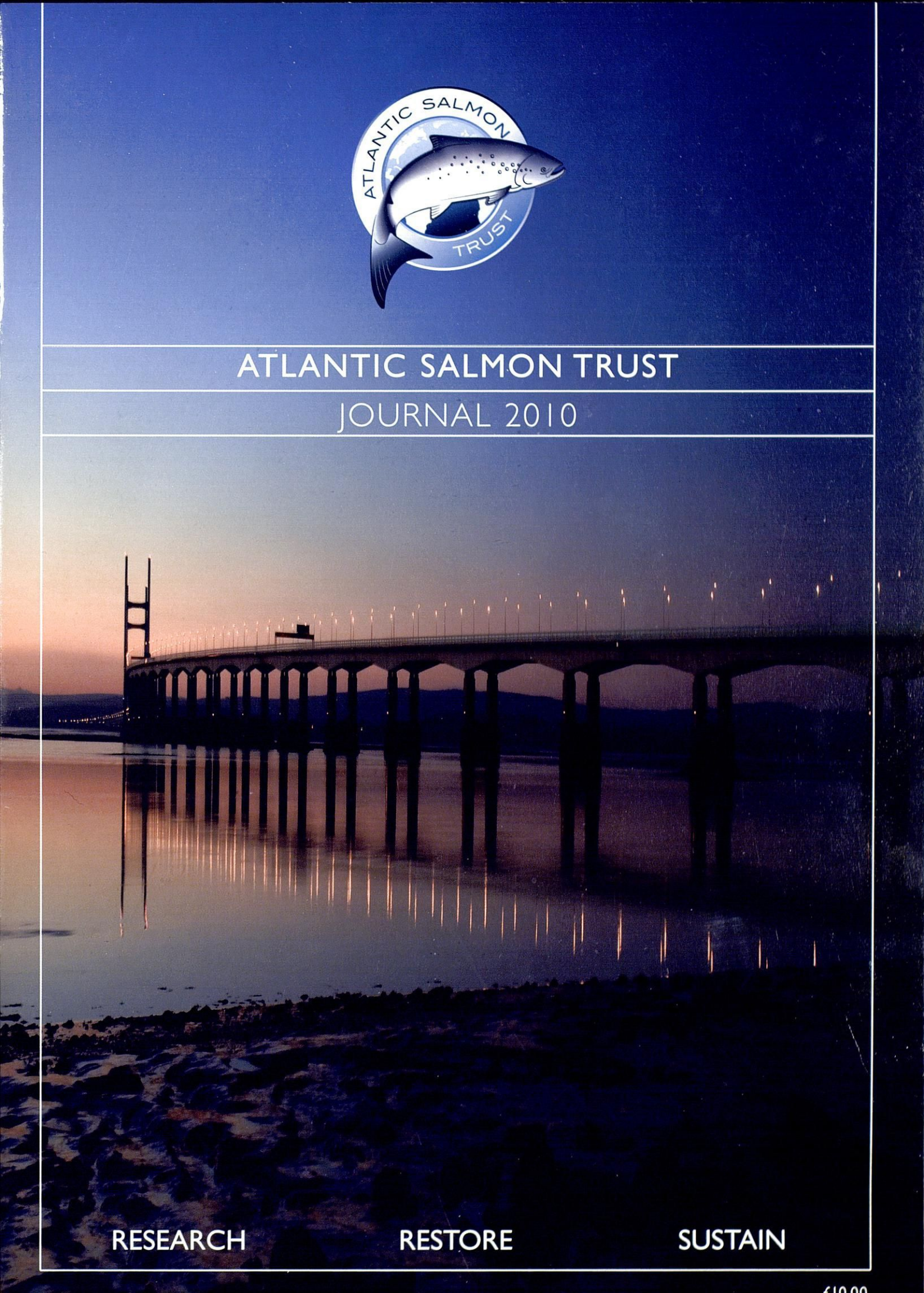
ATLANTIC SALMON TRUST

JOURNAL 2010



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WHAT IS THE TRUST?

- Founded in 1967, the Trust is an international organisation, based in the UK and Ireland, which champions wild salmon and sea trout. It does not represent any person or commercial interest, only wild salmonids themselves
- The Trust, through good scientific data and other evidence, supports efforts to conserve and restore wild salmon and sea trout to a sustainable level
- The Trust is an independent, registered charity, with a small staff, which receives no Government funding

WHAT ARE THE TRUST'S CURRENT ACTIVITIES AND PRIORITIES?

Promoting, taking part in or supporting:

- Research into the survival of salmon at sea and in its freshwater habitats
- Conservation of wild salmon and sea trout, as an essential element of biodiversity
- Reduction of any form of unsustainable exploitation, including mixed stocks fisheries
- Reduction of the negative impacts of salmon aquaculture on wild salmon and sea trout and their ecosystems
- Expansion of the AST's roles in education, information and communications
- Implementation of the AST's Fellowship scheme

WHAT DOES THE TRUST DO?

- Supports research into all aspects of the lives of wild salmon and sea trout, and their habitats and ecosystems
- Gives independent advice to governments, international and national authorities and to commercial enterprises
- Co-ordinates activities with other conservation, environmental, fishery, heritage and wildlife agencies and organisations
- Holds and supports seminars and workshops to investigate issues which affect the lives and habitats of salmon and sea trout
- Publishes scientifically robust reports, booklets and online material to inform, educate and stimulate debate
- Seeks to influence governments, regulators and public opinion on behalf of wild salmonids, using science-based arguments

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AGM & Members meeting: Tuesday 14th December 2010, Fishmongers' Hall.

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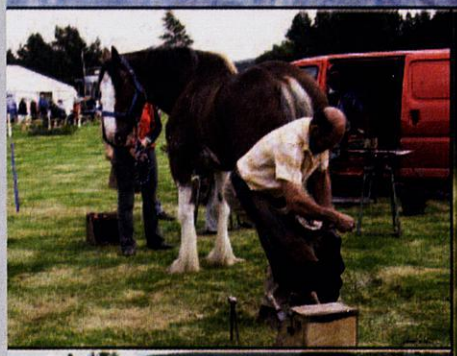
Highland Field Sports Fair

A day out for all the family!



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One of the most significant initiatives for AST going forward is the introduction of the Fellowships scheme, which will draw our brightest young scientists into the world of salmonid fisheries research. In this context, the NoWPaS (European (formerly Nordic) Workshop of PhD and Post-Doctoral fellows on anadromous Salmonids) network becomes even more significant. The aim of NoWPaS, which is sponsored by AST, is to build and maintain an international network to promote collaboration and exchange knowledge. Annual workshops have been run since the Workshop's inception in 2005, and over 150 early-stage researchers have given oral presentations, combined with lectures by invited speakers to each workshop. More about its work can be found at: http://www.nowpas.eu/

EDITORIAL

A revamp of the AST's communications is long overdue, and this Journal marks the first step in the process. More of our regular supporters are using the Internet than even a year ago, which has prompted us to renew the website (www.atlanticsalmontrust.org) and introduce a monthly e-newsletter from April 2010. We think there is probably still a place for the Journal on the basis of a glossy annual publication summarising the best of AST research and our future plans. But we are in no doubt that most of our business will be done by e-mail and through the Internet. We need to know what our readers think about these changes, so please let us have your thoughts about how the AST can extend its outreach to new audiences nationally and internationally.

This Journal focuses on some of the most controversial issues affecting wild salmon and sea trout, amongst which are the Marine Bill in England and Wales, the Severn Barrage proposal, salmon farming, mixed stocks fishing, hydro and wind power generation and news of SALSEA's massive research programme into the lives of salmon at sea. While the new data on the poor condition of 1SW and some 2SW salmon returning to our rivers via the Norwegian Sea is cause for concern, there are encouraging developments in the commitment being shown by the EU through its network of Interreg projects (Living North Sea, Celtic and AARC Projects) with their ecosystem approach, using the sea trout as a key biological indicator. With more than £15 million allocated to these marine and coastal projects on the Atlantic seaboard of northern Europe, there is real hope that increased conservation efforts will follow.

The emphasis on acquiring scientific data highlights the different roles of research and lobbying organisations. As an eminent fisheries scientist said to me recently, "science organisations prepare the bullets for the lobbying organisations to shoot". With public trust in science damaged by manipulated data in the climate change debate, and with wild salmonid groups facing an array of opposing political and commercial interests, we need to be sure that we are clear about the distinction between science and lobbying. If we fail to emphasise the independence and objectivity of our scientific data we will lose the trust of our supporters, lose influence with government and the media, and ultimately play into the hands of those who oppose us. It is therefore vitally important that the wild fish interests distinguish between bona fide scientific data and lobbying for a particular cause. We must at all costs avoid confusing the two, because by doing so our interests will be damaged.

I hope you enjoy this issue of the AST's Journal. Please tell us what you think of it and, when you do, please be sure to give us your e-mail address!

Tony Andrews, Chief Executive

Please note that articles do not necessarily reflect the Trust's views.

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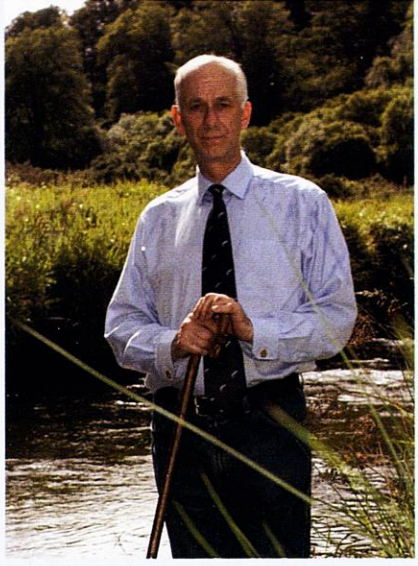
From the Chairman

Sir Robert Clerk



2009 is a year that most of us will probably try to forget as quickly as possible. For many fishery managers and anglers it was a year in which concerns about declining salmon stocks came sharply into focus, with very disappointing runs of spring fish and very late runs of grilse in many rivers. However, on a brighter note, an unexpected abundance of sea trout in excellent condition was widely reported and the SALSEA-Merge project, with which the Atlantic Salmon Trust has been closely associated, has continued to surprise us with the number of post-smolts captured at sea, which provide a wealth of information that is now being analysed.

I mentioned in our Summer Newsletter the possibility of the Atlantic Salmon Trust and other like minded organisations coming together and maybe even establishing a new unified organisation that would promote scientific research for the benefit of salmonids. Lengthy and constructive discussions took place, but in the end it was decided that the status quo should prevail. Far from being unproductive, the time spent on these discussions has led to a refocusing of the Trust's aspirations and objectives.

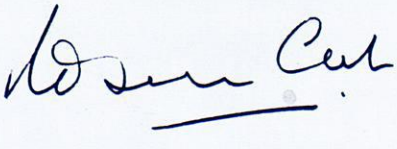
When the Atlantic Salmon Trust was founded over 40 years ago, virtually all salmonid research was undertaken by the staff of government agencies and academic institutions. For many years there was a role for the Trust in commissioning and undertaking fieldwork and engaging in practical research projects. John Webb, the Trust's biologist, became widely known and respected. However, following the establishment of many Fisheries Trusts both north and south of the border, together with their very effective co-ordinating bodies, the Association of Rivers Trusts and the Rivers and Fisheries Trusts of Scotland, there are many biologists employed throughout the country undertaking research and providing sound advice to fishery managers and owners.

There is now no justification for the Atlantic Salmon Trust engaging directly in research or in providing an advisory service as has been done in the past. Therefore, with regret, we decided that we could not continue to retain a directly employed biologist, and after many years' faithful service John Webb left the Trust in late 2009. This winter has also seen the retirement of Dr Richard Shelton, the Trust's Research Director since 2002, who has done so much for us, far beyond the call of duty, in many different ways.

It is with great pleasure that we welcome Professor Ken Whelan who has joined us in a part time executive role from the beginning of 2010 as Dick Shelton's replacement and our new Research Director. The Trust is very fortunate that Ken, a very distinguished biologist and passionately keen angler, has agreed to take over from Dick. I am sure he will prove to be a great champion of our work.

We believe that the Trust's inevitably scarce resources can now best be employed in enabling others to undertake research which we wish to promote, an initiative we plan to support through the establishment of Research Fellowships which the Trust will part-fund in the future. We are also developing a new website which we believe will place the Trust as the point of contact for anyone seeking information about salmon and sea trout, be they fishery managers, anglers or anyone else with an interest in these wonderful fish.

So, 2009 has been a year of change for the Atlantic Salmon Trust, but change which I hope will increase our effectiveness. Fishery managers are confronted by difficult times ahead; climate change and the burgeoning aquaculture industry are but two factors which have the capacity to be severely damaging to wild stocks of salmon and sea trout. If ever there was a time when good science and common sense need to be applied in fisheries management this must be it and the Atlantic Salmon Trust, along with others, will do its best to promote the adoption of both wherever possible.



Chief Executive's report Scotland and International

Tony Andrews, Chief Executive

Concern over numbers of wild salmon and sea trout in the main Scottish rivers prompted the Association of Scottish Salmon Fishery Boards to recommend 100% catch and release in the Spring of 2009, and for fishery boards throughout the country to adopt stricter controls on the killing of fish.

While some rivers, most notably the Aberdeenshire Dee, recovered later in the year, it is now apparent that 2009 was another year of decline. 2010 appears to show no improvement, not yet anyway. Sadly, we cannot escape the bleak prognosis for the future abundance and health of our salmon and sea trout.

Early indications coming from the SALSEA research project and from sample-based research at the Scottish Oceans Institute suggest that it is not just the numbers of returning salmon that should be giving cause for concern, but also the poor condition of 1SW and some 2SW fish returning to Scottish rivers via the Norwegian Sea. The reality of the current situation throughout the North Atlantic Basin, affecting most countries with runs of Atlantic salmon, is that the numbers and the condition of returning adult salmon are such that we should be seriously worried about their ability to gestate and deposit sufficient quantities of good quality fertilised ova to maintain populations above conservation levels. One of the problems faced by managers of wild salmon stocks is that the emerging scientific data is unable to keep pace with the continuing year-on-year decline of stocks.

Advice being given to politicians by civil servants favours the status quo at a time when, in the face of rapid environmental changes, some sort of emergency precautionary approach should be seen as necessary.

In these recessionary times it is clear the economic imperative takes precedence, and environmental sustainability becomes a lower priority. It may be that not everyone in authority, especially in the European Commission, views priorities for the environment in this way.

Sea trout have quickly risen up the agenda, as Dr Nigel Milner described in his article, 'The Rise of the Trout' in our last Journal. The European Union is now funding at least three major coastal and marine projects in which sea trout play a prominent part. These fish are sentinels for our coastal and freshwater environments, because they are easier to measure and assess in terms of their wellbeing than salmon are. The AST, with its partner, the

A 5lb Orkney Sea Trout

Sea Trout Group, is making a priority of promoting the importance of sea trout as biological indicators, a status already recognised in ecological circles through the UK Biodiversity Action Plan.

2010 is Global Year of Biodiversity.

It is depressing that, against the direction of international consensus on what constitutes good migratory fish management, the Scottish Government seems content to allow the arcane practice of mixed stocks exploitation of both salmon and sea trout to continue, not to mention an unwillingness to address

The Dee at Banchory

models from abroad of good husbandry in many aspects of salmon aquaculture. A good example of ignoring best practice is that in Scotland it is permitted for open smolting cages to be located in freshwater lochs where wild migratory salmonids are present. The precedence given to socio-economic considerations over the environment and biodiversity may prove to be short-sighted when the real costs of damage to the genetic diversity of our natural heritage are better understood.

International priorities

International concern for the precarious condition of salmon stocks will highlight salmon aquaculture at the 2010 NASCO conference in Quebec, and in 2011 the focus will be on the impacts of mixed stocks exploitation. As research and mapping of populations of salmon gather momentum, and our knowledge grows, the implications for management will become much clearer. The same applies to sea trout, whose feeding patterns are closely linked to the inter-coastal zone and who are endangered by the impacts of aquaculture, parasites and coastal pollution throughout their lives, with no escape into the deep ocean as salmon do. It is no exaggeration to claim that salmon and sea trout taken together can give us massive amounts of data on the state of the marine environment, and on how sustainably we are managing our estuaries and foreshores. The important thing about sea trout management is that it is within our power to influence conditions during most, if not all, of the life of the fish, in contrast to the salmon whose deep sea odyssey takes it away from our immediate control.

The AST's research and science base

With the retirement of Dr Richard Shelton as Research Director, there was a risk that the AST's work on the marine environment might suffer. The appointment of Professor Ken Whelan, former President of NASCO, and adjunct professor at University College Dublin, has ensured that this will not happen, particularly because Ken was one of the architects of the SALSEA (salmon at sea) project, and has decades of experience of working with sea trout in the context of the expanding aquaculture industry. Ken knows The UK migratory fisheries world well and is recognised internationally for his leadership and research in the areas of salmon and sea trout management.

AST's priorities of work are to prepare for the NASCO conference with a paper from Ken Whelan setting out a possible strategy for assessing and managing risks to the wellbeing of wild salmonids from salmon aquaculture. His paper will build on the considerable amount of research already in the public domain and recently summarised by Janina Gray for the Salmon & Trout Association, but which has not been collated and used collectively before. It goes without saying that a prerequisite for success in persuading the aquaculture industry to adapt its practices to achieve a better level of sustainability will be to open up a proper dialogue with the industry's leaders, based on transparency, objectivity and good science. The Honorary Scientific Advisory Panel has already been strengthened with the additions of Dr Andy Walker, an acknowledged expert on sea trout, and Colin Adams, Professor of Freshwater Ecology at Glasgow University.

In October 2011 NASCO will hold a 'Salmon Summit' in La Rochelle in France. Aimed at managers and decision makers, this important conference will disseminate the findings of the SALSEA research project to enable managers to appreciate the insights, implications and applications that the SALSEA data have for management. Taken in conjunction with genetics research and mapping, we anticipate that there will be a step-change in our understanding of the lives of salmon.

We now need to ensure that there is a similar improvement in understanding the lives and ecology of sea trout, and that is a job for the AST and its partners.

Office & staff matters

The AST will continue to operate out of its office overlooking the tidal reaches of the River Tay until 2012. In the summer of 2010 our Deputy Director, Neil McKerrow will be retiring. He will be greatly missed for his prudent management of the Trust's finances, running the auction with Jenny Sample and for his commitment to good governance and administration. Neil has ensured that the AST ship has remained on an even keel throughout the turbulence of the last two years of recession. We owe him a big debt of gratitude. Thank you, Neil.

