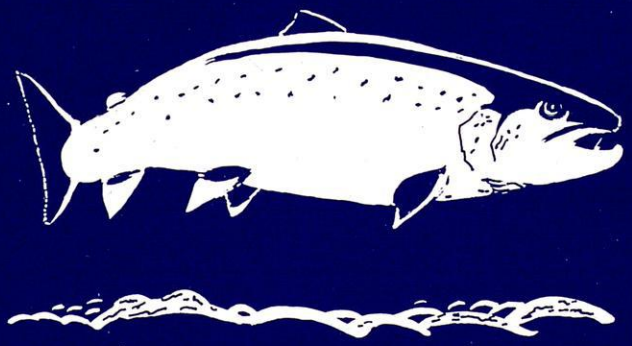
ATLANTIC SALMON TRUST

PROGRESS REPORT

June 1993



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A representative from the Scottish Office Agriculture and Fisheries Department
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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

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CHAIRMAN'S FOREWORD

Never before, I feel sure, has more talk, more time or more paper been expended by more people on the Atlantic salmon than in the last year or so. This is born out of extreme anxiety and increasing frustration that despite the efforts of many organisations and interest groups with a broadly common purpose, we seem collectively so ineffectual in reversing the decline in salmon and sea trout stocks.

Most of the main issues are covered in two important papers printed in full in this Progress Report, so I will be very brief.

I suggest that you should turn at once to the Director's Report and that you will then wish to study carefully papers given to the Dialogue Meeting which took place this month before the 10th Annual Meeting of NASCO in Edinburgh.

The opening address by Magnus Magnusson, the Chairman of Scottish Natural Heritage, demonstrates that he is clearly as much in command of issues affecting the salmon as he is of the contestants in the famous Black Chair on Mastermind.

Robert Clerk, Chairman of the Association of Scottish District Salmon Fishery Boards was speaking for all non-Government organisations in his excellent paper - "The Fisherman: The Salmon's Best Friend".

The NASCO meeting was more positive than of late. Up to now non-Government organisations have only been allowed to attend the NASCO Council meetings. For a trial period observers are to be allowed to attend Commission meetings and this will give then an insight as to how the Commissions come to agreement on quotas etc.

Speaker after Speaker at the Dialogue Meeting implored scientists to be more positive in their guidance, and for administrators, managers and politicians to take action on the "precautionary principle" without waiting for positive proof which may never be available - at least until long after it is too late.

I had the privilege of Chairing the "Salmon in Crisis?" Conference in Fishmongers' Hall just before the NASCO meetings. The Salmon and Trout Association who organised the conference, with the support of the Trust, will be producing a detailed account of its proceedings, which covers most of the same key issues and where more of the views expressed were similar.

We shall keep trying. Please keep on supporting us as you do so generously.

Sir David Nickson

DIRECTOR'S REPORT

In the last Progress Report I included news from the NRA Regions showing what they were doing to protect and improve the salmon stocks. This time I include Reports from some of the major Scottish rivers. There has recently been some criticism in the angling press and elsewhere about the perceived idea that nothing is being done to try and improve the numbers of fish in Scottish rivers. This is, I suggest, an outdated view as the last 8 years have seen a vast change in the attitude of many owners to "their rivers". Several things have contributed to this change. Probably the most significant being the lack of salmon! Up to the early 80's there was a relative abundance of fish and as a result, frankly, many owners were pretty apathetic about their rivers. Then came the 1986 Salmon Act which, although some people did not realise it at the time, has led to a revolution in the management of salmon rivers in Scotland. The Act changed the way District Fishery Boards were elected, the way the Chairman was appointed, and co-opted to the Boards representatives of anglers and tenant netsmen. Before 1986 there was a feeling, rightly or wrongly, that District Fishery Boards and their Association were under the control of netsmen and that angling interests were not well represented. Since 1986 there has been a considerable shift of emphasis and this has been accompanied by a realisation of the importance of angling to the community and its value to the economy of Scotland.

All this has been accompanied by the amazing growth in salmon farming. 12 years ago 1,000 tonnes of farmed fish were produced in Scotland, in 1991 it was in excess of 41,000 tonnes. In a Dundee supermarket in May this year I saw salmon for sale at £2.17 per lb. This dramatic increase in production, and the even more dramatic decline in price has made the commercial netting for salmon, in most cases, uneconomic. As a result it has been possible to buy out some of the netting stations on our rivers and on the coast. Unfortunately, the salmon stocks of the North Atlantic have declined and certainly the catches in 1992 are at an all time low.

What is anyone doing about it? The sceptics say little but I am glad to say they are wrong. More and more owners, through their District Fishery Boards, are taking the initiative. Anyone who attended the opening of the Tweed Foundations facility at Drygrange, in May, cannot fail to have been impressed at the facilities provided. It is an example that other rivers may like to follow. On the Tay, the Tay Foundation has been active in buying out about 50% of the netting stations and supporting the work of the Tay Advisory Committee. Reports of the work on the Tay, Spey and Tweed are included in this Report. The West Galloway Fishery Trust has also continued its good work by combining the efforts of several Fishery Boards. The Carron (Kyle of Sutherland) has formed an Owners Association to try and work together to improve their river and the Hope and Polla are doing all they can to investigate ways of increasing the sea trout population. This is to mention just a few rivers where major initiatives are being made but there are many others. To my mind this represents a much healthier situation than existed a few years ago. The AST is helping wherever it can, and the Freshwater Fisheries Laboratory at Pitlochry and the Marine Laboratory in Aberdeen are always ready to give advice and assurances when they can.

There is a much greater awareness of the problems facing the salmon. But if the level and

quality of management have improved I am afraid that we are far from being able to say that the effects have yet brought more salmon back to our rivers.

There is to be a centre piece display on salmon, on Fishermans' Row at the Game Fair at Gosford Park, east of Edinburgh on Thursday, Friday and Saturday, July 22/23/24th. The Trust caravan will be there and I hope to be able to refresh our subscribers with a dram of J&B. See you there.

D. J. Mackenzie

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HIGHLAND FIELD SPORTS FAIR

6th and 7th AUGUST, 1993 at MOY, near INVERNESS

THE 1993

SCOTTISH LANDOWNERS FEDERATION / COUNTRY LANDOWNERS ASSOCIATION

GAME FAIR

THURSDAY 22ND JULY TO SATURDAY 24TH JULY inclusive

at GOSFORD, LONGNIDDRY, EAST LOTHIAN.

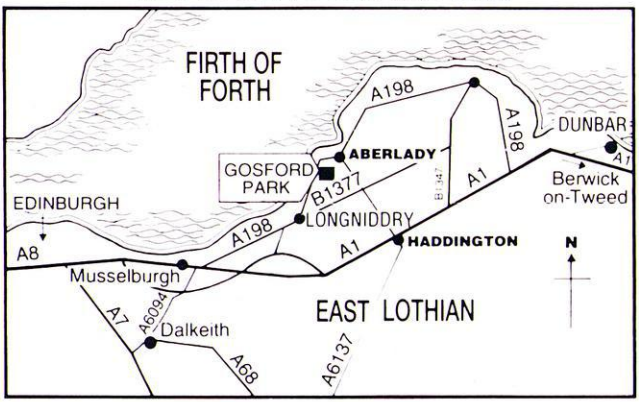
TEL: 0743 - 242127

Location : On A198 between Aberlady and Longniddry.
16 miles from Edinburgh. 5 miles from Haddington.
Close to A1 and Edinburgh by-pass.

Game Fair open daily 9.30am - 6.00pm (Gates open 6.30am).

Admission prices: At Gate £9.00. In advance £8.00.
(Last date for advance booking July 10th).
Children under 14 free. Car parking free.

HOW TO GET TO GOSFORD PARK



The following are just a few of England's Heritage of Country Sports and Pastimes which will be on show at the Country Fair

Punt Guns	Sailing
Rare Breeds	Fencing
Stick Making	Taxidermy
Horse Shoeing	Target Archery
Helicopter Rides	Dummy Throwing
Vintage Machinery	Competition
Olde Tyme Fairground	Ferret Show & Racing
Fish Smoking & Brining	Fly Casting Competitions
Armed Services Displays	Spinning, Weaving & Dyeing
Working Heavy Horses	Gundog Obstacle Course
Fly Casting Tuition	Lurcher Show & Racing
Children's Corner &	Terrier Show & Racing
Inflatable Castle	Gundog Competitions
Catapult Range	Shooting Bygones
Gundog Scurry	Muzzle Loaders
Home Loading	Rifle Range
Gundog Test	Crossbows
Wild Fowl	Pick &
Fly Tying	Mix

Creche

British Field Sports Society

British Association for Shooting & Conservation

Game Conservancy Trust

Hawk & Owl Trust

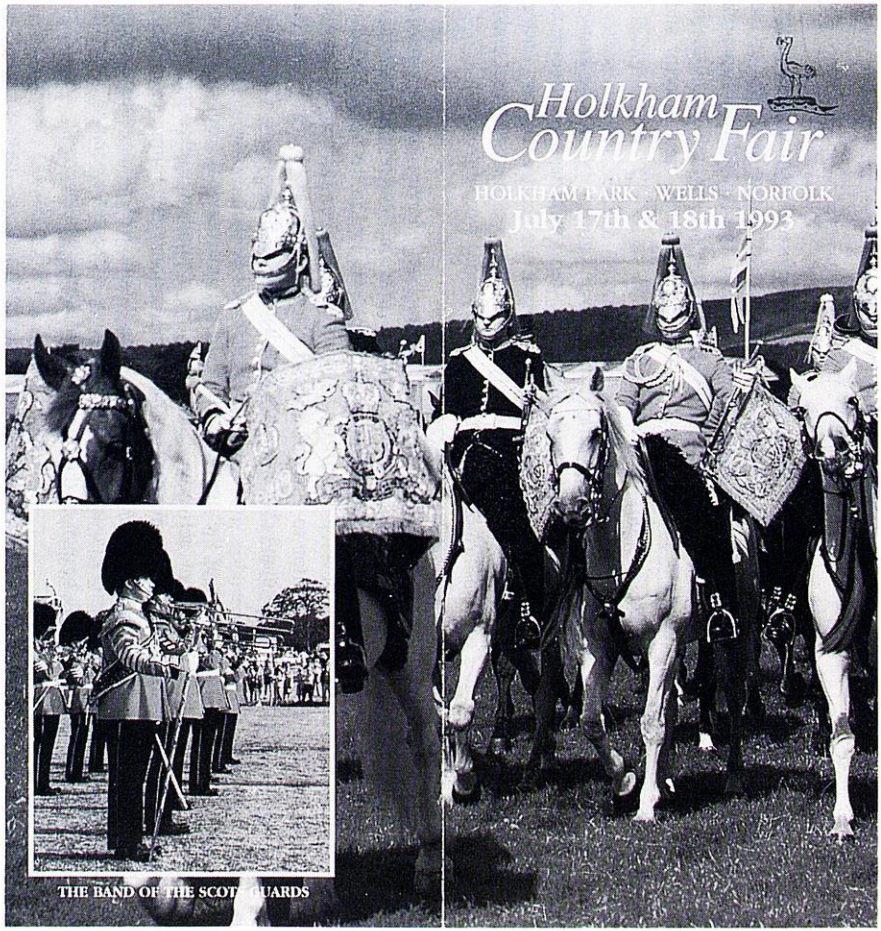
40 BIRD OPEN SPORTING CLAY PIGEON SHOOT
(Felt Wads only)

B.F.S.S. Sportsmans Challenge

OVER 200 TRADE STANDS & RURAL STALLS

It is hoped to make contributions to the following organisations from the proceeds:

Army Benevolent Fund
Atlantic Salmon Trust
British Association for Shooting & Conservation
British Field Sports Society
Burnham Market Day Care Centre
Game Conservancy Trust
Heritage House Day Care Centre – Wells
King's Lynn Hospital League of Friends
Norfolk Boat (Sail Training)
Norfolk Churches Trust
Police Dependents Fund
Red Socks Charitable Trust
Salmon & Trout Association
St. Withburga Church



THE BAND OF THE SCOTS GUARDS

DR. DAVID PIGGINS

(an appreciation by Derek Mills)

With the death of Dr. David Piggins in a Dublin hospital shortly before Christmas, Ireland lost its foremost salmon expert. In 1957 Dr. Piggins was appointed resident biologist at the laboratory of the Salmon Research Trust of Ireland Incorporated (now the Salmon Research Agency) in Newport, Co. Mayo after it was set up by Arthur Guinness, Son and Co., Ltd., in 1955. As the trust grew in strength and more staff were recruited, he became director and held this position until his retirement in 1989.

Under his direction the trust and its scientific work at the Farran Laboratory became known and respected internationally, particularly as a result of the long-term data on fish movements through the traps he installed at Burrischoole. His investigations at the nearby hatchery on the selective breeding of spring salmon are referred to widely in the scientific literature, and under his guidance the first strains of Irish farmed grilse (the Curraun strain) were developed.

