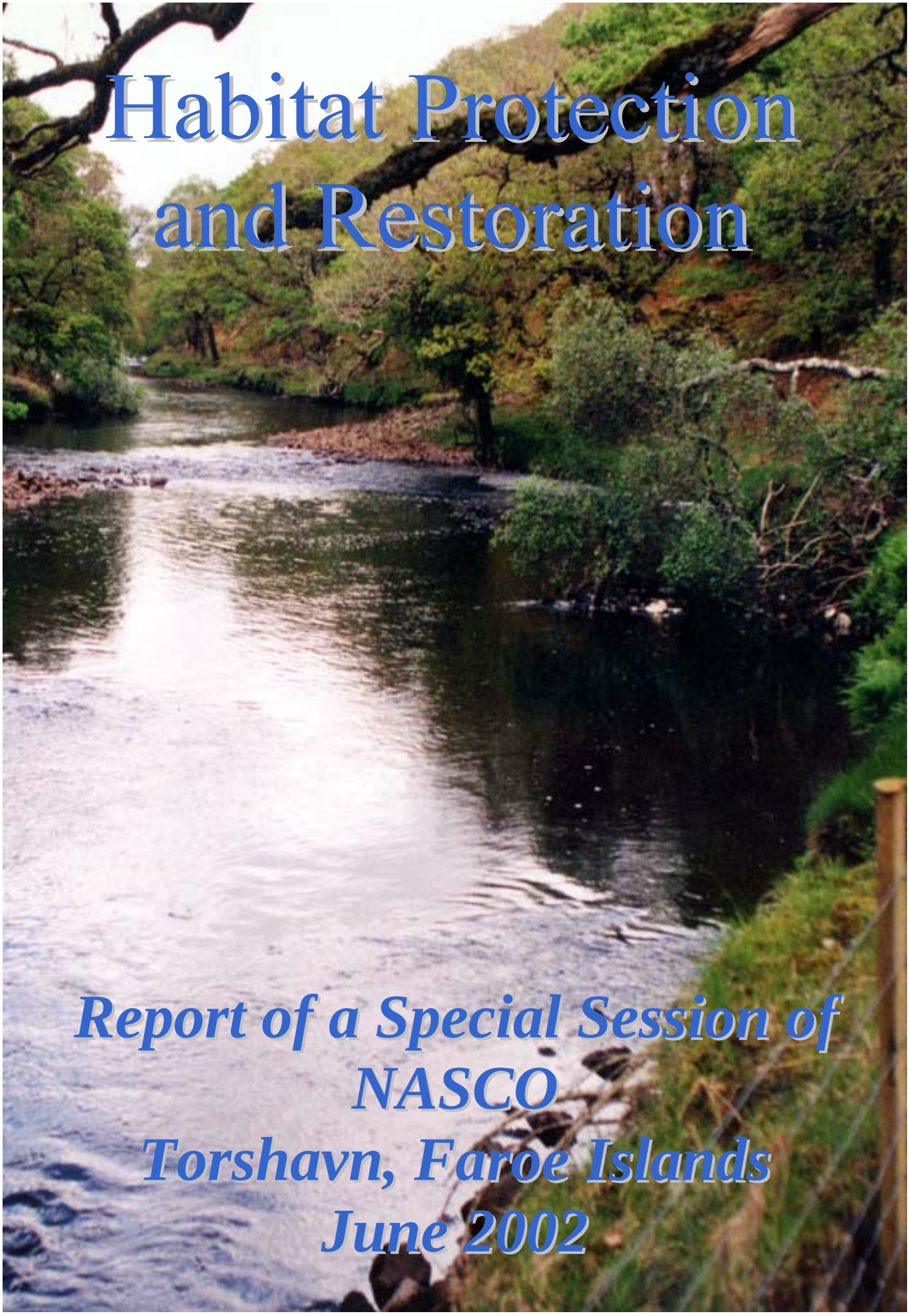

Habitat Protection and Restoration

Report of a Special Session of NASCO

Torshavn, Faroe Islands

June 2002

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on 3 June 2002

CNL(03)15

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Opening Remarks at the Special Session on Habitat Protection and Restoration by Mr Jacque Robichaud, President of NASCO

Distinguished delegates, ladies and gentlemen:

I would like to welcome all of you to our first session of this our Nineteenth Annual Meeting in the beautiful Faroe Islands.