In the autumn of 2010 Jenny Sample, our administrator, book keeper and organiser of the auction, now the largest of its kind anywhere, and the voice of the AST to anyone making contact with us by telephone, will begin working part time with continuing responsibility for the auction and looking after our supporters.

In England and Wales, Ivor Llewelyn will continue as Deputy Director with responsibility for developing AST outreach throughout both countries, working with our partners, principally the Association of Rivers Trusts and the Salmon & Trout Association.

We are currently advertising for an administrator/office manager to run the office and provide support to the Chief Executive, research team and the Board of Directors. From the autumn of 2010 the AST will employ two full time staff, two part-time staff, and the Research Director and Communications Consultant.

Communications.

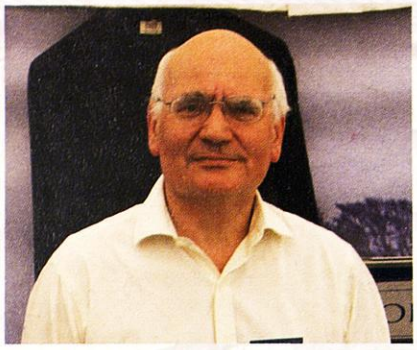
Up to now the AST has depended on a range of printed publications, supported by a relatively 'passive' website, to promote its activities. Now, with the need to extend our messages to a wider public, as well as reaching scientists, the media, river and fisheries managers and our growing supporter base, we will be launching a far more lively and interactive website with monthly e-newsletter updates plus one-off updates when we have important news to disseminate. The Journal in its glossy, boardroom format, will come out once a year. AST 'Blue Books' will normally be published on the website and, where there is the demand, we will print copies for sale. This new communications strategy will be coordinated by Fiona Cameron, our communications consultant, who is also an acknowledged expert on the Scottish salmon aquaculture industry.

The future

The AST depends on its supporters and its revenue earning activities for its income. We need to build on this very welcome though somewhat erratic stream of money which has served us well up to now. But if we are to realise our ambition of working closely with RAFTS and ART and contributing to strategic level projects in research, awareness raising and management, then we need to access project funding. In the next few months we will be launching the AST Fellowships Scheme to bring the brightest young scientists and researchers into the salmonid fisheries sector through participation in projects, always with a practical application for managers on the ground. By forming a strong triumvirate of science-based organisations dealing with international, national and regional issues as they affect wild salmon and sea trout, RAFTS, ART and AST can coordinate the requirements of rivers and fisheries managers across the UK better than ever before.

Trust News – England & Wales

Ivor Llewelyn, Director England & Wales



The Marine and Coastal Access Act 2009

The Marine Bill became law 10 years after the Warren review was published. Most of the changes to salmon and freshwater fisheries legislation that it recommended have finally been implemented.

The main changes to the law were described in the Summer 2008 Journal. In summary the Act:

- reforms the Net Limitation Order (NLO) system to remove the obligation to hold a public enquiry if a single licence holder objects to a proposed change and to make it possible to remove a licence from someone dependent on fishing for their livelihood; instead, such licence holders will be eligible for compensation;
- gives the Environment Agency new powers to control historic installations such as the Severn putchers. These have licences of right, but it will now be possible to impose conditions on the use of these licences to conserve stocks;
- removes fisheries owners' automatic right to compensation for certain byelaw changes; compensation will now be discretionary and during the Act's passage through the Commons the Government stated that it would not expect compensation to be paid for changes needed to conserve stocks;
- introduces a new system of authorisations rather than licences for fisheries judged to pose particularly high risks to stocks;
- enables the Environment Agency to introduce emergency byelaws, with immediate effect, in response to unforeseen problems;
- gives the Government powers to reform, via secondary legislation, rules on moving and stocking live fish.

The Act also makes important changes to the management of inshore sea fisheries, with Inshore Fisheries Conservation Authorities (IFCAs) replacing Sea Fisheries Committees (except in Wales, where inshore fisheries will in future be managed by the Welsh Government). One consequence of this change is that IFCAs will take over responsibility from the Environment Agency for the management of sea fisheries in the estuaries of a number of salmon and sea trout rivers. The Government has made it clear that IFCAs will have a duty to ensure that sea fisheries in these estuaries (and elsewhere) do not adversely impact on salmon and sea trout, and has given an assurance that they will take this duty seriously. In addition, an amendment was introduced in the Commons that gives IFCAs the power to delegate their functions in estuaries to the Environment Agency, a change that the Trust welcomes.

Since the Warren review was published the Trust has been urging the Government to introduce new legislation, and we strongly supported all these measures. Our only regret is that we did not get a new, completely rewritten salmon and freshwater fisheries Act, as the review recommended. The new Act amends several previous Acts, in particular the Salmon and Freshwater Fisheries Act 1975; that itself is a consolidated and amended version of the 1923 Act which in turn consolidated and amended the relevant Victorian legislation. All this does not make the law easy to understand.

Live fish movements

The Government is now consulting on a new system to manage live fish movements which will bring together and reform current systems for native and non-native fish. Anyone wishing to stock fish into a lake, river or pond (excluding garden ponds) will need a permit from the Environment Agency which will list the type and number of fish that may be stocked, and may impose conditions; for example a native fish, such as barbel, stocked outside its natural range might have to be kept in secure and enclosed waters. Permits will cover particular locations, and can be valid for a number of years. Those supplying fish for stocking will have to be licensed, and all movements of fish will have to be accompanied by the correct documentation. For movements which involve a risk to the environment or other fish the Agency will require advance notification, and the stocking of most non-native fish will be banned.

Unauthorised movements of fish pose serious risks to biodiversity, in particular via the transmission of disease and parasites – *Gyrodactylus salaris* is an obvious example. The Trust has therefore welcomed these proposals, which in our view represent a major improvement in biosecurity.

Fish passage

I previously reported that the Government had issued proposals to reduce barriers to fish migration, proposals that the Trust strongly supported. Regrettably, the Government has now announced that the proposed measures will not be introduced until May 2011 at the earliest. The delay is due to concerns at the possible cost of the measures to the owners of barriers at a time of economic difficulty.

The Trust has made its disappointment at this delay clear to the Government. We are particularly concerned that defects in the current legislation are not being addressed at a time when demand for new, small-scale hydropower schemes could lead to increased barriers to migrating salmon and sea trout. We have been assured by the Government that the Environment Agency will, wherever possible, use its licensing powers to ensure that new developments do not adversely affect fish passage. We will be keeping a close eye on the situation.

Severn Tidal Power *(see cover picture)*

The Government published its response to the first phase consultation in July 2009 (see our Summer Update). Perhaps predictably, it has retained the five short-listed schemes, including a barrage from Cardiff to Weston (the Severn Barrage), but it has initiated a scheme to examine the potential of new and developing technologies. Work is continuing on the feasibility study and on the Strategic Environmental Assessment of the shortlisted options; the Trust has participated in a workshop on the impacts on migratory fish. The Government plans to undertake a second consultation once this work has been completed; it has said that there are three possible outcomes:

- to offer a package of support for a preferred scheme or schemes and begin full feasibility work in 2011 towards a planning and consents application;
- to wait and see whether other low-carbon technologies (such as other renewables, nuclear and Carbon Capture and Storage) deliver as expected before deciding on the need for Severn tidal power. This would also allow time to see if new embryonic technologies develop;
- not to support a scheme (although this does not necessarily preclude any development in the future).

The scale of the impact a barrage would have on the Severn estuary, and the damage it would cause to wildlife and the environment, is brought out in a report by the Wildlife Trusts: Energy at Any Price? This can be found at http://www.wildlifetrusts.org/severnestuary The Trust continues to believe that the Severn barrage is not a feasible option, given the cost (£21 billion is likely to be a considerable underestimate) and the impact

River Frome in Dorset

on the environment. We are working with other environmental organisations to persuade whichever party forms the Government after the election to pursue more cost-effective, sustainable and innovative ways of harnessing the Severn's tidal power.

Hydropower

The threats to salmon and sea trout from efforts to produce renewable energy are not confined to tidal power; there is increasing interest in in-river hydropower schemes. We are not opposed in principle to these – we support efforts to generate more electricity from renewable resources – but we are concerned at the potential impact on migratory fish of a proliferation of hydropower schemes, often of very marginal value.

These schemes have the potential to cause significant damage to fish migration:

- The weirs required to create the head of water necessary to drive turbines can cause barriers. Unless sufficient water flows over the weir, or through an adjacent fish pass, fish will not be able to reach spawning areas.
- Weirs can also cause migratory fish to mass in unnaturally large shoals below them, attracting increased predation, poaching and the risk of disease outbreaks, especially in warmer weather and higher water temperatures. This can be a particular problem when the weir is the first barrier salmon and sea trout encounter at the head of the tide on their return migration to their natal river.
- Where mill leats or side streams take water away from the main river channel, migratory fish will become confused as to the route they should travel upstream. Evidence has shown that, unless efficient fish passes are provided, fish disorientated in this way may not find alternative migration routes, and will be lost to the breeding stock completely.
- Turbines can represent a very serious threat to salmon and sea trout smolts on their outward migration. Screening of an adequate mesh size must be properly maintained and positioned in such a way as to act as a deflector to fish as well as a physical barrier.
- Even if fish can get past an individual barrier, the cumulative impact of successive barriers on the ability of fish to reach their spawning grounds must be considered. The effect of barriers to fish migration need to be assessed over the whole course of a fish migration, from the estuary up to the spawning redds.

For these reasons the Trust supports a position paper on hydropower produced by the Institute of Fisheries Management, and we would like to see its principles adopted as Government policy. *The text of the position statement can be found at* http://www.ifm.org.uk/news/IFM_Hydropower_position_statement_FINAL.pdf

Sheep Dip

The Trust has campaigned for many years for a ban on the use of cypermethrin sheep dips; very small quantities of cypermethrin can have a devastating impact on aquatic invertebrates. The sale of these products was temporarily suspended by Defra in February 2006, and we and other fisheries and environmental organisations have been seeking a permanent ban ever since.

We are now very pleased to be able to report that, at the request of the manufacturers, the Marketing Authorisations for all cypermethrin sheep dips have been withdrawn. This means there are now no cypermethrin sheep dips which can be sold legally in the UK.

The Warren Review, 10 Years On

With the passage of the Marine Act, it is worth looking back at what has been achieved in the 10 years since the Salmon and Freshwater Fisheries Review, better known as the Warren Review after its chair, Lynda Warren, was published.

The progress on fisheries management has been encouraging; there has been a very significant reduction in netting, particularly in the N.E. coast drift net fishery; there is a continuing commitment to phase out mixed stock fisheries; a ban on the sale of rod caught fish and tagging of net caught fish has been introduced; measures are in place to protect spring salmon; virtually all the legislative changes the Trust and other fisheries organisations have been pressing for have been achieved. As a result, net catches of salmon have fallen from an annual average of 38,000 fish over the five years prior to the N.E. coast buy-out (1998-2002) to an average of 10,000 fish for the period 2004-08. Over the same period, average annual rod catches rose from 15,000 fish to 22,000 while the percentage of salmon released by anglers rose from 31% to 55%. In addition, salmon from English and Welsh rivers have benefitted from the ending of the Irish drift net fishery. Overall, therefore, there has been a dramatic reduction in the number of returning salmon killed by fisherman.

Despite all this, and modest increases in the number of salmon rivers meeting, or close to meeting, their conservation targets, salmon stocks remain at low levels, and it has become increasingly clear that environmental factors are the principal cause of the failure of stocks to respond positively to the substantial reduction in levels of exploitation. There have been successes. Synthetic pyrethroid sheep dips, identified by the Warren review as a major threat to all forms of aquatic life, are no longer used, and subsidies paid under the Common Agricultural Policy are no longer linked to production. But diffuse pollution from agriculture, including soil run-off leading to siltation, remains a significant problem, as does pollution from urban areas and roads. Excessive abstraction of water, particularly in the South, continues to threaten many rivers, and barriers to fish passage (including the increasing threat from new hydropower developments) make it difficult for salmon and sea trout to access spawning areas. All these factors reduce the chances that fish will breed successfully, that their eggs will hatch and that young fish will survive. And while falling rates of survival at sea are also a key factor for salmon, it is not known to what extent this is influenced by the condition of emigrating smolts – there is evidence that pollution can reduce the ability of smolts to survive in salt water.

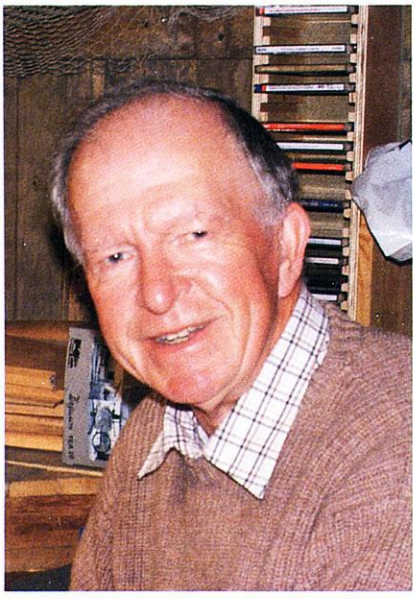
In these circumstances, the work of the Trust in England and Wales, in common with other fisheries organisations, is increasingly focused on addressing these environmental factors. The Water Framework Directive is playing a very useful role here. The state of fish stocks, including those of salmon and trout, is one of the main reasons that rivers fail to achieve their objectives under the Directive, and its implementation provides an unprecedented opportunity to deal with habitat degradation and problems of fish passage. But if we are to persuade the Government to take effective action, we need to be able to draw on convincing evidence, based on science, to show the causes of these problems and how they affect the wider environment. The Trust's efforts to encourage research and to disseminate the results continue to play a key role in the conservation of salmon and sea trout in England and Wales.

Dick Shelton was until 2001 the director of the Freshwater Fisheries Laboratory at Faskally. In 2002 the Atlantic Salmon Trust secured his services as Director of Research. He already had a reputation as something of a polymath, with his wide interest in natural history and the sea. It was the latter – his love of ships, the sea and the foreshore – which he was able to employ in developing research into the lives of salmon at sea. The early experiments with his Norwegian shipmate and scientific colleague, Jens Christian Holst, played no small part in the successful bid by NASCO for funding the massive scientific programme SALSEA, which has already taught us much about where salmon go, how they get there, and what they eat at sea, with all the management insights that this new knowledge can give us. Dick's contribution was immense, as anyone involved with salmon conservation, management or research will recognise. The AST is proud of its long association with Dick Shelton, and we wish him well with his writing career after his two highly successful books, 'The Longshoreman' and 'To the Sea and Back - the heroic life of the Atlantic Salmon'. Au revoir, Dick.

'Au revoir' from Dick Shelton

It seems rather a long time ago that, in a moment of boredom at being confined indoors for too long, I shot a 'cushie doo' (wood pigeon) out of the window of the Gatty Marine Laboratory in St. Andrews. The Director, being of urban origin and unused to country ways, thought that a piece of electronic apparatus had exploded and expressed his concern. Not long afterwards, I was offered a succession of jobs by the Ministry of Agriculture, Fisheries and Food and the Scottish Office, whose Fisheries Laboratories had made something of a name for themselves by developing 'theories of fishing' that described the effects of fishing and natural mortality on fish populations and showed how, by combining the control of size at first capture with that of fishing effort, it would be possible to make the most of the large stocks of fish and shellfish which had accumulated after the Second World War.

It was soon realised that the management requirements of the various species differed greatly. For fish like cod, which take a long time to fulfil their growth potential, the key to wise management lay in delaying their capture until a good proportion of the catch consisted of large, and therefore older, fish, a management regime which also safeguarded the spawning stock. For fast-growing creatures like herring and squid the management priority lay less in allowing adequate opportunity for growth but in ensuring that there were always enough spawners to



sustain the next generation. For a time all went well but, as soon as the need arose to apply the unpopular restrictions that theory required, the politicians of the day proved unequal to the task with the result that, not only are the fisheries of the north east Atlantic now more impoverished than they have ever been, but the very ecosystems upon which they depend have been grossly distorted.

The wild Atlantic salmon is unusual among fishery resources of high unit value in that it is only lightly exploited by the fisheries directed at it and hardly exploited at all before it has attained maturity. Furthermore, the decline in heavy industry and improvements in sewage treatment have allowed many a previously polluted salmon river to recover its fish. By rights, salmon populations should now be at record levels with many large fish among them. In fact, the numbers of wild Atlantic salmon in the southern sector of their range (which includes all of the populations spawning in the rivers of the British Isles) have never, in my experience, been lower nor more lacking in large, multi-sea-winter fish. The truth of the matter is that the current state of our wild salmon stocks is almost entirely a function of the hostile environmental conditions they encounter at sea. Undoubtedly, some of the environmental hostility is anthropogenic, including losses to fisheries for other species, the complex, deleterious effects of intensive aquaculture, the distortion of marine food webs by over-fishing and the 'stoking up' of grey seal populations by the disgraceful practice of dumping large quantities of dead and dying fish at sea. Among the natural environmental factors, none is more important than the effects on growth opportunity of the increase in the mean temperature of the northern oceans inseparable from the warming phase our planet is currently enjoying. There is little we can do about that, however much we carpet our lovely hills with ugly wind farms, but plenty we can do about the other things. Here surely is another opportunity for the Atlantic Salmon Trust to demonstrate again the resolute leadership for which it has long been renowned. I wish it well.

Dick Shelton

… and to John Webb – AST Field and Research Biologist

During the 23 years of John's service as Atlantic Salmon Trust Biologist he established a reputation for delivering high quality work in research and practical aspects of restoration and management of wild salmonids and their habitats. As a respected researcher within the UK fisheries community and abroad, the AST benefited greatly from his numerous collaborations and research, often published in peer-reviewed journals and papers in the UK and abroad.

His work for the AST included research on adult salmon and sea trout behaviour, early running salmon biology, and identification and impact of farmed escapes. Some of this work, such as in fisheries bio-security and catch and release, established him as a leader in the field of wild fish conservation and welfare.

John's unique approach to field work is that he takes the viewpoint of the fish, which enables him to understand potential problems and to communicate sustainable and cost effective solutions to local managers. His empathy for migratory fish enables him to offer advice to the renewable energy industry and fisheries managers needing advice on adapting obstructions to the safe passage of migratory fish. His knowledge of the fish and fishery science, combined with an innate appreciation of the needs of wild fish, makes him uniquely valuable as a source of sound advice.