He pioneered a number of specialist salmon-ranching techniques whereby hatchery-reared salmon are released into the lower reaches of rivers and harvested on their return, after their free existence feeding in the ocean. His knowledge in this field resulted in his being called in as a consultant to many countries developing salmon-hatchery and ranching techniques, and in this context he was a frequent visitor to France, Iceland, North America, Norway and the United Kingdom, where his warmth and charm led to immediate friendships.

He represented the trust each year at the annual meeting of the International Council for the Exploration of the Sea and was an active member, and, for a time, the chairman of its Anadromous and Catadromous Fish Committee. Other international commitments included membership of the Honorary Scientific Advisory Panel and Council of Management of the Atlantic Salmon Trust, and fisheries consultant to the Salmon and Trout Association. He was also an active member of the Irish branch of the Institute of Fisheries Management.

On retirement he continued his involvement in fisheries matters and was joint secretary of STAG (the Sea Trout Action Group) and only last year represented the Atlantic Salmon Trust at the September meeting of the International Council for the Exploration of the Sea in Germany. Colleagues and fisheries scientists world-wide will miss his friendly advice and wise counselling.

"ATLANTIC SALMON: A DIALOGUE"

7-8 June 1993

Prior to the Tenth Annual Meeting of NASCO, a Dialogue Meeting was co-sponsored by NASCO, ICES and the International Baltic Salmon Fisheries Commission. The dialogue was opened by Magnus Magnusson, Chairman of Scottish Natural Heritage. I reprint Magnus Magnusson's address in full, as it points the way forward in safeguarding the salmon.

Robert Clerk, Chairman of the Dee District Salmon Fishery Board and Chairman of the Association of Scottish District Salmon Fishery Boards and a member of our Council, spoke on behalf of the NGO's from this side of the Atlantic. His talk "The Fisherman - The Salmon's Best Friend" is also reprinted here.

KEYNOTE ADDRESS

(by Magnus Magnusson KBE, Chairman, Scottish Natural Heritage.)

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It must be a truly majestic creature which can command the attention and presence of so many eminent people from so many different nations. The Atlantic salmon - Salmo salar - is such a creature: the king of fish, no less. You are here to cerebrate - I am here to celebrate the salmon at the start of your International Dialogue.

Salmo salar: it was Pliny the Elder, the first-century Roman natural historian, who gave it the name salmo in his "Historia Naturalis". To the Romans it wasn't an obscure scientific name; it meant, simply, 'the leaper'. Few names have been more evocative or accurate.

The Atlantic salmon combines grace and beauty with power and an impression of wildness and purity, tantalisingly enveloped in an enduring mystique. The Atlantic salmon and its life-long struggle against both natural and ánthropogénic forces is positively awesome. It has attracted the attention of scientists for many, many years now, but it has never given up its secrets lightly. The basic outline of the salmon life-cycle was first described in the early 16th century, but it was not until the second half of the 19th century that final agreement on it was reached. For a very long time, many eminent scientists believed that what we now know to be the salmon parr was actually a separate species! Similarly, kelts were thought to be a different species and given the specific name, Salmo argentatus.

What we do know for certain is that we still have a great deal to learn about its behaviour, and that this quest for knowledge and understanding is becoming all the more urgent if we are to arrest and reverse the perceived decline in the stocks of this magnificent fish. It's not the first time this has been said. As long ago as 1852, Dugald Williamson bemoaned in an article 'the present scarcity of salmon'. That's hardly surprising: the natural world is full of well-documented cyclical phenomena, with populations of individual species rising and falling over

periods of years. All things are relative: what was a 'present scarcity' to Dugald Williamson may well be considered a glut today. The one thing we can be sure of is that the range and scale of pressures on the salmon in 1852 cannot compare with those of today. Mother Nature may have a way of managing her stocks; it is when the greed and shortsightedness of Man comes into the frame that the problems really start.

Even after the enigma of the salmon's life-cycle was resolved, the question of where they went at sea and perhaps the even more teasing question of how they navigated and returned to their natal rivers, remained unanswered. Their international journeyings are now becoming better understood, and perhaps it's not all that surprising that such an enigmatic individual is found to be extremely cosmopolitan in its distribution.

It is an anadromous life-cycle, with fish spawning in the rivers of many nations but spending much of their life at sea in international waters mixing with fish from the rivers of many other countries - and therein lies a part of the problem. Assuming that Man has any right to claim 'ownership' of any wild animal, who owns the salmon?

Until about 30 years ago, allocating the salmon resource was a fairly straightforward operation and for each salmon-producing country it was purely a domestic issue. The salmon was harvested commercially only in coastal waters and river estuaries, and rod anglers (and saw-bill ducks!) took their share farther up the rivers. It was possible, to a certain extent at least, to manage the stocks: it wasn't perfect, but it could have been a great deal worse. In the last 30 years, however, things have grown a great deal worse, with the advent and escalation of the west Greenland salmon drift-net fishery which, in its early years, was to all intents and purposes unregulated. Combine this with the increasing numbers of predators, the growth of the industrial fisheries for sandeel and sprat which constitute an important element of the salmon's diet, and the general deterioration of water quality, and it is blindingly obvious that the pressures have mercifully declined and are, in part, much better regulated now; but with salmon still being caught at sea far from their natal rivers it is very difficult to collect meaningful fishery statistics to enable proper cooperative management of the stocks.

A striking example of the international dimension can be seen in the Faroese fishery, which is now closed with the exception of one research vessel. It is worth taking a moment to consider the history of this fishery in a little more detail, because there is a number of lessons to be learned from it.

The Faroese, clinging to survival on their rocky islands (and as a native Icelander I have to declare a certain ethnic bias here!), have always been highly dependent on a good harvest of the traditional commercial stocks. As these stocks declined alarmingly in the late 1970's they turned their attention to the salmon as an alternative resource. As is too often the case, alas, the failed management of one stock affects more than just that particular species: a replacement quarry has to be found.

Salmon captured by this new fishery had origins as wide-ranging as Norway, Sweden, France, Ireland, Iceland, the UK and even Canada and the former Soviet Union. With fish from so many different countries of origin being taken in varying, unknown quantities, it was essential

not only to act locally but to think globally, as the modern adage has it. But where the social and economic well-being, and the cultural life-style, of small island communities almost wholly dependent on fish are concerned, it isn't always easy to apply such lofty philosophical principles.

The solution to the problem of accommodating this new additional fishery, when it came, was positively inspired, to my mind, at least. The fishery was closed after private negotiation, when the salmon quota of the Faroe Islands was purchased through the agency of the North Atlantic Salmon Fund (which, I am proud to say, is the brainchild of one of my own countrymen from Iceland); it may not be ideal, but it may well be that the same sort of approach should be considered for other situations in the future.

But back to my theme of celebration of these magnificent creatures. When I look at a map of the journeys they undertake I can only marvel at the scale of their endeavours. They travel the great tracts of the northern oceans with Greenland at the hub, the Piccadilly Circus of the salmon world, if you like. How these wonderful fish navigate, and where they go on these epic and infinitely complex migrations, still remain, in part at least, unresolved. One theory is that out at sea they can sense the earth's magnetic field. As they near home they use the scent of the smolts in their natal river to guide them for their last leaping swim for 100km or more to the small burns and headwaters where they will spawn and die.

It is beyond dispute that Atlantic salmon stocks are in decline throughout the range; and while there are many factors affecting the freshwaters vital to its breeding, the major problems may be found in the oceans. Much can still be learned by using ever more sophisticated tracking equipment. With increasing sophistication, however, come increased costs and growing need for international cooperation - a need which, I submit, should now be seen as an opportunity, not a chore.

I am sure you do not need me to tell you that there are many complications to consider and conflicts to overcome with regard to the Atlantic salmon. The salmon represents so many different things to so many different people. It has inspired a rich folklore in countless countries. It is a natural resource capable of enduring exploitation and enjoyment, for commercial purposes, for recreation, for aquaculture. It also represents a profound intellectual challenge to all of us in this three-cornered dialogue between the user groups, the scientists and the managers: especially, if I may say so, to us in Scottish Natural Heritage, established barely fifteen months ago to help to ensure the preservation, enhancement and enjoyment of Scotland's natural heritage. The salmon is a tremendously important part of the natural resource of Scotland - and also of the people whose livelihoods depend on healthy stocks and an unpolluted environment. I am sure the same can be said of many people in many nations where native salmon still run. Here in Scotland, the value of salmon has been appreciated since time immemorial. Laws to conserve salmon stocks go back a very long way. As early as 1030, Malcolm II of Scotland introduced a close-season on fishing from Assumption Day to Martinmas (the end of August to November 11), and there have been laws governing the taking of salmon ever since. At the beginning of the 19th century the stocks in our Scottish rivers were still very large: more than 100,000 salmon and grilse were being caught on the River Tweed each year, and the River Tay was not far behind. By the end of that century,

however, the output from Scottish rivers was a mere fraction of what it had been, and salmon had disappeared entirely from many rivers. In England the situation was even worse - a far cry from the 14th century when Ranulf Higden, a monk of St. Wesburg's monastery in Chester, noted in his Polychronicon that salmon were so cheap that they were fed to pigs.

With so many modern-day claims upon it, it is inevitable that there should be conflicts over it; but it is vital that all the users of the salmon are accommodated as far as is reasonably possible, and that agreement be reached. Where necessary, compromises will need to be made in the quest for a reconciliation of conflicting demands. We must seek sharing. But at the end of the day we must not lose sight of the needs of the salmon itself.

And this is the intellectual challenge. Surely our search for a solution in the face of adversity should be inspired by the example of the salmon itself. What a wonderfully courageous creature it is as, clad in its various livery, it encounters and overcomes so many obstacles, both natural and anthropogenic. In the open sea it is ambushed by men in trawlers as well as by seals and dolphins. Offshore it runs the gauntlet of invisible nylon driftnets; off rocky headlands, along loch shores and in river estuaries it must thread its way through a maze of stake nets and traps. As it struggles upstream it must ignore the tempting lure of tne angler by day and evade the blazing lights, gaffs and spears of the poacher at night. We must thank providence for giving the salmon the enormous reproductive power which means that only a few adults need to survive all these vicissitudes and spawn in order to maintain the survival of the species.

Yes, a marvelously complex, courageous creature. But in any situation which is dominated by a single species it is all too easy to lose sight of the wider issues and considerations involved. We sustain our own survival by striving to find answers which will explain things which are often beyond our comprehension. But all too often we expect too much. We demand that our scientists 'prove' what we want to see proved. We look for instant definitive predictions and instant black-and-white solutions. We seek scapegoats to blame. We must all resist the temptation of expecting scientists to provide simple, even simplistic, solutions to complex problems for which we often do not even recognise all the variables.

In Scottish Natural Heritage we have to address many such problems, and to assist in our deliberations we draw upon the three principles which guide our policy thinking: environmental sustainability; integrated resource management; and partnership. All three enjoin us not to use up the natural capital of the world's resources at the expense of the future. All three require a self-denying ordinance against excessive expectations. All three promote the principle of sharing. All three embody the precautionary principle. I would commend to you these principles in the debate which will follow as you explore the means of achieving sensible conservation and thus the perpetuation of healthy stocks of Atlantic salmon.

Inevitably, difficult decisions have to be taken, and dilemmas confronted. We have them in Scotland, too. The salmon and all that it represents in Scotland rightly deserves our attention and concern. As a wild animal it is both predator and prey, and therein lies the rub. Apart from man, the main predators of salmon are birds such as sawbills which take the young parr, and seals which some interested parties see as growing over-fat on ever-dwindling salmon

stocks. Depending on your standpoint you can argue the case for the salmon or the seals or the sawbills - but maybe we should take the side of the sandeel or the capelin on which the salmon itself feeds? I do not raise this issue in order to get involved in a scientific or philosophical or even moral debate, but merely to highlight the complexity of the situation. It is vitally important that we take as broad a view as possible of all the issues involved. To us, the essence of sustainability is that not just one user should use it sustainably, but that every aspect of our proper utilisation of a natural resource (extraction, or harvesting, or marketing, or recreational enjoyment) should be part of an integrated sustainability package.

Safeguarding the salmon depends on taking account of everyone's interests. The great value of a conference such as this is that it allows people to hear others' points of view, however unpalatable. It allows us to be provocative without being combative, and it offers an opportunity to seek reconciliation of conflicting interests, and to explore the systems which will put into effect an acceptable equation which does not jeopardise the salmon or its environment. And that can only be done through adhering to the principles of environmental sustainability, integrated resource management, and partnership.

If our objective is the sustainable integrated management of the salmon stocks through a range of partnerships and cooperation, then it is important to recognise that the salmon is a complex animal living in a complex environment within a complex ecosystem. Here in Scotland we have been blessed with a plentiful supply of rivers, large and small, which for the most part still run with the clear, unpolluted waters so vital for the early and final stages of the life-cycle of the salmon. Many other countries were once so blessed - Germany, Belgium, the Netherlands, Switzerland and Czechoslovakia, to name but a few - but no more so, with many rivers so badly polluted or blocked that the salmon can no longer run the gauntlet.