Wild Atlantic salmon have a complex requirement for habitat, homing precisely to the habitat in which they were born. Loss of, or damage to, that habitat is a very serious matter and we will certainly fail in our obligations under the NASCO Convention to conserve, restore and enhance wild salmon if we fail to protect their habitat and restore degraded habitat. Over the last 150 years much habitat has been lost and this must have been a contributory factor in the decline of wild salmon stocks. For example, we believe that the losses from just one factor impacting habitat, acid rain, may be between 100,000 - 300,000 adult salmon per year. There are many threats of a physical, chemical and biological nature to the salmon's habitat. They include increased siltation, barriers to migration, changes to cover, changes to substrate, changes in rivers, changes in water quantity and quality, changes in species composition or abundance and introductions of diseases and parasite. Thus we are dealing with a vital but complex area of our work. One of the complexities is related to the wide range of interested parties involved. Our challenge now is to protect remaining habitat and restore as much as possible of that which has already been degraded or lost.

Last year we adopted a NASCO Plan of Action for the Application of the Precautionary Approach to the Protection and Restoration of Atlantic Salmon Habitat with the overall objective of maintaining and, where possible, increasing the current productive capacity of Atlantic salmon habitat. Under this Plan of Action the Contracting Parties and their relevant jurisdictions should establish comprehensive salmon habitat protection and restoration plans and establish inventories of rivers to facilitate monitoring of progress.

The habitat protection and restoration plans should:

- contain a general strategy for protection of habitat;
- identify and prioritise habitat restoration needs and contain a strategy to meet these needs;
- include participation in the inventory envisaged under the NASCO Plan of Action;
- introduce evaluation and monitoring systems for habitat protection and restoration.

The Plan of Action also recognizes that there are likely to be benefits from sharing and exchanging information on habitat issues and best management practice. The purpose of this Special Session is to facilitate this exchange of information. We will return to the issue of the Precautionary Approach later in the week when we will need to consider arrangements for reports by the Parties on implementation of habitat protection and restoration plans on an ongoing basis and further clarify the role of NASCO in relation to the inventories. Today, however, we look forward to hearing about the initial actions being taken by the Parties.

Strengthening the Atlantic Salmon Habitat Management Program in Canada

Pierre Lemieux, Habitat Management Division, Department of Fisheries and Oceans, Canada

1. Introduction

At NASCO's Sixteenth Annual Meeting in Westport, Ireland, in 1999, a Special Session on Habitat Issues was held during which Canada made a presentation and provided a report that was included in the summary of the Special Session. The report provides details of the:

- distribution of Atlantic salmon rivers in Canada;
- major causes of habitat loss in Canada;
- legislative and policy framework for habitat protection in Canada;
- restoration initiatives over the last decade; and
- current sources of Atlantic salmon habitat impacts.

NASCO and its Contracting Parties have recently agreed to adopt and apply the Precautionary Approach to the conservation, management and exploitation of Atlantic salmon. One of the main points of the Action Plan that has been developed is that in order to conserve, enhance, restore and rationally manage salmon stocks, their habitat must also be conserved and restored. The Action Plan goes on to state that the emphasis must be on protecting the productive capacity that currently exists and, where possible, restoring the lost and degraded habitat.

The purpose of this report is to summarise some of the initiatives since 1999 that have contributed to more effective habitat conservation and restoration for Atlantic salmon in Canada. More specifically, this report provides a summary of the habitat-strengthening initiatives within the habitat management program in Canada, as well as the additional support activities that will contribute to a stronger habitat management program.

2. Habitat Management Program Strengthening

Although there has been a strong habitat conservation and restoration plan in Canada since the inception of the National Habitat Policy for the Management of Fish Habitat in 1986, in 1999 Cabinet decided to further strengthen the program. Although the focus has been on increasing habitat management capacity in the inland provinces where there was little presence prior to 1999, the strengthening program has resulted in an additional 30 new habitat management staff in the Atlantic provinces. The main focus now is to more fully implement the national habitat policy by maintaining the conservation and project review efforts while increasing some of the more proactive activities. The following is a summary of some of the recent strengthening activities. It is important to note that it is the contribution of all levels of government, non-government organizations, community groups and industry that contribute to the conservation and restoration program in Canada.

2.1 Protection and Compliance

As described in the NASCO "Report of the Special Session on Habitat Issues held in 1999" there is a strong legislative foundation for habitat protection in Canada. In addition, the

policy framework as outlined in "The National Policy for the Management of Fish Habitat" tells Canadians how to interpret and implement the different habitat protection and pollution prevention provisions of the federal legislation. The key element of the policy framework is the "No Net Loss" guiding principle which is applied during the review of all new development projects in Canada which have the potential to impact fish habitat.