The advisory role of the Atlantic Salmon Trust's biologist is now being done by fisheries trusts throughout the UK. We are immensely grateful to John for all he has done for wild salmon and sea trout management. It is a sad irony that without John's work many of the Scottish trusts, especially on the West Coast, would not have been able to develop as successfully as they have. He will be much missed by his colleagues in the AST, and we all wish him the very best for the future.

John Webb (right) with the Chairman.

The 21st century has not heralded any let-up in the pressure on our rivers, and it is becoming increasingly urgent that we understand more about the effects of different rates of flow, so that we can better manage their impacts on migratory fish. Effective management of flows will be vital if the Water Framework Directive's target of all rivers achieving good ecological status is to be met. As work on this has progressed, it has become increasingly apparent that we have insufficient knowledge to predict how differing flow rates will impact fish. Ivor Llewelyn reports on the River Flows Symposium and Workshop, organised by the AST and held in York in January 2010, which underlined just how problematic it is to devise appropriate management systems.

Managing River Flows for Salmonids: From Science to Guidance

Atlantic Salmon Trust Symposium and Workshop

One of the Trust's main roles is organising conferences that bring together leading scientists, fisheries managers and others to share information on scientific advances in our understanding of salmon and sea trout and of their environment. Our most recent initiative is two linked events, a symposium and a workshop, to examine river flows.

Our rivers are heavily used, with water drawn off for drinking, for use in farming and industry and, increasingly, for hydropower generation. If too much water is taken, fish and other forms of aquatic life may not survive. Salmon and sea trout will be particularly threatened, as they need ample quantities of water to migrate

Hughenden Stream, one of the many chalk rivers in the Chilterns under pressure.

upstream to spawn. For this reason abstractions of water from rivers are regulated to maintain adequate flows, and in salmon and sea trout rivers flow standards have often been set according to the flows needed for upstream migration.

River flows, though, have a wider impact. For salmonids, they affect all life stages, including downstream as well as upstream migration, spawning success and egg and juvenile survival. Changes in flow patterns can also lead to changes in channel structure, in species diversity and in all aspects of the ecosystem, and so are of critical importance to all forms of aquatic life in rivers, estuaries and even coastal zones.

Because of these multiple effects, flow management of salmon and sea trout rivers needs to move from simple standards, based on upstream migration, to flow regimes that respond to the requirements of many fish, and other, species over their full life cycles, and which encompass dynamics of flow on daily to seasonal scales. However, up to now our knowledge of flows and their effects has not been adequate to implement such a complex system successfully.

Taking a fresh look

It is now 20 years since the last AST workshop devoted to river flows, and in the intervening years there have been major advances in our understanding. In addition, rivers themselves are coming under severe pressure, with the effects of increasing demands for water likely to be made worse by the impact of climate change, and growing interest in low-head hydropower schemes. Moreover, in the last three years, under the auspices of the EU Water Framework Directive, flow standards to protect fish, aquatic insects and plants in UK rivers have been developed; these have been based on expert opinion and in most cases lack a sound evidence base. For these reasons, the Trust believed that it was timely to look again at the possibility of developing scientifically based and integrated flow objectives.

We are doing this in two stages. The first stage was a symposium held in York in January; this was open to all, and gave scientists, regulators, mangers and others the opportunity to hear and discuss presentations on the latest scientific thinking and on current flow management methods. It was followed by a smaller workshop, with invited participants, to distil the outcome of the symposium into practical best practice guidance for regulators and managers. This was held in Pitlochry at the beginning of March.

The symposium was attended by 150 people from over 70 different organisations. It addressed four topics in separate sessions: the scientific basis for setting flow requirements; the changing environmental and legislative context; setting and applying flow standards and managing flows; advances in scientific methods and analysis. Each session ended with a discussion of the key issues raised by the paper. The points raised in these discussions, together with the papers themselves, provided the basic material for the workshop.

Most of the symposium presentations will be published as peer-reviewed papers in a special edition of the journal Fisheries Management and Ecology. There is also a web-based Symposium Report, containing summaries of the papers and an overview of the debates, links to which can be found on the AST website. The guidance from the workshop will be published and made available to all with responsibility for, or an interest in, regulating river flows; it will also be on the web.

Hughenden Stream.

The SALSEA Programme 2008 to 2011

Professor Ken Whelan – Chairman International Atlantic Salmon Research Board
Dr Jens Christian Holst – Scientific Co-ordinator, SALSEA Merge Programme

A major factor influencing salmon abundance is increased mortality at sea. Indeed, there is unequivocal evidence that the return rates of salmon from their sea feeding grounds are just one third to one half of what they were forty years ago. In 2002, NASCO (North Atlantic Salmon Conservation Organisation – www.nasco.int), established the Inter-national Atlantic Salmon Research Board (IASRB) to coordinate a major research programme which would address the issues involved. The main objectives of the Board are to cooperate on research into the causes of marine mortality, maintain an inventory of relevant research and identify gaps and raise funds to finance major new research projects relating to aspects of marine survival of Atlantic salmon.

Following a series of detailed scientific meetings the initial SALSEA (Salmon at Sea) programme was presented to the IASRB at its Annual Meeting in 2005. This was a major programme covering the full marine range of the Atlantic salmon, from Canada and North America in the west to the Kola Peninsula in the east. Once the plan was agreed the Board set about seeking research funding, both in Europe and North America. A wide range of science funders, foundations and private companies were canvassed by the Board. Both the Atlantic Salmon Trust and the TOTAL Foundation (www. foundation.total.com) agreed to contribute funding to the project. In 2007 a consortium of 20 partners was formed to apply for funding under the EU FP7 call for research proposals. The submission was successful and research work commenced in April 2008 on the SALSEA Merge project, which constitutes the European and North East Atlantic component of SALSEA. This project is unique in that it includes the public and private sectors, NGO groups and a wide range of European Universities. It is also the largest Atlantic salmon survey ever undertaken, involving 15 research labs and over 50 scientists and technicians.

Crew of the Celtic Explorer.

Deepening our understanding

SALSEA Merge is designed to provide a unique insight into the spatial and ecological use of the marine environment by different regional and river stocks, which are known to show variation in marine growth, condition, and survival. Different stocks use different marine zones whose environmental conditions will potentially vary independently, differentially affecting growth, condition and survival. In short, we need to understand what routes the different stocks take, how fast they travel, where they feed and what they feed on. To date it has been impossible to identify the origin of sufficient numbers of wild salmon to enable these questions to be addressed. The SALSEA Merge programme is currently tackling these difficult and complex questions and will deliver novel, stock-specific migration and distribution models merging hydrographic, oceanographic, genetic and ecological data.

Progress to date

The marine sampling programme got underway in May 2008 and since that time research vessels from Ireland, Norway and the Faroe Islands have carried out extensive surveys stretching from the west coast of Ireland to the far north west coast of Norway. The surveys have followed the off shore migration pathways of post smolts during their first summer at sea.

The Irish surveys were carried out on the two Irish research vessels, the RVs *Celtic Voyager* and *Celtic Explorer*. In 2008 The *Explorer* survey collected 358 salmon post-

As part of the SALSEA project, NASCO and ICES are holding a 'Salmon Summit' in La Rochelle, France, 11th-13th October 2011. The objectives of the meeting are:

- to review recent advances in understanding of the migration, distribution and survival of salmon at sea and the factors influencing them
- to consider the management implications of this research
- to identify future research needs
- to increase awareness of the issues and to raise support for future research

While the focus of the 'Salmon Summit' will be recent research in the North Atlantic, contributions will also be welcome from the Pacific Ocean and Baltic Sea.

Modifying the trawl.

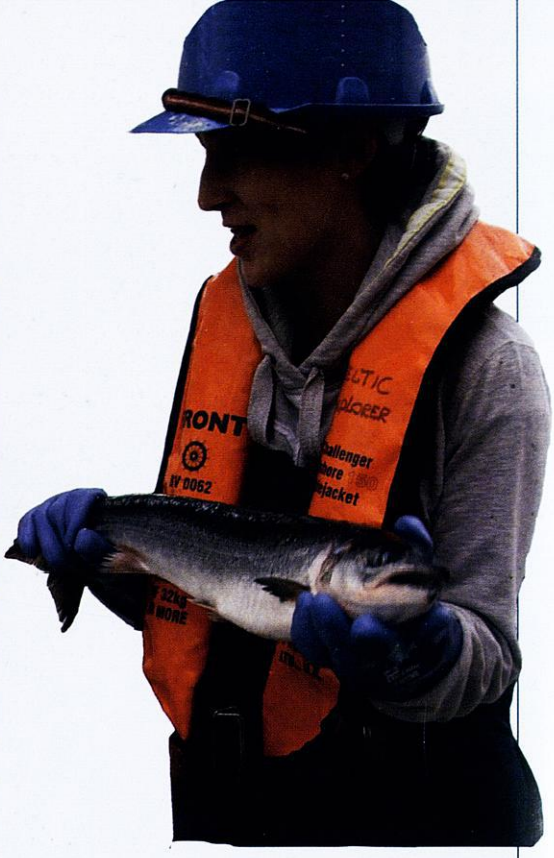
smolts, taken in 27 separate hauls over an 8-day period and from a wide area of the southern range of the early salmon migration. Data relating to water temperatures, depth and salinity were also recorded. Some 76 post-smolts were taken during the cruise of the *Celtic Voyager*, resulting in a total catch of 434 salmon. In 2009 the *Celtic Voyager* again sampled off the west of Ireland but few fish were taken due to very stormy conditions. However the *Explorer* survey, which took place off the west coast of Norway in June 2009, was very successful and overall the two cruises resulted in a total sample of 466 post smolts and 10 adult salmon.

Setting the trawl.

The first Faroese cruise took place from the 2nd to the 16th July 2008, on the RV *Magnus Heinason*. In total 363 post-smolts were caught, with three hauls accounting for 184 fish. The 2009 survey was equally successful and resulted in a sample of 310 post smolts and 10 adult salmon.

The Norwegian research cruises, aboard the RV *Eros* and *Libas*, ventured much further north and surveyed areas of the North Atlantic which had not previously been sampled for post smolts. In 2008 a total of 82 post smolts were taken in 31 net hauls. The westerly distribution of the smolts was of particular interest. Although not numerous, salmon post-smolts were caught in almost every haul, on average three post-smolts per two-hour tow with three tows containing more than 10 salmon. Six adult salmon were also caught, five of them fish that had spent at least one winter at sea (1SW salmon, mean length 50.2 cm) and one 2SW (98 cm) was a previous

Hauling the plankton net. The small plankton catch reflects the low plankton abundance in the Norwegian Sea.



Katie Thomas with one of the very small grilse typical for the Norwegian Sea these days.

spawner. In 2009 a further 87 post-smolts and adults were taken during the Norwegian surveys.

Sampling

Each fish taken was extensively studied and the biological sampling included: scale samples, pectoral fin for DNA sample, disease sample (gill filament, pyloric caeca, spleen, and kidney), disease samples (gill filament and kidney), isotope samples (liver, dorsal muscle, adipose fin, heart, and tip of caudal fin), lipid sample (dorsal muscle), stomach sample, and otolith sample. All of the material collected from the 1700 post-smolts taken over the summers of 2008 and 2009, in combination with the large set of archival material (over 3,500 samples) available to the researchers, will provide the basis for the extensive analysis to be carried out as part of SALSEA Merge. Over the next eighteen months all of the material will be analysed and the resulting data will be assimilated into a comprehensive migration and distribution model of salmon stocks in the North Atlantic. The results from the programme will be presented to an International Salmon Summit, incorporating scientific results from surveys of both Pacific and Atlantic salmon stocks and planned for autumn 2011.

Although just past the halfway point SALSEA-Merge is attracting plenty of attention outside the scientific world. During February and March this year, several presentations have been held for politicians, managers and fishermen, in Ireland by Prof. Ken Whelan and in Norway by the scientific coordinator Dr. Jens Christian Holst. These activities to publicise the work will move up a gear now, as the post-collection phase results are analysed.

There is a dedicated website (www.salmonatsea.com) where you can find information on the full SALSEA programme, including cruise reports from the work package leaders and details of those involved in the programme. This page will be regularly updated from now onwards.

Sorting a typical catch.

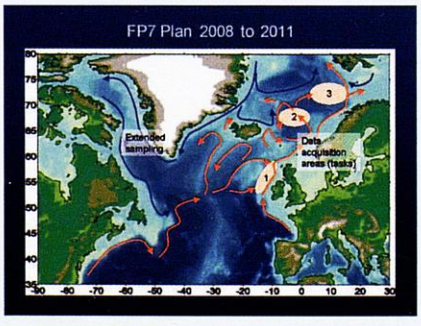


Fig 1: SALSEA Merge survey areas, showing a range of potential migration routes to and from the feeding grounds and the prevailing ocean currents (red: warm water and blue: coldwater). The SALSEA Merge marine survey areas are shown as 1 to 3.

Anyone involved in the science, management or exploitation of wild salmon and sea trout knows that all is not well with stocks of both species. Research affirms that there are problems in the marine environment, but has not yet established their extent nor how numbers and condition of returning adult fish are affected. Where managers have some degree of control is in coastal zones and river estuaries, especially with sea trout which, unlike salmon, do not generally travel far from the coast of their native rivers. A better understanding of the lives of sea trout may help us understand how our inshore waters are changing and provide managers with insights into possible future actions to conserve this important environmental indicator species. The Celtic Sea Trout Project is one of a group of EU funded projects which should extend our knowledge of these fish as Nigel Milner and Ivor Llewelyn report.

Cynllan Sewin Celtaidd (The Celtic Sea Trout Project)

On 11th March the Celtic Sea Trout Project, funded through the Interreg 4A Ireland-Wales Cross-Border Programme, was officially launched in Bangor. The project, which brings together scientists and managers from Wales, Ireland, Scotland and England, will investigate the genetic origin and behaviour of sea trout in the Irish Sea and the rivers that flow into it. The AST is one of the project's sponsors.

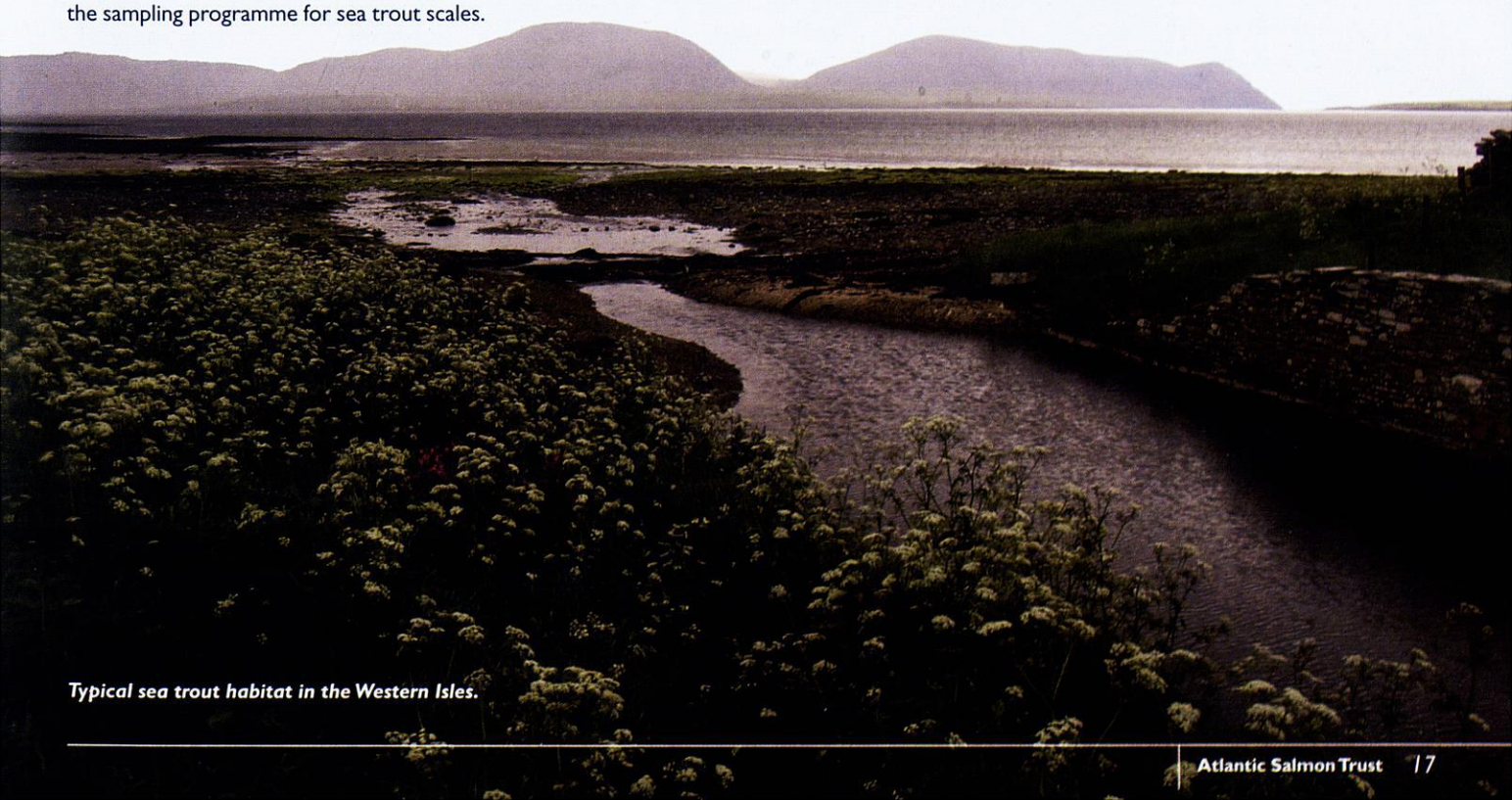
In line with a priority theme of Interreg IVA, the CSTP is developing collaborative activities between Ireland and Wales (and partners in adjacent regions) to enhance the sustainable management of sea trout fisheries, address common climate change issues and promote the active involvement of communities. Specifically in the CSTP, the angling community will be closely involved in the sampling programme for sea trout scales.