Freshwater is only one link in the life-cycle chain, however; pollution is much more widespread and, as with the salmon, it recognises no international boundaries. To save the salmon requires an international resolve to clean up our waters, both fresh and marine - to clean up our act, indeed. This will in the long term be to the benefit of all life. It is a massive task, but the benefits on both a global scale as well as more locally are well worth the effort. The recent return of wild salmon to the River Thames, for instance, had a remarkable effect on Londoners who have no intention or opportunity of ever trying to catch one. It was as if they felt they could sleep better o'nights knowing that salmon were back in the river, as a potent symbol of all being right with the world. This psychological exhilaration but inspires them to strive for an even better environment all round. It becomes a crusade. It becomes a totem of achievement, of the possibility that it is not too late to undo the damage of the past. With such people-power to harness, anything can be achieved.

In all international dialogues of this sort it is all too easy to dwell upon the negative points, and to accuse other parties in the argument of not pulling their weight or taking more than their fair share of the cake. That's life - but mutual recriminations aren't going to get us anywhere. There is always another side to every coin. Successes and opportunities do exist. And it is on those more positive issues that I wish to dwell for the remainder of my time.

I believe we are meeting the intellectual challenge. If the number of scientific papers written

on a subject, and the number of meeting of this sort, can be taken as a measure of concern and progress, we seem to be meeting the challenge head-on. It is the application of all this information which is going to be important. Scientific research is not the panacea which will provide all the answers; but it does make it possible to make informed comment, and we should not shrink from this, even if it leads to the implementation of the precautionary principle. The example set by Canada, with $24 million of federal funds being provided to restore the salmon rivers of Quebec, for instance, is something to be applauded and wherever possible emulated.

Recreation, commercial fishing and aquaculture are not, it would seem, natural bedfellows. At the end of the day, however, it is important that they all cooperate to achieve sustainable use of their common resource through integrated management based on a wider examination of the issues.

Peoples in the past, like the Inuit Indians of North America, have shown they were quite capable of exploiting the salmon in a way which accommodated the natural variations in the stock. It was necessity, not ambition or greed, which was the controlling factor. Those were simpler days, perhaps, and we must not be blinded by the sheer brilliance of the salmon or tempted by sentimentality into trying to preserve everything as it was before, in the good old days. We live in an ever-changing world, with ever greater pressures on our natural resources. With these greater pressures come even greater responsibilities to ensure the conservation of the biodiversity of all our wildlife - including, of course, the salmon - and the improvement of our deteriorating environment.

This cannot be accomplished overnight. But, if I may adapt the old platitude, 'from tiny alevins mighty salmon grow'. The scale of the challenges you are addressing here today is enormous. There have been notable successes. Now we need to do even more.

Salmo salar, the great leaper; the sovereign fish, is worthy of every effort. We would be committing a crime of global proportions if we did not accept our responsibilities and arrive at an answer which, while permitting the legitimate continuation of our 'enjoyment' of the salmon in our many different ways, ensures that the species survives and flourishes. There are not many fish which have inspired poetry, much less from a poet as eminent as the Poet Laureate, Ted Hughes. In just a few brusque lines he encapsulates everything I have been trying to say; I leave them with you to mull over during your deliberations:

The salmon is a miracle.....
But all that's been agreed
We know he is a miracle -
But not the one we need
To organise the baboon brains
That govern human greed.

Thank you for listening to me. I now look forward to listening to you - and may success attend your endeavours here in Edinburgh, and for the years to come.

THE FISHERMAN - THE SALMON'S BEST FRIEND

(by R. M. Clerk)

This paper was given by Robert Clerk at the NASCO/ICES Dialogue Meeting in Edinburgh, 7-8 June, 1993.

The declining number of salmon returning to home waters, evidenced by falling catch statistics, is a matter of grave concern for all who share an interest in the welfare of the Atlantic salmon. Historically salmon stocks when measured by catches taken by anglers or netsmen have fluctuated both in abundance and run-timing but there is nothing to suggest from past records that stocks have been depleted to the extent that appears to have occurred over the last 20 years.

Celebrated for its determination to succeed in the face of adversity, the salmon is held in special affection not only by fishermen but by all who enjoy and appreciate nature. Adapted through evolution to have the best possible chance of sustaining its species the salmon has survived and still returns to rivers where environmental conditions may be far from ideal.

Throughout much of Europe the prodigious runs of salmon of the past have been lost, perhaps not for ever, by the actions of man. Only where the quality of the natural environment has been preserved, and fishing effort has been regulated, have salmon survived and their ultimate survival will be assured only if their freshwater environment is safeguarded in future.

Maintenance of a stock of salmon, or more particularly, the return of salmon to rivers where they were once abundant is taken by many as being indicative of a healthy or improved natural environment.

The true wilderness of the Atlantic salmon is perhaps the reason for it being such a prized quarry but the fact that it forms part of a stock shared between many "users" explains why argument, jealousy and bitterness may so often surround the exploitation of this valuable resource.

Despite the fact that we live in a time of increasing interest in the natural environment the salmon still faces many threats that result from the degradation of its freshwater habitat. Radical changes in land use, particularly afforestation have led to greatly increased siltation of spawning tributaries. Pollution and water abstraction for agricultural irrigation and for both domestic and industrial consumption have catastrophically damaged many salmon rivers. Now generation of power from renewable energy resources may also pose a threat to salmon stocks. In particular run of river hydro-electric schemes and tidal barrages whilst admirable in concept, may seriously impede the migration of adult salmon or cause substantial losses of juveniles.

In the protection of the salmon's freshwater environment the fisherman or "user" takes a leading role. Acting as watchdog and lobbyist he may often be the first to identify the need to take action to preserve salmon stocks. Furthermore it is often the expenditure of the fishermen

that provides funds for protection and enhancement of stocks.

In many countries, and certainly in Scotland, insufficient financial resources are available to adequately support the management of salmon fisheries. Substantial expenditure of public funds is directed towards scientific research and law enforcement both of which are essential if salmon stocks are to be maintained. It is highly unlikely that this expenditure would be made available if it were not for the very considerable contribution that salmon fisheries make to national tourist industries and to the generation of economic activity and of employment often in remote rural areas.

Accordingly the maintenance of economically viable salmon fisheries is fundamental to the future survival of the wild Atlantic salmon. No matter how responsibly others may harvest wild salmon or the lesser species upon which they prey, unless the freshwater habitat and the salmon themselves are protected in this phase of their life cycle their ultimate survival cannot be assured.

Recently in Scotland following the very disappointing returns of fish derived from the smolt year classes of 1989 and 1990 valuable fishings have been unlet on some major rivers denying rental income to the proprietors. Whilst the exceptionally high levels of marine mortality that appear to have afflicted these year classes may not of themselves pose any threat to the survival of salmon stocks the loss of income to proprietors may restrict their ability to finance protection and enhancement of the stocks at the very time when this funding is most urgently required.

To support economically viable fisheries requires returning runs of salmon to be far more abundant than are simply necessary to ensure the survival of the species or even that spawning stocks are sufficient for the river's natural juvenile carrying capacity to be achieved.

Currently in most rivers the number of early running salmon has declined with a large component of the stocks returning to their rivers of origin as grilse or summer salmon. Evidence suggests that this may be the result of a cycle driven by natural phenomena but this pattern of return migration reduces the value of fisheries.

Much excellent scientific research is directed towards increasing our knowledge and understanding of the salmon and its environmental requirements. From the users point of view it is important that this research is targeted in a direction where there is ultimately a prospect of tangible benefit being derived from this investment. Put simply the user aspires only to having more fish available to catch preferably distributed more evenly throughout the permitted fishing season.

Management, or more often administration, of salmon fisheries is not commonly the responsibility of scientists. However, the advice of experienced scientists is essential if correct management decisions are to be taken. Effective management implies a capacity to react swiftly to situations that prevail or are predicted to occur but often this is not possible in relation to the management of salmon fisheries. In Scotland for example District Salmon Fishery Boards do not have the legal powers necessary to actively manage salmon stocks.

Whilst mechanisms exist to introduce new bye-laws and regulations the procedure for implementing these is often too slow to enable effective management action to be taken.

Just as legislative constraints may inhibit effective management so an understandable reluctance on the part of the scientist to offer an opinion until he is entirely satisfied that his case is proven beyond doubt frustrates attempts to manage fisheries. It would be very helpful to fisheries managers if there were to be a greater willingness on the part of experienced scientists to look forward and to predict the likely outcome of current events in such a way that management action can, where necessary, be taken early enough in time to be effective.

In practice it is often the "user" in the form of fishery proprietor or fisherman who has the greatest opportunity to exert direct management influence upon salmon stocks by means of limiting netting or angling pressure. Delayed opening of the netting season, adoption of a policy of fly fishing only or early closure of fisheries in the autumn can all, where appropriate, make a significant contribution towards improved management of salmon stocks. The practices of catch and release and limitation of catches are not commonly adopted in EC Salmon Fisheries but are policies followed by some proprietors.

The majority of EC Salmon Fisheries are privately owned. Recognising that management action may impinge upon an individual's property fishery managers require far more factual information about the status of salmon stocks than is generally available to them at present. If managers are to successfully impose restrictions upon exploitation which may adversely affect the interests of fishery proprietors, at least in the short term, they must be able to convincingly justify the measures they wish to introduce. To this end development of fish counters, preferably of a design that does not require expensive civil engineering work to be carried out within rivers, must be given higher priority.

Fishery proprietors often have an interest in land within their river's catchment. They appreciate the extent to which changes in land use may affect salmon fisheries. Much of the land however in river catchments may be owned and managed by parties having no interest in salmon fisheries. The move towards the concept of integrated catchment management is most welcome and should be encouraged. At a time of agricultural over-production a valuable opportunity is now given to encourage permanent set-aside of river banks and exclosure of grazing livestock. Massive expenditure is incurred each year under the EC Common Agricultural Policy to restrict agricultural production. If a small proportion of this expenditure were directed towards the establishment of well managed riparian "buffer zones" this could make a very valuable contribution towards the improvement of fisheries management.

To compliment integrated catchment management, recognising that each river contains its own discrete stock or series of sub-stocks of salmon there is a very strong argument to support management of salmon on a catchment by catchment basis also. Where possible exploitation of wild salmon stocks should be on an in-river or catchment basis and the current trend to curtail and buy-off commercial netting in the sea should be encouraged, not least because the food requirement for salmon can be met from farmed sources. It must be recognised however that where coastal net fisheries are subject to proprietorial rights, as in Scotland, the interests of those proprietors must be respected.

Indiscriminate interceptory salmon fisheries entirely contradict all currently held views upon sound fisheries management. Consequently the present attempt to close the Faroes and West Greenland Fisheries are welcomed. Continuation of the English and Irish Drift Net Fisheries, despite all the efforts that have been made to achieve closure is highly unsatisfactory. It is disappointing that whereas the Governments of USA, Canada and Norway have contributed substantial funds to achieve the closure of interceptory fisheries no such assistance has been forthcoming from UK public funds. NASCO is urged to take all possible steps to achieve the cessation of interceptory drift netting.

At a time when substantial sums of money are being directed towards the closure of the Faroes and West Greenland Fisheries it is most unsatisfactory that some unregulated salmon fishing continues on the High Seas. Steps must be taken to reach international agreement that there shall be no fishing for salmon on the High Seas. Rigorous surveillance, undoubtedly available through new military intelligence technology, should be used to ensure that these Agreements are observed.

Much scientific research has been directed towards the freshwater phase of the salmon's life cycle and benefiting from this there is now a greater understanding of how managers might best concentrate their limited resources with a view to maximising juvenile recruitment which should be their primary objective.

Once smolts have emigrated to sea comparatively little is known about them but it is evident that salmon are subject to wide variations in the incidence of marine mortality over a period of years. High marine mortality and consequent poor runs of returning adults can have severe implications for the viability of fisheries, as referred to previously.

Despite the inevitable costs involved there is a pressing need for greater knowledge about the marine phase of the salmon's life cycle and in particular a clear understanding of the mechanisms that were responsible for the exceptionally poor survival of the 1989 and 1990 smolt year classes apparently widespread throughout the range of Atlantic salmon. There is scope perhaps for greater attention being given to the interaction of marine species upon each other and of the indirect effect upon salmon or other fish species of large scale industrial fisheries. There would be merit in encouraging dialogue between representatives of all scientific groups engaged in marine biological research and in a greater exchange of information between nations about the commercial catches of all marine species.

Just as salmon fishing makes a significant contribution to the welfare of remote rural communities so also does the salmon farming industry. Salmon aquacultural has expanded dramatically during the last 10 years but with this expansion has come the risk of great damage to wild salmon stocks. Experience in Norway and in the Baltic serves as a constant reminder that all possible steps must be taken to minimise the potential impact of salmon aquacultural upon wild fish stocks, commensurate with maintenance of an economically viable salmon farming industry. These measures should include the establishment of mandatory rules to ensure that no salmon are reared in sea cages within designated exclusion zones around river mouths.

