation, assistance with monitoring, dissemination and encouragement of best practice, conflict resolution, and provision of financial support.

The collation of data and the co-ordination and collaboration of research and management are essential to identify and assess the status fish populations nationally and regionally.
Comment: Co-ordinated monitoring, making use of existing data co-ordinating facilities such as the Scottish Fisheries Co-ordination Centre (SFCC), needs to be given a higher priority. Support for such initiatives will help identify national trends or regional variations.

New legislation is needed to protect freshwater fish, the habitats used throughout their life cycles, and the fisheries based on them.
Comment: The legitimate rights and aspirations of both owners and anglers are not properly met at the moment; the transfer of alien fish into Scotland and across catchments continues unabated, and the public interest in the stewardship of freshwater fish is not secured.

The provision of adequate resources to meet all of the requirements of such a scheme is essential.
Comment: Existing fishery owners and organisations cannot be expected to expand their interests and activities to cover other species and habitats without significant additional funding. For example, the protection of rare native fish, and contributions to meeting government obligations in terms of monitoring and data collection are in the public interest and should be recognised as such.

The development and implementation of new policies to protect freshwater fish should involve all stakeholders in the resource.

CONCLUSION

There is a strong consensus among a range of fishery interests in favour of a Scotland-wide policy, with adequate powers and resources, for all freshwater fish. These interests have come together in this way because of their strong belief in the urgent need for action and a recognition that the status quo is not serving either their own interests or this valuable resource. Nor does the current situation satisfy the people of Scotland, on whose behalf this precious resource is managed.

This consensus statement is intended to change this situation and raise the profile of fisheries, fish conservation and management in Scotland, as well as to serve as a basis from which any new policies could develop.

MANAGING IRELAND'S SPRING SALMON

(Dr Ken Whelan, Salmon Research Agency of Ireland)

INTRODUCTION

Thoughts of spring salmon normally evoke images of the great spring salmon rivers of Scotland: the Dee, the Spey, the Tweed and of course the mighty Tay. However, Ireland too boasts its share of spring salmon fisheries, which in the past consistently produced large numbers of 2 and 3 Sea Winter fish. The true jewel in the crown of Irish spring fisheries is the east coast's River Slaney, one of the most delightful fly waters you could ever imagine. The Slaney is Ireland's equivalent of the Dee and receives the bulk of its stock between February and May. Few grilse enter the system and although rumours abound regarding a strong back-end run, this occurs outside of the present fishing season.

In its heyday the Slaney produced well over 2,000 spring salmon to the rod each season but in recent years this catch has dwindled to the low hundreds. The genesis for our spring salmon seminar was the concern of local interests that a series of exceptionally poor runs throughout the 90's foreshadowed the extinction of the Slaney spring run. The campaign for a pro-active approach was spearheaded by the former chairman of the Salmon Research Agency, Fionán O Muircheartaigh. As you can imagine a request from the Slaney interest groups for support in a proposed stocking programme resulted in some lively debate between the managers and scientists!

Despite our differences in approach, we did agree that the time for action had come and we approached our colleagues in the Central Fisheries Board with a view to organising a seminar and workshop on the conservation and future management of spring salmon stocks.

The principal objectives of the seminar were:

- **Draw attention to the serious plight of Ireland's spring salmon stocks**
- **Assess what is known regarding the current status of spring salmon stocks in Ireland and abroad**
- **Review what action is being taken in other countries to redress this decline**
- **Review how applicable these initiatives are to the Irish situation**
- **Compile an action plan for major spring salmon fisheries**

The Seminar received enthusiastic support from all the experts invited to make presentations and participate. Many of the major authorities on the subject from Scotland, Wales, UK, Norway and Ireland contributed. Financial support for the initiative was sought from a wide range of organisations, angling clubs, fishery owners and individuals. Their enthusiastic support reflected the widely held concern which we wished to highlight.

The Conference was divided into two parts. A morning seminar comprised presentations from 12 invited speakers, covering all aspects of spring fish from practical management issues to the complex genetics of this unique race of fish. The afternoon comprised two workshops: the first dealing with marine survival, freshwater habitat and stocks, and the second with river plans,

fisheries measures and hatcheries and intervention. Participants were provided with a series of background papers and a list of areas to be considered in the context of compiling a spring salmon management plan for their particular system.

The one-day seminar was attended by well over 200 participants and the enthusiastic and at times heated contributions resulted in a stimulating and forceful debate on all of the major issues. The unenviable task of distilling and editing the papers and the workshop contributions fell to myself and my co-editor Fionán O Muircheartaigh.

CONCLUSIONS AND RECOMMENDATIONS

1. Reduction in exploitation of spring salmon stocks

The initiatives taken in Ireland over the past two years to eliminate commercial exploitation of spring salmon stocks should continue and every effort should be made to ensure that exploitation of MSW stocks in distant water fisheries, such as the Faroes and Greenland, is curtailed or eliminated.

Figures presented at the seminar indicated that angling exploitation rates on fresh run spring salmon, under cold water conditions, can be as high as 30% to 60%. Anglers must therefore be encouraged to voluntarily reduce exploitation of spring stocks, through the introduction of bag and/or season limits, catch and release etc.

Recommendation:

Reduce exploitation of spring stocks to ensure optimum spawning numbers

Actions:

- Continue the prohibition of the commercial exploitation of spring salmon stocks
- Reduce rod exploitation of spring salmon through a series of river specific actions. Initially, voluntary measures should be introduced locally. If ineffective, legislative action may be required in the future.

The following could be considered in formulating conservation plans for angling:

- season limits, bag limits, visit (weekly, fortnightly) limits, possession limits
- catch and release: this will require training and is only really effective in the case of fly / spinner (barbless) caught salmon
- method restrictions, to apply after first fish has been taken
- seasonal changes - curtailment of spring season ? size limit after 1st June - only salmon under 80cm (30 inches or 10lb) to be taken
- return all red salmon in August / September
- ban the use of gaffs
- use of knotless material in landing nets

2. Status of spring salmon stocks

From the data presented at the seminar it is obvious that the overall stock of multi-sea-winter salmon is at an all time low. This is particularly true of early running, two-sea-winter salmon. Spring salmon warrant a specific proactive conservation programme. The problems affecting these stocks are marine based and were due to be addressed at a detailed workshop to be held by the Atlantic Salmon Trust in Pitlochry in November.

The 5th International Salmon Symposium, held in Galway in 1997, stressed the need to conserve stocks by adopting a broad conservation programme, encompassing all aspects of the salmon's life cycle, both marine and freshwater. The proceedings of our seminar suggest how this might be done in the case of the threatened spring salmon.

Recommendation:

Collect accurate information from all major spring salmon fisheries.

Actions:

- Complete installation of counters on all major spring salmon fisheries and in partnership with local interest groups plan for the installation of counters on major spawning tributaries
- Ensure that funding and man-power are available to maintain these counters and for data analysis
- In co-operation with owners and anglers, the Fisheries Boards should ensure the collection of accurate, effort-related, statistics. In large catchments consideration should be given to the introduction of a system based on stratified random sampling rather than the total catch estimates attempted at present
- Ensure that every effort is made by the EU, through NASCO, to curtail or eliminate the high seas fisheries off Greenland and the Faroes. To ensure that careful monitoring of high seas industrial fishing takes place on a regular basis and that all bye-catches of salmon smolts are kept to a minimum.

3. Protection of spring salmon habitat

A key element in the management of spring salmon stocks is the identification and preservation of spring salmon spawning areas. Thanks to the development of Geographical Information System (GIS) and Global Positioning System (GPS) technology by the SRA and the Marine Institute, it is now possible for Regional Fisheries Boards to accurately map the exact location of these areas. Designation of these zones as areas of special scientific interest, with all of the protection such a designation affords, would greatly improve the long-term protection of such important habitat. Some of this work has already taken place on fisheries such as the Moy, Corrib and Currane, through TAM supported programmes. The maintenance of high water quality standards and the maintenance of natural flow regimes in all spawning and nursery areas must also accompany designation and protection of the physical habitat.

Recommendation:

Selective protection for spring salmon spawning areas

Actions:

- Work with Dúchas (Irish Heritage Department) and other state bodies to ensure that all spring salmon spawning areas are designated as areas of special scientific interest
- Encourage all Fisheries Boards, in conjunction with technical support from the SRA, Marine Institute, and the CFB, to provide Dúchas with detailed maps of spring salmon spawning areas, with a view to having these areas designated as areas of scientific interest
- Rehabilitate damaged spring salmon habitat
- Work in close co-operation with other State and private sector bodies [eg local authorities, Coillte (Forestry Board), Teagasc (Agricultural Research Agency) etc] to ensure that they are fully aware of the importance of juvenile salmon rearing areas and are committed to the preservation of the physical and aquatic habitat in these areas
- Fisheries Boards to utilise modern technology (GPS/GIS) to ensure that spring salmon spawning areas are clearly and accurately designated
- Maintain highest possible water quality standards in all spring salmon spawning areas

4. Stocking for enhancement

The value of stocking and enhancement was discussed at the workshop and experts on the topic provided conflicting advice. In general, fishery owners, some anglers and fishery managers favoured stocking. They saw it as an essential safeguard to maintaining threatened spring stocks. Proponents of using stocking for enhancement stressed:

- the need to make the most of available spring fish genes - the need to enhance the survival of the offspring of spring fish
- where stocks are low, to avoid "swamping" of early running fish by autumn stocks. Scottish initiatives to breed from spring fish were noted. - Norwegian rules for hatcheries and introductions were noted, which took account of historic practice and the level of stocks present

Scientists and geneticists were generally more negative about stocking and stressed:

- that stocking may be counterproductive
- the delicate nature of individual stock structure
- the need to conserve the genetic integrity and adaptive stock traits
- stocking and supportive breeding should only be considered as a last resort
- the need for clear objectives and modest, realistic expectations

It is obvious from these discussions that an experimental programme to assess the value and potential dangers of such direct intervention is urgently required. Given the apparent success of stocking the River Slaney in the late seventies and the acute stock situation reported to the seminar, a re-activation of the previous stock enhancement programme should be considered.