As it is generally agreed that it is easier to protect existing natural productive capacity of fish habitat than to try to restore it after it has been lost, Canada strives to maintain fish habitat productive capacity on a project by project basis. An average of about 15,000 projects are reviewed every year to help ensure that no net loss is achieved. Where the loss of productive capacity is unavoidable through project relocation or redesign or the implementation of mitigative measures, and is considered acceptable, then the productive capacity must be replaced and monitoring conducted to verify the effectiveness of the compensation measures.

Restoration and enhancement are the two other key elements of the national policy framework, which contribute to the overall objective to "Increase the natural productive capacity of the Nation's fisheries resources, to benefit present and future generations of Canadians". Restoration activities will be discussed later in this report.

As far as enforcement of the *Fisheries Act* is concerned, there has been some improvement over the last two years. Enforcement staff have received better training, habitat cases have received higher priority and there has been further designation of enforcement powers for government personnel. Enforcement continues to be viewed as an effective deterrent to habitat violations in Canada.

For further information on the habitat management program in Canada, please refer to the following web site: http://www.dfo-mpo.gc.ca/habitat/.

2.2 Conservation Initiatives

Under the new National Heritage Conservation Act, the Quebec government has recently declared the Moisie River as one of the first aquatic wildlife reserves in Québec. The proposed aquatic reserve covers an area of approximately 3,897 km^2. It comprises a corridor between 6 km and 30 km wide, taking in the main course of the Moisie river from 37 km to 358 km from its mouth, along with a broad strip of its immediate watershed including the Carheil and Aux Pékans rivers.

The Moisie River is one of the most renowned salmon rivers because of the high average weight (approximately 7 kg) of the individual salmon. The spawning run involves a high proportion of multi-sea-winter salmon and some fish return to spawn several times.

Aquatic reserve status will allow the pursuit of the following conservation objectives: the conservation of a river representing the regional ecological conditions; the protection of the Atlantic salmon population; the preservation of biodiversity in aquatic and riverbank ecosystems; the maintenance of the landscape and the development of certain key elements in the landscape; the acquisition of new knowledge on salmon ecology and on the natural heritage of the Moisie river.

The protected area will be exempted from all forms of logging, mining exploration and production as well as energy production. Existing rights and privileges, such as fishing, hunting, outdoor activities and traditional aboriginal activities, will be maintained.

This announcement comes in the wake of an earlier 2002 announcement which saw the creation of 11 new territorial reserves on the North Shore under the Québec Action Plan. Some of these will ensure the protection of magnificent rivers and their watersheds, such as the rivers Natashquan, Magpie and Ashapmushuan.

2.3 Partnering and Outreach

Protection of fish habitat is an important goal in Canada that can only be accomplished through effective partnerships. In Atlantic Canada, both the Department of Fisheries and Oceans and the provincial governments have a key role in ensuring that development occurs without seriously compromising fish habitat. The Canadian Council of Fisheries and Aquaculture Ministers' (CCFAM) Freshwater Fisheries Strategy Implementation Plan calls for the development and signing of formal partnering agreements (MOUs ((memorandum of understanding)) and Protocols) with each province and territory. These agreements provide a key mechanism to advance habitat management objectives including no net loss of productive capacity of fish habitat. To date, Atlantic Canada MOUs have been signed with PEI and MOUs with Nova Scotia, New Brunswick, Newfoundland and Labrador are under preparation. The objectives of these agreements are to:

- facilitate more effective conservation, protection and enhancement of fish habitat;
- streamline the regulatory process;
- improve quality of decisions by better use of expertise;
- ensure efficient use of government resources;
- improve communications and provide better service to Canadians.

Formal (partnering) agreements with industry are also being developed to help strengthen the habitat management program. Some of the industry associations that have been engaged are the Canadian Electrical Association (CEA), the Forest Products Association of Canada, the Mining Association of Canada, the Canadian Association of Petroleum Producers, and the Canadian Cattlemen's Association. The main purpose of these agreements will be to:

- increase industry understanding of habitat no net loss objective;
- enhance awareness of regulatory requirements;
- promote joint activities with regards to research, training and stewardship;
- improve communications and planning.