The risks of transmission of disease or parasitic infestation from farmed to wild salmon stocks, or the prospect of loss of genetic integrity following cross-breeding of wild salmon with fish farm escapees are well known. From the point of view of the fisherman however, there is the prospect of dilution of the real wildness of the Atlantic salmon. Few sportsmen relish the thought of catching poor conditioned fish recently escaped from sea farm cages but this has already occurred on a significant scale in some Scottish rivers. Equally the salmon netsman has no wish to have fish of farmed origin forming a component of his catch. Of course the salmon farmer would prefer that his stock should not escape from sea cages but inevitably this occurs and more effective measures than presently exist should be made available to salmon farmers or to fishery managers to enable them to recapture salmon following large scale escapes.

User groups have much to contribute in relation to the management of salmon stocks it is therefore regrettable that they should not form part of some of the Delegations to NASCO including that of the EC. There is also the difficulty that within the EC Delegation representing several separate salmon producing nations there cannot be debate in NASCO on any conflict of interest that may be between them.

In conclusion the perspective of the fisherman as user of the salmon resource cannot be separated from that of the manager as suggested in the framework for this Dialogue Meeting. In some EC countries, and in Scotland in particular, users and managers are one and the same. The advice given by the scientist is essential in making management decisions but above all it is the fisherman and the maintenance of economically viable salmon fisheries upon which the future of the salmon depends.

NASCO PRESS RELEASE

During the inter-governmental meetings of the Council and regional Commission of the North Atlantic Salmon Conservation Organization (NASCO), which were held in Edinburgh during 7-11 June, agreement was reached for a regulatory measure for the Faroe Islands fishery for 1994. The agreement establishes a quota of 550 tonnes with reductions in the number of licences issued and in the fishing season.

NASCO also agreed on the need for further diplomatic efforts in order to eliminate fishing for salmon in international waters by vessels which have been reflagged in countries which are not party to the NASCO Convention. Methods of improving cooperation on the surveillance of the area of international waters were also agreed.

Serious concerns were raised about the possible impacts of salmon aquaculture on the wild stocks. In some North Atlantic rivers salmon which have escaped from fish farms comprise up to 90% of spawning populations and there is real concern about the genetic threats to the wild fish together with disease, parasite and other ecological impacts. The Council decided to establish a Working Group to review the options for avoiding adverse impacts on the wild stocks while maintaining a viable aquaculture industry. The North-East Atlantic Commission also agreed to establish a Working Group to examine the question of introductions and transfers. This issue had previously been addressed by the North American Commission and Protocols designed to safeguard the wild stocks had been published.

The Organization held a Special Session, co-sponsored by the International Council for the Exploration of the Sea (ICES) and the International Baltic Sea Fishery Commission (IBSFC), entitled "Atlantic Salmon - A Dialogue". This meeting allowed a frank exchange of views between the scientists, managers and the users of the resource. A keynote address was given by the broadcaster Mr Magnus Magnusson. Chairman of Scottish Natural Heritage, who called for adherence to the principles of environmental sustainability, integrated resource management and partnership.

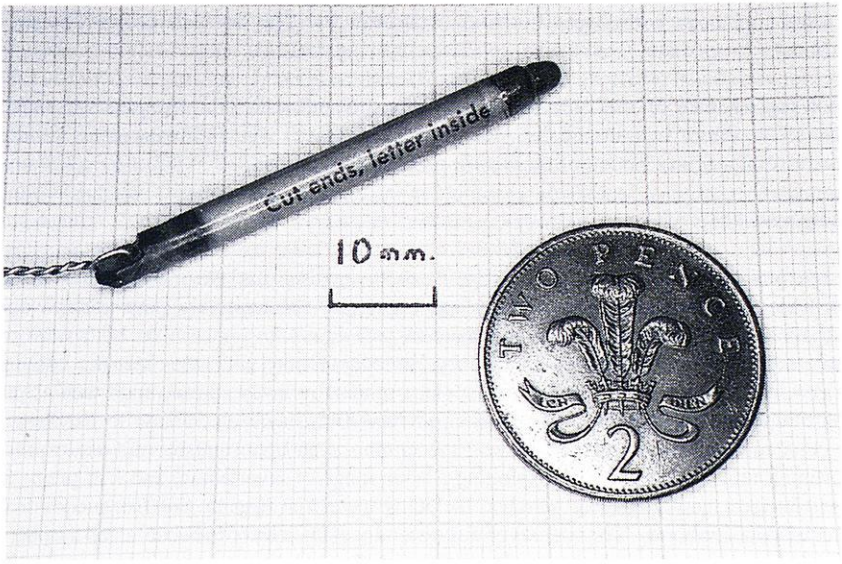
The Council also adopted a minimum standard for catch statistics so as to improve their comparability throughout the North Atlantic.

NASCO operates a Tag Return Incentive Scheme to encourage the return of scientific tags applied to salmon. Prizes ranging from $100 to $2500 are offered annually. The President of the Organization, Mr Børre Pettersen (Norway), announced that the winner of the Grand Prize was P. L. Williams of Wrexham.

The next annual Meeting of the Organization will be held in Oslo, Norway during 6-10 June 1994.

TAGS

All fishermen are asked to keep a special look out for a particular type of tag, pictured below. It is called a "Lea Hydrostatic Tag" and it has been attached to fish off the Faroes.



SCOTTISH OFFICE AGRICULTURE AND FISHERIES DEPARTMENT FRESHWATER FISHERIES LABORATORY

(by Dr. R. G. J. Shelton)

THE BACKGROUND

A substantial part of the research and monitoring programme of The Scottish Office (AFD) Freshwater Fisheries Laboratory at Pitlochry, is designed to provide updated assessments of the Scottish fisheries for salmon and sea trout. The programme uses information from a variety of sources, including the national statistics of reported catches which are the formal records of the fisheries and the results of juvenile surveys undertaken over wide areas of Scotland by Laboratory and locally-based biologists. The results of these extensive investigations provide valuable background information and, in the case of the juvenile surveys, insights into the local adequacy of spawning stocks, but they do not, of themselves, provide sufficient data for the fisheries to be described in terms of the abundance and structure of the stocks upon which they depend. Thus more intensive investigations are required on specific river systems like the North Esk and parts of the Dee and Tay where the facilities exist

to count both adults and young fish and, through tagging experiments, to follow each generation through the fisheries until it forms the parent stock for its successor. This work, supplemented by detailed genetic, ecological and behavioural studies, some of which can be brought into the more tightly-controlled world of the laboratory or hatchery, are the core of the Freshwater Fisheries Laboratory's salmonid research programme. All of this work is done in the context of a comprehensive programme of environmental monitoring and research undertaken in liaison with River Purification Boards and The Scottish Office Environment Department.

Parts of the research of the Pitlochry Laboratory are undertaken in co-operation with, and sometimes the direct support, of the Atlantic Salmon Trust. The following notes summarise the recent results of a selection of these joint projects.

SALMON IN THE SEA

Although preliminary evidence from grilse catches suggests that the marine survival of the smolts which left Scottish rivers in 1991 has improved, the relatively poor catches derived from the 1989 and 1991 smolt years continue to give cause for concern on both sides of the Atlantic. During the year, the Laboratory, in conjunction with the Marine Laboratory, Aberdeen, undertook a major review of the place of salmon in the marine food web as part of its contribution to the AST/ASF Symposium at New Brunswick on Salmon in the Sea. The study concluded that, during its life at sea, the salmon is an opportunistic mid-water predator, supporting a rapid growth rate by exploiting a wide range of invertebrate and fish prey. Small post-smolts feed mainly on invertebrates, including terrestrial insects, but fish predominate in the diet of larger salmon. The species of fish eaten by salmon vary between areas and between years. This suggests that salmon numbers are unlikely to be sensitive to year-to-year changes in the availability of any particular prey but could be influenced by overall changes in secondary production in the North Atlantic.

Analysis of continuous plankton records suggests that trends in total zooplankton production over the last 30 or so years are markedly downward, especially to the north and west of the British Isles. Major changes of this kind are likely to be climatically-driven and just as the marine "mini Ice Age" of the late 1960's and early 1970's was a period of exceptional abundance for Atlantic salmon and a number of members of the cod family, the marine climate of more recent times seems less favourable to these cold water species.

Also for the New Brunswick Symposium, the Marine and Freshwater Fisheries Laboratories reviewed climatic change in the north east Atlantic alongside known changes in the size and sea age composition of salmon catches in a range of British rivers. The results of this review, which is the most comprehensive of its kind ever undertaken, concluded that, in the absence of good quality data on the marine distribution of salmon of known stock origin and age structure, it was not possible to link known changes in marine climate with observed changes in the survival and maturation of salmon at sea.

Collecting data on Atlantic salmon in the sea presents great difficulties because of its relative rarity as a marine fish. However, following the Atlantic Salmon Trust's Edinburgh Workshop

on Salmon in the Sea which took place in 1992, the Laboratory is investigating new ways of sampling post smolts and studying their behaviour shortly after sea entry.

SEA TROUT STUDIES

The survival of sea trout at sea has also worried fishery managers. Here the most acute problems have tended to be regional with most concern concentrated on certain west coast populations in both Scotland and Ireland. Interpretation of sea trout statistics is more difficult than for Atlantic salmon, partly because the pool habitat in which young trout grow up tends to vary annually in extent more than the riffles in which juvenile salmon usually make their early growth. Furthermore, in many trout populations, only a proportion of the stock migrates to sea and this proportion is unlikely to be constant. A review of catches and rainfall for western Scotland concluded that the lack of sea trout could not be explained in terms of reductions in rearing habitat. Analysis of the freshwater-resident component of trout populations provided no evidence that the lack of sea trout reflected a relative increase in the numbers of freshwater-resident fish. As with salmon, the focus of attention is increasingly on the marine phase. The results of preliminary investigations, supported by the Atlantic Salmon Trust, suggest that food supply is not the underlying problem in that the growth and overall condition of surviving sea trout in the affected areas are, in most instances, well within the normal range for those stocks. It would seem that other factors are leading to enhanced loss rates during or shortly before the marine phase. Possible causes are being investigated experimentally with the support of the Atlantic Salmon Trust.

Further experimental investigation of the effects of food supply on smolting in sea trout have been undertaken at Scaliscro in Lewis as part of a joint investigation sponsored jointly by the J. H. M. Mackenzie and Atlantic Salmon Trusts. The study is part of a wider investigation into the feasibility of successfully rearing sea trout smolts in hatcheries. The results showed conclusively that levels of food input which promote rapid growth also tend to trigger sexual maturation in fresh water at the expense of smolting. It would seem, therefore, that at least part of the secret of producing sea trout smolts in hatcheries is to restrict their food supply.

THE SPAWNING OF ESCAPED FARMED SALMON

The extent of interactions between escaped farmed salmon and wild stocks of salmon and trout continues to be a topic of lively interest. As a result of accidents in salmon farms, escaped farmed fish are present both in the ocean fisheries and in the coastal and river fisheries of Scotland. In 1990, a bag-net fishery in western Scotland was monitored by AST and Scottish Office staff and more than 20% of its catch comprised escaped farmed fish. It was found that fish had escaped at all stages of their lives. Indeed, the stomachs of some still contained commercial fish food but, judged by scale-reading, most fish had been at liberty for many months. In 1991 and 1992, escaped salmon were found in the same fishery at about the same frequency although the proportions of fish escaping at the various stages of their lives showed some variation between years.

Until mid-1990 the carotenoid pigment, canthaxanthin, was added to the diets of salmon being reared in sea cages to colour their flesh. The flesh of wild salmon is coloured by a related

algal pigment, astaxanthin, which accumulates during feeding at sea on organisms which eat the algae. Astaxanthin and canthaxanthin can be distinguished in the laboratory. Canthaxanthin can be detected in the tissues of farmed fish for many months after escape; its presence among the pigments of salmon sampled in the fisheries is diagnostic of their having being escaped from sea-cages. In 1990, 65% of those fish captured in the bag-net fishery being monitored and classed as escaped farmed fish, on the basis of scale reading and the presence of residual fin damage, contained canthaxanthin in their tissues.

Towards spawning time female salmon transfer pigment from muscle and other body tissues to their eggs. The eggs of wild fish carry only astaxanthin but the eggs of escaped farmed fish which have been fed the pigment contain canthaxanthin as well. Moreover, maternal pigment continues to be present in progeny for some weeks after the eggs have hatched. The progeny of escaped farmed fish can therefore be distinguished from the eggs of wild fish with some accuracy. In 1991, following spawning in 1990, the maternal pigment loads of salmon alevins were examined at hatching time at sites in 16 rivers, ranging from the Cree near Dumfries to the Carron in Easter Ross.