Recommendation:

Where stocks of spring salmon have been shown to be at a critical level and where the long-term viability of the stock is in doubt, undertake pro-active enhancement through stocking wild spring salmon ova

Actions:

- Assess spawning stocks in the major spring salmon fisheries
- Where stocks have been shown to be critical, undertake a selective enhancement programme using wild spring salmon ova
- Initially such programmes to be carried out on selected tributaries or carefully selected stretches of main channel
- Full assessment of results to be carried out , including genetic analysis of returning adult salmon

5. River plans – millennium project

The importance of comprehensive and practical river plans was emphasised at the seminar.

Recommendation:

Compilation of a comprehensive river plan for each of the major spring salmon fisheries for implementation by year 2000.

Actions:

- In conjunction with overall catchment management plans, the Fisheries Boards and other relevant State services to provide support, on a partnership basis, to owners and angling clubs to ensure that conservation based programmes are in place on all major spring salmon fisheries.

Areas to be considered in the context of compiling a spring salmon management plan:

- Availability of reliable information on spring salmon stocks
- Is it possible to estimate stock levels from available catch returns?
- How is it proposed to a) improve stock estimates b) catch statistics in the future?
- Is it proposed to install a fish counter? Who will fund same? Who will monitor and maintain the fish counter?
- Is it proposed to alter: rod effort and exploitation rates for spring salmon or change seasons towards the exploitation of healthy grilse or autumn stocks?
- Is it planned to carry out physical improvements to a) adult holding areas b) nursery and spawning areas? Give details.
- Is there a detailed map available of the catchment, showing the extent of spawning and nursery areas?

- Has the catchment been included in a GIS (Geographical Information System) by the Fisheries Boards or the Local Authorities?
- Is it proposed to stock with a) native b) non-native wild juveniles?
- What is the source of the non-native juveniles?
- Give reasons as to why you propose to adopt this strategy and a cost benefit estimate of same
- Is it planned to initiate a Catchment Management Plan / River Management Plan? Give details.
- Is it planned to improve water quality? Give details.
- Is protection of fish stock and habitat adequate? If not what is required to strengthen same?
- Is predation a problem a) on smolts b) on adult salmon? List predators and action required alleviating problem. Has problem been discussed with local wildlife officer?
- Provide details of work proposed by the private sector and indicate level of State support (eg technical advice, increased protection, hatchery facilities etc.) required to achieve goals.

6. Research

Practical research programmes should underpin the initiatives outlined above

Recommendation:

Carry out research programmes to assess the effectiveness of the measures outlined above; their effects on stock recruitment relationships; the assessment and achievement of spawning targets; research on novel methods of stock enhancement. Such programmes to take account of strategies adopted in other countries and the results of such initiatives.

Actions:

- Actively support research into the biology, stock dynamics and genetics of the spring component of the salmon stocks and an assessment of the value of direct enhancement of these stocks.
- Work with DANI in Northern Ireland and the Foyle Fisheries Commission to carry out detailed research on the River Finn to assess why this particular spring stock appears to be unaffected by the general decline in spring fish stocks.
- Experimentally assess the value of stocking with F1 wild, non-native, MSW fry and smolts and possible impacts on native, wild, spring salmon stocks.

7. Conservation and legislation initiatives

Although the main thrust of the above recommendations may be carried out without legislative support it is suggested that consideration be given to the following legislative changes to underpin the above initiatives:

Actions:

- No commercial netting should take place before the 1st June
- Ensure that in-river conservation initiatives are effective through the introduction of legislation banning the sale of rod caught salmon before 1st June
- Ban prawn and worm fishing before the 1st June
- Ban the use of gaffs
- Before 1st June an angler may retain one salmon per day. The fish may be taken on fly or spinner. The angler may continue fishing with barbless hooks but must return all other salmon caught. (1)
- Ban the retention, sale and purchase of salmon greater than 80cm or 10lb, taken by rod and line, after 1st June
- Review legislation governing seasons and fishing methods in all major spring salmon fisheries and amend as considered necessary
- To include a provision for the tagging of rod caught fish in any legislation covering tagging and quotas for the commercial sector
- Where voluntary stock conservation methods are ineffective, to introduce formal legislation to ensure that exploitation by rod is curtailed
- Where considered appropriate exclude ranched stocks from these provisions
- Where predation is adversely impacting on either smolt output or adult returns to ensure that the levels of predation are minimised.
- Launch a publicity campaign to increase awareness of the risks posed by imported fish diseases or parasites. The fluke Gyrodactylus salaris has spread on trout to countries such as France, Spain, Portugal and Germany, where it is now a common parasite of domesticated rainbow trout. The SRA and CFB have advised that a pro-active information and prevention campaign should be initiated to ensure that the fluke is not introduced to Ireland through angler's tackle or through the movement of fish farm equipment. Such a campaign should encompass awareness of diseases such as ISA, VHS or IHN, not currently in Ireland but present in the UK or in Europe.

(1) *More stringent bag or season limits may be required on fisheries where stocks are particularly low.*

Draft copies of the seminar proceedings were made available to the Minister for the Marine and Natural Resources in early December '98 and we are pleased to note that many of the recommendations made in the report have been taken on board by the Minister. With the assistance of the Fisheries Boards these will be implemented over the next two seasons.

It was obvious from the workshop that no one set of measures is a panacea and each system must develop its own conservation criteria. We trust that the river plan template provided in the report will encourage all of the interest groups to move forward in a pro-active and constructive manner.

A limited number of copies of the spring salmon seminar proceedings are available from:

Salmon Research Agency of Ireland
Furnace,
Newport,
Co Mayo

Tel & Fax: 00 353 98 41107
Email: sra@iol.ie

Price: £10 plus postage and packaging.

(Preference will be given to interest groups over individuals!)

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IRELAND SALMON UPDATE – SUMMER 1999

(Dr. Ken Whelan)

Spring Catches

Salmon catches have shown a very definite improvement in some systems this spring. Angling has been excellent on the River Slaney, where over 800 salmon have been taken, and also on the Delphi, Galway and Cork Blackwater. Fair angling was reported from the Moy, Boyne and Shannon. Fishing was poor on river sin Mayo, Kerry and Donegal. This was particularly true of Lough Beltra, where few fish have been taken, despite a high rod effort. Following the ocnservation recommendations resulting from the september seminar in Dublin, it was very disappointing to see that Irish anglers released few spring salmon. On the Slaney alone it is calculated that at least six million salmon ova were lost in the declared angling catch.

River Management

The commercial salmon traps on the Moy and Galway fisheries have been closed and counters are being installed to monitor future spawning stocks. Counters are planned for all of the major salmon fisheries including the Slaney, Erriff, Owenmore and Currange systems. A new manager, Declan Cooke, has been appointed to the Moy fisheries. He worked with the Salmon Research Agency from 1992 to 1996 and with the Central Fisheries Board for the past two years. He is a first-class trout angler and an expert fly tyer, and will bring a keen management sense and boundless enthusiasm to the post. It is with deep regret that I must report the untimely death of the former manager, Mike Tolan. Mike, a larger than life figure, dedicated his life to fisheries and will be missed by his family and wide circle of friends.

The carcass-tagging scheme, which was to be introduced on the first of May, has been postponed until the first of January next.

Salmon Commission

The Minister for the Marine has indicated that details of the new Irish Salmon Commission will be announced shortly.

Salmon Research Agency Merger

The Salmon Research Agency is to merge with the national Marine Institute on the 1st July 1999. The staff of the Agency will be absorbed into the new Salmon Services Division of the Institute and the research facilities at Furnace will be upgraded and improved. The core monitoring work of the Agency will continue but its unique experimental facilities, both in relation to aquaculture and wild fisheries will be fully utilised within the context of the Institutes recently published Research, Technology, Development and Innovation Strategy. The merger will ensure an increased national role for the work of the Agency and a consolidation of the trap and laboratory facilities at Newport.

PROJECTS BEING SUPPORTED BY THE ATLANTIC SALMON TRUST IN 1999

Population management: maximising progeny numbers from natural and artificial spawning – DNA finger-printing study

This is a five-year study, now into its fourth year. It is the most significant item in the Trust's support of research. The work is carried out primarily by the Trust's biologist, using a field station on the Baddoch Burn, an upper tributary of the Aberdeenshire Dee and the facilities of the Marine laboratory Aberdeen. It involves DNA marking of the individual families of fish in the Burn in order to investigate their behaviour and survival. This project will provide an unequalled body of data on the effects of different habitats and conditions on salmon in fresh water, coupled with an indication of their eventual rates of survival and return to the river.

DNA Profiling using semi-automated micro-satellite screening

This work will support the development of a much improved, faster and cheaper technique for analysis of DNA samples, and will greatly assist the conduct of the DNA finger-printing project described above. It is taking place at the Marine Laboratory, Aberdeen.

River Eden – Spring Salmon Radio Tracking

The Trust is making a contribution to the cost of a study to determine where in the River Eden (Cumbria) spring salmon spawn, and whether they are unique in particular locations, or whether summer and autumn populations also spawn in the same place. This has recently been suggested by observations in the River Tweed, and the trust is inviting the sponsors of the project, who include the Environment Agency and the Eden Rivers Trust, to co-ordinate their work with that continuing on the Tweed (see next project).

River Tweed – assistance with purchase of micro-tagging equipment

This project is similar in its aim, which is to determine where spring fish spawn in the Upper Tweed in order to try to enhance dwindling numbers. The fish will be tagged after being caught in two new traps to be constructed with the assistance of EU funding. The Tweed Foundation will be invited to co-ordinate their work with the Eden (see above) in order to investigate whether mixing of spring and later fish is a more widespread phenomenon than previously supposed.

Spey Research Trust – portable resistivity counter trials

This project involves the construction, use and validation of a simple electric resistivity counter to fill in the gaps in cover of an existing acoustic counter. If the technique is validated, it will offer the possibility of installing counting facilities in rocky rivers where it is not possible or too expensive to construct the weirs normally required for resistivity counters. This could markedly increase the availability of data for salmon management in many rivers.

Analysis of sea trout growth and survival on the Welsh Dee

This consists of the analysis of some eight years' data from fish sampled and tagged at the Chester Weir trap. It will investigate growth and survival patterns in relation to variations in climate and other factors. This is important work in view of the recent declines in sea trout populations, and the comparatively limited knowledge of the sea trout's life cycle.

AST BIOLOGIST'S REPORT

(John Webb, B.Sc., M.Sc., M.I.F.M)

Lifetime fitness among spring salmon and early-running grilse – DNA fingerprinting studies

This spring's smolt run on the Baddoch burn ended in the second week of May. The total number caught this season amounted to about 1350 smolts. The catch consisted of a mixture of 2, 3, and four year old fish. The 4-year old smolts captured this year will be the last group of fish that will be generated by the first experimental batches of eggs planted back in spring of 1995. The two and 3-year old fish are migrants generated by the groups of eggs planted in 1996 and 1997.