Understanding the issues

The project originated in the International Sea Trout Symposium held in Cardiff in 2004. The symposium highlighted the comparative neglect of research into sea trout and the wide gaps in our knowledge. It stressed that this made it more difficult to protect and conserve sea trout stocks and manage them in sustainable ways for future generations - a difficulty made more serious by the decline in sea trout abundance in recent years. It therefore identified a need for 'long-term, integrated ecosystem-based freshwater and marine studies, incorporating ecology and genetics, to improve understanding of the sea-going migratory habit in trout.' These projects have been developed to help address this need.

The Celtic Sea Trout Project will attempt to answer the following central questions:

- what happens to sea trout after they have migrated to sea and how are the various stocks structured and interlinked ?
- what is their marine ecology in terms of their feeding behaviour, diet and life history variations?
- what environmental and other pressures are they exposed to?
- how do their life histories respond to environmental variation in terms of stock structure and composition and, therefore, the subsequent quality of the fisheries?
- can sea trout life history variation be used as a tool to detect and understand the effects of climate change and serve more widely as a bio-indicator?



Typical sea trout habitat in the Western Isles.

The answers will help to meet the CSTP applied aims of securing the economic and social benefits arising from healthy sea trout stocks by (a) developing science based management advice and (b) leaving a permanent legacy of awareness and collaboration between the peoples of Ireland and Wales.

Genetic profiling

An important element of the project is the creation of a data base of the genetic profiles of the juvenile sea trout and brown trout populations in 100 rivers, from the Solway to South-East Ireland. Given appropriate levels of discrimination, this will make it possible to determine the river or region of origin, and hence the migratory behaviour, of adult sea trout caught at sea.

The project will also explore the use of microchemistry to identify rivers of origin, and possibly migration routes. Small differences in the chemical composition of the river bed and water between rivers can be detected in fish scales and otoliths, and so identify the geographic origin of the fish. This will provide a useful way of cross-checking information derived from genetics. The same methods may also make it possible to identify where in the sea fish have been feeding.

The project will investigate the distribution, movements, feeding behaviour and diet of adult sea trout at sea, and the distribution, quality and availability of spawning and rearing habitats in fresh water. In 20 selected rivers the links between conditions in the freshwater and marine environments and the life histories


7lb cock sea trout in full spawning colours.

strategies adopted by trout will be examined in depth, by analysing life table features (e.g. survival, maturation, fertility etc) obtained from scales and stock assessment data. . Understanding how these life histories respond to environmental gradients and expressing them through modelling is the key to developing the management advice that will form a principal result of the project.

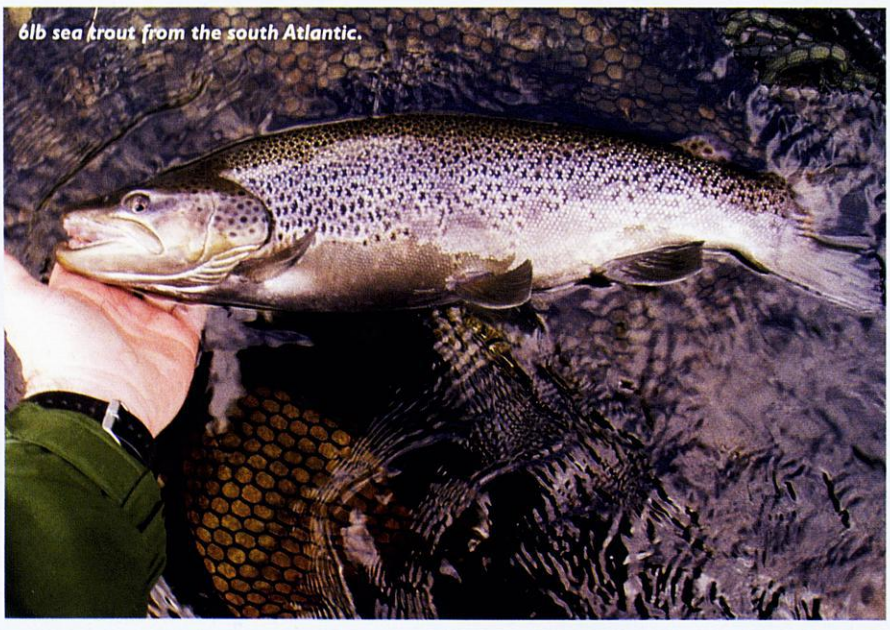
As well as the scientific analytical work, the project will require a massive effort to collect the information and material needed for the different elements; this will include sampling in freshwater by anglers and the use of local netsmen and coastal fisherman to obtain samples at sea.

Wide range of projects

The Celtic Sea Trout Project is one of three major EU funded projects on sea trout in the seas around the British Isles. The other two are the Living North Sea Project and the Atlantic Aquatic Resource Conservation (AARC) Project. The former, as its name suggests, focuses on the North Sea and involves partners in England, Scotland, the Netherlands, Belgium, Denmark and Germany. The latter covers the Atlantic coasts of Southern Ireland, England, France, Spain and Portugal and the English Channel, with partners from all the countries involved. Both projects cover other migratory species, such as eels, shad and lamprey, and will include genetic profiling of populations against their rivers of origin. Other elements of these projects will address habitat and river restoration issues, including barriers to migration. The Living North Sea project was formally launched in Ghent on 26 March and the AARC project will start later this year.

Once these three projects have been completed we should have databases of the genetic profiles of sea trout populations for most rivers in the British Isles, as well as other rivers flowing into the North Sea and the Atlantic coasts of France, Spain and Portugal. We will also have a much greater knowledge of the migration patterns and behaviour of sea trout in the sea and how they react to environmental pressures.

These major projects are supported by a number of local programmes aimed at improving our knowledge of sea trout in particular areas. These include the Anglian Rivers Sea Trout Project, the Moray Firth Sea Trout Project and the South Coast Sea Trout Project. These all aim to review the status of sea trout stocks and identify potential improvements to freshwater habitat. The remaining gaps in the coverage will be the West and North coasts of Ireland and Scotland.


6lb sea trout from the south Atlantic.

For many years, there has been debate over the causes of the phenomenon of prematurely returning sea trout. These fish return to freshwater only days after migrating, in poor condition and often burdened with larval stages of Lepeophtheirus salmonis. Fiona Cameron summarises a recent research paper.

Prematurely returning sea trout and *L. Salmonis*

Debate has centred on whether these fish had been weakened before migrating, and made more susceptible to lice infestation, due to prior attack by bacterial, viral or parasitic pathogens.

A newly published paper[1] provides useful input to this debate.

The authors studied ten[2] prematurely returning smolts caught in the River Shieldaig. Seven of the fish had been previously tagged, and it was therefore possible to determine how long they had spent at sea – ten days or less.
No bacterial or viral pathogens were detected in any of the fish. The authors suggest that this indicates that such pathogens played no part in the premature return to fresh water, or contributed to the fishes' susceptibility to parasite infestation.

However, almost 600 parasites, comprising six species, were found, and all the fish had some. Only two species of parasite (Pomphorhynchus laevis and L. salmonis) were found on every fish in the sample. The maximum number of L. salmonis on any one fish was 69, and the lowest three; the mean number was 30 – all copepodids or chalimus stages.

Since P. laevis has a life-cycle of some three months to adult stage, the authors surmise that these parasites were acquired in fresh water prior to migration. Finding no correlation between infestation levels of the two parasites, Pert et al conclude that P. laevis infestation did not make the fish more susceptible to L. salmonis.

1 *The pathogen burden of early returning sea trout (Salmo trutta L.) infected with Lepeophtheirus salmonis (Krøyer, 1837), in the River Shieldaig, Scotland. CC Pert, J Raffell, K Urquhart, SJ Weir, KMH Kantola and IR Bricknell. Bulletin of the European Association of Fish Pathology, 29(6) 2009, 210*

2 *Only ten fish were sampled, due to the fragile state of the sea trout population in the R Shieldaig. The authors emphasise that this was a short observational study on a very small sample.*

***Electro-fishing for early returning sea trout on the river Shieldaig.* Image crown copyright**

Research currently taking place at the Scottish Oceans Institute under the leadership of Professor Chris Todd could be described as 'the other side of the coin' in measuring stocks. Up to now the measures used have concentrated on the number of fish caught by all methods of human exploitation. But questions are now being asked about the condition of 1SW and 2SW salmon returning to their native rivers via the Norwegian Sea. These tend to be later running fish, and we need to ask ourselves if these fish are able to deposit sufficient good quality fertilised eggs to regenerate stocks. The following article by Professor Todd and post-graduate student Nora Hanson is a wake up call to fishery managers that numbers alone are an inadequate measure....

Multi-source sampling: stable isotope variation and the 'skinny' salmon story

In recent years, Atlantic salmon abundances have been at a historical low despite continued declines in marine and freshwater exploitation. Commercial salmon netting in Scotland continues to decline and catch and release is increasingly practised in Scotland and England. For example, anglers in Scotland returned alive more than 60% of their grilse and salmon catch in 2007. Of additional concern to the conservation of salmon is that there has been a striking downward trend in the condition of fish that do successfully return to our waters. As a low fish condition has been directly linked to a disproportionate reduction in body fat reserves (Todd et al. 2008)1, this decline has serious implications for the successful freshwater migration and reproduction of poor condition (i.e. 'skinny') fish. There is growing recognition in the scientific community that the marine phase is a key factor in the decline of abundance and condition, but this elusive life stage is difficult to study. Traditional methods of studying fish at sea include costly research trawls and tagging studies; these provide us with detailed information about the spatial distribution, diet and behaviour of salmon at sea. While this information is extremely important to our understanding of salmon, such research is expensive and often involves small sample sizes. However, from commercial nets we also have access to fish that have survived their year(s) at sea, and have made it back to Scotland's shores; from these we can glean more information about the conditions they experienced at sea.

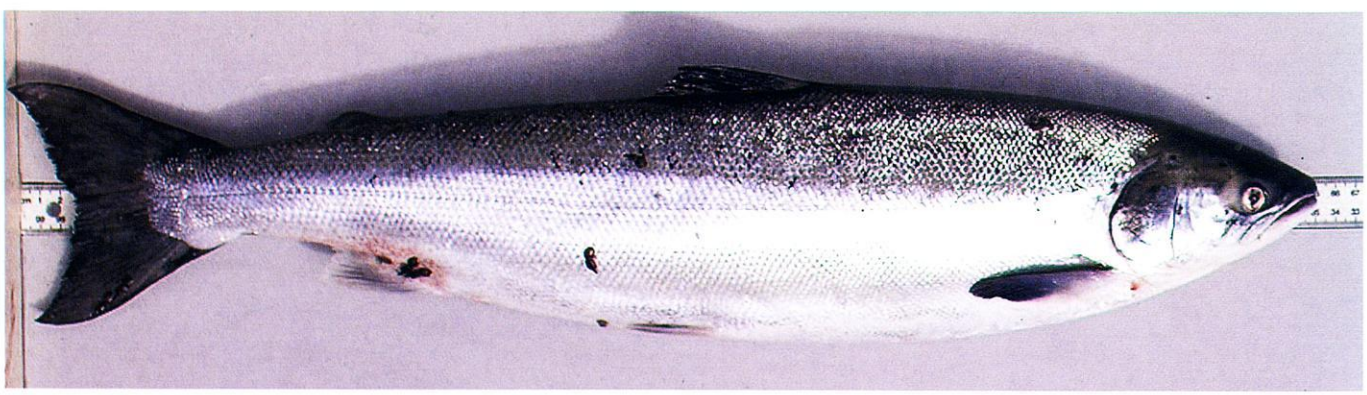
'Reading' the salmon's environment

Proxy records of the environmental conditions encountered by salmon at sea can be created by studying the chemical composition of various tissues of these fish. In particular, the stable isotope signatures of tissues can tell us something about how high fish are feeding in the food chain, their overall nutritional state and even about their thermal habitat. In stable isotope analyses we measure the ratio of a 'heavy' form of an element to the 'light' form using mass spectrometry. Due to the slightly different mass of the isotope nuclei, one or the other may be 'preferred' during different chemical reactions so that the ratio of heavy to light isotopes changes. We can examine the way this ratio changes within different biochemical processes and use it as a proxy for what is happening within an animal. If we look at this ratio in multiple different tissues, we get a slightly different story because different tissues are metabolised at different rates and use different biochemical sources of energy.

For example, by looking at nitrogen and carbon stable isotopes in the white muscle, red muscle and liver of returning one sea-winter fish, and by relating these values to the condition of the fish, we learn about how the nutritional state of the fish has changed during the last parts of its marine migration back to Scotland. We have found that fish in poor condition have particularly high ratios of nitrogen stable isotope values in their livers, which may be indicative of fish essentially catabolising (i.e. burning) their own tissues in order to maintain metabolism. That is, they appear to have been severely compromised by prey availability.

Natural 'data storage'

On a slightly longer timescale, we can use the natural 'data storage tags' that all bony fish possess in their inner ears to see how the



A female, 61cm, 2.61 kg and with a condition factor of 0.95. This fish is about 'normal' in terms of its condition factor; that is, the weight is more or less as expected for a fish of that length.

ambient water conditions change as the fish ages and migrates. Otoliths are small calcium carbonate structures that fish use for balance and to hear underwater; they grow in layers, much like tree rings, and record information about ambient water conditions over time, providing a convenient temporal record for us. By measuring the oxygen stable isotopes in a cross section of these structures on a fine scale (Figure 1), we can see how many years a fish spent in freshwater before migrating to sea; once at sea, we can estimate the temperature of the water it lived in, which may help us to better understand the thermal habitats and oceanic distribution of fish returning in poor and good condition.

Lastly, archived fish scales provide us with an even longer timescale of stable isotope variation, stretching as far back as monitoring efforts (Figure 2). From these records, researchers are able to see how the feeding ecology of salmon has changed over decades and relate this information back to what we know of the prevailing environmental conditions.

The combination of proxy records such as those described above, and information gathered in more traditional manners, will help us to both better understand what is driving the decline in salmon abundance and condition and, more broadly, how changes in the marine climate may impact the organisms that call it home.

Figure 1: A one sea-winter Atlantic salmon otolith in cross-section (left). The area enclosed by the red circle shows the freshwater region of the otolith and the arrow shows the trajectory analysed for stable oxygen isotopes (right). The right hand graph shows the oxygen isotope values changing with the conditions (primarily salinity and temperature) of the surrounding water during the life of the fish. The two transects illustrated are from a 'fat' (white line) and 'skinny' (red line) fish; the jump in oxygen isotope values from -6.00 represents the time when both fish migrated to sea as smolts. The similarity of the transect plateaus indicate that both fish probably migrated to ocean regions of similar temperature. The difference in length of transects relates to differences in fish/otolith size and the number of samples that could be taken.

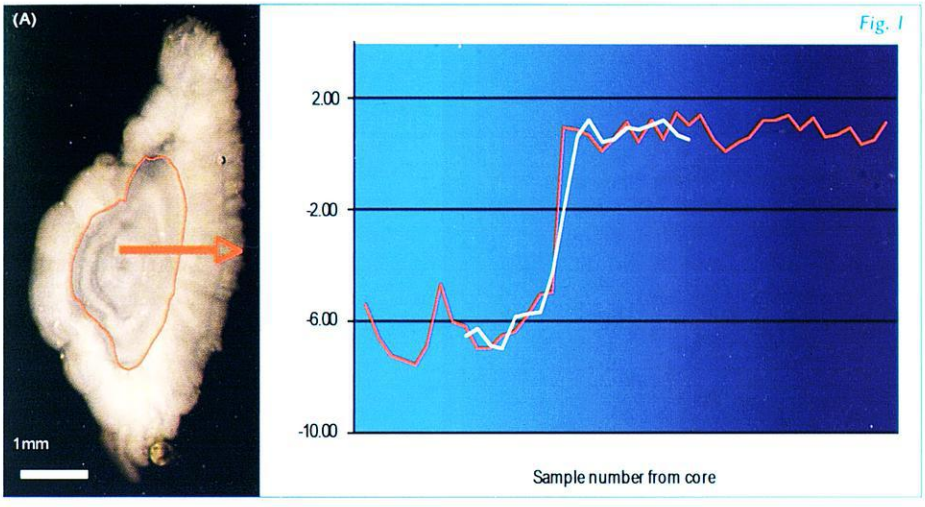
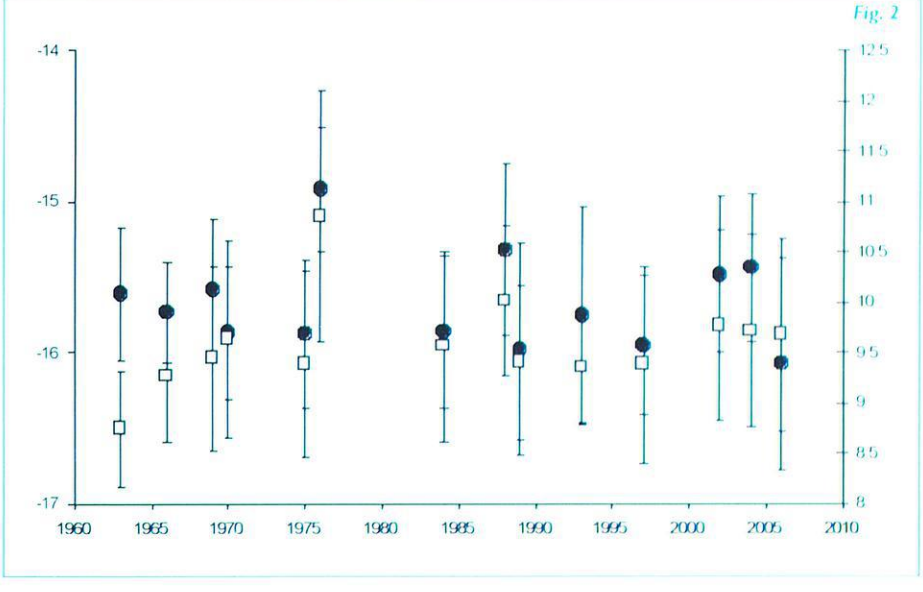


Figure 2: The pattern of carbon (black circles) and nitrogen (open squares) stable isotope values in the marine portion of Atlantic salmon scales returning to the River North Esk. While there is considerable inter-annual variation in these values, there is no evidence for long-term systematic change.



1 Todd et al. (2008) Detrimental effects of recent ocean surface warming on growth condition of Atlantic salmon. Glob. Change Biol., 2008, 14: 958– 970

A male, 62cm, but only 1.93kg and with a condition factor of 0.67, that is, it is about one third underweight for its length. It is almost of the appearance of a spaned kelt but this fish had not even re-entered its natal river.