It is worth noting that the first MOU with a national industry association has been signed with the Canadian Electrical Association (CEA). The Core Group established under the CEA MOU to manage co-operative work has given priority to the development of a Compliance Framework and good progress has been made on it. An interpretation bulletin on instream-flow requirements is also being developed. This is particularly relevant given the fact that the northern-most Atlantic salmon rivers in Canada are being looked at for potential hydroelectric development.

Over the last two years, DFO has also focused on community outreach and education programs. In Newfoundland, for example, there have been well over 200 presentations on

fish habitat to the schools at the primary and secondary levels. Another target audience of new fish habitat education programs has been front-line forestry workers. The strengthening program has led to the development of a training program that ensures that these front line forestry workers are more knowledgeable about forestry-related impacts to habitat and how they can be avoided.

2.4 Stewardship

Effective and well-resourced programs to conserve, restore and enhance freshwater fish habitat are essential to the health and wellbeing of productive fish populations. Although the legal mandate for provision of fish and fish habitat management programs belongs to the federal and provincial governments, there is a broad community of non-government stakeholders that also share this goal. Community volunteers, non-government organisations, and various industries represent important local resources that are capable of making major contributions in support of healthy fish populations. Although there are significant community stewardship activities in Atlantic Canada, it is recognised that they could be strengthened by developing a clearer strategy that addresses the issues and challenges.

An initiative to strengthen community stewardship is presently underway in Atlantic Canada that involves federal and provincial government departments and non-governmental organisations. They have come together to develop a strategy and action plan to help ensure that existing and future community-based, volunteer processes are as effective as possible in conserving and restoring healthy and productive fish habitat. Successful implementation of this strategy will depend on it being strongly supported by federal, provincial and First Nations governments, as well as non-government organisations and other contributing interests. A draft discussion paper has been developed and, once endorsed, members of the working group will seek endorsement of the strategy through their respective departments and organizations.

2.5 Integrated Management

From experience, it has become clear that one of the most effective ways of improving salmon stocks and their habitat is under a clear policy framework in place that enables the development of river-specific conservation, management and protection plans. The key elements of watershed management initiatives in Atlantic Canada are:

- one decision-making process involving government and key stakeholders;
- all parties must recognise the legitimacy of the process through which decisions are taken;
- broad participation including aboriginal and non-aboriginal stakeholders;
- decision-making must be based on the best available information;
- adequate resources to carry out basic functions;
- decision-making capacity should, at a minimum, be advisory to government decision-making;
- clear roles and responsibilities are required;
- the process must have a clear dispute resolution process in place.

In Atlantic Canada, there are a number of successful, relatively recent watershed processes. The province of Quebec probably has the most experience in this type of management as a number of community-based management processes were put in place in the 1970s through

its zone d'exploitation (ZEC) program. Under this program, local organisations manage the resources within a provincial regulatory framework. Over the past decade, Quebec's salmon returns have generally outperformed returns to rivers in other Atlantic provinces. Whether this is attributable to these community-based programs is unclear but the visibility of the community in the management of Quebec's fisheries has been very positive. The Miramichi Watershed Management Committee and the Restigouche River Watershed Management Council are two very recent examples of effective integrated management and the watershed management approach.

2.6 Habitat Restoration

Well over 1,000,000 m^2 of fish habitat has been restored in rivers throughout Atlantic Canada through habitat improvement projects over the last few years. The majority of these projects are conducted by watershed management groups. For example, the Atlantic Salmon Federation has a network of seven regional councils which have a membership of more than 150 river associations and 40,000 volunteers who carry out numerous restoration activities on a yearly basis. In Nova Scotia alone, in 2001, the Nova Scotia Salmon Association Adopt-A-Stream Project restored about 85,000 m^2 of fish habitat. Funding for these projects totalled about $400,000 and came from sportfishery contributions, non-government cash contributions, in-kind contributions and other government funding.

Government is more involved in terms of providing technical advice on matters related to the installation and maintenance of habitat improvement structures, the design of fish passage facilities, the requirements for bank stabilisation works, the requirements of water quality monitoring programs, the development of watershed management plans, etc. Site visits are also conducted as required and advice on the regulatory requirements is provided.

The types of Atlantic salmon habitat restoration projects that are conducted in Atlantic Canada are quite diverse. In heavily impacted, highly developed areas where there has been long-term cumulative effects to river and stream channels and their riparian areas, much of the work focuses on bank stabilisation, erosion protection, and in-stream structures to help restore natural stream processes and increase habitat complexity.