All of the smolts captured in the trap this spring have been sampled for length, weight and adipose fin tissue. Each fish has also been micro-tagged with a coded wire tag before being released to continue their journey downstream to the sea.

All of the fin-clip samples taken from autumn parr and smolts derived from the 1995 egg planting are currently being analysed in the laboratory using the new DNA methods. This work will determine whether the migrants produced are wholly representative of all the family groups of eggs placed in the burn in 1995, or whether particular families dominate (through competition and various habitat effects) the juvenile output from the system.

By historical standards, a total smolt catch of 1350 is not a high number for the Baddoch system. The long term average (1987 to 1996) for the burn is about 2000 smolts. The recent decline in smolt numbers mirrors the sharp fall in the numbers of female 2SW and 3SW spring salmon returning to the burn to spawn since the mid-1990s. However, despite the recent reduction in egg numbers, this season's smolt catch does suggest a very good rate of survival from egg to smolt. Indeed, among the eyed eggs planted in the burn over the period 1994-95, the cumulative trap catches (excluding catches of autumn parr) suggest a rate of survival from egg to smolt of about 2.5 to 3%. These estimates correspond to levels that are between 2.5 and six times the rate of survival that is normally found in upland streams. However, at this stage of the experiment, it is not clear whether the high levels of survival to the smolt stage is due to the planting methods used, or whether it is simply a result of the resulting fish growing at a faster rate – due perhaps to a reduction in various density dependant factors that influence parr populations at more normal spawning levels. Consequently, the burn may now be simply producing fish that are developing into smolts at a younger age.

Research will continue to establish to what extent these different factors are causing the changes in the production characteristics of the burn.

Meetings and publications

In early December I gave a presentation entitled 'catch and release of spring salmon' to members of the Tay District Salmon Fisheries Board and Tay proprietors at their AGM in Perth. This was followed by another presentation on the same theme to members of the Tay Ghillies Association at their AGM in Dunkeld in early January.

In late February, I attended a workshop at the Freshwater Fisheries Laboratory at Pitlochry on the different habitat assessment protocols that are currently being used by District Board/Fishery Trust biologists in Scotland. The meeting was organised by the Scottish Fisheries Co-ordination Centre.

ATLANTIC SAL

Salmon at sea

Salmon feed in many parts of the North Atlantic Ocean. Those from British rivers which spend a single winter at sea (grilse) may go no farther than the Faeroes, but multi-sea-winter salmon commonly go as far afield as Greenland and the Norwegian Sea. They feed on a diet of crustaceans and fatty fish such as lantern fish, sandeel post-larvae, capelin and herring. Salmon tend to double in weight each year, averaging about 6 lb after one year and sometimes eventually reaching over 40 lb.

Under 10% of smolts usually survive to return to their home rivers. Salmon numbers are strongly affected by ocean conditions, and by the availability of prey, of which some species are taken commercially. Threats at sea include many predators such as cormorants, sharks, seals, dolphins and killer whales, as well as commercial fisheries, including those targeted at other species.

Smolt

Each Spring the largest parr become silvery smolts and start to drift downstream at night towards the sea. In the South this is usually after one year; most Scottish smolts, with a shorter summer growing season, are 2-3 years old. They tend to travel in shoals, becoming vulnerable to predation especially at estuary 'bottlenecks' where the threat is often accompanied by the risk of water pollution. They travel near the surface, and head out to sea on their way to the main ocean feeding grounds.

Parr

Once they have grown above fingerling size, the prettily marked young salmon are known as parr. Most live in fast, shallow riffles, although about half may perish each year, mainly due to predation, continuing territorial pressure tends to keep the well-stocked salmon stream fully utilised. The main threat apart from pollution is from summer droughts which can severely reduce available water, oxygen and food. Effects of droughts and floods are increased by hill drainage schemes, especially in commercial forests; faster water runoff can lead to erosion, siltation and (on some soils) acidification of rivers and tributaries.

Fry

On emergence from the gravel fry begin feeding on invertebrates drifting down with the current. Their numbers typically exceed the carrying capacity of the stream and the following weeks usually see the highest mortality rate of the whole lifecycle. Over 90% of fry normally die in competition with one another over the limited number of potential feeding territories.

Alevins

These are newly hatched salmon with attached yolk sacs. Born in early Spring, alevins remain safe under the gravel for a few weeks until the food in their yolk sacs has been used up; the tiny fish then emerge from the gravel as free-swimming fry about an inch long.

Eggs

A 10 lb hen salmon lays about 7,000 eggs in a gravel nest called a redd, and total egg production is normally in excess of the number needed to stock the rivers. Buried deep in the gravel, they suffer little predation and hatching rates may exceed 90% in clean gravel. The main threat is from severe floods which can wash eggs away or silt up the egg pockets in the redd.

Written & illustrated by Robin Ade

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MON LIFECYCLE

Returning adults

At the onset of maturity salmon begin the journey home, apparently finding their way across the ocean with the help of celestial cues and the earth's electromagnetic field. Most return as grilse, with the proportion of big, multi sea winter fish varying in different parts of their range and over different periods of time. On reaching coastal waters salmon can locate their home rivers by smell. In dry weather they remain near the estuaries, some falling prey to nets or to groups of seals, but when the rivers rise after rain they enter them immediately. Adult salmon do not feed in the river and the main freshwater threat, rod fishing, is relatively inefficient. Depleted runs of salmon, especially Spring runs, can however be damaged by angling. Springers are relatively easily caught and may spend up to a year in the river, living on fat reserves which comprise about 30% of body weight.

Breeding pair

After a few weeks in fresh or estuarine water salmon lose their silver coats and begin to develop a colourful breeding dress, the males also acquiring a hooked lower jaw (kype). Spawning usually takes place between October and January in the same stretch of water where the salmon themselves were born. The hen digs a series of nests (redds), laying eggs which are simultaneously fertilised by an adult male, and often by precocious parr as well.

In fresh water few predators apart from man are able to catch adult salmon. Otters can do so but they prefer eels and tend to take salmon mainly around spawning time. Most waters do in fact have enough breeding fish, even in bad years, to fully stock the rivers - the main limitation on salmon numbers is the state of the rivers themselves, virtually all of which have been degraded to some degree by human activity.

rvation and Enhancement

n measures today are aimed at repairing or e streams and rivers on almon production relies, and t is now being broadened to diverse interests which affect n Scotland, Fishery Trusts are abitat regeneration and on.

Traditional management methods are being modified by new scientific findings. Artificial propagation is expensive and has been found to be relatively ineffective, except in special situations where salmon are absent or close to extinction. Fishery regulation remains vital, but is complicated by the fact that it is often concerned with dividing the catch rather than conserving stocks; today the emphasis is on recreational fishing, which produces most revenue for rural communities and river owners. Since the development of salmon farming the commercial value of wild fish for human consumption has declined.

Conservation at sea relies largely on agreements at international level. Drift netting, which takes salmon of different river origins indiscriminately, has been banned by most North Atlantic countries, but commercial fisheries for prey species have remained poorly regulated. The health of future salmon stocks rests on wise management of both saltwater and freshwater environments.

TETHERING SALMON

'NECESSITY IS THE MOTHER OF INVENTION'

(John Hopkinson)

As one of the initiatives to restore salmon stocks in the River Wye the owners set up a hatchery in order to carry out a restocking programme. It was particularly hoped that this would assist in restoring the spring run, which has shown a catastrophic decline. However, it was felt that in obtaining broodstock we should seek to persuade anglers to donate what they caught to the hatchery rather than killing it, and that we should also make use of rod caught kelts, reconditioning them in the hatchery for use as broodstock. Maiden fish would not be caught up in the spawning areas.

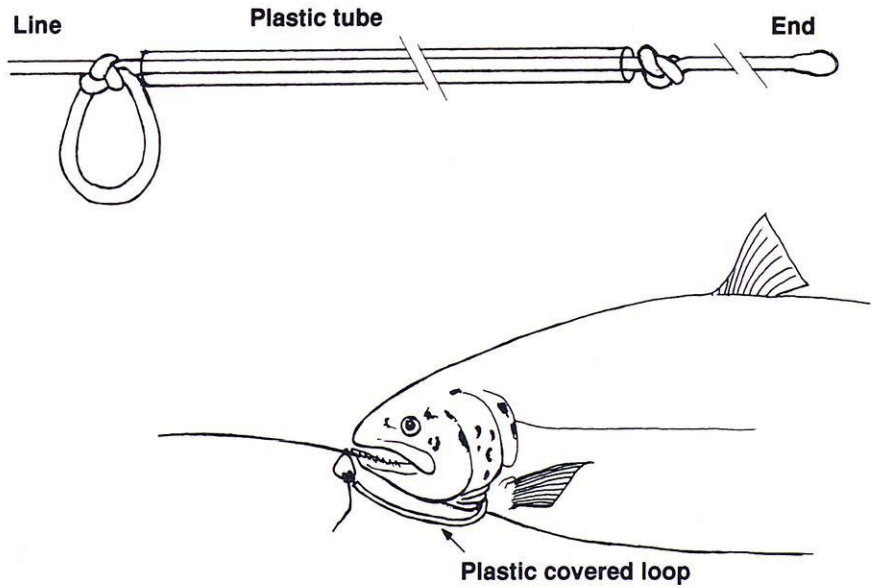
This created the problem of how to hold fish caught on fisheries up and down the river, until they could be collected by hatchery staff. In the first two years we tried using large keepnets used in coarse fishing. These, however, appeared to be responsible for a measure of fish mortality especially among fresh run fish, which lost a lot of scales and also caused a number of cases of blindness through eye contact with the net. It was not practical to establish larger holding cages on each fishery, thus an alternative solution was required.

It is well known to anglers that it is relatively simple to lead a fish through a pool and that it is happy to remain in a place of its own choosing when no pressure is exerted on the line. Armed with this knowledge we came to the conclusion that tethering fish might be the best means of holding them. By this method they could be held in the pool where they were caught and in the least stressful conditions.