The sampled alevins were too small to permit identification of trout and salmon by inspection. Instead, they were allocated to species on the basis of species-specific genetic differences in the protein GPI, detected by electrophoresis. On this basis trout were excluded from samples. In addition, a number of alevins showed the species characteristics of both salmon and trout. These were salmon - trout hybrids. In all the instances in which maternity could be determined, the hybrids were shown by mitrochondrial DNA analysis to be the progeny of female salmon. The progeny carry only maternal mitochondrial DNA and all those examined carried mitochondrial DNA of the salmon type. These fish were retained in the samples.

Alevins carrying canthaxanthin were detected in 14 of the 16 rivers examined (Table 1). In total, 109 out of 2373 alevins examined contained canthaxanthin. Alevins carrying canthaxanthin were detected at the highest frequency (18%) in the River Kerry near Gairloch in Wester Ross. Only 65% of escaped farmed salmon captured in the year in which these progeny were spawned contained canthaxanthin. This value would be expected to underestimate the frequency with which all females of farmed origin contributed to spawning since fish which had escaped or had been released during the fresh water phase of life would not have been expected to bear canthaxanthin. In addition, any contribution to spawning made by escaped male fish cannot be detected using the techniques employed, since males make no contribution to the pigment of their progeny.

Interestingly, of the 23 hybrids between salmon and trout which were examined in this study, 8 were shown to bear canthaxanthin. This suggests that escaped farmed salmon may be less species-specific in their reproductive behaviour that their wild counterparts. One possible explanation is that male trout may have difficulty in distinguishing between the spotted trout-like appearance of some farmed salmon and real trout. Another possibility is that the egg-release response of farmed female salmon is less species-specific than that of wild fish and can readily be released by the adjacent bodily vibrations of large male trout.

TABLE 1

The frequency of occurrence of alevins or fry bearing canthaxanthin among samples obtained from 16 rivers in northern and western Scotland.

River	Canthaxanthin		
	+	-	%
Cree	-	121	-
Aad	4	163	2.4
Forsa	5	139	3.5
Etive	5	192	2.5
Ailort	4	140	2.8
Elchaig	3	157	1.9
Torridon	5	40	11.0
Kerry	21	97	17.8
Gruinard	15	142	9.6
Inver	-	118	-
Laxford	8	162	4.7
Dionard	21	165	11.3
Hope	5	177	2.7
Thurso	7	186	3.6
Helmsdale	5	68	6.8
Carron	1	197	0.5
Totals	109	2,264	

WEST GALOWAY FISHERIES TRUST

(by Dr. A. Stephen)

The West Galloway Fisheries Trust (WGFT), which is funded by the DSFB's of the Rivers Luce, Bladnoch, Cree and Water of Fleet, is conducting a wide range of research into the fisheries in South West Scotland. WGFT employs a full time fishery biologist, Dr. Alastair Stephen, who also conducts other research and survey work for other DSFB's on a contract basis.

The WGFT has been generously supported by a number of organisations and the AST has been especially helpful in the past two years supporting student assistance for projects investigating problems of afforestation and acidification.

Projects undertaken include the following:

1) Juvenile salmonid surveys are carried out on an annual basis on the Rivers Luce, Bladnoch Cree and Water of Fleet. Over the last four years these have highlighted the shortage of salmon in the headwater streams, which has largely been attributed to the combination of large scale afforestation (65% of the Cree catchment is under trees) and acidification caused by acid deposition and the underlying resistant bedrock.

2) Extensive juvenile electrofishing surveys have also been carried out on the River Stincher (1990-1991), the River Nith (1991) and the River Doon (1992), for the respective DSFB or River Improvement Association. These have highlighted the areas within each catchment short of young salmon and the subsequent written reports have identified the likely cause(s). Most of the factors affecting the distribution of juvenile salmon are common to all the rivers. The most common restrictive factors are; impassable obstacles (man made and natural), overgrazing of stock, pollution from agricultural sources (usually silage and/or slurry), water treatment works, siltation and erosion caused by forestry drainage, and acidification caused by acid deposition exacerbated by upland afforestation.

3) On the River Bladnoch, Luce and Water of Fleet, WGFT has set up continuous chemical monitoring sites to assess the episodic nature of the acid flushes experienced during and after heavy rainfall. The Macaulay Land Use Research Institute (MLURI) have also been encouraged to establish three sets of equipment on the headwater streams in the River Cree catchment. On all the rivers the problems are the same, when the water is at base flow the chemistry is reasonable but as soon as the rivers rise the chemistry changes dramatically and acid flushes occur with regularity.

4) On the Rivers Cree, Bladnoch and Water of Luce, egg box experiments have been conducted to test whether fertilized salmon eggs will hatch successfully buried in the gravels of the respective headwaters. These experiments, carried out in 1989, 1990 and 1991, showed that in certain areas survival was very low indeed and in others it was much better. The streams where problems occurred were those on base poor

geology, where it was suspected that acidification could be the limiting factor.

5) The WGFT is setting up experiments involved with instream habitat manipulation on the River Stinchar, to establish whether it is feasible and cost effective to increase the number of salmon parr, and thus smolts, that can be produced from a section of river.

6) A salmon hatchery using eggs taken from fish caught in the four WGFT rivers has been established to produce first feeding fry and two month fed fry to restock or enhance stock areas of the catchments identified as suitable. Genetic integrity has been maintained and only progeny from a certain river are returned to that river. The hatchery has a capacity of 400-500,000 eggs, although in 1992-1993 only 230,000 eggs were collected. WGFT is developing different methods of catching broodstock, ranging from encouraging anglers at the end of each season to retain black or red fish in special enclosures, to building specially designed traps on particular spawning burns. Both methods mentioned above are working extremely well.

7) The WGFT in conjunction with the River Luce DSFB and staff from SOAFD are planning to install a fish counter on the River Luce which will add to the quantitative information on fish runs in Scotland, as up until now there is no accurate way of estimating fish abundance in any river in South West Scotland. It is hoped to install the device during 1993.

8) The WGFT conducts a great deal of survey work in conjunction with Colin Carnie, a civil engineer from Crouch, Hogg and Waterman, on the South West's rivers. These surveys are designed to improve the rivers not only for adult fish and for the anglers attempting to catch them, but by improving and diversifying the instream habitat for the juvenile fish. Beats have been, or will be, improved on the Rivers Stinchar, Luce, Bladnoch, Cree and Water of Fleet following such works.

9) The River Bladnoch is unusual in having a perceived pike problem, which are thought to predate heavily on smolts and parr. The WGFT in conjunction with staff at SOAFD are attempting to quantify the problem.

10) WGFT has established an Annual S. W. Scotland Bailiffs meeting to attempt to co-ordinate anti poaching activities on a Regional basis.

11) WGFT has been involved with monitoring various pollution incidents in the area including severe siltation effects, caused by forestry extraction, and silage spillage into watercourses. WGFT has worked closely on these problems with Solway River Purification Board (SRPB).

12) In fact WGFT enjoys a close working relationship with a number of organisations and agencies and maintains regular exchange of information with; SRPB, Scottish Natural Heritage (SNH), Dumfries and Galloway Regional Council, Forestry Enterprise and Forestry Authority along with some of the private forestry companies.

13) A very important aspect of the WGFT's work is that of education. To this end WGFT has established a primary school education project called "Salmon in the Classroom" which encourages a hands on approach to conservation and especially a personal commitment to looking after the local fish stocks within the burns. In fact the WGFT won the Biwater Award for the best Operation Brightwater Project in 1992-1993 for our work in schools.

SUMMARY OF RIVER SPEY SALMON AND SEA TROUT RESEARCH

(by R. Laughton, Fisheries Biologist, Spey District Fishery Board,
121 High Street, Forres, Moray)

In common with many Scottish rivers the Spey has seen a decline in the spring salmon catches during the 1980's. In order to understand more about this valuable component of the returning adult stock the Spey District Fishery Board commissioned its own programme of research in the early eighties. This short article will review previous research and outline areas of current study. Should readers require more detailed information copies of the relevant research reports are available from the Board.

Early research (1983 to 1985) concentrated on a three year mark and recapture project based at the mouth of the Spey. This project determined an exploitation rate of 20% for the net and coble and rod fishery combined, that is, for every 20 salmon caught a further 80 potential spawners remain. At the same time an ongoing programme of scale sampling was implemented to determine the age of the salmon caught from four fisheries on the river and gain an understanding of where particular components of the salmon stock are exploited. In general, it was established that the further upstream the fishery is from the sea the more it relies on fish which are older in terms of both river and sea age.

More recent analysis of Spey salmon rod catches has indicated that while the spring component is still in decline other components have also declined in the early 1990's. However, a lack of angling effort data creates problems in relating the angling returns to changes in adult salmon stocks. In 1992 a number of fisheries on the river were asked to record the time spent fishing by anglers and hence provide an index of effort. The results from the first year were encouraging and the survey has been extended in 1993.

A study examining the developmental outcome of spring salmon and grilse offspring began in 1985. Spring salmon progeny and grilse progeny were released into a common environment, the Cally Burn, and their subsequent growth and development was monitored. The research suggested that the behaviour of the spring salmon progeny is different to that of the grilse raised under similar conditions. In general, the smolts and presmolts of spring fish commence migration earlier than those of grilse indicating an adaption to a nursery environment further from the sea. The grilse offspring also showed higher numbers of mature male parr.

Current studies at the Cally Burn are examining the survival of planting unfed hatchery fry compared with fry which are tank reared for around three months.

A two year radio-tracking study to examine the movements of adult salmon ascending the Spey was initiated in 1988. The study determined that the early running components of each sea age class, spring salmon and June grilse, migrate to and spawn in the upper reaches of the river. The later entrants, summer salmon and August grilse, remain in and spawn in the lower reaches. It was evident that the upper tributaries of the river are particularly important in the production of the declining spring salmon population.

From 1990 to 1992 a catchment-wide survey of the juvenile salmon and trout was undertaken. In general good stocks of juvenile salmon were found in most tributaries. However, differences within the catchment are present, the tributaries draining areas of limestone and richer soils generally support higher numbers of juvenile salmon than those draining granite areas. Further work is necessary to determine why juvenile salmon numbers are low in these areas and whether any improvements can be made. Some areas, notably above dams were found to have very low numbers of salmon. Subsequent yearly surveys will provide further information on juvenile population trends.

These projects have led to an improved understanding of the Spey salmon stocks and in some cases contributed significantly to a wider understanding of salmon biology. The research has indicated that the river must be seen as a complete unit for example although the main fisheries occur in the lower 75km the upper tributaries are the important areas for juvenile spring salmon production. Thus the salmon stocks in the Spey are highly structured, any future enhancement strategies must be aware of this point.

In order to make further progress a Fisheries Research and Management Plan is currently under preparation to direct future work on the Spey. The Plan owes much to those already in use on the River Tweed and West Galloway. The central theme is to conserve and enhance the River Spey salmon and sea trout stocks. In order to achieve this the Board consider it important to continue and implement fisheries research on a catchment wide basis and to encourage co-operation amongst the wide variety of groups and individuals within the area.

ACKNOWLEDGEMENTS

The Board are indebted to a number of organisations and individuals who have helped guide their research efforts over the last decade, these include Dr. Tony Hawkins, Dr. Dick Shelton, Dr. Bob Morgan, Mr. Willie Shearer, Mr. Gordon Smith, Mr. Ross Gardiner, Mr. Julian MacLean from Scottish Office Agriculture and Fisheries Department, Mr. John Webb, Atlantic Salmon Trust and Dr. David Solomon, Fisheries Consultant.

Thanks must also go to the Moray, Strathspey and Badenoch Enterprise Trust, the former Highlands and Islands Development Board, a number of local companies, trusts and individuals for their continuing financial support.

THE Tweed FOUNDATION

REPORT FROM TWEED

This report by Dr. R. Campbell is extracted from the Tweed Foundation 1992 Review and Progress Report with permission of the Tweed Foundation.

BIOLOGIST'S REPORT

Most of my work centres around the Management Plan published in 1990. The following is a resume of the main areas progressed.

Obstacles to fish movement

During the Habitat Survey of Ettrick and Yarrow, 23 streams were found to have one or more man-made obstacles to fish movement and 11 to be obstructed by deposition of gravel at their mouths. Five streams with man-made obstacles and ten with gravel cones have been given priority for attention.

A list of known obstacles elsewhere in the system is being drawn up, including not only large caulds but also bridge aprons, fords, elevated fords and road culverts which obstruct movement. It should be remembered that brown-trout, in addition to salmon and sea-trout, are impeded by these obstructions. Reports of obstructions from anywhere in the system can be made to either the Biologist or to any of the Bailiffs.

We are producing technical guidelines for bridge aprons, culverts etc. for circulation to contractors, local authorities, the Forestry Authority. These will help to ensure that future works do not create problems for fish movement.

Maximise production of salmon smolts

Our main current priority is to survey the system to find out what parts actually carry salmon juveniles. Sites are being monitored on a regular basis to follow any trends in juvenile population densities and give indices of spawning stock strength.