In other areas, the restoration of access across artificial barriers like dams, causeways and culverts is a major priority and has resulted in major gains in available habitat. In New Brunswick, for example, the Department of Fisheries and Oceans and the provincial Department of Highways have developed a program under which, when highway culverts have to be replaced, DFO advises each year on the requirements for fish passage. There are numerous examples of newly designed stream crossings that now effectively pass fish, including salmon. A similar program has been developed in Newfoundland in the forestry sector where stream crossings are being redesigned for fish passage.

Another example of a restoration initiative for Atlantic salmon is in Quebec. A recent hydroelectric project on a non-salmon river was approved and part of the compensation for the loss of habitat for other species of fish included the improvement of the flow regime on a salmon river downstream of an existing hydroelectric power plant. Ensuring a higher minimum flow throughout the year and an even higher flow during the incubation and emergence period is expected to increase the productive capacity for salmon. Minimising the flow variations should also contribute to the quality of the habitat. Although escapement for this river in recent years has only been between 100 and 500 salmon, the capacity with the

new flow regime is estimated at about 7,500 salmon. Monitoring will be conducted to verify the results of this new flow regime.

The pH levels of the waterways in South Western Nova Scotia are extremely low due to acid precipitation. This is aggravated by the poor buffering capacity of the local soils. A committee, established by the Nova Scotia Salmon Association (NSSA) and the Atlantic Salmon Federation (ASF), recently selected the West River Sheet Harbour watershed, on the province's Eastern Shore, as its first site for implementing a broad-scale liming plan to counteract the negative impacts of acid rain on the Atlantic-coast rivers.

The choice of watersheds is based on a report commissioned from the Norwegian Institute for Water Studies (NIVA). The committee is also developing a long-term liming strategy, setting out criteria for prioritizing all acid rain affected rivers in the province.

2.7 Habitat Inventories

A large array of inventories already exists on riverine, coastal and estuarine habitats in the Atlantic Provinces. Unfortunately, this information is not held in any one common data bank. The Department of Fisheries and Oceans has recently undertaken the Departmental Inventory of Data Holding initiative to ensure that existing data is managed more effectively, shared with those who could benefit from it and avoids the generation of data that may already exist.

Over the last two years there has also been a number of initiatives in the different areas of Atlantic Canada focused on generating more inventory data on Atlantic salmon habitat. Below are a few examples of these initiatives.

The University of Prince Edward Island (UPEI) and the Atlantic Salmon Federation (ASF) recently released the first ever report assessing the state of PEI's Atlantic salmon stocks. The interim report is entitled "Distribution and Relative Abundance of Salmonids in Streams and Rivers on Prince Edward Island". It is expected that a final report will analyse the watershed land-use activities in each river sampled and provide historical accounts of salmon runs and river conditions.

In Newfoundland, DFO, in partnership with the provincial government and the forest industry, has recently completed an inventory of poorly designed or failed stream crossings on resource access roads. Many of these have blocked fish migration and in some cases eliminated sea run stocks, including Atlantic salmon. A database has been created for the entire island identifying and documenting any concerns that may affect fish habitat.

2.8 Habitat Research

Link between chemical pollutants and salmon survival at sea

This ongoing work is based on the concept that freshwater and marine environments cannot be considered in isolation and that conditions within the freshwater zone experienced by Atlantic salmon may be critical to their subsequent survival at sea.

Aerial spraying of pesticides occurred in the Maritimes to combat the spruce budworm between 1975 and 1985. The pesticide used was Matacil 1.8D, which contains the surfactant

4-nonylphenol (4-NP). Spraying was typically carried out in mid- to late spring. Nonylphenol is an Endocrine-Disrupting Chemical (EDC) that mimics estrogen. The hypothesis is that once mixed into freshwater streams, nonylphenol could hinder parr-smolt transformation (PST) of salmon that also occurs in mid- to late spring. Unable to properly osmoregulate, exposed smolts would experience decreased growth rates and higher mortality following their migration to the marine environment. This, in turn, would greatly reduce the number of salmon returning to spawn 2 years later. The researchers (*i.e.* Fairchild, *et al.*) realised that the spraying coincided with the final stages of smolt development and, when looking at this time-frame, effects on salmon populations were apparent.

Although insecticides used in Canada no longer contain nonylphenols, these, and other comparable chemicals, continue to be released from pulp and paper facilities, textile plants, sewage treatment plants, and other industrial facilities.

For Atlantic salmon, if the mechanism of effect on smoltification is due to the estrogenic potential of 4-NP, then many other endocrine-disrupting compounds encountered in the environment may also be important.