But how to tether them? After a certain amount of trial and error including the use of a lasso noose on a plastic coated clothes line the following system was adopted. Braided nylon sea fishing line was used for the tether, it being strong while offering minimal resistance to the river flow. Since the tether would have to pass through and out of the gill cover beside the lower jaw, a piece of plastic tubing - the sort used as fuel pipes on garden machinery - was used to cover the line. This tubing was inserted onto the line below a loop and above a knot, thus it was held in place. Below the knot about four inches of line remained, the tip being burnt to prevent the strands unravelling and provide a smooth tip. This end was used to tie into the loop and so form a non-slip, plastic-covered noose which passed through the mouth and out under the gill cover. The tip of the tether is easy to pass through mouth and gill cover and the loop makes it easy to tie the knot required to form the noose. The plastic cover alleviates discomfort and damage through chafing.

In operation the method is working well, the fish need not be removed from the water, and when released on the tether the fish finds its own position where the line will not get caught up. The length of tether is dependent on the site, and it is best to let the fish find its own position before securing the end to the bank. The fish usually lies up stream of the tethering point with no tension on the line. Fish have been held successfully by this method for over forty-eight hours and even in flood conditions.

We have found that by instituting a system whereby anglers can make a direct contribution to the restocking programme, considerable enthusiasm has been engendered for the conservation of our salmon stock.



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 professional 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 of 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 MEGAFLUME

A new facility for studying the behaviour and ecology of Atlantic salmon

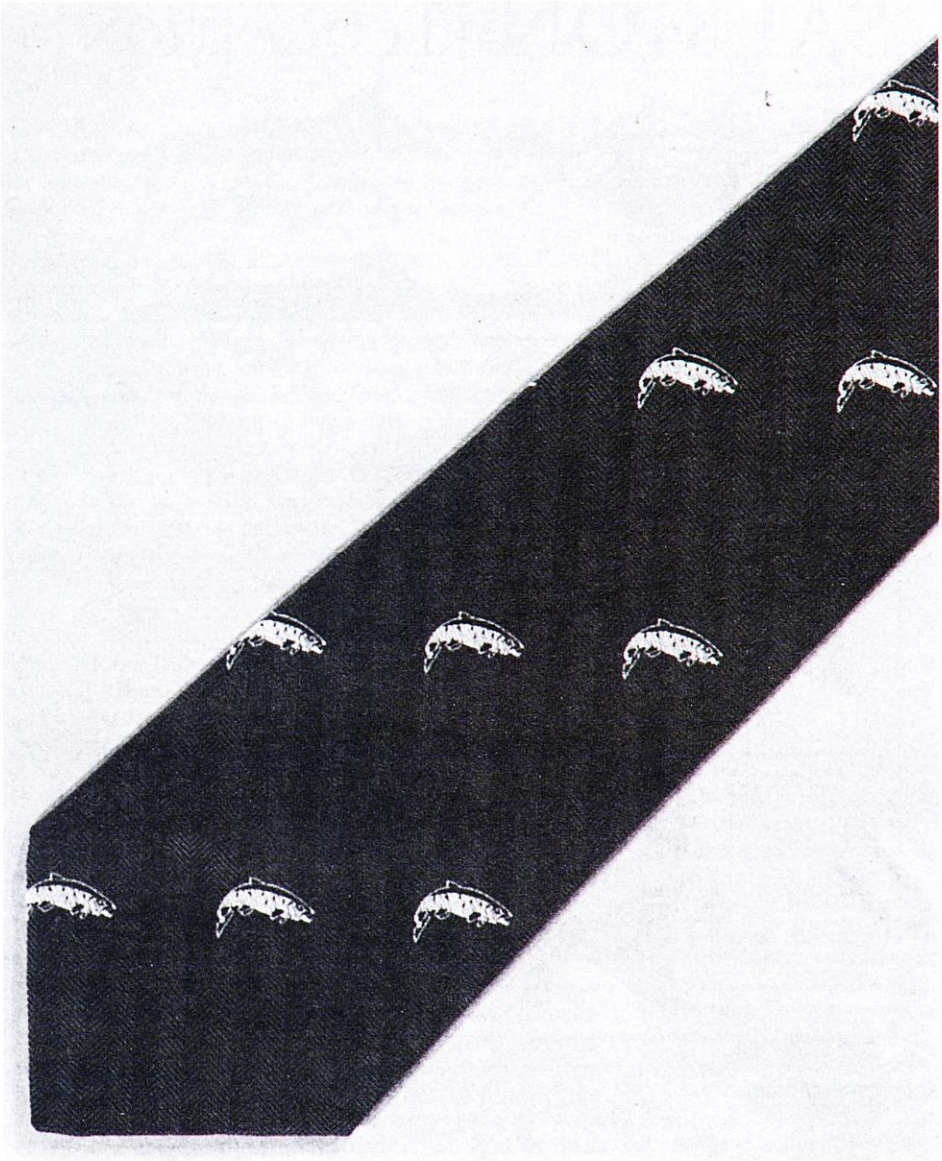
(Dr. John Armstrong, Freshwater Fisheries Laboratory, Faskally)

Undoubtedly, one of the most practical methods of increasing the number of adult salmon available to be caught is to maximise the production of high-quality, naturally-spawned smolts going to sea. Many interacting factors affect the number and sizes of smolts produced in a river. These factors include the rate of water flow, composition of the substrate, abundance of competitors, number of predators, availability of food and distributions of spawning adult fish. Managers of salmon need to understand the relative importance of each of these factors in different river systems in order to develop efficient enhancement and conservation strategies. Recent research using miniature electronic tags coupled with underwater video cameras has shown that salmon parr occupy overlapping home ranges of up to 10m in length. This research also indicates that behavioural interactions between fish have a large impact on the growth and survival of all parr in a given area of a stream.

The extensive home ranges, complexity of behaviour and large number of interacting factors affecting growth and survival of parr make it very difficult for researchers to understand how production of smolts is influenced by the environment. Observational studies of natural streams give clues about the ecology of salmon, but a facility is required for conducting controlled experiments at a suitable scale, with a large number of replicates in which fish can be observed. This need is being addressed by the construction of a new indoor stream ("The Megaflume") at the Freshwater Fisheries Laboratory's research unit at Almondbank.. The flume is a composite concrete, wood and metal structure with glass panels along the length of the interior wall. It is 1.5m wide and is supplied with water from the River Almond by a gravity feed. The water is returned to the river having passed a single time through the flume. Therefore, fish are not exposed to a large build-up of their odours (as is the case in recirculating flumes), which may affect their behaviour. A rotating drum filter removes large debris from the incoming water, but allows invertebrate larvae into the flume. It is envisaged that for some experiments communities of invertebrates will be allowed to develop and these will provide fish with a natural supply of food when required.

The first 40m length of flume was constructed by Mike Miles and his team at Almondbank. A further 40m section will be built this year as part of a collaborative project between the Freshwater Fisheries Laboratory and Graeme Ruxton and Felicity Huntingford of the Zoology Department of the University of Glasgow, funded in part by the Natural Environment Research Council. The first experiments have already been conducted to look at the behaviour of salmon during winter. The Megaflume provided the large array of replicated stream sections required for the work conducted by Siân Griffiths (sponsored by the Natural Environment Research Council), who observed how salmon parr shared underground shelters in a near-natural stream bed. An extension to the main flume has been constructed to support a project investigating exactly how upstream migrating salmon parr approach and move through a fish pass in a weir. This project is a collaboration between the Freshwater Fisheries laboratory and Eliane Guiny and Alan Irvine of the Engineering Department of the University of Glasgow and has been supported in part by the Fishmongers' Company. It will provide critical information on the responses of migrating salmon to various water flows and can be expected to develop insights that may be tested using adult salmon in rivers and then hopefully applied to improve the design of fish passes. This range of projects gives an idea of the flexibility of the Megaflume, which is a unique and important initiative to help Atlantic salmon in Scotland.

ATLANTIC SALMON TRUST TIES



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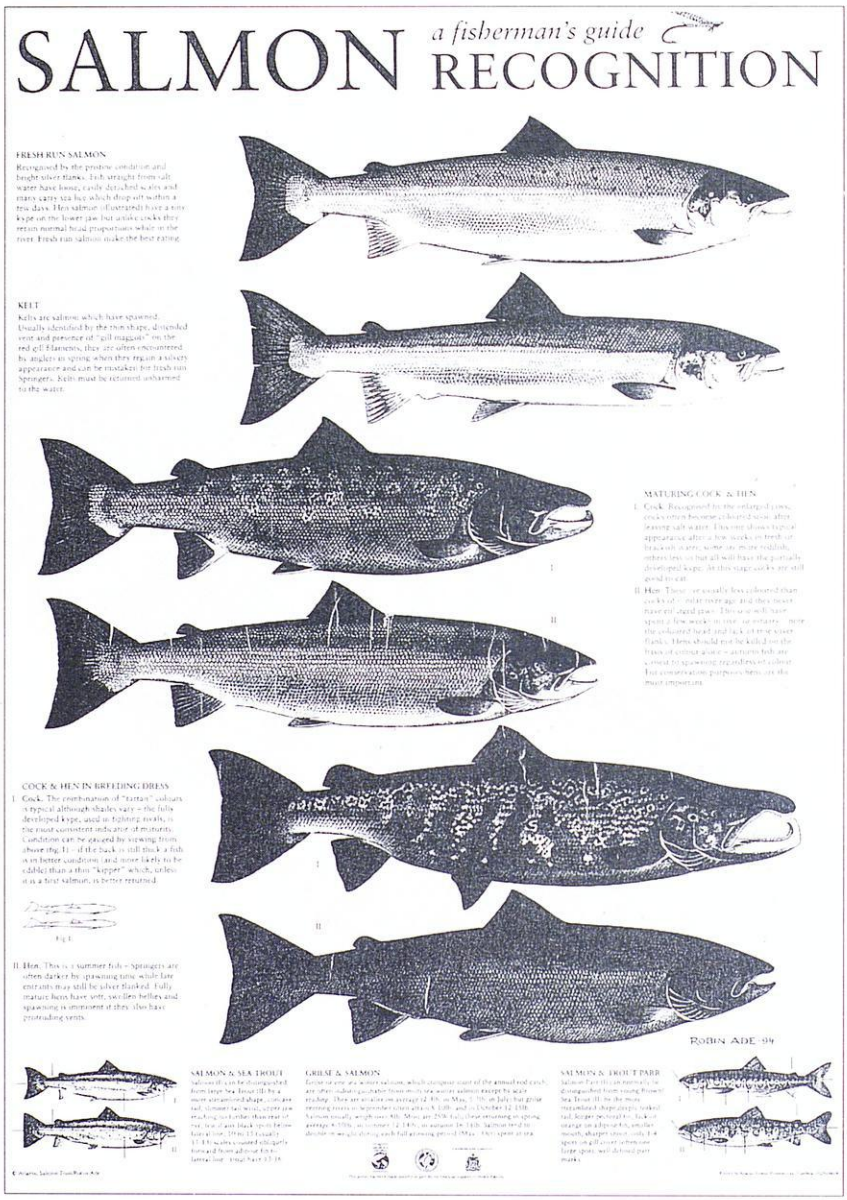