Nineteen such sites on the Ettrick and Yarrow and two on the Leet Water were electric fished over the summer. The strategy is to visit these sites on an area by area basis, so the information from them relates to a particular part of the system at a particular time, rather than going to a scatter of sites over the whole system each summer, where the results from any one place will be unlikely to relate to findings from any other. Help in this electric fishing programme was provided by the RTC bailiffs and members of the Selkirk, St. Mary's Loch and Coldstream Angling Clubs.

Basic survey work will start in 1993 with a back-pack electric fishing set, purchased recently with the proceeds of the Gillies' Ball. This will allow more mobile survey work. Burns that have never been sampled before will be visited to gather simple presence/absence data for salmon. Streams that have been found to lack salmon in previous surveys will be re-surveyed. If salmon are completely absent, we will attempt to establish the cause of this and recommend action to correct the position.

Maximise carrying capacity of nursery streams &
Minimise competition for food and space

The foot survey of habitat quality of Ettrick and Yarrow, where an important part of our spring fish spawn, was undertaken by four temporary assistants over the summer. We now know the extent of habitat degeneration and we are starting to plan how to correct this position. Trout will benefit as well as salmon. The following types of work will be undertaken:

1 Fencing of banks: The work of fencing required for Ettrick and Yarrow would be 25,520m for the former and 49,573m for the latter. Some burns will probably not be worth the investment. The benefits to fish would appear gradually, as the bankside vegetation recovers and bank erosion and collapse ceases. Sampling of the fish population to show benefits would have to be over a long period.

Once grazing is prevented, the medium to long term possibility of the banks becoming overgrown with trees that shade and tunnel the streams has to be considered. Elsewhere, grazing regimes have been worked out which are enough to prevent excessive tree growth but light enough not to damage other vegetation or the banks. In the State of Oregon, it appears that a five year rest period from all grazing after fencing to allow vegetation to re-establish itself is set, followed by a regime that restricts grazing on the banks to one month in early spring.

2 Clearance of streams shaded over by trees: Benefits from this should be apparent within a year or two. Results from the Kirkburn project already show this for trout. Recent Irish work has shown how salmon juvenile numbers increase greatly after this treatment as well.

3 Repair of eroding banks and instream works to re-shape channels: Benefits to fish should be apparent within three or four years, and would not be just in terms of numbers of juvenile salmon and trout, but also in quality - increased production of salmon parr (one and two year old fish) as opposed to fry (young-of-the-year) and larger trout. Results should be observable within four or five years.

4 Restoration of bankside and aquatic marginal vegetation: Some streams encountered in the survey were already protected from grazing through having been included within coniferous plantations, but their banks still showed signs of erosion and instability, sometimes severe. These would be sites in which to experiment with replanting of banks and water margins with aquatic marginal species (Reeds, Canary Grass, Marigolds etc.) to see how this could accelerate the healing process.

Predation

Samples of goosanders were taken under a scientific licence at three times outside the usual cull period to gather information on their diet at those times. The actual diet analyses was undertaken by the Institute of Terrestrial Ecology, Banchory. Samples of grayling were obtained from angling competitions and the stomach contents analysed as an Honours project by a student in the Institute of Ecology and Resource Management of Edinburgh University. A summary of the results of this is available as Biologist's Report No. 1. Another student will examine the stomach contents of eels collected over the summer's electric fishing in Spring 1993.

Salmon Scale Reading

In 1992, 1541 scale samples were collected from the 7 sample fisheries along the main river, compared to 1530 the previous year. Samples from spring salmon were down by half. Samples from the Teviot and Ettrick were also collected, the latter for the first year.

The following analysis from the spring samples if of interest:

Percentage of Spring Catch made up of 4 year old fish

	Feb	Mar	Apr	May	Sample Size
1989	83	87	86	76	390
1991	71	75	68	70	343
1992	61	52	66	59	145

It appears that spring catches on Tweed are very much dependent on a single age of fish - four year old ones. Typically, these have spent two years in the river before migrating as smolts and two years at sea before returning. Other ages are caught in spring - three year olds (one year in the river and two at sea) and five year olds (three years in the river and two at sea) but these do not provide a major part of the catch. If the spring four year old fish are a weak age class, then as they are the "single pillar" of the spring catches, the overall catch will be poor (and the other age classes will show up as *relatively* more important, just because there are less of the four year olds.

The autumn catches of Tweed are, by contrast, more broadly based on three age groups (2, 3, and 4 year old fish).

As can be seen from the table above, the highest spring catch in the three years considered here (in 1989) was composed of around 80% of four year old fish while this year's low spring

catch was composed of around 60% of four year old fish. This suggests a weak 1988 spring fish year class. It might, of course, also point at a weak 1990 smolt class of spring fish, but since the three and five year olds went to sea at the same time (almost all being two sea-winter fish like the four year olds) and these produced a relatively high proportion of this year's spring catches this is not likely.

It is unfortunate that there are no scale readings from the Spring salmon dominated period between the 1920's and 1965 to compare with the present.

Salmon catch records analysis

Record books are borrowed from proprietors and monthly totals abstracted. Analysis of the monthly figures gives information on changes in times of return over the years. Photocopying of the books also provides an archive of records which will be a vital source of information. The catch records now on computer disc are Berwick Salmon Fisheries Co. (1857-1983); Boleside (1888-1991); South Wark (1919-1990); The Hirsel (1855-1970).

A REPORT FROM THE TAY DISTRICT SALMON FISHERY BOARD

(by Ian Mitchell)

Under the Salmon Acts, the Tay District Salmon Fishery Board is required to protect, maintain and hopefully improve the stocks of salmon in the Tay District. With a catchment of 5,200 sq. km and 10 major tributaries, the Tay has a number of different stocks of salmon. The major problem facing the Tay Board is that its influence - however minimal - prevails only in freshwater, the Tay estuary and the immediate coast. The Tay Board cannot protect the stocks of Tay salmon at sea. Even within freshwater, inadequate information on salmon stocks, poses a major problem. Although the SOAFD Faskally Laboratory has been based in the Tay catchment since 1948, no overall survey of juvenile salmon in the Tay District has ever been made. Following poor adult salmon returns in 1990 and 1991, and therefore concerns on the adequacy of the spawning stocks, the Tay Board contacted SOAFD to survey juvenile densities in all rivers accessible to salmon in the Tay system. This survey, funded by the Tay Board, showed better densities than might have been expected, and will form a base study on which future field work will be programmed. Selected surveys will be carried out in the next 3 to 4 years and the major survey repeated.

With a number of tributaries being rendered unproductive with hydro schemes, headwater salmon stocks in particular have been put at risk. A ten year stock improvement in the Tummel hydro system has proved uneconomic. SOAFD and the Tay Board have completed a 4 year smolt tapping programme on the Lochay. The Lochay, which flows into Loch Tay was stocked with ova taken from the lower reaches of the system. The resulting smolts were tagged, half being released into Loch Tay and the remainder being transported and released below the loch in the main river. Returns, due possibly to poorly adapted stock, have been poor and the work will not be repeated until a stock of ova from a headwater stock is available. To give us a greater understanding of headwater stocks and a supply of ova, the Board

commissioned SOAFD to catch and strip a small number of 2 sea winter salmon from one of the headwater stocks. The resulting kelts have been kept alive and are being reconditioned with a view to stripping for a second time in winter 1993.

Scottish Hydro-Electric plc operate fish counters at Pitlochry, Clunie, Stonwich and the Lochay installations. The Tay Board installed a fish counter in the River Ericht in 1990. This has proved a useful management tool. It provides a sufficiently accurate count for Fishery Board purposes and has provided useful information on the environmental conditions required to stimulate fish movement.

ESCAPED FARMED SALMON AND WILD SALMON POPULATIONS PROJECT PROGRESS REPORT: DECEMBER 1992 - JUNE 1993

(by John Webb, SOAFD Marine Laboratory, Aberdeen)

Atlantic Salmon Population Management: Maximising Progeny Numbers from Natural Spawning

Following the successful completion of joint studies on the frequency, distribution and behaviour of escaped farmed salmon, the Atlantic Salmon Trust and SOAFD will continue to collaborate on a new project. The work will have two main themes: to assess rates of survival of juvenile salmon in the wild, focusing on the range of natural variation among families; and to devise means of reducing mortality among juvenile salmon and through maximising habitat use.

The first component of the programme relies on the recent development of a set of genetic markers called "locus specific probes" for studies in fish. These probes produce results similar to the DNA fingerprinting technique which is now well known from its use in human forensic medicine or in the determination of parentage. Using one or a combination of the new probes it is possible to uniquely identify genetic variation present in fish DNA. As genetic variation is heritable it is also possible to use the probes as family markers and to identify the offspring of particular adult pairs. The analysis is carried out in a laboratory and requires only a minute amount of fish tissue, obtained from a small piece of fin or a drop of milt or blood to characterise a fish. Single eggs and alevins may also be used.

The probes are already being used by Queen's University, Belfast and SOAFD to examine patterns of mating among adult salmon in the Girnock Burn. Adult fish entering the stream are captured by a fish trap situated near the mouth of the burn. The fish are counted, sexed and measured and a small sample of adipose fin taken for DNA analysis. The fish are then released above the trap into the stream above to spawn naturally. The redds made by the fish are noted over the spawning period and their locations marked. The redds are sampled during the following spring. Egg sampling is carried out after the eyed stage is reached when the eggs are quite robust. It is then possible to deduce which of the adults that entered the stream are the parents of the progeny contained in each redd.

In the AST supported study, the fate and performance of salmon fry after dispersal from the spawning redds will be investigated. Of particular interest is the dispersal of fry from the redds and the effect of different densities of redds on the distribution and mortality of fry in particular areas of a spawning stream. In addition, studies will also be focused on patterns of utilisation of available fry habitat.

To address these questions adult salmon entering a small upper spawning tributary of the River Dee in the autumn of 1992 were trapped and samples of adipose fin tissue taken for genetic analysis. The fish were stripped and the fertilised eggs planted out as single families in artificial redds along the stream at different densities.

In a programme that is to continue over the next three years, researchers will monitor the survival growth performance and migratory behaviour of the stocked families of juvenile salmon in the stream using the probe technique. Sampling of fry will begin soon after emergence in late May to early June. Further samples of juveniles will also be taken at the end of their first summer's growth - after the main period of fry dispersal and posthatch mortality has occurred. Smolts and migratory parr leaving the stream are routinely trapped and micro-tagged. During the tagging process, the adipose fin is also removed to aid identification of tagged individuals in subsequent adult fishery catches. The fin-clips from juvenile migrants derived from the 1992 spawning will be screened in the laboratory and their parentage determined. This will allow assessment of the contribution of each pair of spawners to the overall production of migrant juveniles. Ultimately, the return of the adult spawners derived from these juveniles will be monitored in relation to parentage and rearing location.

The second part of the collaborative project will involve development of management techniques to alter and improve the distribution of natural spawning by adult salmon in streams. Techniques will be developed to reduce overall mortality of juveniles by reducing interfamily competition and improving the distribution and utilisation of available habitat by making alterations to sections of stream-bed to support spawning by adults will be examined. The success of the alterations made will be assessed on the basis of comparing the spawning distributions recorded over the previous 20 years in the same stream. Finally, in the light of this experience, the methods devised will be assessed in terms of construction, effort required, costs incurred and annual maintenance requirements.

It is intended that from both parts of this new study, strategies will be developed to increase migrant juvenile production by optimising the distribution of spawning adults in streams, minimising mortality among emerging fry and optimising habitat use by fry and parr. It is intended that only indigenous fish be used in this work; thereby conserving the existing natural population structure. Further, any protocols that result from this research will probably be particularly suited to the management of populations sustained by small or depleted groups of spawners.

Genetic Structuring of the Adult and Juvenile Salmon Population of the River Spey

Collaborative genetic studies between the SOAFD, AST and the Spey District Salmon Fishery Board continued on the River Spey in 1992. Seven hundred adult salmon were sampled over

the 1992 season. The fish were caught by the commercial net fishery operating at the mouth of the river and anglers. The tissue samples have now been genetically typed and the associated scale samples read. Analysis of the temporal variation of the various genetic types present in the different seasonal runs of adult fish sampled will begin shortly.
As part of the same study, juvenile salmon have been sampled from 15 different sites within the river system. Genetic screening (using 20 different loci) has been carried out on these samples and full analysis of the results will also begin shortly.

I would like to take this opportunity, on behalf of all three participating parties in this research to thank the proprietors, fishery managers, tenants, ghillies and netsmen for their cooperation and assistance in this study.

Publications and Presentations

A short paper describing the natural prey items found in the stomachs of escaped farmed salmon caught at a bag-net fishery near Gairloch on the west coast of Scotland have been published in the journal, *Aquaculture and Fisheries Management*, **23**, 721-723. A paper describing the levels of thyroid hormones in adult Atlantic salmon during their return migration to spawn has also been published in the *Journal of Fish Biology*, **42**, 293-300. Three papers that describe the results of the second years' study on the Polla (1) and the 1991 farmed female spawning fry survey (2) have been accepted for publication and will be published later this year.

