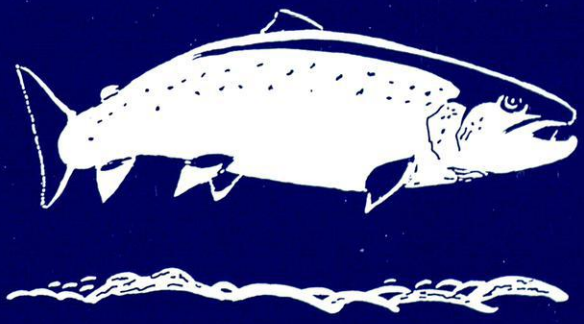
ATLANTIC SALMON TRUST

PROGRESS REPORT

June 1994



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J&B
RARE

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ASDSFB	Mr. Robert Clerk
SPEY TRUST	(A Representative)
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	Mr. John Bennett
S&TA	Mr. T. A. F. Barnes

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K. Whelan. B.Sc., Ph.D. (Salmon Research Agency of Ireland, Inc.)
Professor Noel P. Wilkins, (Department of Zoology, National University of Ireland)

Observers:
M. Aprahamian, B.Sc., Ph.D. (National Rivers Authority)
A representative from the Scottish Office Agriculture and Fisheries Department
E. C. E. Potter, B.A., M.A. (Ministry of Agriculture and Fisheries)

INTERNATIONAL CONSERVATION ORGANISATIONS WITH WHICH THE TRUST IS IN CONTACT

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

Registered Charity No. 252742

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CHAIRMAN'S FOREWORD

The main issues over the last six months have remained the UK funding of the buy-out of the Greenland and Faroese fisheries in support of Orri Vigfussons great initiative and continued pressure on the Government to restrict our own NE Drift Net Fishery.

The Atlantic Salmon Trust joined with the S&TA in honouring Orri Vigfusson in St. James Palace in April when HRH Prince Charles, patron of both organisations, made a presentation. A copy of Orri Vigfusson's generous reply is shown below.

"One month ago I enjoyed a memorable presentation and reception at St. James's Palace, with H.R.H. The Prince of Wales, and numerous friends of the salmon.

Now that I am finally back home, after a long time abroad, I should like to thank you and your organisation in writing for arranging the presentation, and also your hospitality.

I feel that a great honour has been extended to me personally, as well as to the directors of the North Atlantic Salmon Fund. Your gracious recognition is an impetus that will give us added strength in our endeavours to achieve our goals.

I should also like to convey my sincere thanks for the continued support and extraordinary commitment of The Atlantic Salmon Trust to our common cause.

My best wishes for a bright future."

The Trust has been to the fore in supporting the buy-outs and although we can not directly raise funds because of our Charitable Status I Chair the North Atlantic Salmon Fund (UK).

The UK's share of the cost of buying out the Greenland and Faroese commercial salmon fisheries, under the agreements arranged by Orri Vigfusson, comes to a total of £540,000 for the next three years. This takes into account the need to pay a backlog in respect of the Faroese fishery, which has been closed since 1991, and the Greenland fishery, which closed last year.

The appeal to raise these funds has been running for six months. It began in Scotland, with a request to proprietors, through District Salmon Fishery Boards, for £146,000 in the first year. A similar first year's appeal to owners in England and Wales has now been launched. There is no overall register of owners south of the Border, and so I am writing to all Fishery Associations with salmon interests asking them to encourage their members to contribute by 1st August - the total target is just over £31,000. I am also writing to salmon angling associations, in order to reach as many potential contributors as possible, whether owners or individual fishermen.

Scottish District Boards will shortly be receiving a full report on the progress of the appeal. By the end of May, more than £112,000 had already been contributed or promised by Boards. With hopes of a similar response from owners in the rest of the United Kingdom,

supplemented by the public appeal to all salmon fishermen, the North Atlantic Salmon Fund (UK) is happy to say that there are good expectations of reaching the first year's target of £180,000. Many private contributors have been very generous, and their donations continue to be vital in building up a reserve fund to help make sure that the UK's share continues to be met in the coming years.

The closure of the Greenland and Faroes fisheries was forecast to spare over 20,000 extra multi sea winter salmon to return to UK waters this year, with the expectation of increasing numbers as spawning stocks build up. It is too early to judge its success from catches in one spring, particularly when conditions have been difficult in many rivers. However, there has been an encouraging number of reports of good runs of spring fish in many parts. The need for the closure has been emphasised by scientific concern that the genetic attributes of spring-running fish could be lost if spawning numbers were to continue to fall, and this component of the overall stocks might not be able to regenerate.

The North Atlantic Salmon Fund (UK) is more than ever convinced that the United Kingdom must go on playing its part in keeping the high seas fisheries closed.

It is disappointing, to say the least, that there has been no response from the Government to restrict the opening of the NE Drift Net Fishery until the end of June. The case for this is overwhelming and as the Director points out, there is increasing scientific evidence that stocks of MSW fish are too low to ensure survival of that class in many rivers.

We await the outcome of the current NASCO meetings in Oslo and having failed to achieve the necessary action for 1994, will continue to urge Mrs. Shephard to take action in time for 1995.

It is a ridiculous situation that spring salmon spared from the interceptory fisheries of Greenland or the Faroes and financed from the UK entirely by fishermen and fishery owners should be exploited by equally interceptory commercial nets off British coasts.

There is a new European Commission proposal for a ban on drift netting for salmon (among other species) by 1997. This originated from the campaign against drift nets for tuna and Baltic salmon. But it is intended to apply in national waters of member states and so offers another approach to the North East Drift Net problem, which we shall pursue in Brussels.

The Trust will be developing a policy statement on the conservation of MSW salmon and this may well include the need for anglers and angling methods to be restricted in the spring months, albeit on a voluntary basis, to match the continuing pressures for commercial netting to cease.

Nickson

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DIRECTOR'S REPORT

In this issue I hope that I have something to interest you all.

The Trust, along with the Salmon & Trout Association and the Association of Scottish District Salmon Fishery Boards, has been very active in trying to persuade ministers that at a time when the spring component of the run of salmon is declining rapidly, to allow drift netting to continue at its present level is nothing short of a national disgrace.

Scientific evidence is now pointing to what may be a disastrous situation when, in some parts of the country, there is insufficient stock of multi sea winter fish to ensure their survival. This is not a general case but that spring fish are declining seriously cannot be denied. It is with great pleasure that I reproduce in this report the Scottish Anglers National Association pamphlet on returning fish to the river. As the Chairman has said, it is time for all to take a responsible attitude.

The West Highland Sea Trout and Salmon Group has been formed with the following remit.

"To work together with local and other interests to rehabilitate - through co-ordination, co-operation, appropriate resourcing and other means - the sea trout and wild salmon fisheries in the West Highlands of Scotland".

I am honoured to be their Chairman and after three meetings at which we have all been on the learning curve, I am sure we can now produce some firm action proposals at the next meeting in July. The membership of the Group is as follows: Lt.Col. G.D.B. Keelan, Association of Scottish District Salmon Fishery Boards; Mr. Michael Smith, The Salmon & Trout Association; Mr. Jim Semple, representing the proprietors; Dr. John Webster, Scottish Salmon Growers' Association; Mr. M. Gravestock, Crown Estate Commissioners; Messrs. David Dickson, Robert Williamson, and Geoff Owenson of The Scottish Office Agriculture & Fisheries Department; Dr. Richard Shelton and Mr. Andy Walker, Freshwater Fisheries Laboratory and Mr. W. "Rogie" Brown, Scottish Anglers National Association.

The Honorary Scientific Advisory Panel met in May and an account of their deliberations appears in this report. The Trust is very lucky to have such a distinguished group of scientists who give their time to help in our work.

I was taken to task about Andy Walker's account of fishing in Russia, as some did not take it in the light hearted way it was intended. We now have an authoritative summary of fishing in Russia which I am sure you will all find of interest.

It is with great sadness that we learnt of the sudden death "after a wonderful days fishing" of Peter Tombleson who had recently joined the Council as the representative of the BFSS; our condolences go to Mrs. Tombleson and her family.

D.J. Mackenzie

AUTUMN FISHING

by the Scottish Anglers National Association

(A leaflet describing measures which will contribute to conserving early running fish and also enhance angling in the public perception has been produced by SANA and is reproduced here with their permission.)

1. The problem

a. The salmon catch over the whole of the North Atlantic has declined over recent years. In Scotland this decline has been particularly marked for the much sought after early running fish. Experts believe that the decline is related to, among other factors, significant and developing changes in ocean circulation in the North Atlantic.

b. An increasing number of anglers wish to fish for salmon. The present timing of the main salmon runs results in much increased angling effort later in the season.

c. During the autumn months, rivers hold salmon of varying maturity, from firm silver fish to ones close to spawning. Many of the latter are early running fish which have been fasting in freshwater for many months. These fish may become active and provide sport for anglers but are at best of modest culinary value. However their value to the spawning stock, particulary hen fish, is often significant and they merit being conserved.

2. Potential solutions

a. A reduction in intensive angling will assist in maintaining stock levels. Where this is acceptable, limiting the season on the upper reaches of rivers is worthwhile. These upper reaches are likely to hold a higher proportion of early running salmon. Where a closure of the fishery is unacceptable, bag limits and catch and release should be considered and the sale of rod caught salmon discouraged.

b. There is a strong case for the return of gravid early running hen salmon which, in their eggs, carry future generations genetically linked to their parents. With the numerical bias towards females among early running fish the return of similarly gravid early running males may be equally useful.

3. Catch and release in practice

a. Catch and release is a well tried system for brown, migratory and rainbow trout. Properly done, mortality is minimal.

b. For salmon, experience of catch and release in North America, Iceland and Scotland has also shown that mortality is low. Routinely, early season salmon fishermen release kelts with little apparent damage. There are also records of salmon previously caught and released being re-caught several times.

4. Key elements of catch and release

a. Hooks - A single hook will probably inflict less damage than a double or treble or a many hooked lure. Damage can also be ameliorated by using barbless hooks.

b. Playing the fish - Salmon which might be returned should be played firmly and landed before complete exhaustion. This necessitates tackle commensurate with the size of the quarry.

c. Landing fish - Care should be taken to avoid damage to the fish either internally or externally. Salmon should not be gaffed, lifted by a tailer or dragged over beaches. Resulting damage might be disabling or act as a site for fungal growth. Hand tailing or a capacious landing net with knotless mesh are methods of choice.

d. Handling and returning fish - Treat salmon with care and respect. If they are to be kept, dispatch them immediately with a forceful blow from a suitably hefty instrument. Fish to be returned should be held firmly on a clean, non-abrasive surface (preferably a purpose made unhooking mat) and unhooked using forceps. Fish should not be lifted, otherwise unsupported, by the wrist of the tail or damage to the spine may result. Similarly holding up fish by the gill covers may well inflict mortal injury and defeat the purpose of the exercise. The salmon should finally be carefully supported in the water head into the current, any adhering material lightly wiped off and held until it can swim off. This may take a few minutes.

e. Recording the catch - Released fish which could have been legally retained must be recorded for inclusion in catch returns to SOAFD. Weighing fish to be returned is to be discouraged, only in exceptional circumstances should it be contemplated and then in a moist bag, never by suspension from the body. An estimate of the weight should be sufficient but the formula - weight(lbs) = 0.0004 multiplied by length (inches) cubed - ie $w = 0.0004 \times L \times L \times L$ - may be useful.

5. Legally retainable fish

It is not legal to retain fish, either salmon or sea trout, which are unseasonable or unclean. Such fish must be returned to the water, hopefully with care and all possible assistance for recovering from the experience.

a. Unseasonable

An unseasonable fish is, expressed simply in lay terms, a fish not in the condition the angler would hope to land at that time of the season.

Thus fish caught early in the season but which are or will be in spawning condition that "spring" are unseasonable. These fish are often called baggots, rawners or other local terms. On occasion, when newly landed, such fish may be difficult to identify in isolation. A lack of firmness over the gut area is a useful indicator in difficult cases.
Fish caught late in the season may also prove to be unseasonable. To be classed as

unseasonable such fish will be "gravid and on the point of spawning". Gravid means that the eggs or milt sacks are well developed but this alone does not imply unseasonable. To immediately identify a fish "on the point of spawning" can be difficult at the water side. The phrase includes fish which would be capable of spawning within two or three weeks. If firm pressure applied progressively backwards along the underside of the fish produces eggs or milt then the fish is certainly unseasonable. This might on occasion indicate a sea liced fish to be unseasonable while a fish which had spent many months in freshwater was not. However this latter fish would be dark or red and of poor eating quality.

Other criteria indicating a fish to be unseasonable are a prominent vent and a soft and flexible underside, particularly in the case of females. External colour and overall body shape also give pointers but beware that females close to spawning may not exhibit the array of colours of males.

b. Unclean

An unclean fish is one which has spawned but has not yet returned to salt water, usually referred to as a kelt.