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REVIEW OF SCIENTIFIC LITERATURE ON SALMON

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

1. Smolts

River-Specific Target Spawning Requirements for Atlantic Salmon (Salmo Salar) based on a Generalized Smolt Production Model
Chaput G; Allard J; Caron F; Dempson J B; Mullins C C; O'Connell M F
Canadian Journal of Fisheries and Aquatic Sciences 55 (1):246-261

Atlantic salmon *(Salmo salar)* management in eastern Canada is based on ensuring that there is sufficient spawning escapement to meet an egg deposition target that maximizes the production of smolts. Using available egg deposition to smolt production data, we show that the present strategy of basing spawning targets on the presence-absence of lacustrine habitat for the rearing of juvenile salmon is a valid approach. We further show that a general smolt production model that accounts for this difference in available habitat when combined with the biological characteristics of the recruiting adults provides river-specific spawning targets. Targets corresponding to maximum yield tend to be less than half the target values currently used. A target representing the egg deposition for 90% of maximum yield serves as an example of a risk-averse strategy. The lower target values relative to those currently used are in large part determined by low sea survivals. The targets that we derived for four example rivers would correspond to the currently used target egg depositions if the long-term sea survivals were 2-3 times those observed in the last 6 years.

The Relative Role of Density-Dependent and Density-Independent Survival in the Life Cycle of Atlantic Salmon *Salmo Salar*
Jonsson N; Jonsson B; Hansen L P
Journal of Animal Ecology 67 (5):751-762

Density-dependent factors appeared important for the survival of juvenile Atlantic salmon in the River Imsa whilst density-independent factors were more important for the older fish at sea. In fresh water, density dependence was indicated by a stock-recruitment relationship with increasing loss-rates from eggs to smolts and from eggs to adults as egg density increased. 73% of the loss-rates were explained by variation in egg density. At sea, density independence was indicated by the lack of a significant relationship between loss-rates and smolt densities. The relationship between smolt density and initial egg density was best described by an asymptotic 'Cushing' type relationship with a plateau at densities higher than approximately 60,000 eggs for the total river areas of 10,000 m^2. The number of smolts developed from the eggs spawned varied between 350 and 2400. The relationship between smolt biomass in wet mass (kg 10,000 m-2) or energy (kJ 10,000 m^{-2}) and the amount of salmon eggs in the River Imsa increased asymptotically. Annual smolt biomass ranged from 13 to 88 kg 10,000 m-2, or 66,000 and 431,000 kJ 10,000 m^{-2}. Variation in egg density accounted for approximately 45% of the variation in smolt biomass (mass or energy). Total wet mass and energy of adults (kg 10,000 m-2 and kJ 10,000 m-2) produced in relation to the amount of eggs at the start of the year-class, were not significantly correlated, due to a high variation among years. The biomass of adults ranged from 73 kg 10,000 m^{-2} to 655 kg 10,000 m^{-2} and in energy from 370,000 kJ 10,000 m^{-2}

to 3,270,000 kJ 10,000 m^{-2}. Total adult biomass (adults caught at sea and in rivers) and the returning adults to the River Imsa in mass or energy were correlated with the size of the smolt cohort from which they originated. Yearly total adult biomass ranged between 240 and 3,711 kg 10,000 m^{-2}, when the number of smolts ranged from 397 to 2,751, respectively. The biomass of adults returning to the River Imsa was between 59 and 614 kg, produced from between 672 and 1,621 smolts.

Long-Term Study of the Ecology of Wild Atlantic Salmon Smolts in a Small Norwegian River
Jonsson N; Jonsson B; Hansen L P
Journal of Fish Biology 52 (3):638-650

Backcalculated lengths at the end of the first growth season in wild Atlantic salmon Salmo salar differed significantly between parr smolting at age 1, 2 and 3 years over a period of 11 years (i.e. 1983-1993). Mean body lengths of the respective age groups at the end of the first growth period were 11.1, 6.2 and 4.7 cm, respectively. The mean percentage distribution of fish smolting at age 1, 2 and 3 was 14, 78 and 7%, and the mean smolt age was 1.95 years. Mean lengths at smolting of age groups 1, 2 and 3 were 13.6, 15.8 and 17.5 cm, respectively. Females outnumbered males among the downstream migrating smolts with a mean sex ratio (females/males) estimated at 1.61, with a significant female surplus in 7 of the 11 years sampled. Of the smolts sampled, 14% exhibited enlarged gonads indicative of parr maturation, and all were males (37% of the parr males sampled). Mean annual smolt density from 1975 to 1996 was 13.4 individuals 100m-2 ranging between 0.3-31 smolts 100m^{-2}. Mean densities (100m^{-2}) of the smolts aged 1, 2 and 3 years were 1.5, 9.3 and 0.9 fish, respectively. Mean annual biomass for the 22-year period (1975-1996) was estimated at 437 g 100m^{-2}, with a range of variation from 136 to 683 g 100m^{-2}. Smolt age 2 made up 81% of the mean annual biomass (355 g 100m^{-2}) and smolt age 1 and 3, 8% (35 g 100m^{-2}) and 11% (47 g 100 m^{-2}) respectively.

2. Post-Smolts

Marine Temperatures Experienced by Postsmolts and the Survival of Atlantic Salmon, *Salmo Salar* L., in the North Sea Area
Friedland K D; Hansen L P; Dunkley D A
Fisheries Oceanography 7 (1):22-34

The survival of two Atlantic salmon stocks that inhabit rivers confluent with the North Sea was examined in respect to historical distributions of sea surface water temperatures. The rivers Figgjo and North Esk are relatively small salmon rivers in southern Norway and eastern Scotland, respectively. Wild salmon smolts have been tagged in these rivers since 1965. Tag returns were used to evaluate the survival of salmon in the North Sea. Survival rates of one-sea-winter (1SW) and 2SW fish were correlated within stocks, as well as between stocks. Survival rates were compared with the areal extent of thermal habitat in the north-eastern Atlantic Ocean.

A positive correlation was found between the area of 8-10°C water in May and the survival of salmon. A reciprocal negative correlation was also found between survival and 5-7°C water in

the same month. An analysis of sea surface temperature distributions for periods of good vs. poor salmon survival showed that when cool surface waters dominate the Norwegian coast and North Sea during May, salmon survival has been poor. Conversely, when the 8°C isotherm has extended northward along the Norwegian coast during May, survival has been good. The effect of water temperature distributions on the growth of postsmolts and other survival factors are discussed.

3. Salmon Migration

Survival of Radio-Tagged Atlantic Salmon (*Salmo Salar* L.) and Trout (*Salmo Trutta* L.) Smolts Passing a Reservoir during Seaward Migration
Jepsen N; Aarestrup K; Okland F; Rasmussen G
Hydrobiologia 371-372:347-353

High mortality rates of seaward migrating salmonid smolts when passing reservoirs and lakes have earlier been found in the Danish River Gudena watershed. To reveal the causes of mortality of migrating smolts in Lake Tange, a 12 km long, shallow reservoir, 50 salmon smolts and 24 trout smolts were tagged with internal miniature radiotransmitters, and released in the river just upstream of the reservoir on May 1, 1996. The salmon smolts were hatchery-reared, while the trout smolts were wild fish, caught in a smolt trap. The tagged smolts were tracked daily for 3 weeks, and when possible the cause of death was determined. During the 3-week period, 90% of the tagged smolts died. The main cause of death for both trout and salmon was predation from fish and birds. The most important predator was pike (Esox lucius L.), being responsible for 56% of the observed mortality. Avian predators were assumed to be responsible for 31% of the observed mortality. No trout smolts left the reservoir, but 5 salmon smolts got out through the turbines. Others did traverse the reservoir, but were unable to enter the river downstream, and were later eaten. The present results suggest that mortalities for migrating smolts through Lake Tange are of such a magnitude, that stocking of juveniles in the river upstream is futile, and further, that the establishment of a natural population of salmon or sea-trout in river Gudena, upstream of Tange, is unrealistic under present conditions.

Migration of Adult Atlantic Salmon (*Salmo Salar*); The Effects of Artificial Freshets
Thorstad E B; Heggberget T G
Hydrobiologia 371-372:339-346

The upstream migration of Atlantic salmon tagged with radio transmitters was analysed on a 6 km long stretch of the River Mandalselva (southern Norway), where the residual flow was $3 m^3 s^{-1}$. Over a period of 40 days six artificial freshets were released. Two of the freshets lasted continuously for 48 hours and four of the freshets consisted of successive pulses of increased water discharge. There were significant differences in mean migration distance per hour between the freshet period, the 11 hour post-freshet period and the residual flow period for three of the freshets. However, no clear relationship between increased water flow and stimulated salmon migration was found.

The Migratory Behaviour of Juvenile and Adult Salmonids in relation to an Estuarine Barrage

Russell I C; Moore A; Ives S; Kell L T; Ives M J; Stonehewer R O
Hydrobiologia 371-372:321-333

There is wide concern regarding the effects that estuarine barrages may have on estuarine environments and the species which utilise them. Of particular concern are the possible effects on diadromous fish which move between fresh and salt water. This paper presents results from a 3-year investigation (1993-95) of the migratory behaviour of both juvenile and adult salmonids undertaken in the vicinity of a barrage on the River Tawe in South Wales, which was completed in 1992. The localised upstream movements of acoustically tagged returning adult salmonids (n = 28) were investigated in the immediate vicinity of the barrage and associated fish pass using a High Resolution (HiRes) tracking system. The behaviour of salmonid smolts (n = 52), tagged with miniature acoustic transmitters, was also monitored during their spring seaward emigration within the impounded estuary. The upstream movement of adult salmonids appeared to be delayed by the presence of the barrage with many fish holding station close to the barrage structure. Of these, about half were clearly attracted by the plume of water from the fish pass, but few fish ascended the barrage by this route. Approximately one third of those fish detected below the barrage were subsequently detected upstream in the impoundment, most moving past when the barrage was over-topped. The movement of fish over the barrage was significantly unimodal with respect to the tidal cycle with a mean passage time of 4 minutes after high water. Once in the impoundment fish often remained close to the barrage (< 100 m) for several hours or days during which time movements appeared largely random. The movement of salmonid smolts through the impounded estuary and into the lower estuary, downstream of the barrage, was not continuous. Smolts held position within the impoundment immediately upstream of the barrage. The movement of smolts upstream of the barrage was predominantly random, and fish that successfully negotiated the structure did so by migrating through the ship lock or over the weir during an over-topping flood tide. The migratory behaviour patterns of juvenile and adult salmonids are compared with previous studies in unmodified river estuaries, and discussed in relation to the possible impact of barrages on salmonid migration.