Illustrated presentations were given to the annual District Salmon Fishery Board's Superintendent's meeting at Pitlochry (April) and the annual meeting of the Association of District Salmon Fishery Boards at Battleby near Perth (April).

A new poster display for the AST caravan describing salmon scale reading will be produced for this year's game fairs and shows.

NO MORE HOB-NOBBING

(Fishing Lines by Keith Elliot from The Independent on Sunday)

The latest tabloid revelations about the Royal Family have almost certainly stuffed my chances of a week's fishing on the Queen's private water in Aberdeenshire.

Just imagine! Six days on one of the most beautiful stretches of the river Dee, fishing in the shadow of Balmoral Castle, for little more than £450. Chris the Antique Dealer and I agreed it was too good to miss.

John Ashley Cooper's *The Great Salmon Rivers of Scotland* calls the upper Dee "a fairyland of delightful surroundings". With Lochnagar (now there's a familiar name), the Cairngorms and other high hills as backdrop, the Dee is justly rated the most attractive of all large Scottish rivers. But there's little chance of us appreciating that beauty, come March.

My wife, a student of history, would love the legends of the area. There is the old keep of Abergeldie Castle, a Gordon family stronghold since medieval times, and the hill to the south, Craig na Ban. It's named after Kitty Rankin, who was rolled down the hill in a barrel and burnt alive at the foot for witchcraft. But my wife won't be doing any history-spotting either. I could pay a bit more, around £1,000, and share the Dee around Drum, just outside Aberdeen, with three others in early February. That price includes a three-bedroomed cottage too. I could spend a day on a prime stretch of the Tay (about £450) or come closer to home and enjoy a week on the river Wye near Monmouth (£600) or the river Avon in Hampshire for just £350. But it's not the same as catching royal salmon legally.

For as little as £100, I could fish the mighty Tweed, knowing that my money was going towards better fishing. The Tweed Foundation believes that juvenile salmon have a far greater chance of survival if their habitat is improved and will be spending heaviiy on this work. But I had my heart set on chatting to Charles about afforestation and acid rain, or discussing the relative merits of the Blue Charm fly against the Dunkeld with the Queen Mother. No chance now.

The trouble is, you see, that any hobbledehoy with a fat wallet can book the stretches I've just mentioned. They are among the 227 lots in the annual postal auction run by the Atlantic Salmon Trust, a charity that works to preserve and improve stocks of wild salmon. This auction is the organisation's main fund-raising event, and the £35,000 or so plays a vital part in its research work. The Trust can't afford to be picky about its bidders.

So you can just imagine what will happen when Fleet Street realises it can spend an invited week in the Queen's back garden, tearing up the lawns in their XR3is, for less than the average expense chit. Personally, I feel sorry for the gillie, whose services come free with the water. The poor old chap will probably be required to cart around tripods and scanning equipment rather than to locate salmon.

Media excitement will know no bounds when they discover the names of the river's best pools. I have nothing against David Profumo of the *Daily Telegraph* - he seems a jolly nice chap - but what can he do when his news editor spots that the *Telegraph* Pool is only a mile from Balmoral? Goodness knows what sort of puns the *Sun* and *Star* will concoct with the river Muick, or the Laundry Pool (for all that dirty washing).

One thing's for sure: come March, there will be some of the strangest salmon you've ever seen on the banks of the Dee, with telephoto lenses instead of fins. And if that salmon sings like Elvis and has two heads instead of one, you'll know that the *Daily Sport* put in the highest bid.

As a result of publicity like that given by Keith Elliot, in spite of the recession, the Auction was a success.

Results were as follows: AST (£36,534), ASCT(S) (£4,496), Tweed Foundation (£6,856), Wye Owners' (£4,133), grand total £52,019.

MIGRATORY SALMONID ANGLER LOGBOOK SCHEMES USED BY THE NRA

(by Dr. M. W. Aprahamian)

Information on the status of stocks is fundamental for effective Fisheries Management. On most river systems there is extensive data on the status of the juvenile population, however, on very few is there any estimate of the size of the adult stock. In the majority of cases the only index of the size of the adult migratory salmonid population is the catch.

In a number of instances the historical catch record has been the only data source available. Such data have shown that during the 20th century the composition of the catch and by inference the stock has changed from a multi sea winter dominated population to one where grilse are preeminent.

If catch is directly related to stock, then catch data is an extremely powerful monitoring tool. However, catch is known to be affected both by effort, the efficiency of the gear and environmental conditions e.g. river flow. Over the short term the efficiency is not likely to have changed substantially though over the long term the general feeling is that with the wide spread availability of nylon in the 1950's the present tackle is more efficient than that used at the start of the 20th century. In addition there is at present a wider range of lure used compared to the past, when fly dominated.

Effort on the other hand may have altered substantially over the decades, and can vary markedly between years, and is largely dependent on flow conditions. As such, catch per day or hour fished may be a better estimate of stock size than catch alone and it is for this reason that the NRA have included effort, number of days fished, on the National Licence Catch Return Form, and in a couple of Regions an Angler Logbook scheme is being promoted.

The Angler Logbook scheme presently operating in the North West and Welsh Regions of the NRA aims to collect catch and effort data for each fishing visit. It is hoped that with this level of data a better understanding of which factors, in particularly flow, affect fishing performance on a stretch of river. On those rivers which do have the means of estimating stock size either through fish counters or by trapping it will be possible to assess whether catch per unit of effort can be used as an estimate of stock size. If such a relationship is found to exist then a very powerful monitoring tool will be available to Fisheries Managers.

For those who fish regularly in the rivers of the North West Region of the NRA and wish to participate in the scheme or would like further information please contact; The Fisheries Section, NRA North West Region, Richard Fairclough House, Knutsford Road, Warrington WA4 1HG or for those wishing to fish on the Dee, Towy, Tawe, Ogmore, Conwy and Taff in Welsh Region; The Fisheries Section, Rivers House, St. Mellons Business Park, St. Mellons, Cardiff CF3 0EG.

THE SALMON'S TAIL

(A unique new music project)

One summer morning an old ghillie dies struggling with the largest fish he has ever caught. His life is far from over, however. To his amazement he is forced to return to the river, to live the entire life cycle of one of the salmon he has spent a human lifetime pursuing. Reluctant at first, he begins to learn a completely different kind of knowledge of the ways of the river.

"The Salmon's Tail" is a musical learning tool. It follows in the steps of Brittan's "Young Person's Guide to the Orchestra", and Prokofiev's "Peter and the Wolf", but takes its followers and participants beyond the certainties of the written score into the uncharted waters of improvisation.

The piece was first performed on 16th November 1991 at the Bonar Hall in Dundee, by children from the Harris and Menzies schools in Dundee, Kevin Murray, Tommy Smith, John Rae, members of the Scottish Chamber Orchestra, other leading Scottish musicians, and the well-known actor, Peter Grimes.

Kevin Murray designed "The Salmon's Tail" as a performance piece and learning tool. His intention was to create a piece which would allow young and non-professional musicians to explore the world of improvisation in the company of professional players of the highest standard. Participants were thus able to gain knowledge of techniques outwith their normal musical experience.

MODELLING GROWTH OF SALMONIDS

(by J. Malcolm Elliot, Institute of Freshwater Ecology, Windermere Laboratory)

This article introduces a new research project supported by a grant from the Atlantic Salmon Trust. The project started in July 1992 and its chief objective is to develop an improved mathematical model for predicting the growth of trout, especially in relation to varying water temperature. I will first attempt to explain what is meant by a mathematical model and why such models are important in ecology. I will then describe and earlier growth model developed in the early 1970's, and provide examples of how it has been used for trout in the wild. Finally, I will summarize the chief weakness of this 'prototype' model and introduce the features of a new improved model.

Models are simplified representations of complex situations and are therefore always approximations of reality. In everyday language, the term 'model' is used to describe a small three-dimensional representation of larger objects such as buildings, bridges, roads, railways, aircraft, ships and road vehicles. These miniature models are simplified versions of the real thing and the degree of simplification depends upon the accuracy and detail of the model. When a model is built in advance of the actual construction, it may be used to test if the final construction is aesthetically acceptable and will function! Such models require mathematical

equations for their construction. The geometry of Pythagoras enabled building by trial and error to be replaced by that based on exact calculation and prediction. Similarly, the calculus of Newton initiated the development of mathematical models to describe the movement of objects in time and space. Although these physical models now have a long history with well developed theory, there are still questions to be answered and hypotheses to be tested.

Modelling in ecology is relatively new and therefore it is not surprising that there are few well established 'laws' as found in the physical sciences. These laws originate from hypotheses. A hypothesis is basically a guess as to how something functions, but it should be an informed guess that is consistent with a wide range of observations. Although not essential, it is often convenient to state a hypothesis in the form of a mathematical equation that is less ambiguous than a statement in works, and that can be used to predict a number for comparison with observed values. Remember that a hypothesis can never be proved, only disproved. If it survives many tests, it could be promoted to a 'theory' and eventually even a 'law'! Remember, however, that 'exact science' does not exist and even so called 'laws' can be disproved. For example, one of Dalton's 'laws' of atomic theory stated that "all matter consists of small indivisible particles called atoms", but we now know that the law is applicable to only chemical reactions; atoms are not indivisible in nuclear reactions. Another 'law', that light always travels in straight lines, was disproved when it was found that light could be bent in a gravitational field. Mathematical modelling and the testing of hypotheses are therefore inextricably linked. The relatively new science of quantitative ecology urgently requires the development of a theory with its own laws. The development of mathematical models will greatly facilitate this requirement.

An ecological model should therefore be based on realistic, testable hypotheses and the relationships between variables in the model should be represented by one or more equations with defined parameters (a variable is a quantity that can be measured or counted; a parameter is a quantity that characterises a relationship between variables and therefore remains constant, at least over a defined period of time). Parameters can rarely be measured directly and are therefore estimated by statistics obtained from field samples or laboratory experiments.

The ideal models are 'conceptual' with parameters that can be interpreted in ecological terms, rather than being simply convenient constants with no ecological meaning. Ecological models should preferably be 'stochastic' rather than 'deterministic', but this adds to their complexity and is often a difficult condition to fulfil. In a deterministic model, the predicted value from a given starting point will always be the same and is therefore free of random variation. Such models are mathematical analogues of physical processes in which there is a one-to-one correspondence between cause and effect. Stochastic models express the predicted value in terms of probabilities. Therefore the outcome of the model's response is not always the same because the model contains random variables that follow probability distributions. Such models are most relevant to biology because, although variability is a characteristic of all natural phenomena, its magnitude generally increases progressively from the physical to the chemical to the biological sciences. It is usually ignored in physics and grudgingly acknowledged in chemistry. It cannot be ignored in biology because it is an essential property of all living organisms. If variability was absent, neither natural selection nor evolution could occur.

Although this introduction to modelling is brief, I hope it has shown why mathematical models in ecology should be based on realistic, testable hypotheses, should be conceptual with meaningful parameters and, if at all possible, should be stochastic so that they incorporate essential biological variability. It must be emphasized again, however, that all models are abstractions and simplifications of reality. The perfect model of a salmon is another salmon, preferably a sibling of the same sex! Perfection is therefore an unattainable goal but what really matters is not the degree of perfection, but the adequacy of a model for predictive purposes.

Although modelling in ecology has a relatively short history, it has already proved to be a useful tool for those responsible for the conservation and management of naturally sustainable resources. The models can serve many functions but the three most important are:

(i) they provide insight into how a system works;
(ii) they can be used to identify populations or life-stages that are under-performing (or more rarely, over-performing) compared with expectations;
(iii) They can be used to predict the effects of changes due to natural causes (e.g. droughts, spates, climate change) or human activities (e.g. river regulation, afforestation, stocking).

A suite of mathematical models have now been developed in a long-term investigation in a sea-trout nursery stream, Black Brows Beck in the English Lake District (see references in Elliott 1993). This study has lasted over 25 years. Models can now be used to predict total production in each year and year-class, and to predict survivor density and mortality rates from the egg density at the start of each year-class and to predict the length of a critical period in which the chief mechanisms for population regulation operate at the start of the life cycle. These models usually provide values close to observed values in the stream, but occasionally they do not work, for example during severe droughts. They can be used to illustrate the effects of management. For example, if natural egg density equals or exceeds an optimum value, then stocking with eggs or juveniles will decrease survival and hence the number of fish recruits to the population. It will also reduce the variation in the size of individual fish because high initial densities produce a more uniform fish size. Therefore overstocking of a valuable commercial or sports fishery can lead to lower catches and the absence of the rare, but large, specimen fish beloved by anglers.