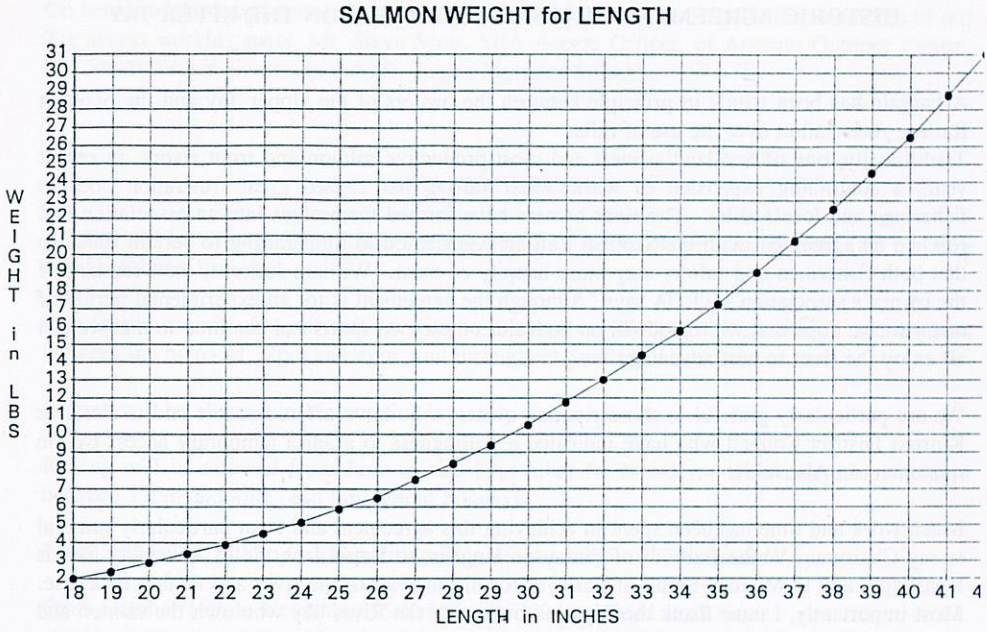
Unclean fish will most commonly be encountered during the early months of the season but can also be encountered late in the year. Fish which have commenced spawning but have not completed the process fall into the unclean category.

Although fish in poor condition caught in salt water or estuaries may apparently be kept we recommend that such fish, eg recently arrived sea trout kelts in the spring, should be carefully returned.

It can be seen from the above that it is the internal condition of the fish which is the determining factor and, even for experienced fishermen, this may not always be readily discerned. Genuine mistakes will occur but it should be unlikely that any prosecution would be brought over the ill judged keeping of a single or occasional fish. In doubtful cases the return option is always available to avoid any difficulties.

The Weight of a Salmon

When a salmon is to be returned to the water this should be done as soon as possible without the added trauma and risk of damage if weighed. Thus for returned fish, which are not unseasonable or unclean, the angler has either to estimate the weight of the fish based on his experience or to use some other yardstick to give the weight. This weight is required for the statutory returns to SOAFD. A visual estimate of the weight of a fish can be simply confirmed if the length of the fish is obtained since the range of weights for a particular length is limited for fish in average condition. The length of the fish can be found by having a tape rule to hand or noting the length of the fish against the rod, net handle, wading stick etc. and the length then obtained later. Some anglers might calibrate one of the above for an immediate answer. The graph below shows the typical relationship between the weight in pounds and the length in inches of salmon for the range of weights which anglers usually encounter.



The more numerically inclined might use various formulae to obtain a weight for a known length. In this vein the graph above can be simply and reasonably described by:-

weight(lbs) = 0.0004 x length(ins) x length(ins) x length(ins)

or for those who prefer metric

weight(kgs) = 11.3 x length(m) x length(m) x length(m)

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HISTORIC AGREEMENT HEADS OFF CONFLICT ON THE UPPER TAY

A bargain has been struck in principle between the owners of the Upper Tay and the Scottish Rafting Association over the use of rafts.
Traditionally, one of Scotland's finest and most productive salmon and trout rivers, in recent years a continuing expansion of white water rafting has caused great frustration both to fishermen and locals alike. The river owners have formed themselves into an association and reached an agreement with the Scottish Rafting Association to limit rafting to certain times so that both fishermen and rafters may more happily co-exist. William Jackson, the Secretary of the owner's association UTROA says "Although the agreement is for an experimental period of one year we hope that with goodwill on both sides these two sports can continue so that we can all enjoy the river to best advantage.

We are particularly grateful to those riparian owners who have offered access and to Perth & Kinross District Council who have indicated a willingness to grant a temporary access by the monument in Aberfeldy.

Much work and time has been spent in achieving this agreement and I am particularly grateful to my Chairman, Wattie Barbour of Finlayson Hughes, to David Ironside of Aberfeldy for his legal input and to Michael Smith of Farleyer for his analysis of the river and fishing expertise. Most importantly, I must thank the Riparian owners of the River Tay who own the salmon and trout fishing rights who gave Wattie and I the remit to negotiate this agreement with the Scottish Rafting Association and to the rafting companies who have been accommodating in their attitude".

Stuart Bell, a representative of the Scottish Rafting Association says, "This important agreement recognises that everyone on the river has a shared responsibility in sustaining this valuable but finite resource for everyone's enjoyment. Realising the long term importance of this, for ourselvs as well as the Riparian owners, we saw co-operation as the best way forward for maintaining the enjoyment and quality of experience for the fishermen, rafters and other river users.

During our lengthy negotiations with the Riparian owners we have tried to accommodate the complexities of the sport of fishing regarding timing during the day, season and year. The owners have for their part helped us produce an acceptable annual timetable for rafting, which will minimise the effect on the fishermen, and have minimal impact on the fish, recognising as it does prime fishing and spawning seasons.

Time zoning such as this is not new to areas of resource conflict. Increasingly people are realising that sustaining the environment must be top of the agenda. At the National Water Sports Centre at Holme Pierrepont rafters and canoeists already operate exclusive time zoning.

The negotiation process has helped both parties to better understand each other's perceptions and values. I hope we can use this common ground to develop a lasting agreement on the River Tay.

On behalf of the Scottish Rafting Association I would like to thank the fellow members of our Tay access working party, Mr. Steve Scott, SRA Access Officer, of Ancrum Outdoor Centre, Mr. Stuart Turner, Secretary and Mr. Angus Myles of Splash".

RAFTING TIMES

Rafting will be allowed from January 1st to March 31st except for January 15th (the opening day for salmon fishing).

During the month of April rafting will be allowed on Mondays, Wednesdays and Fridays between the hours of 12pm and 4pm, and throughout Sundays.

Rafting will be allowed in May on Sundays only.

Rafting will be allowed from June to mid September on Mondays, Wednesdays and Fridays between 12pm and 4pm, and throughout Sundays.

From September 15th to October 15th rafting will be permitted only on Sundays.

From October 16th to November 15th rafting will be permitted at all times.

From November 16th to December 31st there will be no rafting.

N.B. Rafting may also be allowed at times of high water, but further restricted at times of low water.

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DEE SALMON ACTION PLAN

The Atlantic Salmon Trust welcomes the Dee Salmon Action Plan which has recently been issued. A Summary of The Plan is given below.

The Dee is different from most of the other major Salmon rivers in Scotland in that it is very heavily reliant on its stock of spring fish. Other rivers have a more significant summer and autumn run of salmon. Spring (MSW) salmon stocks have fallen dramatically throughout the North Atlantic. The Dee is particularly sensitive to changes in this stock. That being said the Dee, according to the latest figures available, still catches more Spring salmon than any other river in Scotland (Scottish Statistical Bulletin 1992).

Strategies and Objectives

The DSAP is split into six sections. The main strategies and objectives for each strategy are explained below. Actions are detailed in the full plan.

SECTION 1

Strategy :

To collect sufficient information to prioritise actions within the Western catchment of the Dee.

Objectives :

1.1 To identify understocked areas of the western catchment.

1.2 To identify the cause of understocking.

1.3 To improve the information base to allow prioritisation of stock enhancement and habitat improvements.

SECTION 2

Strategy :

To actively increase the number of smolts produced to sea while maintaining the genetic integrity of the population.

Objectives :

2.1 To improve accessibility of understocked tributaries to salmon.

2.2 To increase utilisation of all potential nursery habitat.

2.3 To reduce loss of juvenile parr and smolts from predation.

2.4 To consider changing the seasonal pattern of the fishing effort within the DDSFB area.

2.5 To consider changing the seasonal pattern of the fishing effort outwith the DDSFB area.

SECTION 3

Strategy :

To improve the carrying capacity of the river system by increasing the quality of stream habitats.

Objectives

3.1 To improve the overall condition of the riparian zone.

3.2 To reduce sediment input.

3.3 To improve water nutrient status.

3.4 To increase food supply available to juvenile salmonids.

3.5 To reduce peak water temperatures on upper spawning tributaries.

3.6 To improve stream flow patterns.

SECTION 4

Strategy :

To create a monitoring, development and research programme that supports the needs of the Dee Salmon Action Plan.

Objectives :

4.1 To gain agreement among the many research organisations to collect data in a co-ordinated way.

4.2 To gain agreement to investigate all avenues of mutual support.

4.3 To ensure that from all future research the catchment managers gain information that is relevant to their needs.

SECTION 5

Strategy :

To build bridges with our long loyal customers to take the action plan forward together.

Objectives :

5.1 To ensure that everyone connected with supplying salmon fishing is aware of the benefits that accrue from the use of customer care techniques.

5.2 To create links, including Associate membership, with our loyal customers.

5.3 To ensure that the Dee is attractive to current and potential fishing clients in terms of cost and quality.

5.4 To increase information to potential customers on the availability of fishing and accommodation on Deeside.

5.5 To identify and communicate with all important target audiences, key organisations and individuals.

SECTION 6

Strategy :

To create the motivation to have the plan resourced and implemented.

Objectives :

6.1 To motivate all key players to adopt, resource and implement the parts of the plan that fit with their own organisation's objectives.

6.2 To explain to local, national and fishing publics the need for immediate positive action.

6.3 To persuade organisations to allow personnel to operate outwith their normal roles in support of the DSAP.

6.4 To persuade organisations and individuals to find additional financial resources for the DSAP.

6.5 To obtain finance from fundraising.

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THE TWEED FOUNDATION

(The AST is supporting the Habitat Improvement Project on the Tweed and the report from the Tweed Foundation newsletter is reproduced here with their kind permission.)

Habitat Improvement Project

The lack of spring salmon is putting at risk between 20 and 40% of the £5 million a year which salmon angling contributes to the Borders economy.
The removal of obstructions to the movement of fish; the prevention of further damage to the natural environment of the river corridor by forestry and agriculture; and the improvement of areas that are already degraded are of the very greatest importance if we are to maintain and improve the fish stocks in the Tweed system.

The Objective of the Habitat Improvement Project is therefore to increase the economic return from angling on the Tweed system by improving the natural production and survival of juvenile salmon and trout and so increasing the number of adults, for both angling and spawning. This can be achieved by re-establishing the best possible environmental conditions on the nursery streams.

Our aim will always be to encourage landowners and other conservation and public bodies to carry out the required work wherever possible. We see the role of the Tweed Foundation as co-ordinator and catalyst - identifying the work that needs to be done; drawing together the various sources of funding and expertise; developing the potential for training and job creation, and managing the programme.

Progress to Date.
In 1993 a Habitat Improvement programme was initiated in the Ettrick, Yarrow and Upper Tweed, with significant financial backing from the Scottish Borders Enterprise. Based on the findings of the surveys conducted in 1992, the programme initially concentrated on improving access to the tributaries by:

a) removing obstacles and

b) in-river works, to assess the extent to which degraded nursery streams can be improved to increase their ability to sustain larger populations of juvenile fish through to migratory stage.

a) The work on removing obstacles that was done in 1993 and is planned for 1994 will have opened up over 4,000 metres of head streams which were previously completely blocked to spawning salmon, and improved access to over 3,300 metres.

The original costs were estimated at £38,968, but as other parties (ie. farmers, Roads Department, etc.) were persuaded to do much of the work themselves the actual cost to the Foundation is likely to be less than £10,000. It is estimated that the resulting increase in salmon from these areas will be worth £10,000 annually to the Borders economy.

The above estimates are based on the current average carrying capacity of the Ettrick and Yarrow systems. It is reasonable to assume that salmonid production can be increased in proportion to improvements in habitat.