The Migratory Behaviour of Wild Atlantic Salmon (*Salmo Salar* L.) Smolts in the River Test and Southampton Water, Southern England

Moore A; Ives S; Mead T A; Talks L
Hydrobiologia 371-372:295-304

Thirty wild Atlantic salmon Salmo salar (L.) smolts, tagged with miniature acoustic transmitters, were tracked in the River Test and Southampton Water, to describe the freshwater and estuarine patterns of migration. Migration in fresh water was predominantly nocturnal (mean time 23:42) and smolts tagged earlier in the study spent significantly longer in the river before migrating into the estuary than fish tagged later in the study. Movement in the upper estuary section of the River Test was indicative of a nocturnal ebb tide transport pattern of migration. The majority of smolts migrated seawards at night and during an ebb tide (mean time after High Water +1 h 54 min), close to the surface and within the fastest moving section of the water column. Smolts continued to emigrate seawards through the lower estuary and Southampton Water during the ebb tide (mean distance 4908 ± 609 m; mean ground speeds of 35cms^{-1}), although the diurnal pattern of movement was not evident.

There was also a significant seaward migration of smolts during the latter part of the flood tide (mean distance 3469 ± 522 m; mean ground speeds of 14 cms^{-1}), suggesting active directed swimming. Smolts emigrated rapidly through Southampton Water, and there was no apparent period of acclimation required when moving from fresh to salt water. The results are discussed in relation to the environmental cues controlling smolt migration.

A Radio Telemetry Study of the Migration of Atlantic Salmon (*Salmo Salar* L.) and Sea Trout (*Salmo Trutta Trutta* L.) in the Upper Rhine
Gerlier M; Roche P
Hydrobiologia 371-372:283-293

Atlantic salmon disappeared from the Rhine River in the mid-fifties when pollution and canalization of the main course of the river blocked access to their spawning areas. After water quality improved in the 1980's, a reintroduction program was begun in the French upper Rhine basin in 1992. To better define the difficulties encountered by the returning salmon on their way between the Iffezheim dam, the first main obstacle in the Rhine, and the upriver spawning areas, we undertook a radio-tracking study. Among the fish captured by electro-
fishing below the dam in 1996, we tagged 20 salmon and 10 sea trout with radio transmitters, released them upriver and followed them with portable receivers and automatic recording stations. While the salmon captured during the summer interrupted their migration or even migrated downstream after being released, those captured in the autumn migrated immediately upstream. We were able to study the behaviour of salmon confronting 15 obstacles. Only two salmon were recorded in the Rhine above the confluence of the Ill River, the main tributary of the Rhine on the French side. Most of the salmon made their way in the Ill toward the Bruche, a tributary of the Ill where spawning was observed. Four sea trout regurgitated their transmitters within three months. Most of the trout migrated upstream to the second obstacle in the river, the Gambsheim dam, while two of them chose to migrate up the Ill. We observed that the fish blocked by the dams in the Rhine often explored and possibly spawned in tributaries whose confluence was located a short way downstream. The initial phase of our study provided useful information on the behaviour of salmon and sea trout returning to the upper Rhine. It confirmed the need to improve migration passages at most of the dams and enabled us to better define migration equipment priorities. It also confirmed the good prospects of the Bruche as a spawning stream for salmon.

Homing in Juvenile Salmon in Response to Imposed and Spontaneous Displacement: Experiments in an Artificial Stream
Huntingford F A; Braithwaite V A; Armstrong J D; Aird D; Joiner P
Journal of Fish Biology 53 (4):847-852

Displacement of juvenile Atlantic salmon Salmo salar within an artificial stream was either spontaneous (fish left areas of shallow water in response to experimental reduction in water level) or imposed (fish were removed by the experimenter from areas of shallow water and placed at a distance from their home site). Prior to displacement, the fish showed a high degree of site fidelity in terms of preferential use of specific areas within the stream, but the extent to which this persisted once they had left/been removed from their preferred sites was variable.

Direction of displacement was not a critical factor, but homing was significantly less likely to occur following spontaneous as opposed to imposed displacement. In the case of imposed displacement, fish that were more strongly site attached prior to displacement were more likely to return to their home site after this manipulation.

Movement of Adult Atlantic Salmon in the Usk Estuary, Wales
Aprahamian M W; Jones G O; Gough P J
Journal of Fish Biology 53 (1):221-225

A total of 56 salmon was tagged in the Usk estuary using combined acoustic and radio tags. Those fish migrating within the estuary oscillated with the tide over c. 10 km, being towards the seaward end at low water and moving upstream on the flood tide. Fish migrating through the estuary moved upstream on the flood tide and stemmed displacement downstream during the ebb. These findings, together with information on the hydrodynamics of the estuary, indicate that the fish utilize tidal currents to migrate passively in their preferred direction.

Simulating Migration Mortality of Atlantic Salmon Smolts in the Merrimack River
Blackwell B F; Gries G; Juanes F; Friedland K D; Stolte L W; McKeon J F
North American Journal of Fisheries Management 18 (1):31-45

Successful restoration of Atlantic salmon Salmo salar to New England rivers involves the identification and management of mortality sources at different life history stages. The purpose of this study was to examine the effects of mortality during migration on Atlantic salmon smolts exiting the Merrimack River. Our objective was to review data pertaining to smolt production, migration, passage at hydroelectric facilities, and predation in the Merrimack River and construct a simulation model of smolt migration. We constructed a migration model incorporating, river-flow-based decision rules affecting migration rate, delay at dams, dam passage mortality, and migration mortality. Mean model estimates of in-river survival ranged from 0.7% to 23.5%. Estimated transit times generally increased in migration scenarios in which smolts began migration later in the season; beginning migration later in the season also resulted in lower in-river survival. The model was evaluated by comparing records of returns of two-sea-winter adults to the Merrimack River to a likely range of marine survival rates. For 9 of 14 smolt years, model estimates for the number of smolts exiting the river were comparable with the range of smolt output necessary to achieve the corresponding adult returns. Model estimates of in-river survival that fell below the lower threshold for 5 of the 14 smolt years could be explained in part by relatively high marine survival experienced by these cohorts. We argue that this model can have important applications in population assessment, river management, and salmon restoration.

4. Genetics

Genetic Changes in Atlantic Salmon (*Salmo Salar*) Populations of North-West Irish Rivers Resulting From Escapes of Adult Farm Salmon

Clifford S L; McGinnity P; Ferguson A

Canadian Journal of Fisheries and Aquatic Sciences 55 (2):358-363

A study was made of rivers in North-west Ireland where escapes of adult Atlantic salmon (Salmo salar) are known to have occurred from adjacent sea cages. Two markers that showed substantial frequency differences between these farm and wild populations were used: an Ava II-B mtDNA haplotype and allele E at minisatellite locus Ssa-A451211. Farmed populations also showed a significant reduction in mean heterozygosity over the three minisatellite loci examined. Independent occurrence of mtDNA and minisatellite DNA markers in several juvenile samples indicated interbreeding of escaped farm salmon with wild salmon. The proportion of juveniles of maternal farm parentage in two rivers ranged from 18% in 1993 to 2% in 1995 with an average of 7% in both rivers (1993-1995) and a maximum frequency of 70% in an individual sample. Only a small proportion of 29,000 adult farm salmon that escaped in spring 1992 appears to have bred successfully in the rivers studied. Juveniles of farmed parentage survived to at least the 1+ summer stage, but the subsequent fate of these fish could not be determined in the time period of the study.

Genetic Changes in an Atlantic Salmon Population Resulting from Escaped Juvenile Farm Salmon

Clifford S L; McGinnity P; Ferguson A

Journal of Fish Biology 52 (1):118-127

The study was undertaken on three adjacent rivers in NW Ireland, on one of which an Atlantic salmon *Salmo salar* freshwater juvenile rearing unit is situated. Two markers which distinguished farm and wild populations were used. An Ava II-B RFLP in the ND1 region of mtDNA was at a frequency of 0.58 in the farm strain but absent in the wild populations. Allele E at minisatellite locus Ssa-A45/2/1 was at a frequency of 0.91 in farm samples, but at a maximum of 0.41 in the populations in the two rivers adjacent to the one with the juvenile rearing unit. The farm strain showed a significant reduction in mean heterozygosity (0.281 ± 0.057), over three minisatellite loci examined, compared to wild samples (0.532 ± 0.063). The occurrence of farm genotypes and the independent occurrence of mtDNA and minisatellite markers in several parr samples from the river indicated that escaped juvenile salmon completed their life cycle, bred and interbred with native fish, upon their return to the river. Escaped fish homed accurately, as adults, to the site of escape, i.e. the area adjacent to the hatchery outflow in the upstream part of the river. Breeding of males in the lower part of the river was also indicated but this could have been due to mature male parr which had moved downstream. The return of adults of farm origin to the river to breed was indicated by the presence of the Ava II-B haplotype in adults netted in the estuary.

Genetic Implications of Hatchery Rearing in Atlantic Salmon: Effects of Rearing Environment on Genetic Composition
Crozier W W
Journal of Fish Biology 52 (5):1014-1025

In an experiment to investigate genetic consequences of hatchery rearing in salmon, allozyme variation at five polymorphic loci was examined in Atlantic salmon of known initial genetic composition, which were reared throughout freshwater life in the hatchery or stocked into the wild as swim-up fry. The genetic composition of the juveniles in the hatchery remained homogeneous from fertilization up to stocking, and from stocking to 2+ in the wild, however, those remaining at the hatchery developed genetic differences among smolting and non-smolting 1+ parr. These differences were attributed to conditions leading to early smolting at 1+ among the hatchery fish, with 1+ smolts diverging from the gene pool from which they were derived, whereas those stocked into the wild did not smolt until a year later and retained the original genetic composition. The results are discussed in relation to hatchery rearing of salmon and implications for the use of reared fish in stocking and enhancement programmes.