In the following article Fiona Cameron tells the story of Scottish salmon aquaculture. She highlights the need for scientific objectivity if the industry is to become genuinely sustainable. One of the problems is that one person's 'sustainable' is another person's 'unacceptable practice', with the result that Scotland's wild salmon and sea trout have suffered, in some places to the point of extinction. The AST wants to see minimal impact of aquaculture on wild stocks through much better regulation and standards of enforcement, with the long term likelihood of closed containment systems, sealed from the open sea or located ashore.

Salmon farming in Scotland: economic success or ecological failure?

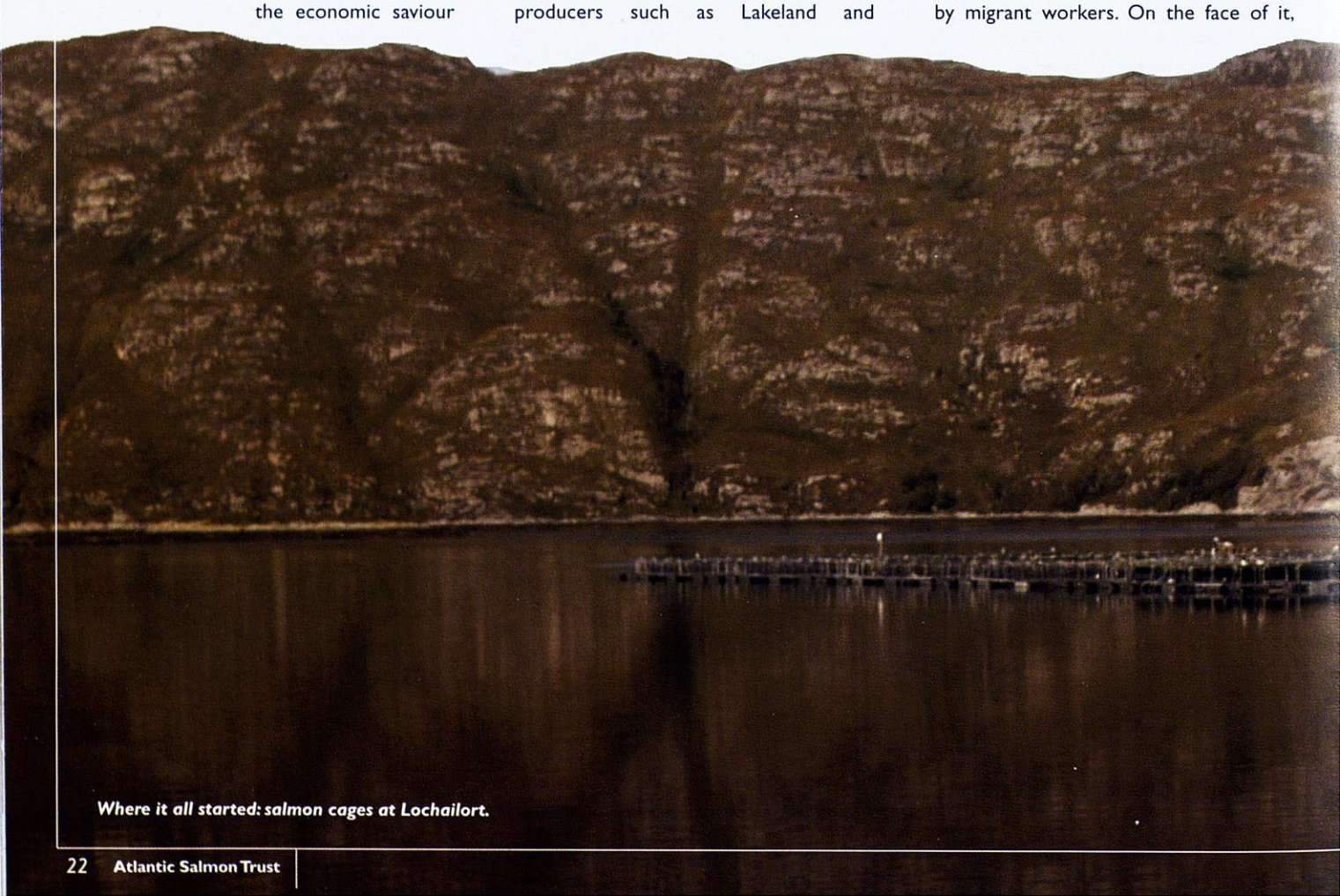
Salmon aquaculture has now been with us in Scotland for more than four decades, since the first fish were raised in cages in Loch Ailort by the first incarnation of Marine Harvest. During the first twenty years or so of its existence, there was a fairly substantial failure to see the problems which were likely to arise. The result is that we're now living with the severe impacts on Scotland's biodiversity which have built up cumulatively, while successive governments and regulators paid too little attention. In many Highland rivers, populations of native salmon and sea trout are now so depleted as to be almost totally lost.

In its early days, the industry was hailed as the economic saviour of the Highlands and Islands. Those in government who encouraged the pioneers painted a rosy picture of every crofter with a couple of salmon cages. But that's not how it turned out. Year on year, salmon production has been concentrated in the hands of fewer and fewer companies.

Marine Harvest is still with us, after reinventing itself many times, and is still the biggest of the 'Big Four' which control around two-thirds of Scottish production. The members of this quadrumvirate – Marine Harvest, Scottish Sea Farms, Lighthouse Caledonia and Greig/Hjaltland – are all owned by companies listed on the Oslo stock market. Other substantial producers such as Lakeland and Mainstream are also owned by Norwegian multi-nationals.

Economic impact

Few would deny that the salmon farming industry is a massive contributor to our economy. Using the Scottish Government's multiplier, the £36 million wage-bill translates to an input of almost £166 to the Scottish economy, most of it in the Highlands and Islands. According to its own figures, the industry spends a further £223 million on supplies and services in Scotland - £143 million of this in the same area. Of the 6,200 full and part-time jobs in aquaculture, 1,579 are in remote, rural locations – and contrary to popular perception, just 13% of these jobs are held by migrant workers. On the face of it,



Where it all started: salmon cages at Lochailort.

these impressive totals would appear to outweigh angling-related jobs lost to the area.

That's not to minimise the impact of small, localised tragedies typified by the loss of employment caused by the demise of Loch Maree's sea trout fishery. However, it seems inevitable that successive governments have appeared to set more store by the employment offered by salmon farming – particularly against a back-drop of recession and over-dependence on public sector jobs. Holyrood is grateful for any success story, be it salmon farms or wind farms.

And a success story it is, at present, for the salmon companies. In February, Marine Harvest reported global profits of over 70 million for Q4 2009. For the same period, Lighthouse Caledonia reported profits of over £4 million, compared to a £375,000 loss in the corresponding period of 2008. Others are following the same pattern.

'Could do better'

If we're pragmatic, we must accept that salmon farming is here to stay in Scotland. That doesn't mean we have to accept that there's no room for improvement. Yes, there have been improvements - even dramatic ones – over the years in terms of farmers' ability to keep their stock in their cages, and to control sea lice infestation levels.

But there are still too many fish escaping – over 133,000 reported in 2009, in addition to those which doubtless 'leaked' from cages (particularly freshwater ones) unreported. There is now a body of irrefutable evidence that escapes are a bad thing – whether in terms of potential hybridisation with native stock, or competition for feed, or spreading of parasites and disease. The only acceptable level of escapes is zero – and there's little evidence that the 'zero tolerance of escapes' policy which various companies boast of is achievable, while the fish are still held in net pens. Scotland's west coast weather is likely to become more rather than less stormy; seals, like the poor, are always with us, and will always be attracted to salmon cages; no matter how much training workers are given, we'll continue to see escapes caused by 'human error'.

It's the same story with control of parasites such as Lepeophtheirus salmonis and Caligus elongatus. There have been substantial improvements with the spread of Area Management Agreements, which have delivered single year class (syc) management of entire sea lochs, and the added benefits of synchronised de-lousing and fallow breaks. But we mustn't forget that, at the end of the day, area management is voluntary, as are the add-ons like syc management. Smaller producers – and the indigenous industry now consists almost solely of small producers – will always struggle with syc, because it requires a geographical spread of sites which not all can attain.

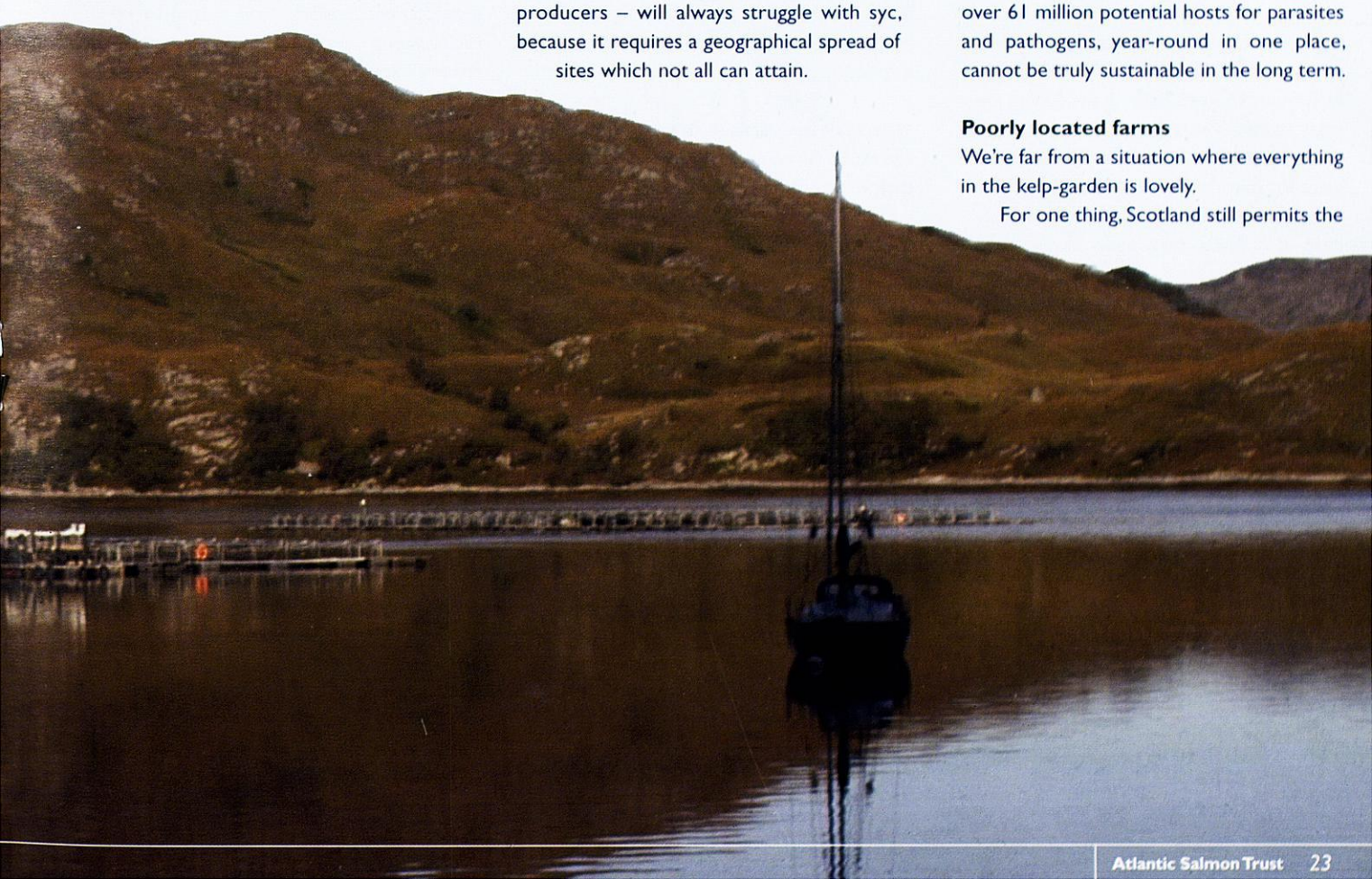
Added to this, we've seen the first signs of decreasing efficacy of SLICE, the in-feed sea lice treatment which was hailed as the panacea just a few years ago. This was inevitable, just as the development of resistance to previously-used lice treatments was inevitable. Scientists in Norway now describe the spectre of 'super-lice' which are resistant to several products. Salmon farmers in Europe and Scandinavia have had to work with a very small number of anti-lice products, and their use of these in Scotland is very strictly controlled – quite rightly; we can't afford to have just anything tipped into the marine environment. There's considerable angst among creel fishermen in Norway at present because of the increased use of an anti-louse product they claim not only kills lice, but also lobsters.

Scotland would appear to be faring somewhat better than many parts of Norway at the moment in terms of keeping on top of the lice problem. But reports of rampant lice infestations in Shetland in late 2008, and the apparent struggle to keep infestations tolerably well-controlled elsewhere, show there's absolutely no room for complacency. Adequate control involves flawless management, constant vigilance – and a large element of 'fingers crossed'. Our native wild salmonids in the Highlands and Islands are outnumbered by farmed salmon by a factor of more than 700 to 1. Holding over 61 million potential hosts for parasites and pathogens, year-round in one place, cannot be truly sustainable in the long term.

Poorly located farms

We're far from a situation where everything in the kelp-garden is lovely.

For one thing, Scotland still permits the



damaging practice of raising farmed fish to smolting stage in net pens within freshwater systems containing native migratory fish. The damage this causes to migratory behaviour is just beginning to be scientifically documented, although we've all known about it for many years. On top of that, there's the ongoing problem of 'leakage' of fish directly into salmonid systems. Norway doesn't permit this style of farming. The technology for growing smolts in closed facilities is tried and tested, and widely used. There's no excuse at all for not making its use mandatory in Scotland.

There are also major concerns over marine farm sites which are in very poor locations, simply because they were set up before there was such widespread realisation of the damage they could cause to native salmonid populations. Relocation of these is a difficult issue – we need to ensure that we don't simply create the same problems elsewhere.

Expansion plans

But it's an issue that needs to be faced. Because Chile's production of farmed salmon has been decimated (by a combination of disastrously poor management, parasite infestation and disease), and because Norway could well put a standstill on expansion of production tonnage, due to the problems they're experiencing with lice control, we're likely to see a global shortfall of 190,000 tonnes of salmon this year. Scottish producers are eager to take advantage of this opportunity. Recently, Marine Harvest has announced plans for four new 'super-farms', and other companies such as Lighthouse Caledonia have also been very open about their ambition to expand output. Overall, it's believed that the Scottish industry seeks to expand production by one-third, in pretty short order.

The message to the government, to local authorities, to Highlands & Islands Enterprise and to the industry must be 'ca' canny'. We've seen the problems which rapid expansion has brought to Chile and to Norway. The Norwegian media have reported that scientists at the country's Institute for Nature Research (NINA) believe Norway's production of farmed salmon may be over six times larger than is sustainable. We need to learn from others' mistakes, rather than blindly repeating them.

Solutions, rather than problems

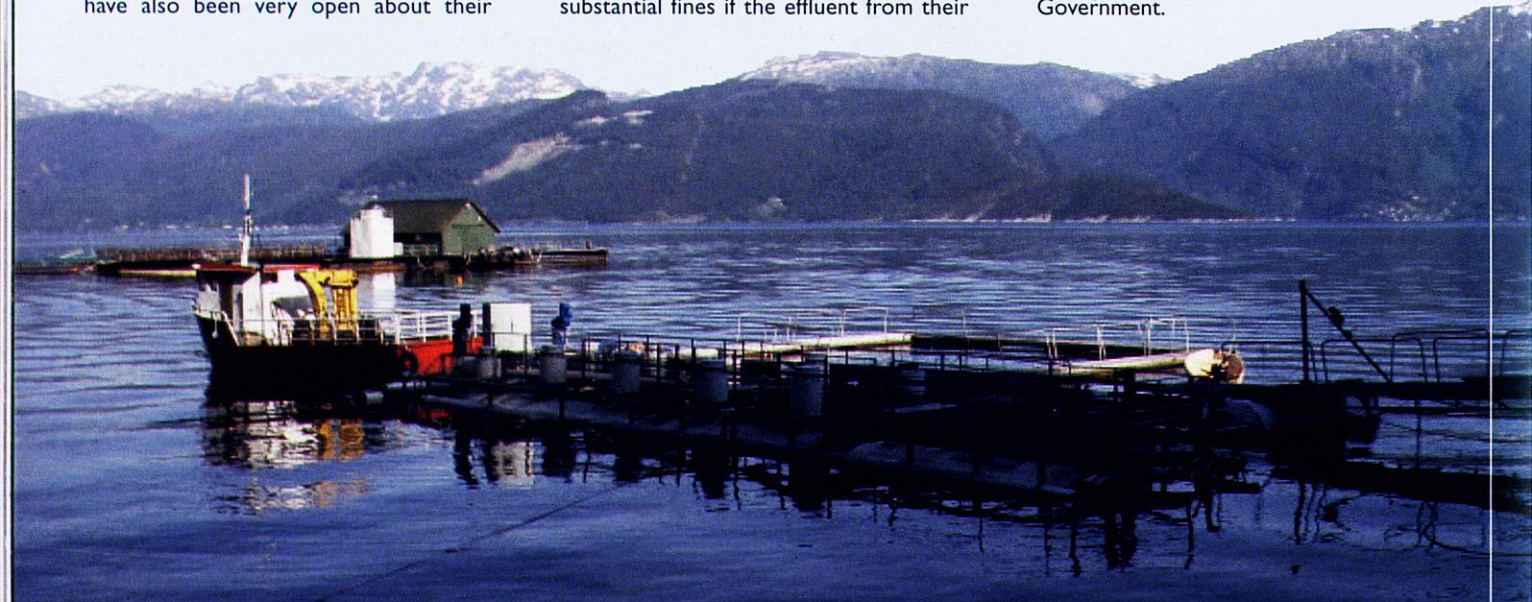
Is there an answer to long-term sustainability for the salmon aquaculture industry? Several companies worldwide are working hard to develop commercial-scale facilities for growing salmon through to harvest in closed containment systems – some are going down the route of land-based recirculation units (which give farmers the ultimate level of control of growing conditions), others are experimenting with huge floating systems. Whichever turns out to be best, all have the advantages of preventing escapes, preventing sea lice getting onto the farmed fish in the first place, and extracting all solid fish waste and uneaten feed for safe disposal.