A recent study into habitat improvement in Ireland has estimated that the costs of producing one additional adult salmon returning to the river in the 25 year post-enhancement period are likely to be in the region of £2.14/fish. Given that each salmon caught on the Tweed is estimated to bring around £500 into the Borders economy, this represents a very substantial return on investment. The character of the Irish river system and the improvement options adopted obviously differ from those pertaining to the Tweed. Nevertheless, given the potential for increasing access to, and improving the environmental conditions in large areas of the upper Tweed catchment it is anticipated that the Tweed Habitat Improvement Project could prove equally, if not even more, cost effective. The first results from the pilot projects, which were started in 1993, will become available this year. Electro fishing will show the extent to which the schemes have resulted in an increase in the number of fry surviving to parr and smolt stages, compared to control areas - allowing us to undertake a more accurate cost/benefit analysis under Tweed conditions.

b) In-river work was undertaken on 250 metres of the Deloraine and 350 metres of the Rankle Burns, and at the mouth of the Douglas Burn with the aim of concentrating the flow during low water. These pilot schemes appear to have worked. The instream deflectors are still in place, having survived the winter spates, and have succeeded in diverting the streams into narrower channels during periods of low water. Electro-fishing in 1994 will establish to what extent these works have enabled a higher proportion of fry to survive. Experience gained at these two sites will aid the development of solutions at other sites in the system. The in-river projects are described in more detail below.

1994 - The Plan.

In 1994 the intention is to:

- Complete the survey of the Upper Tweed; survey the Teviot system, and , if resources permit, survey the Whiteadder catchment.

- Complete the outstanding work identified from the 1992/93 surveys on the Upper Tweed and the Ettrick and Yarrow.

- Fence and plant as much of the banks of the Deloraine, Rankle and Douglas Burns as possible in support of the earlier in-river works.

- The programme of electro fishing will be doubled to establish essential baseline data, and monitor the effects of the improvement work.

- Communication/Public Relations.

Much of the success of the project will depend on the co-operation and enthusiasm of other people and organisations. A lot of effort will be devoted this year to raising the awareness of farmers, landowners and conservation groups through seminars, workshops and the publication of guidelines on good conservation practice.

Judith Nicol, Director

The Habitat Improvement Projects To Date

(a) **The Deloraine Burn.** Because of the extreme nature of the habitat degradation on the lower portion of this burn, it was chosen in the confident expectation that if habitat rehabilitation could be demonstrated in such an area and could show a marked increase in the survival of juvenile salmonids, especially into their second year, then the practice of habitat rehabilitation for a cost-effective long-term increase of the salmonid populations was viable and necessary.

In order that any results produced from this burn can be verified it was decided that the first 250 metres of the burn will be left in their present state. The next 250 metres will then be improved and fenced and planted. By good fortune, an area upstream has already been fenced for amenity woodland. This will be monitored to record the effects of fencing and planting without instream works. An area between two of these sites is suitable to demonstrate what gains can be expected solely by fencing livestock from the stream and allowing a natural regeneration of vegetation.

(b) **The Rankle Burn.** The Rankle Burn is an extremely important upper tributary for the production of early running salmon. For practical purposes the burn can be divided into two distinct areas. The lower 3 miles is open haughland grazed by sheep and cattle, although there is some cattle fencing to restrict their movements, while the upper parts of the burn are totally enclosed within a forested area.

A 350 metre length of the burn in the centre of grazed haughland has been chosen because of its proximity to an already established sample site, to demonstrate that the carrying capacity for parr (as opposed to the abundant fry) of a stream can be improved in isolation without the associated fencing and planting. The area is badly eroded and the burn is very wide and very shallow. Although it has ideal spawning gravel, it suffers from excessive temperature problems in summer and freezing in winter and has very few areas of sufficient depth or extent

to provide any habitat for larger salmonids. The lower 3 miles of the burn are characterised by acres of loose and mobile gravel. It is intended, by using bank protection and a range of deflection devices, to produce a self scouring, stable and suitable habitat in terms of deeper water for larger sizes of fish which will markedly increase the smolt and trout populations in that area.

(c) **Stream-mouths and Gravel Cones - Elimination Experiment**

The Douglas Burn. Gravel cones at the mouths of spawning streams present obstructions to the passage of migratory fish. Simply digging out and removing the gravel is not an option as the cones will reform after each spate. In some way the mouths of these streams must be made self-scouring. As gravel is deposited on the downriver side of the mouth of the stream, the stream-mouth moves upriver to bypass it. This process continues until the stream-mouth has progressed to such a degree upriver that when the river is in spate it stems the stream back. Gravel is deposited in the stream to such an extent that the channel is blocked and the stream breaks out and recreates a channel further downriver. The cycle starts again.

Any solution must deal with maintaining the mouth in a stable position by self-scouring and deep enough so that migratory fish are not deterred from entering the stream.

The Douglas Burn was chosen because it is an important spawning tributary within the Habitat Improvement area.

From an initial inspection it was decided to delete the lower 60 metres of the channel and turn the stream so that it flowed over a shorter 30 metre course and entered the Yarrow Water at right angles where there was maximum gradient and river velocity to remove the ejected gravel. Both banks of the stream were built up with timber revetment on a reasonably narrow width to provide depth and velocity. If, after observation, the principle is found to be effective then other problem stream-mouths will be tackled.

Andrew Veitch, Habitat Improvement Manager

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NORWAY - ITS SALMON AND ITS RULES

(by Margit Brooks)

Norway, maybe the most beautiful country in Europe, is blessed with 400 salmon and sea trout rivers. Most of these are sparkling clean snowfed rivers. Unfortunately close to a quarter are closed to the sport of fishing at present. Thirty-four rivers have been infected by the parasite Gyrodactylus - some of these rivers have been treated successfully with Rothenon. Others, especially right on the coast close to the sea, have been overflooded with escaped farmed salmon.

NASCO

The president of NASCO, the Vice Minister of the Norwegian Ministry of the Environment, Mr. Bǿrre Pettersen will be hosting the next NASCO meeting from 6th to 10th June in Oslo. There will be a special session on "Impacts of Aquaculture on Wild Stocks". The principle aim in Norway is to get all the salmon farms in closed facilities.

All Salmon fishing in Norway is banned unless otherwise stated.

Norways Ministry of the Environment has introduced the worlds most severe restrictions on salmon fishing. They have banned all salmon and sea trout fishing, unless otherwise stated.

River Categories

The Ministry of the Environment has introduced a River Category system ranging from 0 to 5, indicating rules for the opening season for salmon and sea trout fishing of rivers in each category.

0 Rivers without salmon or sea trout.
(may be opened for fishing)

1 Rivers where the natural stocks of salmon and sea trout are extinct.
(may be opened for fishing up to 4 months)

2 Rivers where the stock is threatened by extinction.
(closed for salmon fishing/may be opened for sea trout fishing)

3 Rivers with reduced production and where stocks may be endangered due to Hydro-power development, pollution, sickness, escaped farmed fish, over fishing etc.
(may be opened for salmon fishing maximum 2 months. Sea trout fishing 1 or 2 months. If the salmon stock is endangered but the sea trout stock is very healthy, permission may be given for salmon fishing 2 months and sea trout fishing 3 months during the night with fly or worm between 2100 hrs and 0600 hrs)

4 Rivers where natural spawning is at a minimum due to Hydro-power development, but large runs of salmon return to the river due to artificial stocking and rivers in areas with acid rain but which still have large stocks of salmon and sea trout.
(may be opened for salmon and sea trout fishing maximum 2½ months)

5 Rivers where stocks are, and have been, large for a long time.
(may be opened maximum 4 months)

Tackle restrictions

Specific rules are applied, if and when fishing is allowed in a particular river. 'Fly only' rule may be imposed for a part or for the whole season. Certain types of lures are prohibited and sometimes also lead or weights. Maximum size hooks are specified, 12mm between shank and

point and one treble limited to each lure, - and among other things forbidden, are prawning and the use of leaded fly lines.

Law against sub-letting

The Ministry of the Environment has surprised the entire salmon fishing fraternity with innovative sub-letting rules. These are rules against any sub-letting of fishing rights. A party with a contract for the sporting rights from a landowner is prevented from letting this to a client or a third party. This seems to be a serious intrusion on Norwegian property rights.
(This law will soon be tried in court in counties of North and South Trøndelag where the lease holder has the support of the Farmers Organisations as well as the Association of River Owners).

Furthermore, the prohibition against sub-letting may cause prices to drop drastically on the best sporting rivers in Norway, leaving the landowners in a very fragile situation. If the landowners convert their rivers into dayticket water, they can never get the prices they get when letting their sporting rights by contract 3 to 5 years ahead. The Ministry of the Environment wants the common man to be able to fish and hunt anywhere at very low costs. Is this a way of opening the possibility of nationalizing Norwegian Rivers?
(The same ministry has also introduced new similar laws on hunting).

Bend nets and pound nets used in Norwegian fjords

Since all driftnetting for salmon outside the Norwegian coast was totally banned on the 4th August 1988, the use of bend nets has been reduced to six days in total for the whole season. The use of pound nets is reduced to three fishing days a week, between June 1st and August 4th. Bend nets leave net marks on salmon. Pound nets do not, only on grilse. During 1992 and 1993 only 5% to 10% of salmon caught in rivers were netmarked against 80% in 1991.

Pirate fishing

Last year Norway established a maximum prison sentence of six years for illegal harvesting of threatened species. If illegal fishing takes place on mixed stock some of the salmon may come from a threatened river.

Gyrodactylus

Last September nine gyrodactylus infected rivers in Møre og Romsdal were treated with Rothenon thus killing all river life. The main river being the beautiful Rauma. Two hundred people worked a whole week on the project which, until now, seems to have been successful. The gyro parasite attacks only salmon parr and fry in sweet water. They are not harmful to trout. The parasite hooks itself onto the skin or fins with a couple of hooks and a sticky secretion. It is under 1mm and it produces live larvas.

Fish farms

Norway now produce 150,000 tons of farmed salmon a year. Every year a large number of salmon escape from the farms during storms or for other reasons. Already in January and February this year some 500,000 salmon have been lost. When farmed fish enter rivers on the coast and try to spawn, they become a danger to the wild stock. This makes the genetic pollution a fact.

Sea lice

Over the last years, with mild winters, an acute problem has arisen in many fish farms on the coast. Sea lice. Research work shows that sea lice can function as a vector and hide-out for pathogenic bacteria and viruses, meaning that wounds caused by sea-lice increase the susceptibility to secondary infections. In other words, a sea-lice coming from an infected salmon fish farm can infect wild salmon with Furunculoses, ISA, infectious salmon anaemia and other diseases. Different viruses and bacteria have been found on the surface of the sea-lice and in the gut. If too many sea-lice attack a smolt, or even a larger salmon, the fish will die due to interruption of the "salt-fluid balance" and bad conditions in general. The Directorate for Nature Management (DN) has successfully organised a co-ordinated elimination of sea-lice in fish farms in the Trφndelag area during 1993. The winter of 1993/94 has so far been colder than the last five or six winters. This could indicate that the temperature in the sea will be lower and conditions for the sea-lice less favourable. DN has suggested holding a symposium on sea-lice where Ireland, Scotland and Norway take part. A scientific committee in Ireland handed in a report to the Minister in late March where they stress that there is a connection between the collapse of the sea trout stock and the production of juvenile sea-lice from fish farms within a 20km range. This is the first time Scientists have accepted this in Ireland. We can only presume it will have a major impact on the regulations and protocol in respect of salmon farming in Ireland, Scotland and Norway.

Gene banks - live and deepfrozen

DN has, over the last years, built up gene banks to ensure the genes of important salmon stocks will be secured. The live genebanks are at Eldfjord on the Westcoast and at Hemne in the middle of Norway. The gene bank at Eldfjord is being developed further for around £1,000,000. The frozen sperma which is collected from 100 threatened rivers and represents many thousand individual salmon, is being kept in Trφndheim at a veterinarian station.

Norway's participation in the buy-out at the Faroe Islands

Norway's Ministry of the Environment has participated in the buy-out project of the NASCO salmon quota and contributed 55% of the total costs for the years 1991 through 1993. Before the 1994-96 re-agreement was finalised by the Committee for the Purchase of Open Sea Salmon Quotas, the Ministry made several stipulations which were all carried forward into the agreement. However, the Ministry has now indicated a wish to withdraw the Department from the buy-out obligations and leave it to other Norwegian interests to assume the responsibility of Norway's future financial obligations. The Norwegian public funds for the buy-outs have been

repaid by the salmon fishing fraternity in Norway through a general levy of the national salmon fishing licence of forty Norwegian Kroners (£4). 110,000 salmon sports fishermen paid this amount in 1993, including some 30,000 foreigners.

Salmon season 1993

The statistics have now been published and in general there is a small decline in catches compared with the previous year. Only 10 out of 50 rivers can show an increase in catches, of which the best known is the beautiful Lærdal river. Most rivers reported satisfactory spawning stocks.