Population Structure of Atlantic Salmon from the Conne River, Newfoundland as determined from Microsatellite DNA
Beacham T D; Dempson J B; Journal of Fish Biology 52 :665-676

Variation at four microsatellite loci was examined for three populations of Atlantic salmon Salmo salar from the Conne River, Newfoundland. Samples of wild parr were collected from the mainstem Conne River during 4 years, and from tributaries Twillick Brook and Bernard Brook during 2 years. No significant temporal variation was observed in allele frequencies at the Ssa14, Ssa197, Ssa202, and Ssa289 loci. No difference in allele frequencies was observed between parr from Bernard and Twillick brooks at any locus, but allele frequencies of mainstem Conne River parr were significantly different from those of the tributaries at Ssa14 and Ssa202, indicative of differentiation among local populations. Atlantic salmon from the Conne River system were well differentiated from those in Nova Scotia, Canada and from those in Europe.

The Malic Enzyme MEP-2* Locus in Spanish Populations of Atlantic Salmon: Sea Age and Foreign Stocking
Moran P; Perez J; Garcia-Vazquez E
Aquatic Sciences 60 (4):359-366

Wild Spanish populations of Salmo salar were analyzed for their variability at the MEP-2* locus that determines the malic enzyme expressed in muscle mitochondria. The allele frequencies of these populations have been found to be associated with sea-age of returning adults and freshwater temperature; to a minor extent with foreign stocking of Irish and Scottish alevins; and finally, no association was found with precocious parr maturation.

5. Hybridisation

Natural Hybrids of the Atlantic Salmon Salmo Salar with the Sea Trout *Salmo Trutta* in the White Sea Basin Rivers
Makhrov A A; Kuzishchin K V; Novikov G G
Voprosy Ikhtiologii 38 (1):67-72

Protein electrophoresis was used to detect hybrids between S.salar and S.trutta among young individuals in the Keret and Nilma Rivers. Loci encoding esterase and mannose phosphate isomerase were used for the diagnosis of the hybrids. It is suggested that the formation of hybrids between salmon and trout is for the most part a result of anthropogenic influence.

6. Parasites

Potential for Dispersal of *Gyrodactylus Salaris* (Platyhelminthes, Monogenea) by Sea-Running Stages of the Atlantic Salmon (*Salmo Salar*): Field and Laboratory Studies
Soleng A; Bakke T A; Hansen L P
Canadian Journal of Fisheries and Aquatic Sciences 55 (2):507-514

Population growth of Gyrodactylus salaris increased exponentially on Atlantic salmon (Salmo salar) smolts in laboratory experiments conducted at 12°C. Furthermore, G. salaris was transmitted successfully from salmon smolt to parr at 0.0, 7.5, 10.0, and 20.0permill salinity and reproduced in fresh water after direct transfer from 7.5permill (16 days), 20.0permill (4 and 8 h), and 33.0permill (5, 15, and 30 min). No G. salaris were observed on salmon parr exposed to 33.0permill for 60 min. The prevalence of G. salaris on wild salmon smolts caught approximately 25 km from the river mouth in the Drammensfjord (surface salinity 2.0-3.5permill) was 71.2% compared with 88.0% on those from the neighbouring River Lierelva. Adult wild salmon caught as pre-spawners, spawners, and post-spawners (kelts) in the River Drammenselva were infected with G. salaris. The prevalence and abundance increased from autumn to spring, in contrast with earlier studies on salmon parr, demonstrating the possible importance of adult salmon as reservoirs for G. salaris during winter. The results support the hypothesis of brackish water dispersal of G. salaris by infected salmonids migrating in estuaries and fjords. The use of salt as a disinfectant against G. salaris in hatcheries, and the stocking of possibly infected fish into brackish and seawater, should also be re-examined.

7. Predation

Diet of Cormorants, Mergansers, and Kingfishers in North-Eastern North America
Cairns D K
Canadian Technical Report of Fisheries and Aquatic Sciences 2225:1-29

Cormorant, merganser, and kingfisher diets in north-eastern North America are reviewed. Double-crested cormorants (Phalacrocorax auritus) breed and forage primarily along the coast, but may invade fresh water during spring runs of anadromous fish. Diets include a substantial fraction of Atlantic salmon (Salmo salar) during smolt exodus in rivers whose runs are supplemented by stocking. At other times birds feed on a variety of marine and estuarine species. Great cormorants (P. carbo) occupy marine habitats, and chiefly eat marine bottom fish.

Common mergansers (*Mergus merganser*) eat juvenile salmon and other freshwater fish during spring and summer, but tend to move toward river mouths and estuaries in late summer. Red-breasted mergansers (*M. serrator*) have a largely coastal distribution, where they feed on estuarine, diadromous, and some salmonid species. Hooded merganser (*Lophodytes cucullatus*) diet in the region is poorly known, but probably includes a variety of fish and invertebrates. Belted kingfishers (*Ceryle alcyon*) live mostly along rivers, where they eat salmonids and other freshwater and diadromous fishes. Mean representation of commercial and recreational prey species is 44% for double-crested cormorants (outside the Atlantic salmon smolt run), 31% for great cormorants, 43% for common mergansers, 3% for red-breasted mergansers, and 34% for belted kingfishers. Despite large sample sizes (total N > 6,982), reported diets only approximately reflect actual food ingested. Major sources of bias include differential digestion rates, erroneous inclusion of prey from prey stomachs, incomplete spatial and temporal coverage, and over-representation of samples from salmon rivers.

8. Habitat Improvement

An Evaluation of Inter-Basin Water Transfers as a Mechanism for Augmenting Salmonid and Grayling Habitat in the River Wear, North-East England
Gibbins C N; Heslop J
Regulated Rivers Research & Management 14 (4):357-382

Transfers of water from the Kielder system have been used for 12 years to avoid low flow problems in the River Wear. Transfers are scheduled to avoid breaches of the river's statutory Minimum Maintained Flow (MMF). Despite this routine use, the role of transfers in augmenting instream habitat has never been evaluated. A physical habitat simulation (PHABSIM) study was undertaken in 1996 to investigate the influence of transfers and the MMF policy on brown trout Salmo trutta, Atlantic salmon Salmo salar and grayling Thymallus thymallus instream habitat at three sites on the Wear. Transfers support total habitat levels up to 10% greater than unregulated conditions. They impact usable instream habitat (weighted usable area) to a much greater extent. For salmon parr, the species/lifestage whose habitat is most limited by low flows, transfers have maintained relatively stable usable habitat levels during periods when otherwise they would have fallen by as much as 70%. The MMF policy results in minimum flow values which are higher than those which would have been set using the Montana Method and the availability of salmon parr usable habitat does not fall below 10% of its mean annual value. Judged in these terms, the MMF-based transfer regime has played a positive role in avoiding extreme habitat loss in the Wear. Simulations of four alternative Kielder transfer release policies indicate that near-optimum habitat levels could be maintained throughout summer low flow periods. However, this would result in unnatural temporal patterns of flow and habitat availability.

Evaluation of Atlantic Salmon Parr Responses to Habitat Improvement Structures in an Experimental Channel in Newfoundland, Canada
Mitchell J; McKinley R S; Power G; Scruton D A
Regulated Rivers Research & Management 14 (1):25-39

Distributional patterns and microhabitat selection of Atlantic salmon (*Salmo salar*) parr were investigated in relation to habitat improvement structures in a controlled flow experiment channel at Noel Paul's Brook, Newfoundland. The channel consisted of six replicates, each containing three randomly arranged treatments. Each replicate included a control treatment with no habitat modification, a mid-channel treatment with a boulder cluster and low-head barrier dam, and a stream bank treatment with undercut banks and wing deflectors. The influence of size class, density, discharge and diurnal/nocturnal differences on microhabitat selection were evaluated. Results showed that the mid-channel treatment did not serve its purpose at lower discharges (0.032-0.063 m l s^{-1}), and as a result was not the treatment of choice. However, as the discharge increased (0.13 m l s^{-1}), more salmon took up residence in this treatment. In all experiments, greater depths were selected in the stream bank treatment, and salmon parr in the mid-channel treatment consistently selected positions closer to cover. Larger parr preferred greater depths and were found closer to the improvement structures. Benthic and drifting food availability were also estimated, and results showed that 'funnelling effects' of the drift were created near the structures. This study indicates that these structures have the potential to create favourable feeding sites, and provide the necessary physical characteristics required by salmon parr.

The Response of Wild Atlantic Salmon Parr to Acute Reductions in Water Flow
Armstrong J D; Braithwaite V A; Fox M
Journal of Animal Ecology 67 (2):292-297

A seasonal reduction in water flow, due both to prevailing weather conditions and anthropogenic disturbance, is a prominent feature of the habitat in many riverine systems, yet the response of many aquatic vertebrates, such as juvenile Atlantic salmon, to low flows is not well understood. However, in accordance with general fitness optimization theory, it might be predicted that salmon will emigrate from shallow areas to seek refuge in pools as water levels decrease to critically low levels (fitness approaches zero). To test this prediction, we directly measured the movement response of individual Atlantic salmon (*Salmo salar* L.) (74-109 mm) to drought in near-natural mesocosms. In five separate trials during summer, groups of salmon were introduced into enclosed 30m long sections of stream, each comprising a central 10m long region of shallow riffle habitat bordered upstream and downstream by 10m long regions of deeper water. After fish had settled into home ranges, those fish inhabiting deep areas were removed and the water flow was later decreased to zero over 2 days, so that the riffles were nearly dry. The movements of each individual fish within the enclosures were monitored remotely and continuously using a passive integrated transponder (PIT) tracking system. Of the total of 33 fish with home ranges that included only riffle habitat, 14 moved into deep water at some point during drought, but only seven of these fish (0-50% between trials) established new home ranges that included deep areas. The others returned to regions of riffle during the drought. None of the eight fish that definitely had not sampled in pool habitat prior to settling on riffle emigrated during drought.