Other freshwater contaminants may also act in a number of ways to reduce marine survival. Pesticides such as atrazine may interfere with PST, and reduce the ability of the fish to physiologically adapt to saline conditions. Atrazine is a widely used pre-emergent herbicide often applied to corn crops, and has high run-off in the first rain after field application.

In the environment, atrazine is derived primarily from intensive agriculture, and nonylphenol family compounds from sewage treatment plants (STPs) and industrial effluents such as textile mills. Monitoring of salmon rivers and estuaries in the Inner Bay of Fundy catchment has measured atrazine near agricultural fields and nonylphenols in STP effluents in the low µg/L range. The concentration range of these measurements is similar to the range described above in experiments that had a negative effect on the growth and survival of smolts. In addition, laboratory studies have indicated that a combination of low environmental levels of atrazine and 4-NP may have a synergistic effect on smoltification, again reducing survival of smolts in seawater.

The concern is that the Inner Bay of Fundy salmon smolts may be exposed to atrazine while in streams, and then to nonylphenols in the lower river or estuary. That is, two or more pulses of exposure a few days apart. This is a very similar pattern to that used in some of the experiments that have been carried out, and matches the timing pattern of historical forestry spraying of nonylphenol very well. Based on the evidence presented above, it is conceivable that the exposure of the smolts to both atrazine and nonylphenol during downstream migration may subsequently affect growth and mortality of the smolts once they enter the Inner Bay of Fundy.

Further work is continuing throughout the geographic range of the Atlantic salmon to determine the role of exposure to mixtures of contaminants on marine survival of salmon and model impacts of contaminants on populations.

Marine survival research

Since 1999 the Atlantic Salmon Federation (ASF) and the Department of Fisheries and Oceans (DFO) have been conducting research into the declining numbers of Atlantic salmon

in the Bay of Fundy. This cooperative tracking study is designed to help determine where Atlantic salmon smolts go at sea after leaving their natal rivers. Through the tracking, capture and release of live salmon post-smolts at sea, the research team intends to discover locations, times and potential causes of salmon mortality at sea. They have also been gathering data on the health and condition of Atlantic salmon from both the inner and outer rivers while the salmon are in the bay.

The researchers are using newly developed technology in the form of acoustic tags that were specially designed for small fish. They have developed and successfully used new methods of monitoring tagged post-smolts in the Bay of Fundy to deliver information on their movement, behaviour, habitat and survival from the time they leave the rivers. The fish and tags used are the smallest successfully tracked at sea over such a large area to date.

Water temperature monitoring

The Atlantic Salmon Federation (ASF), the Department of Fisheries and Oceans (DFO) Science Branch, Gulf Region, and the Restigouche River Watershed Management Council Inc. (RRWMC) are undertaking the largest project to date to obtain data on seasonal and year-round water temperatures in the Restigouche River and its tributaries. Atlantic salmon spend a great part of their lives in fresh water. During all their freshwater life stages, they are particularly sensitive to water temperature. According to climate change predictions, water temperatures are expected to increase substantially and may become the most important limiting factor in the Atlantic salmon's habitat. The water temperature monitoring program will provide invaluable information to address this issue for Atlantic salmon, not only for the Restigouche River, but for the species overall. It will also guide proactive programs for protecting and enhancing those critical habitats which provide appropriate temperature environments for Atlantic salmon."

3. Related Regulatory Activities

3.1 Species at Risk Act

The *Species at Risk Act* (SARA) is aimed at fulfilling Canada's commitments under the United Nations Convention on the Conservation of Biological Diversity, which Canada ratified in 1992. The SARA Bill was passed by the Senate and obtained Royal Assent in December 2002. A series of regulations are currently under development and must be completed prior to Proclamation, which is expected by fall 2003. Three Competent Ministers are identified under SARA as having responsibility for implementing SARA and protecting certain groups of species. The Minister of Fisheries and Oceans is responsible for the protection of aquatic species and their critical habitat (as defined by the *Fisheries Act*).

There are five components that make up the SARA process.

1. **Assessment**. COSEWIC (Committee on Status of Endangered Wildlife in Canada) reviews the species Status Reports and determines extirpated, endangered, threatened, species of special concern and date-deficient designation.

2. **Response Statements**. Ministers prepare a first response to the designation. The response gives the government intent and accountability and all jurisdictions work collaboratively to develop response statements.

3. **Legal Listing**. The COSEWIC list is submitted to Governor in Council for adoption. Cabinet decides which species are placed on the Legal List. As SARA stands now, all species presently on the COSEWIC list will automatically be placed on the Legal List when the law enters into force.