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THE RUSSIAN ATLANTIC SALMON ROD FISHERY

(by Michael Savage)

In 1972 the first licence was issued to fish for salmon on a river since the Russian Revolution. By 1990 the total rod reported catch in 19 years was 9913 salmon from 22 rivers. In 1988 the very first foreign fishermen were allowed to explore some rivers on the Kola Peninsula but it was not until 1991 that the first commercial camps started operation. Growth was swift and two years later at least 20 camps were available and an estimated 700 rod weeks were fished. This is similar to the total amount of foreign fishermen per year on the rivers of Iceland. In 1994 the total is likely to exceed 1,000 rod weeks of which about 50% will be from the United States and 50% from Western Europe. Although it is early on in the learning curve, enormous progress has been made but there is still an element of "Adventure Tourism".

Two articles have been published by the Atlantic Salmon Trust in the "Blue Books" both were written after one week on a river and they portrayed very different experiences. Many other articles have been printed in the National and Sporting press, again most were written about one week's experience. I have been fortunate to fish with five different operators, I have stayed in 11 camps and fished 10 rivers and 8 tributaries, fishing for a total of about 9 weeks. This is enough for me to know how little I know!

The Kola Peninsula is about the size of Scotland and rivers vary greatly as can be seen from the table and notes. In 1992 one fisherman was left to try the "Big Sea Trout River" but he never found it - there was only a trickle! But in general the rivers provide ideal fly water, they are relatively shallow and the water is peat coloured. On the North coast the terrain is rugged and the rivers are clearer and steeper than in the South.

East of the line Murmansk/Kirovsk/Umbra the Peninsula is barren with the forest only in the South West. There are few inhabitants apart from one mining area far from the rivers that I have fished, and apart from one isolated Naval base which is supplied by sea, a few remote villages and small Lapp communities provide the only signs of human activity. Most of the land is tundra with much bog and many lakes, consequently rivers rise and fall slowly.

Only two river systems have really big runs of salmon - the Ponoi and Varzuga, both provide superlative fly fishing. Other rivers at times provide plenty of salmon and very interesting fishing at the right time of the season. Most of the Southern Kola rivers flowing into the White Sea are "user friendly" whereas the rivers of the North flowing into the Barents Sea provide conditions and fish similar to Norway. The walking and wading on these rivers can be tough, the numbers of fish are not so great but there is a chance of large fish, even very large!

The camps vary as much as the rivers, the operators have been listening to suggestions and most have been improving fast. At least 10 are now permanent hutted camps but a good tented camp can be as comfortable. In a well run camp, the guest cabins have electrical heating or perhaps wood burning stoves, electric light and in some cases en suite bathrooms. There should be good mosquito precautions, nets and coils and tents should have built in ground sheets over wooden platforms. The food varies in quality and style but has always been plentiful and palatable and in some camps the food is excellent. In all camps that I have experienced, the Russian staff have been a pleasure to meet and nothing has been too much trouble. They are keen to learn English and as much as they can about fishing. Some have Ph.D's, others are country boys who have done National Service. The helicopter pilots and engineers are immensely skilful. Access and supply are dependent upon helicopters and their costs have increased rapidly, if they reach international levels the fishery will die as fast as it has grown.

Some operations are run on a simple level and do not have a resident helicopter and facilities are primitive. Last October I was in the worst! This was further east, on the mainland far beyond the Kola. We were a rather senior party of seven Englishmen, we found ourselves living together in one teepee and snoring for Europe! The teepee was perched on a river beach and we nearly floated away as the river rose. Facilities were non-existent, the camp radio did not work, there was no helicopter, it was freezing and there was a revolution in Moscow. Some salmon had run through but most had stopped below us because the water temperature was so low. We were looked after by two charming "Nenetz" who looked like tea cosies and spoke their own tribal language (one was a doctor and the other a school mistress). The guides were keen and we did catch three fresh salmon, some pike and some hundreds of grayling. We also caught 12 kelts and saw some paw tracks of bear and wolf. An interesting experience. Fishing in Russia is not all about numbers!

In most camps there is an official Fishing Inspector, his transport and accommodation is provided by the camp and this enables them to be on rivers that previously they could seldom reach. This has resulted in a significant reduction in poaching. Their task can be dangerous some do a very good job, they know and love their rivers and are keen naturalists. One, sometimes, entertained us after dinner, playing a piano accordian and singing folk songs to his and our great enjoyment.

Poaching can be a serious problem and comes in many forms. Some is harmless, consisting of local fishermen keeping out of our way and taking a few fish with a spinner mainly at night. Where the few remaining official netting stations operate, the rivers are strictly controlled and well looked after, the spawning beds are protected and efforts made to catch the pike. Netting stations are allowed to fish one day in three only and not during the main run of fish in June.

However, where there is a small isolated community at the mouth of a river the run of salmon seems very uncertain and when the most remote rivers are visited sometimes there are nets across the mouth. Rivers with a significant local population and easy access are poached very heavily. Last year as a result of a "management decision" the Fishery Inspectors seemed less interested in poachers than extracting income from visiting fishermen and the camp management, enforcing rules which were unpredictable! After the inevitable protests it seems that in 1994 they will return their attention to poachers and not persecute the geese that are laying golden eggs!

The good operators maintain a very high standard, they provide wonderful sport and a high percentage of clients return. They insist on fly fishing only, debarbed hooks and "catch and release" although a few fish are retained to eat and one may be taken home. Poaching has been reduced, very few released fish die and more fish spawn than before. A new tourist industry has been established providing income and employment without environmental blight. Local fishermen are licensed to fish in reserved areas for sport and food. There are also some Finnish camps which tend to be more simple and most fishing is with spinners.

Although the Kola Peninsula is the main attraction, on the mainland Atlantic Salmon occur in rivers as far as Karatayka River on the border of Asia. The Pechora may once have been the greatest Atlantic Salmon river of all. It is four miles wide at the mouth and still one and a half miles wide 150 miles upstream! It drains a quarter of the Urals and salmon penetrate 1,000 miles. Sadly, it is very severely netted and subject to large forestry schemes and erosion and it is unlikely to provide an interesting fishery.

As can be imagined there has been considerable reconnaissance of rivers to the south of the White Sea and all the way East to the limit of the salmon's range. So far no fishing of great interest has been discovered and no well run camps are known to the writer. There are several rivers with salmon runs and some have good sized fish but poaching and local fishing is more extensive than on the Kola. Many rivers have much that is described as "frog water", but perhaps one "middle of the range" fishing may be discovered and opened up in due course.

Why do I go back again and again?

I see a window of opportunity between the end of the Cold War and before the cost of helicopters begin to make it prohibitive to fish some of the rivers. Each time I visit I realise there is so much to learn. I enjoy the pure air, the virgin country and being cut off from the world. I enjoy, as a party of only 8, fishing a river from top to bottom, having very long beats and discovering new pools and lies. I detest the over emphasis on large numbers which may sometimes be caught. I have had my share of blank weeks in Scotland and a few people have also had blank weeks in Russia. I am happy to practice catch and release, and I believe this should be mandatory on any river that does not have a sufficient stock to maximise spawning potential. I also enjoy the enthusiasm of the Russian guides and staff and the magic carpet provided by the noisy, smelly helicopters! Above all, I am grateful to the pioneers who have created this opportunity.

NOTES ON RIVERS

Kola River	Easily accessible, close to Murmansk - interesting for local fisherman
Rynda	In 1994 it may be fished by mobile camps and rubber boats
Kharlovka East Litza	Very interesting fishing, some big fish, strenuous walking and wading. Spey casting desirable.
Varzina/Penka	Very interesting fishing, some big fish, strenuous walking and wading. Spey casting desirable. Much still to be learned.
Iokanga	Interesting river with some difficult wading. A large Naval Base close to the mouth. Netted, active local fishermen, spinning permitted in 1993. Has been at least one very good weeks fishing.
Ponoi	The main camp is excellent in every respect. The river fishes consistently and extremely well. Strong American influence. Much fishing is from boats with jet outboards. A very big river and a very big run of fish. In 1992/93 about 700 rod weeks and about 14,000 salmon caught.
Polanga and outlying rivers	An excellent Russian operation fishing four small/medium sized rivers. Fishing quality not numbers. Like Sutherland fishing at its best. An average catch for 8 rods would be about 100 salmon and sea trout.
Strelna	A river with potential and occasionally a very good week. There is a big fall only 5km from the sea which checks salmon at some river heights. Fished with 3 other rivers, (Chavanga, Chapoma and Indera).
Varzuga Kitza/Pana	The biggest run of salmon on any river on the Kola Peninsula. Probably equal in numbers to all the rivers of Iceland. Average size about 1lb smaller than Ponoi. The Kitza joins the Varzuga near the sea and is interesting to fish. The Pana joins the Varzuga about 60km upstream and provides extremely good fishing early in the season. Excellent fly fishing throughout five good camps for eight rods per camp. 1992/93 207 rod weeks 5574 salmon caught.
Umba	The river has fine fish but has disappointed many fishermen. It is too accessible, poaching is out of control and the river is in danger of being ruined. At present, it seems best to leave it to the local fishermen.

SELECTION OF KOLA RIVERS (FROM 65 LISTED)

RIVER	MAIN TRIB	RIVER LENGTH KM	SALMON ACCESS IN KM	AVERAGE FLOW M^3	WATERSHED KM^2	LAKE %	NO. OF CAMPS	NO. OF RODS	NOTES
UMBA		125	No obstacles	78	6250	13	2	16?	
VARZUGA	Kitza/Pana	254	No obstacles	76	9825	3	5	40	
STRELNA		213	25	30	2775	1	1	12	
PYALITSA	Ust Pyalka	92	44	-	1200	1.2	0		known as "The Outlying Rivers"
LIKHODEEVKA		37	12+	-	300	2.4	0		"
BABIA		42	28	-	348	9.6	0		"
PONOI	Pomache	426	?	164	15450	2.1	2	30	
YOKANGA		203	?	71	5950	5.2	1	8?	
VARZINA	Penka	28(+12)	No obstacles	16(+5)	1100	16.3	1	10?	
EAST LITZA		118	8	28	1850	11	1	8	
KHARLOVKA		126	?	32	2000	8	1	4	
RINDA		98	?	18	1000	11	1	?	

NOTE: For comparison, average flow of some Scottish rivers

Tay	165 M^3 per second
Spey	64.3 M^3 per second
Scottish Dee	45.7 M^3 per second
Don	19.7 M^3 per second

GENERAL NOTES

No radioactivity! Detectors have been worn by several fishermen in 1993 and when tested on return home nothing abnormal was traced.

Mosquitos Early and late in the season they should not be a problem. On a windy or cold day they disappear but if it is warm or calm they may appear in millions. It is essential to be prepared with nets, deet, coils and repellent. Iceland is the only salmon fishing country virtually free of biting insects.

Ecology The Russians are now very strong on ecology which is something carried to the extreme. No tree may be cut down or trimmed on pain of a fine even for the smallest sapling, branches may not be cleared on even the very best pools. Huts are not allowed to have foundations. The tundra is very sensitive to misuse and tracks take many years to heal. Ecologists are frequently illogical but ecology is definitely a "good thing".

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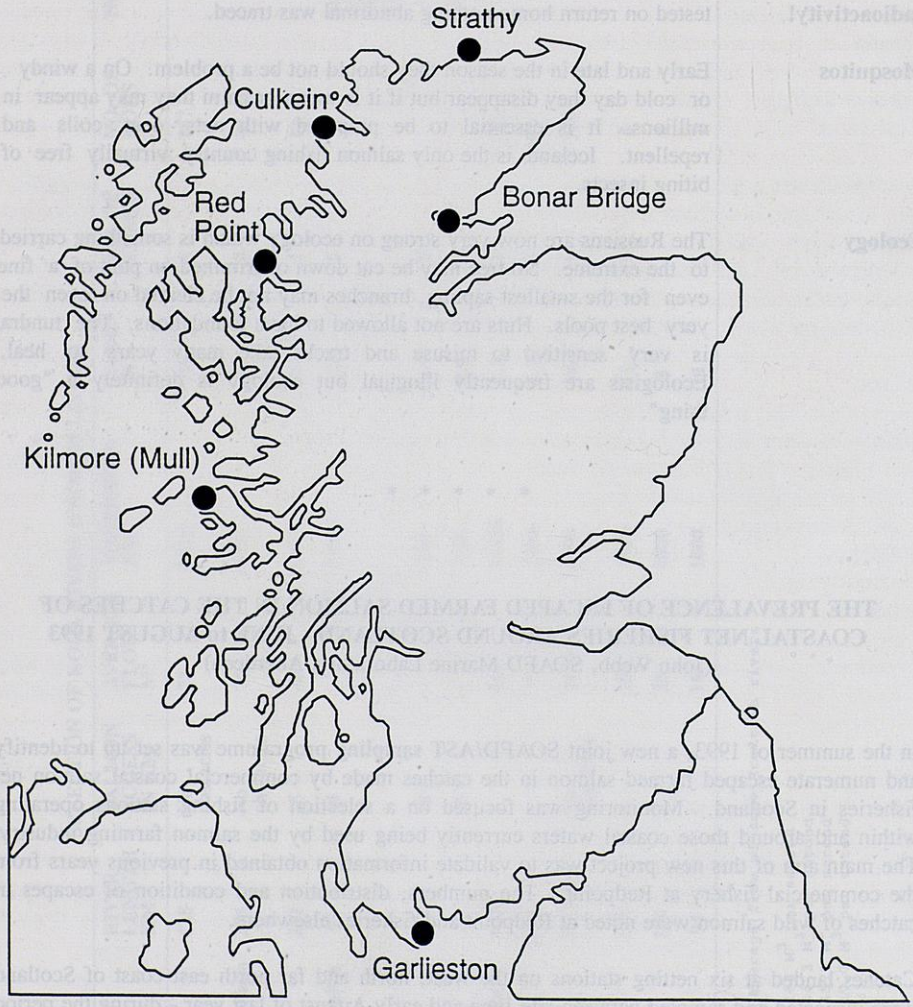
THE PREVALENCE OF ESCAPED FARMED SALMON IN THE CATCHES OF COASTAL NET FISHERIES AROUND SCOTLAND - JUNE to AUGUST 1993

(John Webb, SOAFD Marine Laboratory, Aberdeen)

In the summer of 1993, a new joint SOAFD/AST sampling programme was set up to identify and numerate escaped farmed salmon in the catches made by commercial coastal salmon net fisheries in Scotland. Monitoring was focused on a selection of fishing stations operating within and around those coastal waters currently being used by the salmon farming industry. The main aim of this new project was to validate information obtained in previous years from the commercial fishery at Redpoint. The numbers, distribution and condition of escapes in catches of wild salmon were noted at Redpoint and fisheries elsewhere.