In the early 1970's, I developed growth models from laboratory experiments using trout of different sizes. The fish were kept at a range of fairly constant temperatures and fed on natural foods, chiefly freshwater shrimps and the larvae and nymphs of mayflies, stoneflies and caddis-flies. These models provide a reasonably good description of trout growth in Black Brows Beck. They show that the fish are usually feeding on maximum rations, except during the first winter of the life cycle when growth surprisingly ceases (but not in the second winter!). When trout were kept on maximum rations in the laboratory, growth occurred in the temperature range 3.8-19.5°C with maximum growth at 13-14°C (see Elliott 1975a,b). When the daily ration was reduced, both the maximum and optimum temperatures for growth decreased markedly with decreasing rations. It is therefore impossible to state the best temperature for trout growth, without first knowing the amount of food eaten in a day. There

is also some variability in the growth of trout kept under identical conditions. It should be obvious by now why modelling growth in brown trout, or any other salmonid species, is difficult!

Although my growth models have now been used by other workers to investigate growth potential in at least forty stream populations of brown trout, I am all too aware of their limitations. The models have also been used to predict the effects on trout growth of changes in water temperature due to reservoir construction or possible climate change. In some of these studies, the models have been extrapolated well beyond their original conditions; annual mean water temperatures have been substituted for fortnightly mean values, no attempt has been made to allow for marked differences in diet, and predictions have been made for trout well outside the size range of the fish used in the original experiments. This illustrates one of the dangers of modelling, but the person producing the original model cannot be held responsible for its misuse by others!

There are several problems with the original 'prototype' growth models. First the experimental data were limited to 55 trout fed on maximum rations. The fish varied in weight from 5-281g and were kept at fairly constant water temperatures within the range 3.8-21.7°C. Two models had to be developed, one in the range 3.8-12.8°C in which the growth rate increased with increasing temperature and one in the range 13.6-19.5°C in which growth decreased with increasing temperature. Each model requires three parameters, only one of which, the weight exponent, could be said to have biological meaning. The models are deterministic and therefore it is sometimes difficult to decide if an observed growth rate in the wild is significantly different from that predicted by the model.

The new model originated as part of a PhD thesis by Robert J. Fryer who was supported by and NERC studentship and supervised by Professor Richard Cormack (St. Andrews University) and myself. The model was fitted to the original data set of only 55 trout. Since then, the new research project has enabled this data set to be increased substantially by experiments on 130 trout with a greater weight range of 1-325g. These new experiments were performed with less variable water temperatures than previously, using new tanks with temperature control of ± 0.2°C. Once again, the trout were fed on natural foods, chiefly freshwater shrimps. The new model has now been fitted to the larger data set and new parameter estimates have been obtained. This work is performed in collaboration with Margaret Hurley who is the Biometrician at this Institute.

Apart from the larger data set, the new model has several advantages over its predecessor. A single model covers the entire temperature range of 3.8-21.7°C and there are five parameters, one less than in the earlier models that had a total of six parameters. Each parameter can be interpreted in biological terms and therefore the model is conceptual unlike its predecessors. Three parameters define the upper, lower and optimum temperatures for growth on maximum rations, a fourth defines the growth of a 1g trout at the optimum temperature and a fifth serves as a weight exponent, as in the earlier model. The properties and adequacy of this new model are now being explored. This work will be summarized in the next Progress Report of the Atlantic Salmon Trust.

The growth rate of brown trout (Salmo trutta L.) fed on maximum rations. J.M. Elliott, 1975a. Journal of Animal Ecology, 44: 805-821.
The growth rate of brown trout (Salmo trutta L.) fed on reduced rations. J.M. Elliott, 1975b. Journal of Animal Ecology, 44: 823-842.
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.

PROBLEMS WITH ESCAPEE RAINBOW TROUT

(by Allen Edwards, Anglers' Co-operative Association)

The Anglers' Co-operative Association was founded in 1948 to use common law actions on the behalf of members to prevent pollution and to obtain damages for members. As recently when in the important case on the behalf of Savernake Fly Fishers and their fishery on the River Kennett.

The Fly Fishers first alerted the Anglers' Co-operative Association about the disruption to their fishing by rainbow trout of 2 to 3 inches in length in August 1989. There was a further escape of rainbow trout into what was a strictly preserved brown trout fishery in 1990. The Anglers' Co-operative Association instigated legal action against the trout farm alleging negligence and nuisance. The case was heard in the County Court at Swindon and in all 4 days were taken up in legal arguments. At the end of the proceedings Judge Dyer stated that there had been substantial nuisance and that the interests of Savernake Fly Fishers had been affected by the negligence of the trout farmers. He awarded £10,200 damages for the ruin caused to their season of native brown trout fishing by the invasion of hundreds of 2 to 3 inch rainbow trout. He further awarded costs estimated at £10,000 and £2,750 interest on the damages to the members of the Savernake Fly Fishers Club.

The case has highlighted the fact that there is no doubt that problems caused by escapee rainbow trout are on the increase. The Anglers' Co-operative Association already has in hand a further two cases on behalf of members, one on the River Nidd the other on the River Eamont.

The defendants in the River Kennett case, who were Gale and Ainsley owners of the trout farm near Marlborough in Wiltshire, have now appealed against the earlier decision of the Court. It remains to be seen how the appeal will be viewed, but it is the intention of the Anglers' Co-operative Association and the Savernake Fly Fishers to see the matter through to the bitter end.

REVIEW OF CURRENT LITERATURE ON SALMON RESEARCH AND DEVELOPMENT

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

GENERAL

1. Le développement du saumon atlantique au Québec: connaître les règles du jeu pour réussir. Collection Salmo salar no. 1. 1993. Proceedings of an International Symposium under the auspices of the Fédération québécoise pour le saumon atlantique, December, 1992. Available from FQSA, 4120. boul. Chauveau, bureau 240, Sainte-Foy, (Québec) G2E 5A6, price $40.

JUVENILES

1. Production of juvenile Atlantic salmon, Salmo salar, in natural waters. 1992. (eds.) R. J. Gibson & R. E. Cutting. Canadian Special Publication of Fisheries & Aquatic Sciences, 118, National Research Council Canada.

This is the proceedings of an international symposium to examine the ecology and population dynamics of young Atlantic salmon, with a view to applications in estimating yields of smolts, and assessing the status of Atlantic salmon stocks.

2. Testosterone is a potent odorant in precocious male Atlantic (Salmo salar L.) parr. 1991. A. Moore & A. P. Scott. Philosophical Transactions of the Royal Society of London. B. 332, 241-244.

Electrophysiological recordings from the olfactory epithelia have shown that testosterone is a potent odorant in precocious male Atlantic salmon parr. However, the olfactory epithelia of these fish only appeared to be responsive for a limited period of any time. The results are discussed in relation to the role of testosterone in the physiology of the salmon and its possible role as a behavioural pheromone.

3. Salmon investigations in the River Tay, 1991. G. Struthers, D. Stewart & M. MacDonald, 1992. Scottish Office Agriculture and Fisheries Department, Fisheries Research Services Report. No. 18/92. Covers the results of juvenile surveys of the River Braan and River Almond, the upper Tummel stock enhancement programme and smolt trapping and transporting on the River Lochay.

4. Comparative feeding, growth and movements of Atlantic salmon (Salmo salar) parr from riverine and estuarine environments. 1992. R. A. Cunjak. Ecology of Freshwater Fish, 1: 26-34.

The diet composition, movements and growth of parr in the estuary of Western Arm Brook, Newfoundland, were compared with those of parr from riverine habitats. Estuarine parr consumed a variety of prey, including many freshwater organisms (mainly insects), which

indicated a dependence on freshwater drift from the river. Prey of estuarine origin (amphipods and sticklebacks) were increasingly consumed between spring and autumn. Parr from outer estuary sites were very mobile compared with parr from the estuary site closest to the river mouth, which behaved more like parr in the river proper in displaying strong site fidelity. Movement patterns of parr were primarily along the shoreline.

5. Smolt size in relation to age at first maturity of Atlantic salmon (Salmo salar): the role of lacustrine habitat. 1993. M. F. O'Connell & E. G. M. Ash. Journal of Fish Biology, 42, 551-569.

Back-calculated growth and size of smolts were compared in two groups of river systems in Newfoundland. One group consisted of rivers dominated by lacustrine habitats while the other had rivers characterized by fluvial habitats. Back-calculated length at each age and smolt size was significantly higher for the rivers dominated by lacustrine habitats. Associated with this was a lower proportion of maiden large salmon in adult returns.

6. Is there a threshold size regulating seaward migration of brown trout and Atlantic salmon? 1993. F. Økland, B. Jonsson, A. J. Jensen & L. P. Hansen. Journal of Fish Biology, 42, 541-550.

The influence of variation in body size and growth rate on age of smolting in Atlantic salmon and brown trout was investigated in four Norwegian rivers. In salmon smolt ages varied between 2 and 6 years, and in brown trout between 2 and 7 years. Smolt age was negatively correlated with parr growth and positively correlated with smolt size. Smolt sizes and ages were more variable in brown trout than in salmon. The authors state that within populations smolt age depends on growth rate so that fast-growing parr smolted younger and smaller than slow-growing parr. They hypothesize that smolt size and age is a trade-off between expected benefits and costs imposed by differences in individual growth rate.

SEA LIFE

1. Migratory behaviour and growth of hatchery-reared post-smolt Atlantic salmon Salmo salar. 1993. N. Jonsson, L. P. Hansen & B. Jonsson. Journal of Fish Biology, 42, 435-443.

Individually tagged 1+ and 2+ hatchery-reared smolts were released in early spring and summer at the mouth of the River Imsa, south-western Norway. The post-smolts moved mainly northwards in the sea with the coastal current. The estimated mean migratory speed ($\pm$ SD) of those captured in the sea along the coast was 7.45 ($\pm$ 6.26) km day^{-1}, in the fjords it was 1.63 ($\pm$ 2.33) km day^{-1}. Many of the post-smolts ascended rivers the same year as released: 37.3% of the total number recaptured were caught in other rivers throughout the middle and southern parts of Norway. The fish recaptured in rivers were probably sexually mature and entered rivers to spawn.

MIGRATION

1. Factors affecting emigrating smolts and returning adults. 1993. Report of the Salmon Advisory Committee. Available from the Salmon Advisory Committee, Nobel House, 17 Smith Square, London SW1P 3JR, price £4.00.

Discusses the influences of environmental factors on smolt emigration and adult return and human activities affecting emigrating smolts and returning adults. General recommendations cover water quality, river flows, fish passes and protection of fish at intakes and outfalls.

2. Thyroid hormone levels in Atlantic salmon (Salmo salar) during the return migration from the ocean to spawn. 1993. A. F. Youngson & J. H. Webb. Journal of Fish Biology, 42, 293-300.

Serum thyroid hormone levels were determined in adult salmon of both sexes caught in the ocean and at a sequence of locations on their return migration to spawn. Tri-iodothyronine (T3) levels were greatest in fish caught in coastal or estuarine waters or in a river near head-of-tide. T3 levels were lower in fish caught in rivers throughout the angling season. Thyroxine (T4) levels were lowest in immature fish captured in the ocean in winter but raised in fish captured in spring; many of the latter group showed endocrine evidence of their becoming sexually mature. T4 levels were greatest in fish captured in coastal waters and progressively lower in fish captured in an estuary, near head-of-tide and in rivers. T4 levels in fish captured at tributary entry near spawning exceeded those in fish caught in rivers earlier in the year. In general, these data support the hypothesis that motor activity level in migrant fish is a determinant of thyroid status.

PREDATION

1. Predators of Atlantic salmon, Salmo salar, 1991. S. P. R. Greenstreet & J. R. G. Hislop. Scottish Office Agriculture and Fisheries Department, Fisheries Research Services Report No. 16/91.

A comprehensive record of predation at various stages of the salmon's life cycle by fish, birds and mammals.

PARASITES

1. Seasonal variations in the prevalence and infestation intensity of Gyrodactylus salaris Malmberg, 1957 (Monogenea: Grodactylidae) on Atlantic salmon parr, Salmo salar L., in the River Batnfjordselva, Norway. 1992. T. A. Mo Journal of Fish Biology, 41, 697-707.

The prevalence of Gyrodactylus salaris on both yearlings and older parr in the River Batnfjordselva was 100% throughout most of the year. With one exception, uninfested fish were only found in the winter and spring after the water temperature had fallen to almost 0°C for 2-3 months. In general, the abundance (i.e. the mean number of parasites per investigated fish) of G. salaris increased during the warm period of the year (summer and early autumn).

Abundance as high as 1153 and 4418 in early autumn was found on yearlings and older parr respectively.

HYBRIDIZATION

1. Incidence of natural hybrids between Atlantic salmon , Salmo salar L., and brown trout, Salmo trutta L., in Britain. 1993. W. C. Jordan & E. Verspoor. Aquaculture and Fisheries Management, 24, 3, 373-377.

Samples of salmon parr were taken for studies of geographical patterns in genetic protein variation from 43 sites in 23 river systems throughout Britain. Hybrids were found in 8 river systems giving an overall level of hybridization of 1.0% (34 hybrids among 3389 fish). The majority of these hybrids (22 individuals) were found at sites in the River Tweed.

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