4. **Protection**. Mandatory prohibitions on harming listed extirpated, endangered and threatened species and their residences.

5. **Recovery**. Mandatory preparation of recovery plan for extirpated, endangered or threatened species. For species of special concern, management plans will be required. These management plans may be based on existing plans. There are provisions in SARA for stewardship programs and landowner incentives to be used to protect critical habitat if it is found on private land; these would be funded by responsible agencies. Under SARA, the federal government must protect all critical habitat under its jurisdiction. Critical habitat that is not under federal jurisdiction, and that is not being effectively protected by other legislation, can be protected under SARA as a last resort (Safety Net).

SARA is intended to complement other legislation, not replace it. Provisions of the *Fisheries Act* will remain the tools used to protect aquatic species, since SARA will only offer direct protection where no other legislation is providing effective protection.

The Inner Bay of Fundy Atlantic salmon populations were listed as endangered on Schedule 1 of SARA in 2001. These populations spawn in those rivers of Nova Scotia and New Brunswick that drain into the Bay of Fundy. They differ from other populations of Atlantic salmon because after they go sea, they remain in the Bay of Fundy, at least until autumn, but it is not known where they spend the winter. These populations have declined by approximately 90%: they were estimated at 40,000 adults in some years, but have declined to less than 500 in 1998 and less than 250 in 1999. Population growth appears to be limited by marine survival rather than freshwater production capacity. The cause of the collapse of marine survival is unknown, but may be due to ecological changes in the Bay of Fundy.

The recent listing as endangered means these populations will form a part of the complement of species that will be automatically "rolled over" to form the SARA legal list of species. SARA will apply to these species upon proclamation. Because there are 48 species being rolled over at once, the timeline for preparing recovery strategies has been extended. For the Inner Bay of Fundy salmon stock, a recovery strategy must be prepared within 3 years of proclamation. If possible, its critical habitat will have been identified in the recovery strategy and will have to be protected at this time. Habitat management will continue to be conducted in accordance with the *Fisheries Act* but special consideration will need to be given when a species at risk may be impacted.

Recovery planning for the Inner Bay of Fundy, involving government and other organizations, is already under way. The new program involves tracking salmon during their migration from natal rivers to the Bay of Fundy to elucidate the migration patterns of endangered young Atlantic salmon. This information will help design recovery strategies. Recovery also involves some gene banking of some of the more important rivers in this area to ensure the preservation of the genome of the Inner Bay of Fundy rivers.

3.2 Agriculture Policy Framework

The Agriculture Policy Framework is a five-year federal/provincial/territorial initiative, starting this year, that will fundamentally reshape Canada's agriculture sector. Under the framework, governments' goals will be to reduce agricultural risks to the environment, including fish habitat, and preserve the health and supply of water, soil and air as well as ensure compatibility between biodiversity of species and agriculture.

In Atlantic Canada and elsewhere, long-term, predictable programs will be put in place that will enable farmers to better identify and adopt environmentally responsible farm practices that will, among other issues, address fish habitat and riparian concerns on agricultural lands.

Atlantic Salmon Habitat Enhancement in Finland – the Atlantic Rivers

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1. Atlantic Salmon Rivers in Finland

In addition to several salmon rivers draining into the Baltic Sea basin, there are two river systems in Finland supporting Atlantic salmon stocks that drain into the Atlantic Ocean, the Rivers Teno and Näätämöjoki. Both rivers are in the subarctic area, located between 68ºN and 70ºN, and they are border rivers with Norway with their lowest sections belonging to Norway only (Figure 1). The River Teno (Tana in Norwegian) is a large salmon river with a drainage area of 16,386 km^2 and a mean discharge of 170 m^3/s. Two thirds of its drainage area belongs to Norway, including the large headwater tributaries, Rivers Iesjoki and Karasjoki (Figure 1). In contrast, more than 80% of the River Näätämöjoki system (Neidenelva in Norwegian, drainage area 3,160 km^2) is located in Finland (Figure 1).