Catches landed at six netting stations on the west, north and far north east coast of Scotland were inspected and sampled between late June and early August of last year - during the period corresponding to the peak of the fishing season. Samples of scales together with other details of sex and body weight were taken from a number of total daily catches landed at bag-net stations at Garlieston (Solway), Kilmore (Mull), Redpoint (Gairloch), Culkein (Loch Inver), Strathy (north coast) and the net and coble fishery at Bonar Bridge (Kyle of Sutherland) [Fig.1].

Figure 1.


Strathy
Culkein
Red
Point
Bonar Bridge
Kilmore (Mull)
Garlieston

Scale growth patterns were then analysed in the laboratory using discriminatory methods developed in Norway. The technique allows a skilled observer to identify the patterns of scales growth associated with culture in a hatchery or seacage and in many cases, the stage at which a cultured fish was lost from a rearing facility. The use of the scale reading method of identification is particularly useful for identifying adult salmon derived from fish of reared origin that were released as parr or smolts. In contrast to adult salmon lost directly from sea cages, many reared fish lost from culture during their juvenile phase and that have undertaken most or all of their sea growth while at liberty at sea, often lack the more obvious external characters associated with life in a fish farm.

The results of the survey were as follows. (Note: The data are presented as proportions to protect commercial confidentiality).

Incidence of escaped farmed salmon in the catches of six coastal fishing stations around Scotland, June to August 1993

	Proportion of catch (%) of reared origin		
Fishing station	Overall	Proportion of farmed escapes	
		Growers	Smolt
Garlieston	2.7	1.5	1.2
Kilmore	23	3.4	19.6
Redpoint	37.5	23.7	13.8
Culkein	23	2.8	20.2
Strathy	20	6.4	13.6
Bonar Bridge*	2.6	0	100

*Net and coble fishery
Total sample: 1340

In nearly all of the coastal net fisheries operating on the north and west coasts of Scotland whose landings we sampled, escaped farmed salmon contributed substantially to their catches. Indeed, in some cases, many of the levels of escapes recorded during this study were up to three times the largest previous estimates at the same stations. The lowest numbers of reared salmon were found in catches made at stations positioned outside the coastal area currently used by the cage farming industry (Garlieston and Bonar Bridge). The highest numbers were detected at Redpoint, Kilmore and Culkein - all of which are located well within the commercial sea rearing zone. In this respect, the distribution of fish farm escapes found in this study is consistent with the results of similar research carried out elsewhere. In Norway, it has been found that escaped farmed salmon, in most circumstances retain some measure of fidelity to their site of release: the numbers of escapes landed tending to be greatest in those coastal and fiord fisheries operating within the coastal waters used by the largest concentrations of cages.

More detailed interpretation of the actual numbers and proportions of reared salmon of different types in the catches made at each study site is difficult. Migratory studies using tagging have shown that at least on a regional level, escaped farmed salmon behave differently from wild salmon in coastal waters. Consequently, this may effect the efficiency with which the various gears used by the netsmen intercept fish of either group. However, from the detailed day-to-day catch monitoring carried out at the Redpoint fishery in 1991, there was no indication that escaped farmed salmon were being exploited differentially to that of the wild fish in the same area. On many days the relative catches of members of both groups of fish appeared to reflect fish availability and fishing conditions generally.

However, the possibility that the groups were constantly subject to differential exploitation throughout the fishing season cannot be ruled out. Nevertheless, it seems most likely that the frequency of escaped farmed salmon in the catches of the various fisheries monitored in 1993 reflected their overall frequency among salmon in waters near to each fishing station. Interestingly, with the exception of the catches made at Redpoint where the proportions of escaped "growers" in particular (and escapes generally!) in landings were greatest, most of the reared salmon detected during the course of this sampling programme were derived from fish released as hatchery reared parr and smolts. Hatchery reared smolts tend to have a survival rate that is typically less than one tenth of that of their wild counterparts. Consequently, it would appear that very large numbers of reared juveniles would have had to be released over the previous two years to generate the numbers and proportions of adult fish detected during the course of this investigation.

This data resulting from this work was submitted to both the ICES study group on Interactions of wild (ranched) and reared salmon and the North Atlantic Working group at their respective meetings in Iceland earlier this year.

Atlantic Salmon Population - Maximising Progeny Numbers from Natural Spawning: Studies on the Aberdeenshire Dee

Following the problems experienced last winter (see June 1993 Progress Report) with the excessive silting of experimental groups of eggs in containers buried in the stream, a new incubation system derived from the Kashmir box method was devised and installed in a trap facility near the study site in the native stream. In the early autumn of last year approximately 50,000 salmon eggs were laid down. Incubation was undisturbed up to "eyeing" in late March, and in early April the eggs were picked and counted. In contrast to last year, mortality up to this spring (to mid-April) was at 1.4% - a level comparable to most commercial hatcheries. The eggs were stocked out in their respective family groups, in the upper reaches of the study stream in late April. In the study area, spawning by adults is currently prevented by limited accessibility and a lack of suitable spawning habitat.

The distribution and performance of the various planted experimental groups in their first year of life will be assessed between late June and September of this year. Sampling and analysis will begin in the mid summer.

Publications and Presentations

A paper describing the incidence of hybridisation between escaped farmed female salmon and wild male trout in Scottish rivers has recently been published in the journal *Canadian Journal of Fisheries and Aquatic Sciences* (Vol. 50 pages 1986-1990).

In late November 1993, I presented a short paper on "The Prevalence and Behaviour of Escaped Farmed Salmon in West Coast Rivers" at the one day meeting held near Inverness. The meeting was jointly organised by the Atlantic Salmon Trust and SOAFD to discuss and review the status of the salmon and sea-trout stocks on the West coast of Scotland. A Blue Book describing the proceedings of the meeting entitled "Problems with Sea Trout and Salmon in the Western Highlands" has just been published and can be obtained from the AST office in Moulin (price £3).

The results of all of the studies conducted on escaped farmed salmon in Scottish waters since 1989 are being written up in the form of a review paper as a Scottish Fisheries Research Report. The report will be published later this year and will be available from SOAFD or the AST office at Moulin.

A short paper describing the "Identification of escaped farmed salmon and their prevalence in Scottish coastal waters" has been submitted for publication in the *Salmon Net Magazine*. It is hoped that the article will be published later this year.

Eratum

In the short article on the spawning of salmon in the Aberdeenshire Dee that was described in the last Progress Report (December 1993 Progress Report; p.22) it is stated that 331 spawning redds were located at Murtle. This total was in fact a printing error and should have read 31 redds.

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SUPERINTENDENTS AND BAILIFFS MEETING - MARCH 1994

(by John Webb)

The annual two day Superintendents and Bailiffs meeting was held earlier this year at Scotland's Hotel in Pitlochry. The meeting was organised as usual by Andy Walker of the Scottish Office Freshwater Fisheries Laboratory at Pitlochry and attracted superintendents, bailiffs, biologists and river managers from all over Scotland.

The first day of the meeting saw four talks on very different aspects of fish biology, current research, legislation and fishery management. The first presentation was by Mr. Colin Carnie (Salmon Advisory Committee) who gave a brief summary of the latest report to be published by the SAC. The report is called "Factors affecting emigrating smolts and returning adults". This is the fifth report to be published by the Committee and contains a wide ranging account

of the environmental factors that influence the emigration of smolts from rivers and subsequent adult returns. In addition, in a later section of the report, there is an account of the main ways in which human activities affect the survival, migration and reproduction of salmon and trout in rivers. Perhaps the most interesting parts of the report are its general recommendations - the sections concerned with fish pass facilities and the protection of fish at intakes and outfalls are particularly interesting. To summarise a good example, the report states that "the committee recommends that research and field study should continue into the design parameters for fish passes and the need to encourage the development of new and more efficient design concepts". On the subject of protection of migrating fish at intakes and outfalls, the committee is quite clear in its views. The report states that the committee considers "it quite unacceptable that both smolts and adult fish are being killed, damaged and delayed at a range of abstractive intakes, power generating stations and outfalls" and that there is an urgent requirement for "immediate implementation and strict application of existing legislative systems appropriate for large intakes, and tidal barrages to afford the greatest protection to stocks". On this note Mr. Carnie suggested that the background low-level mortality commonly associated with the passage of migrating smolts through low head turbines was no longer acceptable in the SAC's view.

The second presentation was given by Dr. Philip Smith from the Scottish Office Marine Laboratory in Aberdeen. Dr. Smith gave a brief outline on his recent work on developing a portable electronic fishcounting system using the existing "Logie" counter unit. The purpose of this work was to attempt to design a system that could be installed and operated in rivers and streams without the use or necessity of having to construct an expensive Crump-type weir.

The results achieved so far on this project have been, on the whole, encouraging. However, experience has shown that the careful siting of the electrode array is crucial for upstream and downstream counts to be recorded accurately. To date, the electrode arrays used in the various field trials have been relatively short in length ($<$ 8-10m) and as a consequence, the system could be reliably used in its present development state only in quite small channels.

In the third presentation of the day, Dr. Emily Bridcut described how the acidification of fresh waters continues to be a cause for concern in parts of Britain where soils are thin and lacking in Acid Neutralising Capacity (ANC). The problem may be made worse by the influence of airborne sea salts and the planting of coniferous trees. Quantifying the acid sensitivity of catchments has been a problem for managers for some time. One new way of defining the sensitivity of a habitat is to estimate its Critical Load (CL) by chemical analysis and to undertake surveys to see whether the CL has been exceeded. So far as fresh water is concerned, the CL is defined as the highest acid loading that a stream or lake can withstand without long term harmful effects on aquatic life. The utility of the CL concept has been tested in Scottish streams by Dr. Bridcut, working at the Freshwater Fisheries Laboratory at Pitlochry. Dr. Bridcut has compared the extent to which the CL values of particular systems have been exceeded with the results of detailed surveys of salmon, trout and aquatic insect populations. She has shown that, in Scotland, in some instances, fish and aquatic insect populations are better represented than CL exceedance values would suggest and that Acid Neutralising Capacity (ANC) is probably a more reliable indicator of fisheries status.

The final presentation of the first day was given by Mike Donaghy of the Freshwater Fisheries Laboratory at Pitlochry on the recently commissioned research project that is currently being conducted on the River Loth in NE Sutherland. The study is focused on assessing the performance of non-native stocks of salmon introduced into rivers and the effects of subsequent genetic mixing of native and non-native stocks. This partly EC funded project is part of a much wider collaborative research effort involving scientific teams working in Scotland, Ireland and Spain. The project is now in its second year and two experimental year classes of young fish are already in place in the stream. After dispersal from the redds, the stock types of the young fish will be distinguished using predetermined genetic markers. Mr. Donaghy reported that among the hatching eggs and emerging fry being monitored, there were already evident differences in the behaviour of juvenile fish derived from the different source river stocks (Shin, Oykel and Nith). Monitoring will continue up to the point when the resulting juvenile migrants leave fresh water to enter the sea.

The second day saw a further four presentations. The first considered kelt reconditioning. Developed and used in the USA and Canada over a number of years, the technique is being currently evaluated in Scotland by biologists at the Freshwater Fisheries Laboratory at Pitlochry. The main points covered in the presentation are detailed by the speaker, Dr. Bob Morgan in a separate article elsewhere in this edition of the Progress Report.