This is not such a big thing to ask. After all, terrestrial farmers are expected to prevent their livestock from stravaiging around the countryside; they are also hit with substantial fines if the effluent from their cattle-courts or chicken-houses leaks into waterways – yet the effluent from salmon cages goes straight into freshwater lochs and sea lochs day in, day out.

The salmon farmers' main complaint about closed containment systems – apart from elevated initial capital costs – is the energy cost involved in operating them. Mention 'carbon footprints', and suddenly these companies become greener than green. For once, let's see Scotland get in at the ground floor of these technologies, and capitalise on both our great engineering tradition and our potential for marine-based renewable energy. Let's lead the world in sustainable aquaculture technology, rather than trailing at the coat-tails of Scandinavia.

Successive Scottish governments have paid lip-service to protecting our country's biodiversity. The present administration could set an example by taking its responsibilities to Europe and future generations of Scots just a wee bit more seriously, rather than being seduced into inaction by short to medium term economic fixes.

The Welsh Assembly Government has made a clear commitment to environmental protection within its aquaculture strategy: it has prioritised development work on land-based recirculating systems. The Assembly's Fishery Strategy only recognises one aquaculture sector as being suitable for the open marine environment: shellfish cultivation. Other sectors are operated in closed facilities. It is time to see a similar commitment from the Scottish Government.



Floating closed containment salmon site on Hardangerfjord, Norway, operated by Preline. **Photo: Preline**

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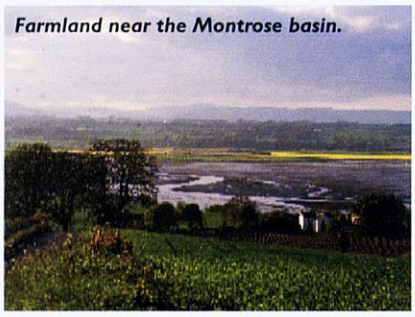
The EU's Water Framework Directive highlights the importance of catchment management as an ecosystem approach to managing fisheries to conserve the full biodiversity of distinct genetic populations of wild salmon and sea trout. Dr Marshall Halliday, Director of the Esk Rivers and Fisheries Trust and Kelly Ann Dempsey, Project Manager of the River South Esk Catchment Partnership, explain how the different interests within the catchment have come together to produce a groundbreaking plan for the future management of the South Esk.

The Important Role of Catchment Planning and Fishery Management in Small Catchments

Strictly speaking, management is the maintenance of the status quo. In terms of fisheries with the ever increasing environmental pressures affecting stocks, this might be a valid objective in its own right. However, many fishery managers have considerably higher aspirations, including the improvement of fish stocks and the aquatic environment. This takes us forward from basic management into the concepts of



Farmland near the Montrose basin.

leadership and change. In order to implement change effectively, a shared vision among all stakeholders is an essential prerequisite. For small catchments with limited resources, it is difficult to imagine the initiation of such wide ranging discussions by a Trust or Board at the level required to ensure the active involvement of all the stakeholders. These include Scottish Natural Heritage (SNH); the Scottish Environmental Protection Agency (SEPA); local council economic development, roads and planning departments; the Forestry Commission; Scottish Water; Agricultural Policy Groups and farmers; tourism bodies, and many other institutions with an interest in the socio-economics of the catchment.

Caring for a river environment can generate further investment including visitor attractions, accommodation, catering outlets, leisure and sporting activities such as fishing, walking and cycling. Initial investment in facilities for recreation, education and environmental improvements will almost certainly increase future investment. Investment in sustainable development opportunities will continue as the resulting economic benefits begin to become apparent. Creating a framework of cooperation between different agencies involved in projects will generate further economic social and cultural investment.

Strength in numbers

This is where there is a major role for a catchment planning group. In the first instance, the initiator of such a group can be the local council economic development department supported by fisheries interests (Trust and/or Boards), SNH and SEPA. Even in these difficult times, forward thinking councils can find economic support to initiate such ventures provided there is a basic commitment from the founder members. The cross-fertilisation of ideas and objectives, often from disparate agencies, is an essential and powerful impetus to the formation of an effective catchment plan underpinned by a shared vision. Having such a document puts an existing fishery plan in a wider context. It provides fishery interests not just with a list of issues and actions but with a coherent and credible agreed strategy to implement fisheries projects identified within the plan, with which to approach prospective funders. In addition, these fishery objectives are in the wider context of a catchment plan which adds to their relevance. No fishery manager should doubt the opportunities which such an approach offers, even in these harsh economic times.

A further important issue to be considered is the application for grant aid. It is important to define the local economic partners who could benefit from, and link with, project development, and ensure that they are involved in the planning process from the outset. Their input will provide assistance with the opportunities for sustainable economic development, through balancing economic and environmental considerations. Most importantly, it will allow each partner to appreciate the relative values of the project to other partners.

Most of the catchment steering group agencies will have some difficulty with participating in a formal

Montrose basin.

structure, such as becoming directors of a limited company or trustees of a charitable organisation. A fishery trust in the form of a limited company with charitable status fits the bill. Thus the fishery trust can be the applicant of behalf of the catchment steering group. Funding applications achieve greater credibility when they are effectively endorsed, or applied for, on behalf of a catchment partnership, and are much more likely to have a positive reception. The harmony and diverse stakeholder involvement in Trust projects clearly ticks many of the boxes in funding applications.

Looking to the future

Projects require to have long-term vision for economic investment opportunities. However it can be difficult to convince funders of the value of investing in environmental projects when they are used to measuring outputs solely in terms of job creation. It is important to balance the economic investment opportunities to ensure the right balance is achieved between financial advantages associated with tourism and leisure opportunities and the less financially obvious advantages of environmental and community benefits.

Monitoring the progress and successes of a catchment plan is vital to securing ongoing funding. This can be difficult. It is therefore important to identify regional statistics and indicators which are of relevance to economic activity within the catchment. Some new statistics may require to be generated. From the outset of the implementation of the catchment plan, there should be study of:

- The available economic indicators and environmental status of the catchment
- The generation of additional performance indicators against which future changes in the catchment can be assessed, pursuant to setting a benchmark

The importance of identifying the current performance indicators within the catchment cannot be over-emphasised, as these will pay dividends in the future.

Glen Doll.

THE RIVER SOUTH ESK CATCHMENT PARTNERSHIP

A small scale catchment management success story

The South Esk catchment (area 613 km^2) is on the east coast of Scotland and is entirely within the county of Angus. The River South Esk is about 49 miles (79 km) long from its source to the sea and has four main tributaries: White Water, Prosen Water, Burn of Glenmoye and Noran Water. There are also seven major areas of standing water.

The catchment supports a wide range of economic activity in industries such as farming, forestry, fisheries, tourism and recreation and as a private drinking water source. The river and its catchment support a rich variety of wildlife.

The River South Esk is a designated Special Area of Conservation (SAC) for Atlantic salmon and freshwater pearl mussels whilst Montrose Basin, the large enclosed estuary of the River South Esk is a Ramsar site*, Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI). In the northern extremity of the catchment is Caenlochan SAC, which is also an SPA and SSSI. The upper tributaries of the River South Esk also pass through Corrie Fee National Nature Reserve.

Appearances can be deceptive

At first glance this intrinsically pleasing catchment would appear to be in pristine condition, due to the wide range of wildlife it supports. However, monitoring and consultation suggest otherwise: the ecological status of some tributaries is poor or moderate; fish stocks and freshwater pearl mussels at certain life stages are in decline; non native invasive weeds are spreading in the middle to lower areas of the catchment; flooding is a serious concern in some areas, and the sustainable economic development of the catchment is in its infancy. Ongoing pressures placed on the catchment and continual changes in legislation affecting activities carried out in the area have reinforced the need to develop a more integrated approach to the way this water resource is managed to promote the protection and enhancement of water quality, biodiversity and the social and economic well-being of communities along the river and its tributaries.

To address these issues, representatives of various organisations have met regularly since 2004, with the development of an integrated Catchment Management Plan at the forefront of their aims. Gradually an informal Steering Group was

formed comprising representatives from the Esk District Salmon Fishery Board, Angus Council, Scottish Natural Heritage, Esk Rivers and Fisheries Trust, the Scottish Environment Protection Agency, Atlantic Salmon Trust, Scottish Agricultural College, Forestry Commission Scotland, Farming and Wildlife Advisory Group, Cairngorms National Park Authority, Macaulay Institute, Scottish Water, National Farmers Union Scotland, Scottish Rural Property and Business Association, and the Scottish Government Rural Payments and Inspections Directorate.

Making progress

The process of developing the Catchment Management Plan (CMP) began in earnest in

2008 with the employment of a part-time Project Officer to oversee a dedicated, intensive two year project which was launched in June 2008. Extensive public consultation was carried out over the following year to capture people's views on what they considered the key environmental, social and economic issues within the catchment. From initial consultation an issues document was drawn up and was available for further public consultation. Subsequently, these responses and direction from within the steering group were used to form the basis of the plan's strategic aims, catchment objectives and actions.

Upper South Esk catchment.

The South Esk CMP was completed and published in December 2009. The key aim of the CMP is to bring together all of the users of the catchment to carry out specific actions identified in the plan relating to the key environmental, social and economic issues affecting the catchment. These actions, agreed through previous public consultation, will guide the future management of activities in an integrated and sustainable way throughout the entire catchment.

The South Esk Catchment Partnership is now faced with raising awareness of the plan and what it is hoping to achieve, plus implementing the actions in the plan. This will involve promoting major projects to be initiated in the first year including an Invasive Non Native Species (INNS) eradication project, developing a River Watch scheme, creating an education programme and developing an interactive website. The Steering Group has selected the INNS project as a priority, as it believes that the best way of engaging stakeholders is the early demonstration of the implementation of the South Esk CMP with a high-profile project that is applicable to many of the plan's action cards. The INNS project will also bring benefits to the local community within a short timescale through improved access to and amenity of the river, and a reduction in the health and safety risk of giant hogweed.

If you would like to find out more about the River South Esk and the Catchment Partnership visit www.angusahead.com/southesk for further information.

**The Ramsar Convention (The Convention on Wetlands of International Importance) is an international treaty for the conservation and sustainable utilisation of wetlands, to protect them now and in the future and recognise their fundamental ecological importance, plus their economic, cultural, scientific, and recreational value. It is named after the town of Ramsar in Iran, where the Convention was signed in 1971.*

Angus farmland, one of the sources of diffuse pollution.

This article about the Salmon Genetics Project (SALGEN) was co-commissioned by the AST and FRS to update our non-scientist readers on the considerable amount of new data now available on the genetics of salmon. This area of research is telling us more about the composition of salmon stocks than has been available previously. As we learn more about the origin of salmon, their run timings and where they feed, the manager can use the new information to ensure with precision that exploitation of a particular genetically distinct group or population is sustainable.

Why the genes should fit

Many readers will have heard a little about 'salmon clans', and be aware that salmon are genetically adapted to their natal river. However, the report of the SALGEN project (sponsored by the AST and funded by the European Commission) makes it clear to all fishery managers that these aspects of the species' genetics matter – indeed, taking on board the importance of genetic differences could make all the difference between saving a river's stock and losing it.

The SALGEN project, started in 2001, set out to muster and refine our understanding of the ways in which Atlantic salmon vary across their range in terms of important characteristics and behaviour. It's a sobering thought that more than 99 per cent of the Atlantic salmon which now exist are farmed, and therefore largely dependent on man for their day to day survival. Across parts of its natural range, the King of Fish is already extinct or nearly so.

So surely restocking is the answer? The SALGEN report answers this with a resounding: 'No!'

So much the same, yet so different

Although this most noble of fish may look pretty much the same across all of its range, the diversity of local adaptations is truly amazing. To begin with, salmon from the West Atlantic and east Atlantic are completely distinct populations; they may meet at the oceanic feeding-grounds, but they go their separate ways thereafter, and don't interbreed. The last time they formed part of a single population was long before the last Pleistocene glaciation in the order of 600,000 years ago. Within Europe, though they were only established since the last Pleistocene glaciation, the Atlantic and Baltic populations are already genetically and geographically isolated, and biologically distinct. .

We think of the Atlantic salmon as an anadromous fish, without exception. Yet there are places where some of the fish remain in fresh water throughout their lives, often where there is no physical impediment to seaward migration. Even within these populations there are variations. Some individuals are either river or lake residents; others spawn in rivers then migrate to lakes, returning to the river year after year.

River Brora in Sutherland, typical salmon habitat.

There are also dramatic variations among the fish which exhibit 'standard' migratory behaviour. Juveniles spend anything between one and seven years in their natal rivers, before going to sea for one to four years, and subsequently returning to the river to spawn. There are some populations in North America where most fish survive to repeat the cycle of migration and return, in some cases up to six times.

Spawning behaviour also varies. Research has shown that large numbers of male parr may mature and breed successfully before going to sea for the first time. In addition, multiple mating appears common, with a higher survival of offspring from those parents with more mates. The SALGEN authors argue it is very important for fishery managers to take factors such as these into account when designing breeding systems to supplement stocks. For instance, managers should strive to estimate the numbers of mature male parr within a river, because these may have a substantial influence on breeding population size, especially in a small or declining population, and be important in maintaining genetic diversity.

Distinct populations

Atlantic salmon in different rivers and tributaries within rivers are organised by their homing tendency into distinct groups of breeders, representing distinct genetic populations. These genetic populations evolve over time to be distinct, across geographical regions, between river systems, and even within the same river system. Indeed, the resulting genetic distinctiveness means individual salmon can often be traced back to the river or tributary where they were born.

Growth and body composition are the traits most likely to be inherited and show genetic differences among populations, followed by general health condition and resistance to diseases, and the evidence points to these traits playing a major role in local adaptation. A very significant example of this is the Baltic salmon's resistance to *Gyrodactylus salaris*. Much about the importance of genetic differences among populations in adapting them to their local environments can also be inferred from the failure of salmon translocation programmes, and the poor performance of domesticated stocks in terms of disease resistance.

These distinct genetic populations, formed variously over decades, centuries and millennia, are the basic biological units controlling local species characteristics and abundance. 'As such,' state the SALGEN authors, 'they must be the central focus of species management and conservation... River managers (have) no choice but to take [...] genetic characteristics into account' in conservation and enhancement schemes.

The principal reason for this is simple: genetic variation (at individual and population level) is crucial to survival and reproductive fitness in a salmon's local environment, and ensures that each population is best suited to the particular environmental conditions it encounters in its river or tributary, and at sea.

In Pacific salmonids, the genetic differences among populations have been exploited for more than two decades to identify which populations are being fished, and control fishery openings and closures, assess catch allocation, etc. In Atlantic salmon, DNA-based genetic identification is routinely used to assess the continent of origin of fish in the West Greenland fishery, with greater than 99.9% accuracy. The same technique is also used to estimate wild stock proportions and national contributions to Baltic salmon catches, and could be extended to other parts of the species range, at a regional level, between rivers and within rivers. Thus there is exciting potential for using genetic markers more widely for stock analysis in Atlantic salmon management in the future.

Does fishing affect genetic variation?

Fishing targets fish non-randomly (on a seasonal basis). This causes loss of genetic diversity, both directly (by selectively removing a particular genetic population) and indirectly (by reducing population size, leading to the adverse results mentioned below).

It is crucial for fishery managers to appreciate this, and seek to minimise both effects. To achieve this, exploitation needs to be population-centred and managed so as not to reduce the numbers of breeders in each genetic population to the point where genetic diversity is lost. It should also seek to impact all demographic elements in each population equally so that all components of genetic diversity are affected to the same extent and the genetic character of a population is not changed.

If population sizes and patterns of genetic structure are known, harvesting can be carried out in a way which improves the genetic 'health' of a population without much loss of yield.

Atlantic salmon populations may adapt genetically over time to changing habitats – but there are some types of change which can't be accommodated. However, when possible, adaptation may take many generations. As such 'A precautionary approach is the only realistic option to habitat management' – until we have a more detailed understanding of the capacity of populations to deal with specific habitat changes.

Can genetics help us rebuild wild populations? Stocking and ranching

Falls in population numbers make them more prone to extinction, due both to there being fewer fish and to the loss of genetic variability, which increases inbreeding and reduces the ability of populations to respond to changes in the environment.

The minimum effective number of breeders for a population is suggested to be in the order of 100 and 167 per year – a number likely to be much lower than the census population size and difficult to determine in practice for any population. Thus in general, the objective needs to be to keep numbers of wild breeders, including mature male parr, as high as possible given the carrying capacity of a river or tributary.

Fishery managers may have done more harm than good in the past through stocking – not by design, but through ignorance. We don't have much knowledge of the impacts of historical stocking, but the story is unlikely to be a happy one.