The optimal response of salmon parr to moderate natural drought appears not to be fixed, but for many individual fish it may be to stay in shallow riffle areas. The optimal response of salmon parr to extreme natural drought and anthropogenic de-watering will, in many cases, be to move. An increase within the population of traits that promote an ideal response to natural drought will therefore make it more vulnerable to severe drought and anthropogenic de-watering and vice versa. The absence of emigration by salmon from shallow areas during acute drought can be reconciled with fitness optimization theory if, when natural drought progresses, fish become stranded in shallow areas some considerable time before the point at which they die.

Pamehac Brook: A Case Study of the Restoration of a Newfoundland, Canada, River Impacted by Flow Diversion for Pulpwood Transportation
Scruton D A; Anderson T C; King L W
Aquatic Conservation 8 (1):145-157

In the early 1970s, dams were constructed in the upper reaches of Pamehac Brook, Newfoundland, Canada, and the headwaters of the system were diverted into the main stem of the Exploits River to facilitate waterborne transport of logs to a pulp and paper mill. This de-watered 12 km of high quality brook trout (*Salvelinus fontinalis*) and Atlantic salmon (Salmo salar) rearing and spawning habitat. In 1989, a project was conceived to address the man-made obstructions to fish migration and restore (re-water) the lower reaches of Pamehac Brook. This project was pursued as a partnership between the Environment Resources Management Association (a local conservation group), Abitibi-Price Inc. (a pulp and paper company), the Environmental Partners Fund (of Environment Canada), and the Canadian Department of Fisheries and Oceans. The restoration of Pamehac Brook in August 1990 included replacement of the control dams with bridges and culverts and removal of the diversion dyke to re-water the stream. Habitat surveys conducted before and after the project indicated a gain in fluvial habitat of 450 units (1 unit = 100 m^2), a 62% increase, through re-watering of the stream channel. Improved access was provided to 175 habitat units in the headwaters which had previously been obstructed. Population estimates of juvenile fish from electrofishing surveys were used to document the rate of recolonization of the re-watered habitat and to estimate the increase in fish production potential. Results suggested limited response by fish populations in the initial 2 years after restoration. Electrofishing results in 1996 indicated a dramatic increase in biomass of larger juvenile salmon and trout (> 0 +), attributable to the increased habitat area and altered microhabitat conditions, in part related to creation of standing water areas from beaver dams. Population estimates in 1996, in consideration of available fluvial habitat, indicated a production potential of juvenile fish of 330 kg, an 18-fold increase from pre-project estimates.

9. Pollution

Assessing the Impacts of Acidification on Atlantic Salmon (*Salmo Salar*): A Simple Model of Stream Chemistry
Marmorek D R; Lacroix G L; Korman J; Parnell I; Watt W D.
Canadian Journal of Fisheries and Aquatic Sciences 55 (9):2117-2126

We developed a model that simulates the effects of changes in sulphate (SO_4^{2-}) deposition on the chemistry of naturally organic-rich streams, linked this chemical model to a model of Atlantic salmon (*Salmo salar*) production (Korman et al. 1994. Can. J. Fish. Aquat. Sci. 51: 662-680), and assessed its performance on three acidified streams in southwest Nova Scotia. The chemical model closely tracked current chemistry by estimating the charge density required for charge balance on each sampling date. Calculated charge densities were generally low (1-3 muequiv./mg dissolved organic carbon (DOC)), inversely related to DOC, and positively related to pH. Predictions of minimum pH and salmon smolt output were relatively insensitive to the assumed F-factor (watershed neutralization of deposited acidity) in the parameter range most likely for the three streams. The model permits rapid impact assessment of acid deposition scenarios with a modest amount of input data (acid-neutralizing capacity, pH, SO_4^{2-} and DOC, ideally sampled weekly) while retaining natural cycles and processes.

The Effects of Siltation on Atlantic Salmon, *Salmo Salar* L., Embryos in the River Bush
O'Connor W C K; Andrew T E
Fisheries Management and Ecology 5 (5):393-401

The tolerance of incubating salmon embryos to spawning gravel sedimentation was examined under hatchery conditions and also in the natural state on the River Bush, County Antrim, Northern Ireland. In a laboratory assessment alevin survival was closely related to the level of fine material. The number of individuals was reduced at the 10% fines level while >15% fine material was found to be deleterious to survival. Mean survival on the river (19.26%) was found to be better than that recorded in the hatchery, although no clear relationship was established between the level of fines and percentage survival in the wild. The mean fines accumulation (13.59%) in the river incubators at the end of the experiment was shown to be statistically similar to the background substrate. The role of high flow events in the contamination of gravels scoured by spawning fish is discussed.

Decision-Making for the Restoration of Atlantic Salmon Populations Damaged by Acid Precipitation: The Interplay of Biology and Economics
Power M
Canadian Journal of Fisheries and Aquatic Sciences 55 (1):143-149

Acidification of Atlantic salmon (*Salmo salar*) rivers represents a major threat to salmon production in much of Nova Scotia, Canada. Efforts at understanding the efficacy of proposed remedial strategies have concentrated on estimating the biological parameters of the acidification issue.

However, the dominance of societal values in the allocation of resources to fisheries management problems demands alternative strategies for the remediation of acidity in salmon rivers be developed that account for both the biological and cost constraints on remedial strategy selection. A theoretical framework incorporating biological and cost detail is developed that demonstrates the dependence of optimal remedial strategy selection on the biological, physical, and cost parameters of acidification and responses to it in the juvenile portion of the life history. Marine smolt survival is also shown to have an influence on the selection of the optimal remedial strategy. Only when all relevant biological and cost parameters are appropriately estimated, validated and included in decision-making can useful strategies promising to optimize the restoration of Atlantic salmon stocks in acidified waters be developed.

10. Stocking

Modeling the Effects of Post-Stocking Survival Rates on the Success of Stocking Hatchery Atlantic Salmon in a New Brunswick River
Locke, A
North American Journal of Fisheries Management 18 (3):547-560

The effect of post-stocking survival rate on the success of a hatchery stocking program to enhance Atlantic salmon Salmo salar was modelled with empirical data from the Nepisiguit River, New Brunswick, Canada. Removal of adults from the wild population for use as hatchery broodstock was beneficial to population growth if the survival rate of their hatchery-reared progeny was 10% or more of that of wild-reared juveniles in the first year following stocking and equivalent to the survival of wild-reared juveniles and adults thereafter. Returns of marked adult fish to a counting fence were consistent with average poststocking survival rates (relative to wild-reared fish) of 5-20%, so it appears the hatchery program was probably successful in enhancing returns of adult Atlantic salmon to the river.

11. Salmon Farming

Incidence of Escaped Farmed Salmon, *Salmo Salar* L., in Commercial Salmon Catches and Fresh Water in Northern Ireland
Crozier W W
Fisheries Management and Ecology 5 (1):23-29

External morphological characteristics were used to identify escaped farmed Atlantic salmon, *Salmo salar* L., in a coastal salmon fishery in County Antrim, Northern Ireland during four fishing seasons and at an adjacent freshwater location (R. Bush) during a 5-year period. Out of a total of 36,326 adult salmon examined in the fishery, 883 (2.4%) were identified as having escaped from sea cages. Annual average values ranged from 0.26% to 4.04% of fish caught. Occurrence of escapees entering an adult trap in fresh water averaged 0.88%, with a range of 0.13-2.62%, depending on year. No correlation between presence in the marine fishery and in fresh water was evident, the latter year-round figures probably being more indicative of presence of escapees in spawning stocks. Entry to fresh water was significantly later on average for escaped farmed salmon, compared with wild salmon.

The Straying of Icelandic Ranched Atlantic Salmon, *Salmo Salar* L.: Release and Recapture Techniques

Johannsson V; Jonasson J; Osakarsson S; Isaksson A Aquaculture Research 29 (9):679-686

The straying rate of ranched Atlantic salmon, Salmo salar L., into rivers in Iceland was estimated on the basis of coded wire tag recoveries. Out of a total of 15 158 recaptured tagged salmon from the releases between 1987 and 1992, 189 fish (1.3%) strayed into 25 out of the 79 salmon rivers observed. Most of the strayers were found in neighbouring rivers to the ranching stations. There were no significant differences in straying rate between different age classes of salmon returning from the same smolt year class. Generally, there was a delay of 26-27 days in running time between strayers in rivers and salmon returning to the ranching stations. Higher straying rates were observed for ranching stations using riverine traps than for stations using estuary traps. By close inspection of seven key rivers in Iceland and assuming a 50% exploitation rate (fishing effort) in the rivers, on average, 2.1% of the returning salmon in ranching were estimated to stray to native salmon rivers over the years. A limitation of using these numbers to estimate gene flow between ranching stocks and wild populations.

12. Catch & Release

Remote Monitoring of Heart Rate as a Measure of Recovery in Angled Atlantic Salmon, *Salmo Salar* (L.)

Anderson W G; Booth R; Beddow T A; McKinley R S; Finstad B; Okland F; Scruton D Hydrobiologia 371-372: 233-240

The introduction of 'Catch and Release' fishery programs are now widely employed by fisheries managers in most Atlantic Provinces, primarily due to the recent decline of Atlantic salmon stocks on the east coast of Canada. However, there is still considerable debate among special interest groups and regulators as to the effectiveness of the technique. Heart rate telemetry has been utilized as a tool for the assessment of metabolic rate in wild fish by a number of investigators, and was employed in the present study in order to assess recovery following staged angling events in Atlantic salmon. Wild Atlantic salmon were successfully angled at 20±2°C and 16.5±1°C at Noel Paul's Brook, Newfoundland. In addition, hatchery reared Atlantic salmon were angled at the Ontario Ministry of Agriculture and Fisheries Research Station, Alma, Ontario, at a temperature of 8±1°C. Survival rate for the angled salmon was 20% at 20±2°C; 100% at 16.5±1°C; and 100% at 8±1°C. Mean resting heart rate for the fish angled at 16.5°C and 20°C was approximately 1.6 and 1.8 times greater than that of fish angled at 8°C. Heart rate, post angling, was found to increase 1.2 fold in the 8°C group, 1.3 fold in the 16.5°C group and approximately 1.15 fold in the 20°C group. Time to recovery was assessed as a return to observed resting heart rate for each individual fish and was found to be similar for both the 8°C and 16.5°C angled groups (approximately 16 h). Although heart rate telemetry in fish is, perhaps, not an ideal measure of metabolic rate, the present study has demonstrated that remote monitoring of heart rate is a good indicator of post-exercise physiological activity.

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