In a talk entitled "Salmon and rivers or rivers and salmon", Dr. Willie Duncan of Scottish Natural Heritage appealed for a more holistic approach to river management in Scotland and urged a greater level of co-operation between the various land use agencies. In his view, the drawing up and effective implementation of catchment management plans was to be encouraged. However, he stressed the need for a full understanding of what the primary target of such plans might be - whether it is aimed solely at fishery enhancement or towards the more wider ranging sustainable use of all resources within a river catchment. In summing up, Dr. Duncan emphasised the potential benefits of careful, planned management within catchments, plan structures and timetabling. However, he went on to comment that the proposed changes to local government may make such a task more difficult in the future.

Dr. Pete Batt of the Applied Environmental Research Centre Ltd. gave a short account of the fish radiotracking work that has recently been undertaken on the River Annan, in Dumfries-shire. This tracking project, has been part of a wider environmental impact assessment sponsored by BNFL as part of a feasibility study into the possibility of constructing a new nuclear power station at Chapelcross. Cooling water would be obtained by constructing a reservoir on a tributary of the main river and using it to regulate river flow. A radiotracking project was therefore set up specifically to attempt to evaluate the factors affecting fish movement in the River Annan and its tributaries and 40 salmon and 60 sea trout were tagged over the period of study. Anyone wishing to find out more about the results of this work should contact Dr. Batt at the AERC office at Lochmaben.

The final presentation of this year's meeting was given by Robert Williamson, Inspector for Salmon and Freshwater Fisheries of Scotland. The theme of his brief talk was current topical legal issues. His first point was the introduction of a new amendment to the Salmon (Definition of Methods of Net Fishing and Construction of Nets) (Scotland) Regulations 1992, in February of this year on the minimum thickness of twine that can be used in legal Scottish

net fishing gears. The new regulation is an attempt to reduce the possibility of gears being used to ensnare salmon and sea trout by the gills, deliberately or otherwise. The new minimum thickness is 0.9mm. Notes for guidance are available from Pentland House.

The second issue raised was that of the recent debate over the rights of anglers (particularly on the River Tay) to fish with more than one rod at any one time from a boat. Mr. Williamson stated that he considered that the Act outlawing the use of more than a "single rod and line" relates to the historical practice of double rod fishing, ie the use of two or more rods to control a SINGLE bait or lure. The use of more than one rod, each controlling DIFFERENT baits was in his opinion quite different and was legal. However, he did add that, these days, a Procurator Fiscal or a Sheriff might interpret "single rod and line" as meaning fishing with a single rod and line. He also drew attention to the possibility that, if any of the rods were not held in the hand, it might be argued that the fishing was akin to the use of a set line and therefore unlawful.

Finally, there was the question of the definition of an "unseasonable" fish landed during the legal angling season. Mr. Williamson said that the law as it stands at present was quite clear: the "seasonability" of a salmon or sea trout could indeed be independent to that of the statutory fishing season within a fishery district. In his view, it is quite possible to catch unseasonable (gravid) fish during the legal fishing season. In practice, it was up to the managers, bailiffs or ghillies to advise anglers as to what was or was not a keepable fish. The taking of fish that were about to spawn, or fish that had failed to spawn ("baggots") or kelts is an offence.

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RECONDITIONING ATLANTIC SALMON (SALMO SALAR L.) KELTS

(R.I.G. Morgan, I. Mitchell* and D.S. Keay)

The Scottish Office Agriculture and Fisheries Department, Freshwater Fisheries Laboratory, Faskally, Pitlochry, Perthshire PH16 5LB. *The Tay District Salmon Fisheries Board, c/o Condies, Tay Street, Perth PH1 5LJ.

Introduction

Kelts are Atlantic salmon (Salmo salar L.) that have spawned and are making their way back towards the sea. Some kelts do survive and are seen again in net and rod catches. Atlantic salmon that have spawned up to five times have been recorded, though there appears to have been a decline in the number of repeat spawners in sampled catches in recent years. Recognising that kelts may have a contribution to make towards future spawning runs, they are protected by law and, if caught, have to be returned unharmed to the water. This sentiment was not always so, writers towards the end of the last century regarded kelts as a nuisance because they were believed to eat young salmon and trout on their way down to the sea. However, just after the turn of this century, some work on the cellular structures of the stomach and digestive system of kelts suggested that they had broken down and that digestion

was impossible. Although this work was shortly after shown to be in error and that the preparation of the tissues had contributed to the tissue break up seen, it was widely believed that kelts were unable to feed in fresh water. In the late 1920's, a little reported American work described a reduction in the digestive capability of the Atlantic salmon stomach and gut during its upstream migration but a later, post spawning recuperative increase.

Where kelts have survived the rigours of down-stream migration, recovered and returned to spawn again, two types of fish have been noted. These are the short absence fish and the long absence fish. Short absence fish tend to be grilse (1 sea-winter, 1SW) at their maiden spawning and long absence fish tend to be salmon (multi-sea-winter fish MSW) at their maiden spawning. Large rivers generally contain both grilse and salmon, whilst small rivers contain grilse, and the grilse component tends to enter the rivers from about June onwards. These observations help to explain the long or short sea absence habit. If a large (MSW) fish enters a river early and migrates to the headwaters to spawn - as has been demonstrated by radio-tracking - the energetic costs are high. A smaller grilse, entering a river system later, not only has a reduced period of starvation but is less subject to the energetic costs of reaching spawning grounds as either the river is shorter, or spawning occurs in lower tributaries. In the case of early running grilse, which also tend to spawn in headwaters, the later river entry time reduces the energetic cost of the river residence time. It is this energetic cost reflected in the loss of stored energy reserves that is critical. The act of spawning for the female can result in a loss of up to 25% of its body weight. The male weight loss on spawning is much less, but the male spawning behaviour differs to that of the female. Males may arrive on the redds earlier than the females and unlike the female that leaves the area soon after spawning, the males remain. During this residence period, the males may fertilise the eggs of several females and indulge in aggressive behaviour towards other males. Because male sperm production greatly exceeds the number of eggs produced, the male behaviour may be a way of maximising the numbers of the progeny of successful males. The penalty is, however, high. Although roughly equal numbers of males and females are present post spawning, the numbers of females in repeat spawning runs greatly exceeds that of males. It has been suggested that death occurs if body weight loss of more than 40% occurs. It is likely that a large loss of body weight coupled with a reduction in the capability of the immuno-suppressive system allows fungal and bacterial infections to break out which will kill the kelt. If, however, a kelt manages to return to the sea, encounter an adequate food supply, it can recover and return to spawn again.

Of interest here are the rate and timing of feeding. It has been shown for other salmonids that large fish tend to miss a year before they mature again and the probability is that lost energy reserves - primarily fats - are more easily replaced in small fish than in large. There is also evidence from experimental studies on the maturation of Atlantic salmon both as parr and as pre-adults, that a reduction in the feeding opportunity at critical times can reduce the incidence of maturation. If the pre-winter energy loss (including migration and spawning) has not been too great and the fish feed well in January to April, maturation will occur in the autumn of that year. The challenge for kelts appears to be to survive spawning and its associated migration energy loss, to return to the sea and start feeding as early as possible to alow maturation in the year of sea re-entry.

The ability of Atlantic salmon to survive spawning and remature has long been of interest to fisheries managers. Repeat spawners tend to be larger than at their maiden spawning and produce more eggs per fish. The egg yield is less variable for repeat spawners than for maiden spawners. Repeat spawners are therefore of great benefit to the river in terms of their egg deposition. Reconditioning of kelts in captivity has been carried out under a variety of regimes and with variable success. In previous work, rematuration of all females after one year of reconditioning was unusual and frequently egg and alevin quality was poor. However, if kelts can be reconditioned to produce viable eggs and alevins, the various problems associated with broodfish capture can be avoided. A management policy based on enhancement or augmentation is dependent on a reliable source of eggs and kelt reconditioning offers a solution to the bottleneck that may be caused by a lack of broodfish. In the light of current concerns regarding the apparent decline of spring salmon, reconditioning may offer an alternative means of egg production.

This study was undertaken to establish the feasibility of reconditioning early-running MSW salmon under low technology conditions. In particular the percentage of females rematuring after one year and the quality of the eggs produced was examined.

Materials, Methods and Results

Adult Atlantic salmon were obtained from the River Tilt, a tributary of the River Tay some 70 kilometres from the sea, in November 1992 before they had spawned. They were transferred to the Almondbank hatchery and kept in fresh water until ripe, and then stripped. At stripping, each fish was measured, weighed and a scale sample taken. Each fish was tagged with a VI (Visible Implant) tag in the clear tissue just behind the eye for future identification. The eggs from each female were incubated separately in upright stacking incubators. At stripping, each fish was injected with oxytetracycline to reduce bacterial disease and in March vaccinated against furunculosis. The fish were further treated during the holding period when required. The survivors of the reconditioning process were checked for maturity in November 1993, and if ripe, stripped. Water quality, water temperature and light were not modified during the reconditioning programme.

Feeding was initiated in February 1993. A food item would be presented to a fish and the fish gently encouraged to take it into its mouth. Once a food item had been ingested, the feeding response became less hesitant. At this stage the temperatures were low (ca 2°C), but as the kelts became more familiar with feeding and the water warmed up, feeding became more positive. Feeding peaked at the end of June and then declined with the exception of four fish that continued to feed. The reconditioning kelts were offered a range of food items including prawns (Pandulus borealis), sand eels (Ammodytes sp), sprats (Sprattus sprattus), squid (Loligo pealei) and small herrings (Clupea harengus). Curiously, the kelts could not be persuaded to eat commercial salmon pellets. The quantity of food eaten by all the fish per week is shown in Figure 1. It should be noted that the numbers of fish change during the period due to mortality (see Figure 2).

Fig.1 WEEKLY FOOD INTAKE

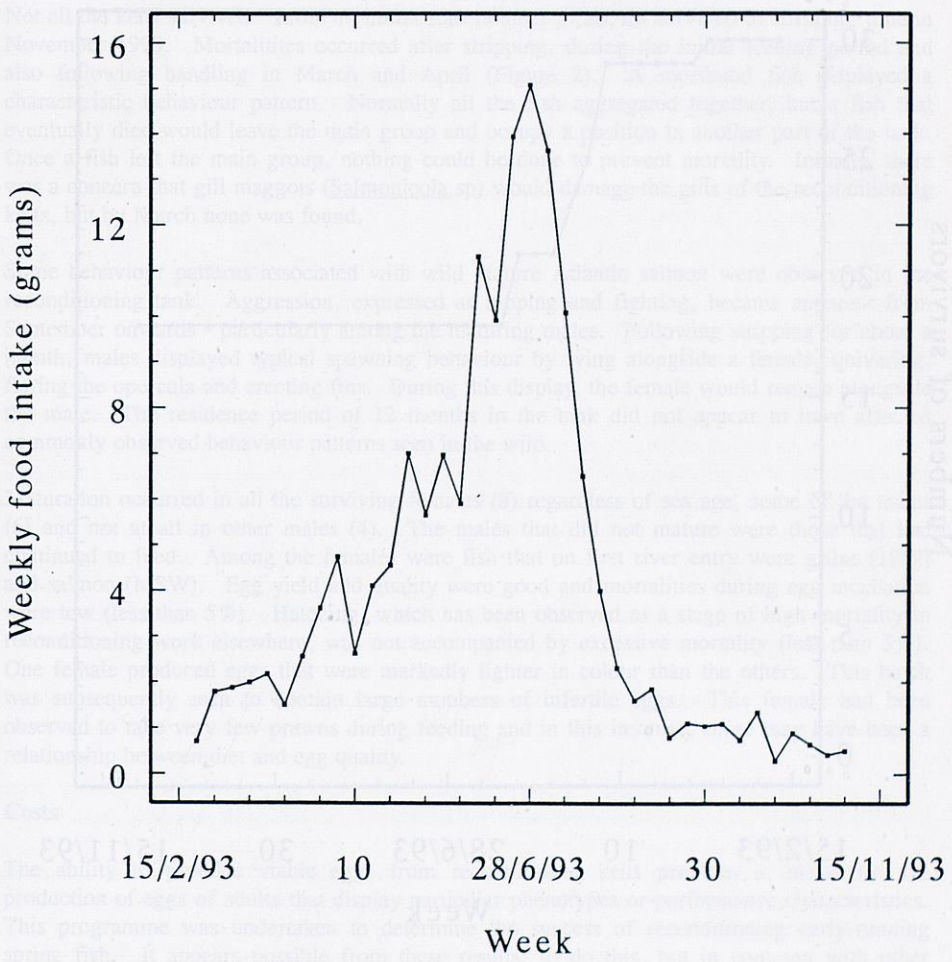
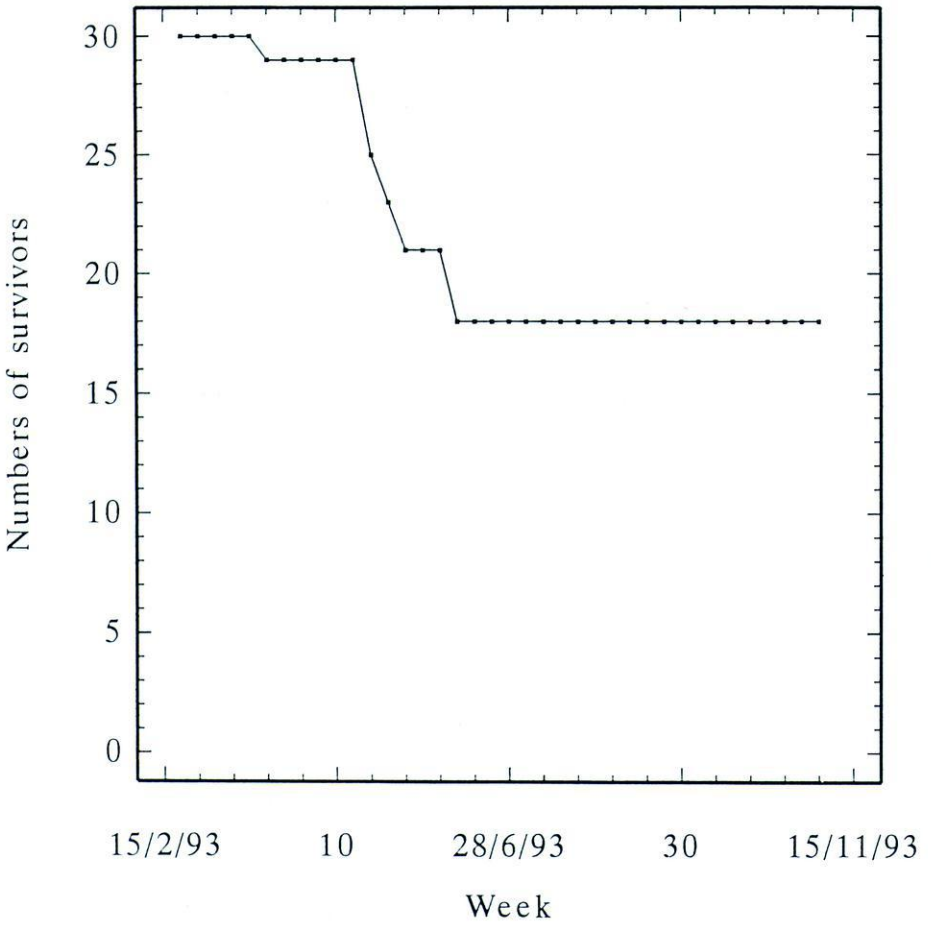