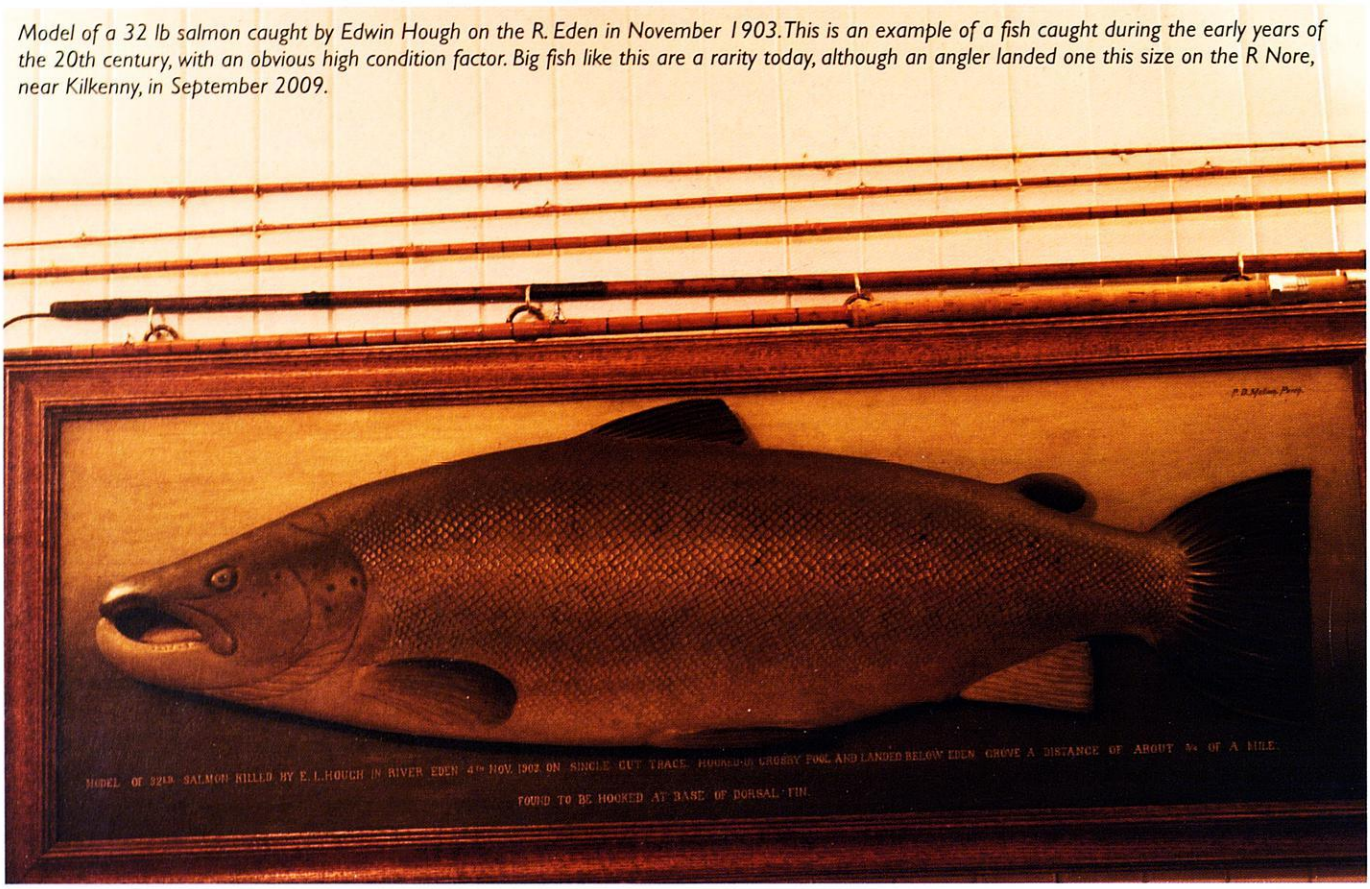
'In general, stocking will have either no or a detrimental effect on wild populations, both within targeted catchments as well as in neighbouring catchments,' state the SALGEN authors. 'Positive outcomes are unlikely and, if observed, likely to be short-term at best.'

They stress that where stocking is being considered, the aims need to be clearly defined, and a risk assessment of rehabilitation options undertaken by experts. 'Stocking and ranching should be seen as a last resort [..] not a first option, as heretofore,' they warn. It's essential to understand the targeted river or tributary stocks, in terms of both numbers and genetic population structure. It's also crucial to monitor and evaluate the impacts.

Where stocking is carried out, the authors believe that the use of non-local strains for restocking should be avoided if at all possible, 'nor should farmed strains be used for stocking or ranching'.

The optimal tactic, according to the SALGEN authors, is to improve habitat and let nature take its course through natural recolonisation. However, if the river in question is

Model of a 32 lb salmon caught by Edwin Hough on the R. Eden in November 1903. This is an example of a fish caught during the early years of the 20th century, with an obvious high condition factor. Big fish like this are a rarity today, although an angler landed one this size on the R Nore, near Kilkenny, in September 2009.



geographically distant from healthy wild populations, stocking or ranching may be the only answer. In this case, great care must be taken in the selection of brood fish, using wild source populations from the closest rivers with the most similar environmental conditions. Farmed strains should never be used.

Impact of farm escapes

Despite pressure from wild fishery interests all around the Atlantic to improve containment, salmon farmers still release hundreds of thousands of fish into the environment every year. Indeed, year on year, the equivalent of around half of total wild stocks in the north Atlantic escape from farms. Escapees now comprise 20 – 40% of the salmon in some areas – and over 80% in some Norwegian rivers.

Not only are there escapes from marine cages: in countries where pre-smolts are held in freshwater net pens, escapes directly into salmonid watercourses occur, contributing to this undesirable scenario.

Most escaped farm fish will die before breeding but those which survive their precipitate introduction to independent living generally enter rivers adjacent to the point of escape – but they can also migrate to distant rivers to spawn. Farmed females have greater reproductive success, compared to males, and the offspring will thus be disproportionately of mixed farm/wild parentage.

Not only will interbreeding lead to reduction in the effective size of wild populations, and increase genetic drift. There's the additional problem that competition with escapees and their progeny (which are larger) can reduce wild smolt production.

Hybrid fish have reduced lifetime success, reducing overall recruitment. The worst scenario is produced by repeated ingress of escapees to the same river – this can lead to the extinction of fragile wild populations.

The authors acknowledge that the salmon farming industry is making efforts to better contain its stock. However, they recommend that the industry/NASCO guidelines on containment should be regarded as a minimum standard. They also recommend that marine cages should not be situated within 30 kilometres of salmon rivers.

What of the future?

The SALGEN report sees a role for Live Gene Banks (LGBs), in some contexts, especially in the face of recent, dramatic population declines.

They also give pointers to mitigating the negative side-effects of captive rearing programmes.

- Use of molecular or pedigree analysis to minimise inbreeding and retain maximum variation
- Screening of potential broodstock to identify fish of appropriate ancestry
- Release of reared offspring to the river as fry to maximise adaptation
- Development of molecular genetic methods to track and compare survival of offspring reared under different conditions
- Cryopreservation of milt from the founder and subsequent generation of brood fish, for use later in the programme, to reduce the 'domestication' effect
- Experimentation with different management practices, mate selection and rearing and release strategies

In conclusion, the authors recommend that permanent, in-house genetics expertise should be brought in, to advise on management programmes; there should be more research into cost-effective ways of collecting genetic information on local stocks; genetic methods for defining population boundaries should be more widely used.

Finally, they recommend that we should 'Develop a more specific understanding of those aspects of the character of Atlantic salmon which are involved in local adaptation.'

The recent passing into law of Scotland's Marine Act has brought improved protection for seals, including a comprehensive licence system and tougher penalties for those who harm the animals. This has focused the minds of fishery managers on attaining a better understanding of exactly how big a threat to our salmon and sea trout these undeniably attractive but predatory animals cause. The following article by Iveta Matejusová, Jonathan Neve, Fiona Doig, Mike Snow, John D. Armstrong, and Stuart J. Middlemas Of Marine Scotland Science throws light on this.

The use of DNA to investigate the occurrence of salmon and sea trout in the diet of seals

Management of predation on salmon and sea trout requires information on the occurrence of these fish in the diets of seals. Examination of bones specific to individual prey species recovered from seal scats has so far suggested that salmon and trout together comprise a very small component of the diets of seals around Scotland. In instances where bones have been found, it has seldom been possible to distinguish between salmon and sea trout. However, the use of fish hard parts in scat samples to infer seal diet may underestimate the incidence of salmonids if, as has been claimed, seals often consume only the fleshy parts of large fish. Furthermore, the bones of salmon and sea trout are more fragile, and therefore less likely to occur in scats, than those of other prey.

To overcome these problems, a molecular method (termed quantitative real time polymerase chain reaction: qPCR) was devised to allow the detection of prey DNA in seal scats. The technique has the advantages that it does not rely on the consumption of fish bones and allows remains of salmon and sea trout to be differentiated. The new approach was tested, and shown to work, on scats collected from captive seals fed on a known diet. Both salmon and sea trout qPCR assays were shown to give no erroneous results when tested using DNA extracted from another 31 species of prey commonly found in seal scats.

The assays were then applied to samples of scats from wild seals collected in the Moray Firth during May and July 2003. This combination of sites and months was chosen to give the best chance of detecting salmon and sea trout in the diet. In total, 161 scats were examined for the presence of bones and also for DNA of salmon and/or sea trout. DNA was found more frequently than bones (Figure 1), doubling the number of scats with salmon or sea trout to 15% of the sample. In the case of samples collected in the Cromarty Firth during May, DNA also provided evidence of seals consuming sea trout, which would have been missed if the analysis relied on the presence of hard parts alone.

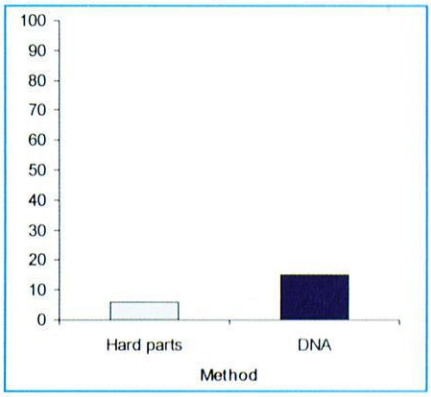
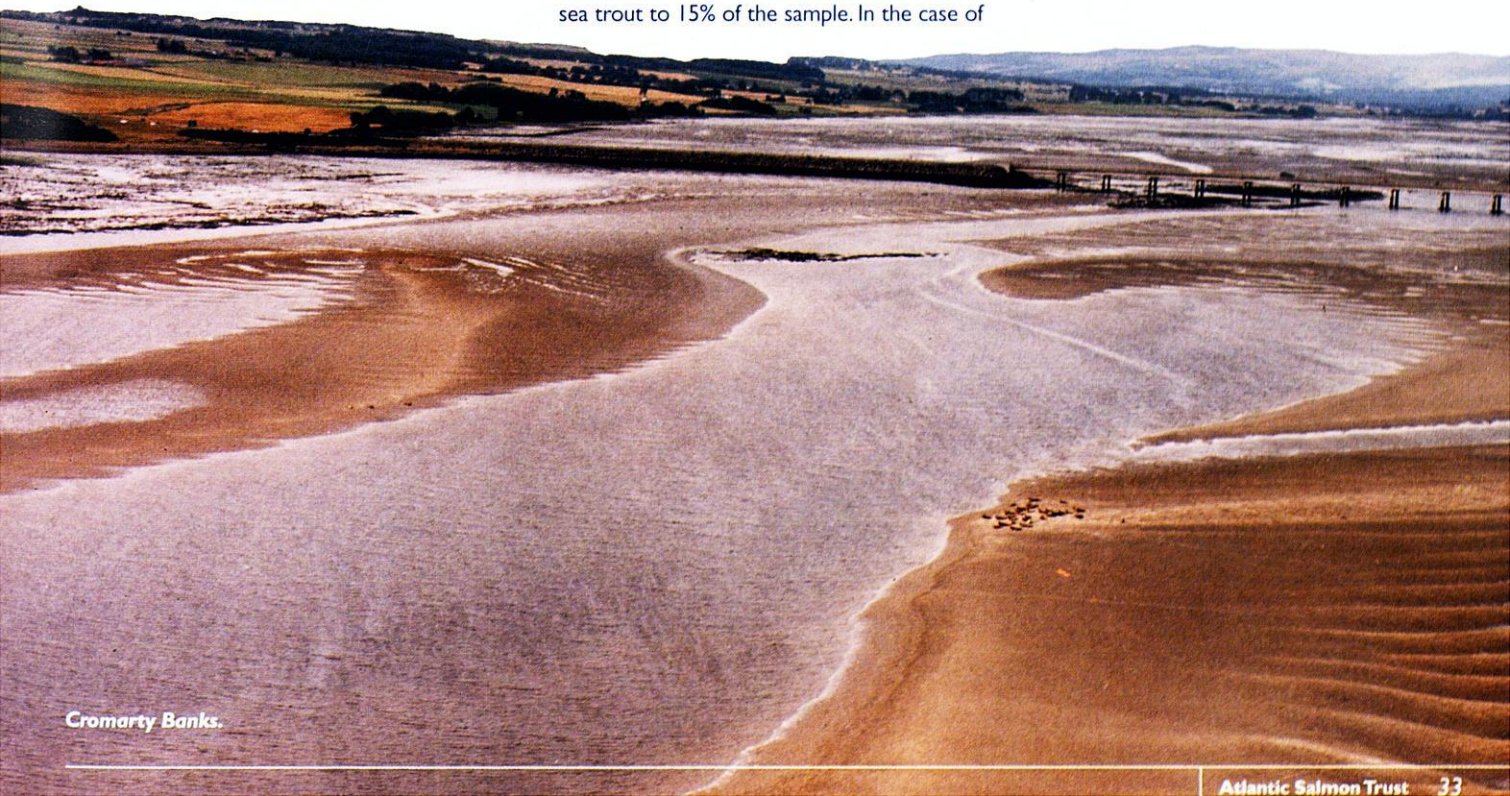


Figure 1 The percentage of scat samples collected in the Moray Firth during 2003 in which remains of salmon and/or trout were detected using hard parts and DNA.



Cromarty Banks.

Unlike hard parts analysis the DNA technique allows the occurrence of both salmon and sea trout to be measured. In the samples analysed both species were more prevalent in July than May and overall sea trout were detected in more scats than salmon (Figure 2).

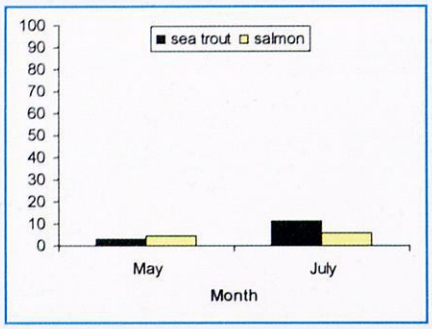


Figure 2 The percentage of scat samples collected in the Moray Firth during 2003 in which remains of salmon and trout were detected using DNA.

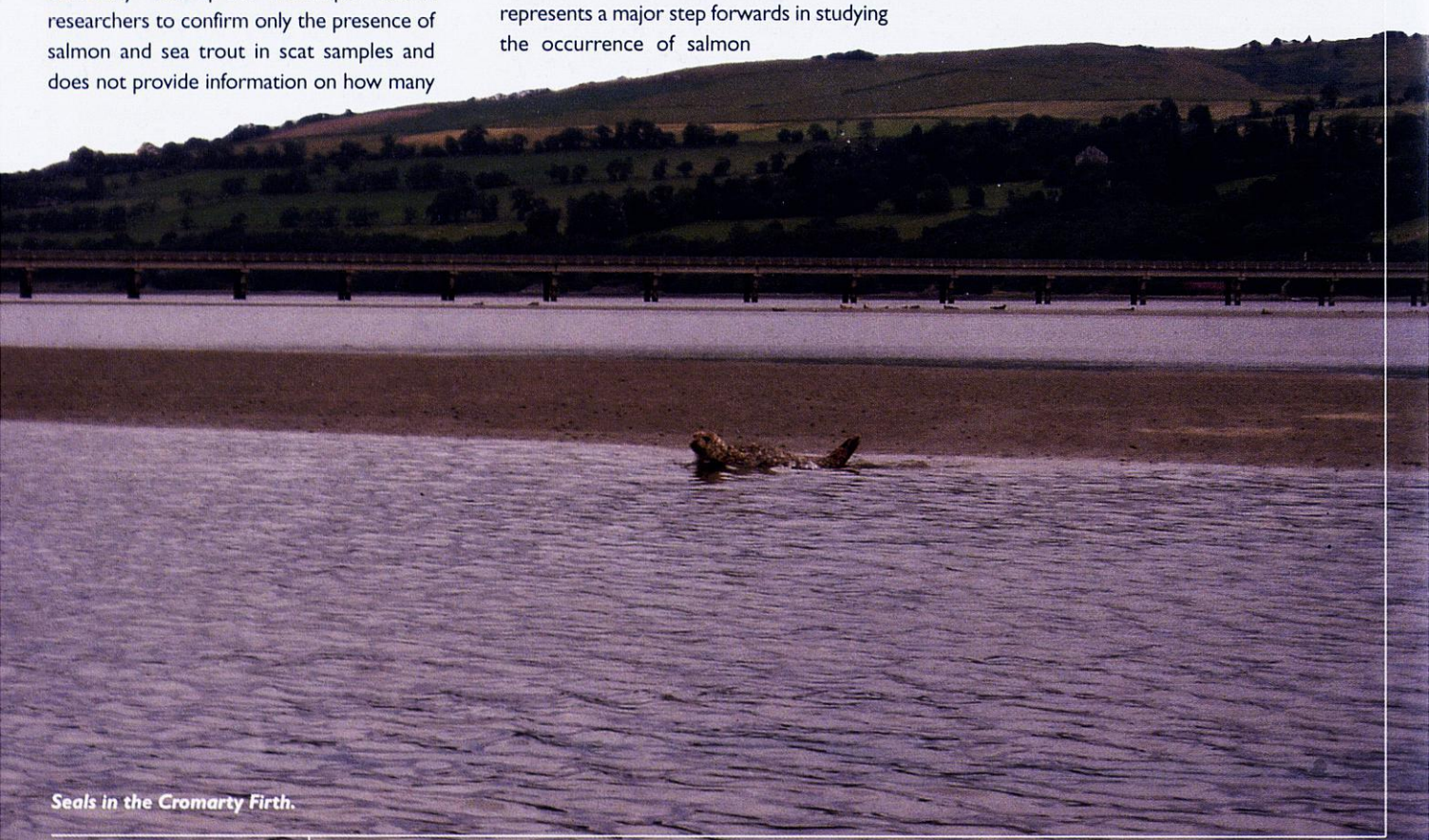
A selection of bones from salmon and sea trout.

Currently the qPCR technique allows researchers to confirm only the presence of salmon and sea trout in scat samples and does not provide information on how many fish have been consumed. Further work is required before such a quantitative assessment of the diet can be obtained. It is now necessary to develop the capacity to identify other species besides salmon and trout from their DNA remains to build a picture of the full diet. This work has been continued through a student project sponsored by the Buckland Foundation, which has investigated the finding that scats with salmonid DNA also tend to contain the remains of flatfish, rather than sandeels.

The application of these molecular methods represents a major step forwards in studying the occurrence of salmon and sea trout in the diet of seals. Overall, although the DNA evidence suggests that salmon and sea trout may be more prevalent in the diet of seals than analysis of hard parts has suggested, they were nevertheless detected in a minority of the scats examined.

A seal at Finavon River South Esk, 15 kms from the tide.

For further information see
Matejusová et al. (2008) Using quantitative real-time PCR to detect salmonid prey in scats of grey Halichoerus grypus and harbour Phoca vitulina seals in Scotland – an experimental and field study. Journal of Applied Ecology



Seals in the Cromarty Firth.