Fig.2. SURVIVORS DURING RECONDITIONING



Prawns appeared to be the preferred food item and tended to be ingested whole. Sand eels were ingested by first being attacked in the mid section and then swallowed, the tail and head disappearing last. On the one occasion when dead salmon parr were introduced into the reconditioning tank, they were readily ingested.

Not all the kelts survived. From an initial start number of 30, 18 survived to stripping time in November 1993. Mortalitites occurred after stripping, during the initial feeding period and also following handling in March and April (Figure 2). A moribund fish displayed a characteristic behaviour pattern. Normally all the fish aggregated together, but a fish that eventually died would leave the main group and occupy a position in another part of the tank. Once a fish left the main group, nothing could be done to prevent mortality. Initially, there was a concern that gill maggots (Salmonicola sp) would damage the gills of the reconditioning kelts, but by March none was found.

Some behaviour patterns associated with wild mature Atlantic salmon were observed in the reconditioning tank. Aggression, expressed as nipping and fighting, became apparent from September onwards - particularly among the maturing males. Following stripping for about a month, males displayed typical spawning behaviour by lying alongside a female, quivering, flaring the opercula and erecting fins. During this display, the female would remain alongside the male. The residence period of 12 months in the tank did not appear to have affected commonly observed behaviour patterns seen in the wild.

Maturation occurred in all the surviving females (8) regardless of sea age, some of the males (6) and not at all in other males (4). The males that did not mature were those that had continued to feed. Among the females were fish that on first river entry were grilse (1SW) and salmon (MSW). Egg yield and quality were good and mortalities during egg incubation were low (less than 5%). Hatching, which has been observed as a stage of high mortality in reconditioning work elsewhere, was not accompanied by excessive mortality (less than 5%). One female produced eggs that were markedly lighter in colour than the others. This batch was subsequently seen to contain large numbers of infertile eggs. This female had been observed to take very few prawns during feeding and in this instance, there may have been a relationship between diet and egg quality.

Costs

The ability to produce viable eggs from reconditioned kelts provides a means for the production of eggs of adults that display particular phenotypes or performance characteristics. This programme was undertaken to determine the success of reconditioning early-running spring fish. It appears possible from these results, to do this, but in common with other management activities, the cost/benefit of this approach must be evaluated. The ultimate cost/benefit of such an exercise would have to be determined by direct observation, but some provisional estimates of cost can be made.

Production cost per 1,000 eggs (tank, feed etc.) =	£50
Assuming a 1% survival from planted unfed fry to smolt, smolt production cost =	£5
Assuming 100,000 eggs and unfed fry were produced and planted out and 1,000 smolts produced, taking ocean survival at 10%, 100 adults would return to the river at a unit cost =	£50
Assuming an in-river mortality of 10% and an exploitation level of 10%, 9 fish would be caught at a unit production cost =	£550
However, spring fish exploitation is higher between 30-80% (mean ca 50%), making exploited fish cost =	£111

Ironically, the higher exploitation level on spring fish reduces the production cost per captured fish. These estimated costs can be compared to the costs of eggs from commercial salmon hatcheries (£30-£40 per thousand) and to the broad estimates of the cost involved in catching a fish derived from a planting or stocking exercise (£400-£500).

Summary

1. Early running, multi-sea-winter female Atlantic salmon were successfully held in freshwater following stripping.

2. Feeding of the kelts was initiated in February and peak food intake occurred at the end of June.

3. All the surviving females matured after 12 months and egg yield and egg quality were good with little mortality being observed among the incubating or hatching eggs.

4. Low technology reconditioning of MSW kelts is viable and the eggs obtained may be used in management policies where difficulty is experienced in obtaining sufficient numbers of broodstock.

5. Provisional estimates suggest that reconditioned eggs and returning captured adults are comparable in cost to both commercially produced eggs and recaptured fish from enhancement practices.

Acknowlegements

This pilot study was commissioned by the Tay District Salmon Fisheries Board who were a source of encouragement and enthusiasm throughout. Our colleagues Mike Miles and Jimmy Muir provided invaluable help during the holding and reconditioning process. Adult capture was carried out with the assistance of Dave Stewart, Alasdair MacDonald and Richard Lyons.

(An information video describing the elements of this programme is available from the Atlantic Salmon Trust for the usual consideration).

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MEETING OF THE HONORARY SCIENTIFIC ADVISORY PANEL

(by Derek Mills, Chairman)

The Honorary Scientific Advisory Panel met in Edinburgh on 10th May at the NASCO headquarters. The main items discussed were recent and future workshops, the publication of Blue Books and AST-funded research projects.

The last workshop was one held jointly with ICES at Bushmills, Northern Ireland, on Salmon Spawning Stock Targets from 7-9 December. This was a most useful meeting as it enabled both North American and European scientists to meet to discuss methods to achieve reliable targets for salmon spawning stocks. The Canadians, in particular have advanced their techniques far more than their European colleagues due to the greater uniformity of their salmon rivers when compared to those in Europe where river habitats are extremely variable, even within the same system. Publication of the proceedings will follow.

There are no other workshops planned at present although AST will be contributing to a symposium on aquatic predators and their prey being organised by the Royal Society of Edinburgh. This is to be held in Aberdeen from 13-15 September.

There have been two Blue Books published recently, namely "Surveying and Tracking Salmon in the Sea" and "Problems with Sea Trout and Salmon in the Western Highlands". A further book is imminent and that is "Automatic Salmon Counting Techniques: a Contemporary Review" by Adrian Fewings and based on information collected while a Bensinger-Liddell fellow. One other book, presently in preparation, is "Salmon in England and Wales" by Gordon Bielby. Subjects for other books are being considered.

A number of research projects have been or are close to completion. A most interesting study on spawning of wild and precocious male salmon parr has been completed by Diogo Thomaz of Leicester University. It reveals that spawning of precocious male parr is far more widespread than was thought.

Also completed is an impact study of Donegal salmon populations by Philip McGinnity of Queen's University, Belfast. This has consisted of malic enzyme studies. The aim of these has been to monitor a group of hatchery-reared salmon right through one complete cycle of their life. If selection should act upon the experimental population it is likely that it would have an effect during one or more life history events where mortality is high.

Other projects nearing completion are: "What makes a sea trout?" by the Salmon Research Agency at Burrishoole; Tweed habitat improvement by the Tweed Foundation and "A stochastic growth prediction mode!" by Malcolm Elliott of the Freshwater Biological Association.

An exciting project on "Population Management" by John Webb and Alan Youngson of the Marine Laboratory is under way having been delayed by floods last year.
Proposals for research projects are always welcome and applications for funding should be sent to the Director.

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MODELLING GROWTH IN SALMONIDS: PROGRESS REPORT

(by J. Malcolm Elliott, Institute of Freshwater Ecology, Windemere Laboratory)

A previous article in the Progress Report for June 1993 introduced a new research project supported by a grant from the Atlantic Salmon Trust. The chief objective is to develop an improved mathematical model for predicting the growth of brown trout (including sea-trout), especially in relation to varying water temperature. The earlier article introduced the concept of mathematical models and their importance in ecology, then described an earlier growth model developed in the early 1970's and summarised its chief weaknesses. The present article first describes the new experimental methodology used to obtain a much larger data set on trout growth, then describes the fitting and testing of the new model, and finally discusses differences between the old and new models and between the old and new data sets.

Individual growth rates were obtained for only 55 trout in the earlier experiment and 40 of these fish had a similar weight of about 50g. The trout were all obtained from a commercial hatchery and their pedigree was unknown. For the new experiments, the fish were reared in the hatchery of this laboratory and were the progeny of wild sea-trout obtained from a tributary of the River Leven in northwest England. They were kept at five constant temperatures: 5.0, 10.0°C (range maintained at ±0.1°C), 13.0, 15.0, 18.0°C (±0.2°C). Oxygen concentration in the water always remained at 100% saturation. There was subdued, natural daylight with half of each tank covered by black polyetheylene to provide some refuge for the trout. Only one fish was placed in each tank and all fish were fed to satiation on freshly killed, freshwater shrimps, the feeding procedure being the same as that used in the earlier experiment, except that all uneaten food was removed immediately with a small air-lift extractor. When the trout were first placed in the tanks, they were kept at the same temperature as that in the hatchery. After 5 days, the temperature was increased or decreased at about 1°C per hour until the experimental temperature was attained. Fish were never used more than once.

Each trout was measured (fork length to nearest mm) and weighed (wet weight to nearest 0.01g for fish < 80g and 0.1g for fish > 90g) at the start and finish of the growth period which always lasted 42 days. For trout with initial weights close to 1.3g, 5g, 12g and 50g, there were five fish of similar size at each of five temperatures. The number of replicates was reduced from five to three at each temperature for fish with initial weight close to 100g and 300g. Estimates of growth were therefore obtained for 130 trout; a much larger sample than that of 55 in the original experiment. The size distribution of the fish was also more even than that in the original experiment with its strong bias to 50g fish. Obvious advantages with the new tanks were the greater temperature control and the high oxygen concentrations. The trout in the new experiment were also obtained from wild parents. The new experimental methodology therefore had several advantages over that used previously.

A detailed description of the new model would be out of place in the present article, but its most important properties can be summarised. The model is continuous over the temperature range 3.8-21.7°C and has five parameters, all of which can be interpreted in biological terms.

Three parameters are temperatures; the optimum value for growth and the upper and lower values at which growth rate is zero. The fourth parameter is the growth rate of a 1g trout at the optimum temperature, and the fifth parameter is the weight exponent that corrects for fish of different sizes. The latter parameter is also the power transformation of weight that produces linear growth with time. Two versions of the model have been produced. The first estimates growth rate at a known water temperature and at an instant in time when the live weight of the trout is known. The second, more useful version, estimates fish weight at the end of a given period of time and requires knowledge of the mean water temperature and the initial weight of the fish. It was an excellent fit to the growth data for the 55 trout of the original experiment, the 130 trout of the new experiment, and both experiments combined.

When the growth model is applied to wild brown trout in the field, the null hypothesis is that the fish are growing at their maximum potential. Use of the model assumes that: (i) fish weight is measured without error, (ii) mortality is random, (iii) the five parameters in the model are estimated exactly without error, (iv) all fish grow according to the model with no variability in growth rate between fish, (v) water temperature is constant for the growth period. These assumptions are presented in an approximate order of probability from highest to lowest. The procedure for applying the model to field data has been examined and a suitable test for maximum growth potential has been developed. The test takes into account the variability in the estimated mean weight and the variability in the actual mean weight obtained for a sample of trout in the field.

In applying the model, it is assumed that temperature is constant for the growth period and this is unlikely unless this period is short. The effect of increasing the time period over which mean temperatures are estimated was examined by comparing estimated final weights for two year-classes from a long-term study of a sea-trout population (Elliott 1993, 1994). The 1973 year-class was one of the better year-classes for growth whereas the 1983 year-class was one of the worst. However, for both year-classes the estimated weights increased with increasing time periods. This effect was small for an increase from two weeks to a month, especially for the 1973 year-class, but was marked for an increase from three to six months. The increase

would, of course, be even greater if only annual mean temperatures were available. Values for the two-week periods were closest to the observed weights obtained in the field but it is perhaps surprising that use of longer periods of one or three months would lead to only a slight increase in expected weights. If these examples are representative, then it would appear that predictions from the model are robust when mean temperatures are estimated over periods of less than three months, and especially less than one month, but become markedly inaccurate when the time period exceeds three months.

Although parameter estimates for the new model are very similar for the original and new experiments, they are still significantly different, according to some sensitive statistical tests. Fortunately, these differences have a negligible effect on values predicted from the model. The discrepancies are, however, puzzling. An iterative exercise, varying common and different parameters, showed the differences to be due to two parameters; the optimum termperature for growth being slightly higher at 13.37°C in the original experiment than that of 13.07°C in the new experiment, and the closely related growth rate of a 1g fish at this temperature also being slightly higher at 3.077 in the original experiment compared with that of 2.802 in the new experiment. Differences between the two experiments could possibly explain these discrepancies. The most obvious is the poorer control of constant temperature and oxygen concentration in the original experiment compared with the new one. Water temperatures varied from $\pm$ 0.3°C at 3.8°C to $\pm$ 1.0°C at 21.7°C and oxygen concentration from 85% to 100% saturation in the earlier experiment, whereas temperatures were always maintained at $\pm$ 0.2°C or less and oxygen concentration at 100% in the new experiment. Although these differences could explain the discrepancies in the parameter estimates, they also show the negligible effects of such differences on the expected weights estimated from the model. For example, it would appear that fluctuations in oxygen concentration between 85% and 100% saturation do not have a biologically significant effect on growth rates.

Another obvious difference between the experiments is the source of the trout. Fish in the original experiment were all from a commercial hatchery, but the similarity between their growth rates and those of wild trout fed to satiation supported the conclusion that their growth was typical of wild brown trout. Fish in the new experiment were reared from wild migratory brown trout (sea-trout) and were heavier than fish of similar lengths from the original experiment for fish less than 30cm. For example, estimated weights from log weight on log length relationships were 10.2g, 81.5g, 274.5g for trout from the original experiment and 11.7g, 85.8g, 274.5g for trout from the new experiment for lengths of 10cm, 20cm, 30cm respectively. Such differences could be due to the larger migratory trout females producing larger eggs, alevins and fry than the hatchery females (see also Elliott 1994), and/or genetic differences between the wild and hatchery trout. Once again, such differences appear to have a negligible effect on the expected weights estimated from the new, improved growth model. The latter therefore provides a testable model not only for investigating growth potential in different populations, but also for exploring possible genetic differences in growth between populations of brown trout.

This work is described more mathematically and in more detail in a paper submitted recently to a journal for publication. My co-authors are Margaret Hurley, who is the biometrician at this Institute, and Robert J. Fryer, who now works at the Marine Laboratory in Aberdeen but was

once a PhD student at this Institute and was co-supervised by myself and Professor Cormack at St. Andrews University. We are continuing this work by examining the effects of reduced daily ration on trout growth. This work should lead to another growth model that incorporates the effects of changes in energy intake by the brown trout. New data on the growth rates of trout kept on different ration levels have now been obtained from laboratory experiments and statistical analyses will commence in the near future.

A 25-year study of production of juvenile sea-trout, *Salmo trutta*, in an English Lake District stream. J.M. Elliott, 1993. Canadian Special Publication of Fisheries and Aquatic Sciences, 118: 109-122.
Quantitative Ecology and the Brown Trout. Oxford University Press, Oxford. xi + 286 pp.

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REVIEW OF SCIENTIFIC LITERATURE ON SALMON

(by Dr. Derek Mills, Institute of Ecology and Resource Management,
University of Edinburgh)

1. Taxonomy

Morphometric and meristic characters in salmon, Salmon salar L., Salmo trutta ., and their hybrids. N.P. Wilkins, H.P. Courtney, E. Gosling, A. Linnane, C. Jordan and A. Curatolo, Aquaculture and Fisheries Management, 25, 505-518, 1994.

Atlantic salmon, brown trout and their hybrids are normally identified in the field by empirical differences in maxilla length, thickness of the caudal peduncle, degree of forking of the tail and overall body conformation. This study quantifies these characters and analyses their variations in electrophoretically identified hatchery-reared individuals. The results confirm that frequencies of hybrids of these species cannot be reliably assessed by morphological characters alone, and even for individuals of the pure parental species, independent confirmation of species status is advisable. Early reports of hybrid frequencies in wild stocks should be treated with caution.

2. Juvenile salmon

Fine sediment infiltration into gravel spawning beds within a regulated river experiencing floods: ecological implications for salmonids. D.A. Sear. Regulated Rivers: Research and Management, 8, 373-390, 1993.

Infiltration rates into eight gravel spawning beds were monitored over a range of discharges including compensation flows, peak hydropower generation and floods of up to bankfull capacity. The results indicate that the interrelationship of sediment supply and discharge influence both the rate and grain size composition of infiltrated sediments, with maximum rates experienced during bankfull floods when sediments are scoured from upstream pools. The

effect of river regulation for hydropower are shown to produce a finer matrix infill in the absence of unregulated tributary sources, although the rates of infiltration are much lower than for sites downstream of unregulated tributaries. Values for infiltration rates are shown to be detrimental for small salmonid spawning redds during post-flood conditions when sediment transport is not restrained by supply.

3. Juvenile sea trout

The movement of wild sea trout, Salmo trutta L., smolts through a river estuary. A. Moore and E.C.E. Potter. Fisheries Management and Ecology, 1, 1-14, 1994.

The movement of sea trout smolts through the River Avon, was studied using miniature 300kHz acoustic transmitters and an array of strategically placed acoustic sonar buoys. Movement was predominantly nocturnal and occurred mainly during an ebb tide or the period of slack water between two high waters. During hours of darkness the ground speed of the smolts through the estuary was similar to that of passively drifting objects. However, where movement did occur during daylight hours ground speeds of smolts were significantly slower.

4. Predation

Fish eating birds by M. Marquiss and D.N. Carss, NRA R&D Report 15.
The NRA has published its report commissioned from the Institute of Terrestrial Ecology.

5. Management

Stocking strategies. I.G. Cowx, Fisheries Management and Ecology, 1, 15-30, 1994.

Stocking, transfer and introduction of fish are commonly used to mitigate loss of stocks, enhance recreational or commercial catches, restore fisheries or to create new fisheries. However, many stocking programmes are carried out without definition of objectives or evaluation of the potential or actual success of the exercise. This paper describes a strategic approach to stocking aimed at maximizing the potential benefits. A protocol is discussed which reviews factors such as source of fish, stocking density, age and size of fish at stocking and mechanism of stocking. The potential genetic, ecological and environmental impacts of stocking are described.

International management of Atlantic salmon, Salmo salar L., by the North Atlantic Salmon Conservation Organisation, 1984-94. M.L. Windsor and P. Hutchinson, Fisheries Management and Ecology, 31-44, 1994.

This paper summarises the progress made in the 10 years since this Organisation was established. Agreements on regulatory measures have reduced the proportion of the total catch taken by the distant water fisheries and, in the case of the West Greenland fishery, management is now firmly based on scientific advice. The stability created by these regulations has allowed NASCO to address the broader areas of conservation called for under the Convention.

Atlantic Salmon: A Dialogue. Ninth ICES Dialogue Meeting, No. 197. ICES Co-operative Research Report, 1994.

This is the proceedings of the very successful dialogue held in Edinburgh in June, 1993, immediately prior to the annual NASCO Council Meeting. The contents include the Keynote Address by Magnus Magnusson the following review papers: History of salmon fisheries and management in the North Atlantic by Kevin Friedland; History of the Baltic salmon, fisheries and management by Ole Christensen, and Comparison of the salmon situation in the North Atlantic and Baltic. There are a series of papers by the user-groups, scientists and managers followed by discussions and overviews.

6. Genetics.

Maintenance of genetic variation in hatchery stocks of Atlantic salmon, Salmo salar L. : Experiences from the River Bush, Northern Ireland. W.W. Crozier, Aquaculture and Fisheries Management, 25, 383-392, 1994.

An examination of biochemical-genetic variation at seven polymorphic loci was carried out among five year-classes of wild Atlantic salmon in the River Bush and in a hatchery strain derived from the wild population. Within some of the year-classes, gene frequencies at several loci differed significantly between wild and artificially reared salmon. Highly significant temporal variation in gene frequencies was detected among successive year-classes of the hatchery strain, while this was less significant among the wild salmon.

7. Salmon farming.

Symposium on Cultivation of Atlantic Salmon. Aquaculture and Fisheries Management, 25, 1, 1994.

This issue of the journal is given over entirely to the above symposium and publishes 11 papers including the following: Reproductive strategies in Atlantic salmon by J.E. Thorpe; Farming of salmonids in Russia by L.A. Dushkina; The role of behaviour in determining salmon growth and development by N.B. Metcalfe; Survival, growth and feeding of Atlantic salmon smolts after transfer to sea water in relation to the failed smolt syndrome by L. Stradmeyer, and Genetic effects of selection on polygenic traits with examples from Atlantic salmon by H.B. Bentsen.

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FILMS AND VIDEO CASSETTES AVAILABLE FOR HIRE

"Will There Be a Salmon Tomorrow"	- 16 mm film
"Salar's Last Leap"	- 16 mm film
"The Salmon People"	- Video (VHS)
"Irish Salmon Harvest"	- Video (VHS)
"Managing Ireland's Salmon"	- Video (VHS)
"Salmon Tracking in the River Dee"	- Video (VHS)

Films and videos may be obtained from the Trust for private showing by Clubs, Fishery Managers, etc. A donation to AST funds is required in return.

HEARTCLIC

"Cast a lifeline in the fight against cancer, leukaemia and heart disease"

HEARTCLIC is a charitable campaign on behalf of the British Heart Foundation and **CLIC (Cancer and Leukaemia in Childhood)**. It aims to raise at least **£1 million** in 1994 from the Nation and its anglers and to share that money equally between the two charities. It already has the support of celebrities such as Ian Botham, Roger Daltry, Chris Tarrant, Fiona Armstrong, Judith Hann and Jack Charlton. The list is growing!

HEARTCLIC has been inspired by the personal contact with heart disease and childhood cancer of two friends and trout farmers, Bob Booth of Welham Park Trout Farms and Ian Peters of Bibury Trout Farm. Bob's mother **Dorothy** has three times successfully undergone open-heart surgery whilst Ian's baby daughter **Felicity** died from Leukaemia on Wednesday 20th January 1993.

The catalysts behind **HEARTCLIC** are of course **Felicity** and **Dorothy**. However Ian and Bob know that virtually all of us will have had some contact with either heart disease of cancer and so they are asking everyone they meet or to whom they write to identify with their cause through their **own personal experience** and to **THEN do something to help!** They hope that in this way the campaign can become more personal and of course achieve more.

HOW YOU CAN HELP RAISE THE MONEY.

1. **HEARTCLIC symbols**. These are specially designed enamel badges and are available for donations of **£1** or more. They have already proved immensely popular and are worn by men, women and children with equal enthusiasm!

2. **HEARTCLIC events**. There are a whole range of fund raising activities taking place throughout the year. Although Ian and Bob have aimed specifically at the world of angling, the aim is to reach that magical target of **£1 million** and so **ANY** help is welcome, the more innovative and eye catching and of course, successful the better!

The response to date has been particularly enouraging and pledges have been received for at least 400,000 badges. However Ian and Bob are conscious that they still have a very long way to go before they achieve their target of **£1 million**. Although it is a personal campaign started by two friends, not only would Bob and Ian like *everyone else* to become involved on their own *personal* level, they would also like **HEARTCLIC** to have *united every angler* of whatever cast, in a decent and common cause.

Please help them achieve their aim. Thank you!

For information about the badges, fund-raising ideas and the two charities please write to: Miss Janie Orr, **HEARTCLIC**, Freepost 27 (WD4872), 4 Tenterden Street, London W1E 2AF. Telephone 071 355 4848, or call Bob Booth on 07541 474200 or Ian Peters on 0453 832540.

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