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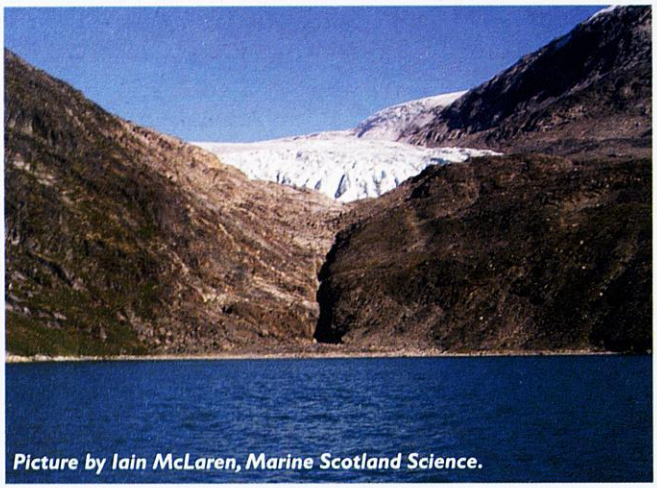
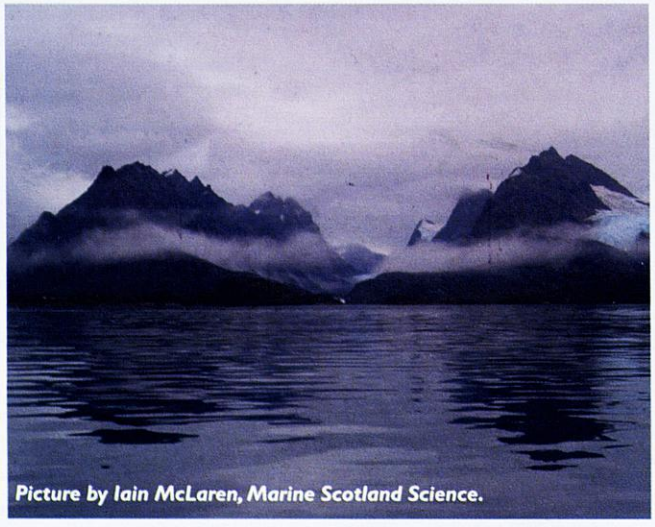
The west Greenland coast: still feeding N Europe's salmon



Picture by Iain McLaren, Marine Scotland Science.

The seas around the coast of the vast continent of Greenland are the destination for many of Northern Europe's multi sea-winter Atlantic salmon. During the 1960s huge numbers of salmon were commercially harvested by the people of Greenland. Today, as a result of international negotiation and agreements, the only catch remaining is at a small subsistence level.

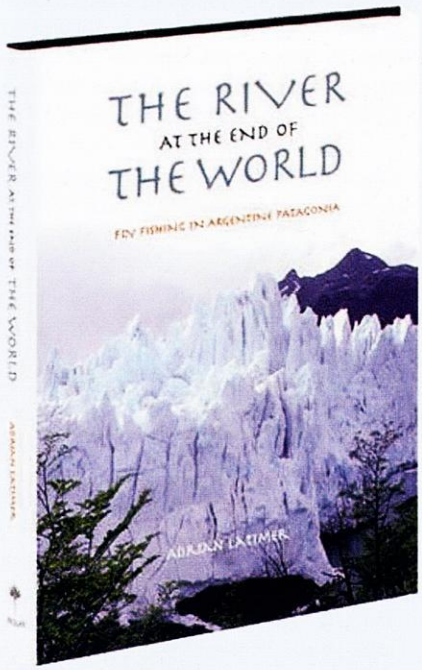
As climate change takes its toll of the prey species on which our salmon are dependent for their growth at sea, it is heartening that in the winter of 2009/2010 the arctic polar ice cap expanded to dimensions not seen since 2001. After two cold winters, and reports of salmon in excellent condition caught in SALSEA surveys off the west Greenland coast, it is now widely recognised that Greenland is one area of the ocean where our salmon are doing well. This is in contrast to salmon passing through the Norwegian Sea, where the 'skinny grilse' and some 2SW salmon syndrome continues to cause concern.



Picture by Iain McLaren, Marine Scotland Science.

Picture by Iain McLaren, Marine Scotland Science.

Book Reviews



The River at the End of the World – Fly fishing in Argentine Patagonia

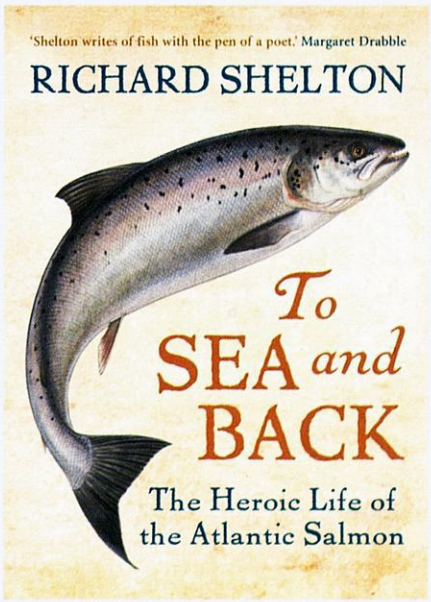
By Adrian Latimer

The Medlar Press

ISBN 1-899600-83-0

One of the very last wildernesses for the adventurous fisherman lies in the Southern part of South America, divided by the Andes mountains, in both Chile and Argentina. Adrian Latimer's inspiring and informative account of fishing in remote rivers and lakes for native species such as dorado, as well as brown trout and sea trout, should fire the imagination of people who want a new experience. He contrasts the elemental splendour of the glaciated landscapes of the high Andes with the surprises of fields of introduced lupins and Swiss style chalets. Patagonia should remind us of our lost European wildernesses and encourage us to find ways of restoring their rich diversity so damaged by wars, industrialised farming, forestry and over-fishing. Adrian Latimer is passionate about the conservation of wild salmon and sea trout and has given all the royalties from this book to the Wild Trout Trust and the North Atlantic Salmon Fund in their efforts to restore stocks to robust conservation levels and ultimately to the abundance only older people have experienced.

www.medlarpress.com



To the Sea and Back – The Heroic Life of the Atlantic Salmon

By Richard Shelton

Atlantic Books

ISBN 978-1-84354-784-6

www.atlantic-books.co.uk

This is the story of the complex relationship between salmon and people in the presence of history and science. Dick Shelton uses symbols from pre-history, such as the carved stone at Glamis, and links the salmon, probably in this case representing wisdom, with the social, cultural and economic benefits of salmon to human beings. As a scientist and former director of the freshwater fisheries laboratory at Faskally, he tells the story of salmon and the extraordinary people who have studied its life history and habitats. The author is essentially a man of the sea, which comes through strongly throughout the book as he describes the research voyage of the ship Challenger and his own more recent research into the lives of salmon at sea. Dick Shelton's originality is found in his obvious love of natural history and his intuitive understanding, always backed by science, of the interactions between living things. He writes beautifully and at times poetically. This is a book for everyone who has ever fished for salmon and anyone else who has ever wondered at the extraordinary odyssey each generation of salmon undertakes. The story it tells is as much about us as it is about the salmon, and it will surely become a classic alongside the works of that other great Scottish scientist and writer, D'arcy Wentworth Thompson.

Financial Overview

2009 was a challenging year for all organisations, not least those operating within the charitable sector. The Trust has had the additional distraction of reviewing its future as part of the background drive for consolidation within the fisheries sector, and emerged much the stronger for that process.

Gift aided donations increased satisfactorily over the first nine months to January this year, and income showed a small increase over the previous year, assisted by the continuing benefits of a most successful Annual Fishing Auction.

The Board's confidence in the future has been reflected in a number of non-recurring outlays and decisions. One taken with great sadness was the cessation of the Trust's Field Advisory Service in the form of John Webb, the longstanding Trust Biologist, for whom a tribute appears elsewhere. Most fisheries now employ their own biologists, and this cost, when compared to other competing research priorities, was no longer considered justified. Expenditure has also been incurred on a complete makeover of the Trust's presentation and publicity materials for public consumption at Game Fairs and other such occasions, while planning for the Flows Conference at York in January has taken much of Ivor Llewelyn's time.

The Board was anxious to sustain its research commitments, as a result of which a deficit is anticipated for the year. This will be funded by cash realised from the Trust's investment portfolio, which has made a strong recovery under the auspices of the new manager JO Hambro. £60,000 has been committed to continuing support for the SALSEA-Merge Research Project into salmon mortality at sea, and also the work of Professor Todd and St Andrews University into the condition of returning grilse. In addition, a special grant of £10,000 was provided to the GCWT to assist their rescue of the Research station and Laboratory at Wareham.

The Trust has been further looking to the future with the appointment of Professor Ken Whelan, past President of NASCO, and adjunct professor at University College Dublin, to take over from Dr Dick Shelton as Research Director. His expertise and knowledge will be an immense asset to the Trust, and we look forward to his contribution.

With a successful auction just completed, which will see a record level of funds put back into fisheries trusts, the outlook, while naturally challenging, is full of promise. Steps have been taken to underpin the Trust's unique position as the lead scientific research organisation working exclusively for the benefit of wild salmon and sea trout. With the benefit of our new website and greater public relations activities, we will be seeking increased support and funding to help us achieve our important objectives. We are enormously grateful to our many existing supporters and funders who continue to provide vital funding, without which we would be unable to survive and progress. Thank you to all these, and do please keep up your valued contributions!!

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We have a new range of quality merchandise bearing our new logo available to purchase.

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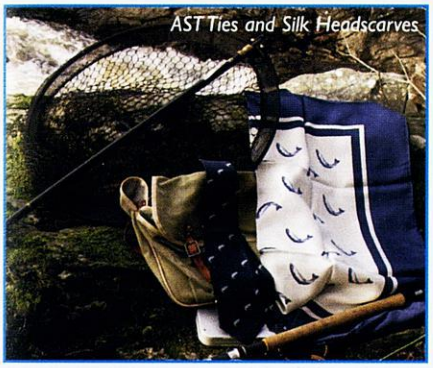

Silk Headscarves **£25**

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To order any of these items, please contact Jenny at the Trust's office on **01738 472032**, Suite 3/11, King James VI Business Centre, Friarton Road, Perth PH2 8DG or email **info@atlanticsalmontrust.org**

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Fundraising and Annual Fishing Auction
Following this year's record proceeds, we mean to build on 2010's success and make next year's Annual Fishing Auction better than ever. The auction is the Trust's prime fund raising event, and we believe it can go from strength to strength.

With the support of RAFTS, ART, the Wild Trout Trust and the Sea Trout Group, members have generously contributed not only mouth-watering fishing, but articles, artefacts, and even opportunities for expert tuition.

These arrangements are on the basis that the Trust returns all monies generated by these lots, directly for the benefit of the rivers trust or organisation concerned, less a contribution to the running costs of the Auction itself.

This is a genuine 'win win' for everyone involved; the Trust benefits from access not only to wonderful fishing, but also access to a wider audience of anglers and fishing enthusiasts.

So we look forward to Auction Day 2011 with keenest anticipation. Watch the website for more details of our new-look event.

Above all, please bid generously when the time comes.

WE VALUE YOUR SUPPORT – PLEASE HELP US KEEP UP THE GOOD WORK!!

You can help us by making a Gift Aid Donation, no matter how small. Some examples of current costs and projects are given below:

£15,000 – cost of a privately hired research vessel in North Atlantic for one day

£10,000 – major research project on salmon genetics or predator/wild fish interaction

£5,000 – research project on river restoration or fish farming impact on water system

AS A SUPPORTER

You can help us in one of a variety of ways:

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The form is on the facing page. The Trust can reclaim Income Tax. Higher rate tax payers can obtain the benefit of additional relief. Donations can be made by single donation or by Banker's Order.

Make a gift of shares to the Trust.
You can claim Income Tax relief on their value, and will be exempt from any Capital Gains Tax charges.

Sponsor the Trust or a specific project
For fuller details of projects please call Tony Andrews.

Make a legacy to the Trust
Bequests to charities
Your Will could express a donation in various ways, eg. The gift of a specific sum of money, a gift of specific assets (such as shares), or a gift of all or a specific part of the balance of your estate once all other legacies (eg. to the family) are taken account of. This is known as the 'residue'.

Bequests to charities are deducted from the total value of the estate before the calculation of any inheritance tax therefore reducing the total inheritance tax payable.

If you would like to leave a legacy to AST by changing your Will please consult your legal and financial advisors. Some families invite friends to give the Trust donations in memory.

If you would like to leave a legacy to the Atlantic Salmon Trust please contact our Financial Director, Neil McKerrow, who will be very pleased to advise further.

Being a Supporter will secure you a copy of the Journal which is produced twice a year, as well as access to publications and research findings. Above all, you can be sure in the knowledge that you are assisting a most worthwhile cause.

PLEASE DONATE – AND ENCOURAGE OTHERS TO DO SO!!

Leaflets and other publications can be supplied for fishing huts and beats

Gift Aid Declaration and Banker's Order Form

If you would like to support the Atlantic Salmon Trust, you can help us by making a cash donation or setting up a Banker's Order. Please complete the Gift Aid Declaration and parts A or B

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- A Declaration can be cancelled at any time by notifying us. It must cease if you no longer pay tax.

A. Cash donation. I enclose a cheque in the sum of £ made payable to the Atlantic Salmon Trust

B. To make a series of donations, which will be of great help in allowing the Trust to budget for work in future years, please complete the Banker's Order below.

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Branch Address

Post Code

Please pay to BANK of SCOTLAND, 76 Atholl Road, Pitlochry PH16 5BW (80-09-41) for the credit of

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on the _____ day of _____ 20____ and a like amount on the same day each month/quarter/half year/year

(delete as appropriate) (a) until I give you notice in writing OR (b) for a total period of _____ years.

Account to be debited A/c No Account name

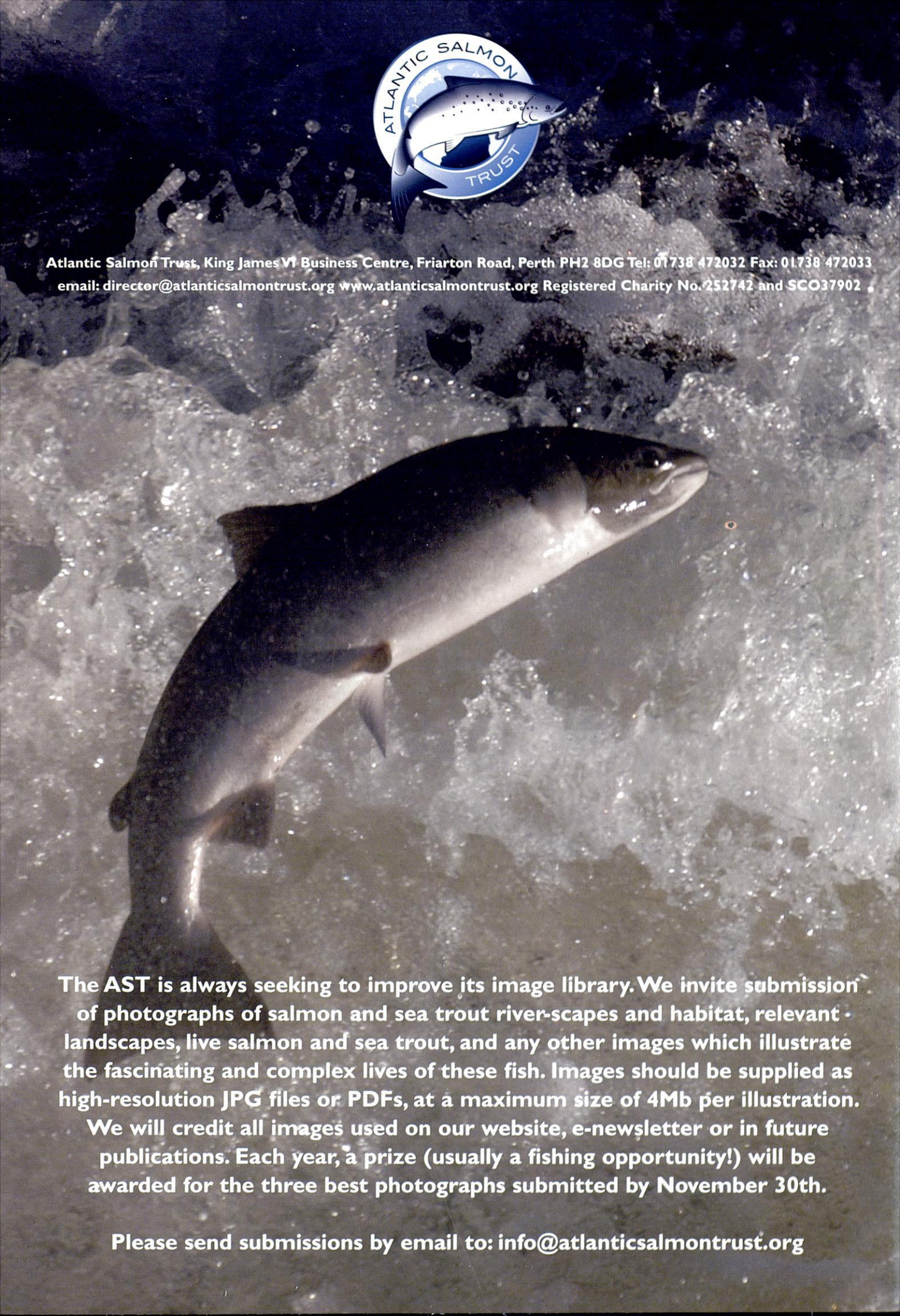
Signed Date

Full Name A/c No

Address

Post Code

PLEASE RETURN THIS COMPLETE DOCUMENT TO THE ATLANTIC SALMON TRUST, 3/12 KING JAMES VI CENTRE, FRIARTON ROAD, PERTH PH2 8DG.



Atlantic Salmon Trust, King James VI Business Centre, Friarton Road, Perth PH2 8DG Tel: 01738 472032 Fax: 01738 472033
email: director@atlanticsalmontrust.org www.atlanticsalmontrust.org Registered Charity No. 252742 and SCO37902

The AST is always seeking to improve its image library. We invite submission of photographs of salmon and sea trout river-scapes and habitat, relevant landscapes, live salmon and sea trout, and any other images which illustrate the fascinating and complex lives of these fish. Images should be supplied as high-resolution JPG files or PDFs, at a maximum size of 4Mb per illustration. We will credit all images used on our website, e-newsletter or in future publications. Each year, a prize (usually a fishing opportunity!) will be awarded for the three best photographs submitted by November 30th.

Please send submissions by email to: info@atlanticsalmontrust.org