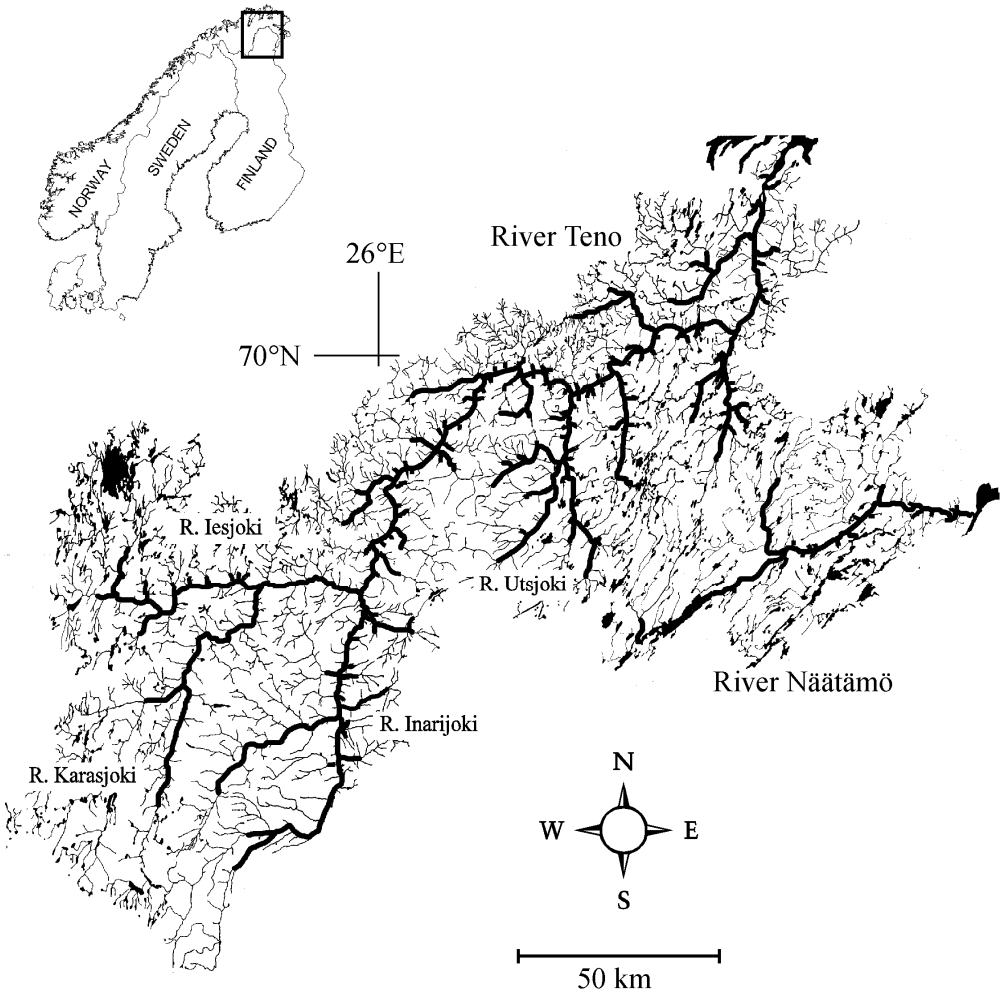


Figure 1: The Rivers Teno and Näätämöjoki and distribution of Atlantic salmon in the river systems (thick lines)

Given their northern subarctic nature, and little or no human influence on the water quality or physical environment, large proportions of the drainage areas of the rivers Teno and Näätämöjoki are virtually pristine. All salmon production is natural, and no releases of salmon are allowed in these river systems. The only tool for salmon stock management is fishery regulations introduced and agreed by the Finnish and Norwegian authorities for the river fisheries. A variety of both national and bilateral legislation regulate the nature conservation, land use and fishing activities in both rivers (Siirala & Huru 1990).

Atlantic salmon populations in these rivers are considered healthy with large fluctuations in the yearly abundance of salmon but no declining trend (Figure 2). Salmon stocks in these systems comprise both 1SW and MSW salmon. The variety of natural salmon life-histories in the River Teno is one of the widest in any salmon rivers, with smolt ages varying between 1 and 8 years (mostly 3-5), and sea ages between 1-5 years (Niemelä et al. 2001). The River Teno system supports one of the most abundant, if not the largest, wild Atlantic salmon populations in the world; the yearly river catch of salmon mostly varies between 100 and 200 metric tonnes, and the catch exceeded 200 tonnes in the last two years (Figure 2). Furthermore, the River Näätämöjoki typically belongs to the top ten Norwegian salmon rivers in terms of yearly catch. Hence, it is not likely that major problems in salmon habitat exist in these river systems. However, some concerns on the status of the physical habitat quality have been raised, mainly in the River Teno valley. A brief review of such unfavourable factors and corresponding mitigation attempts is presented in this paper.

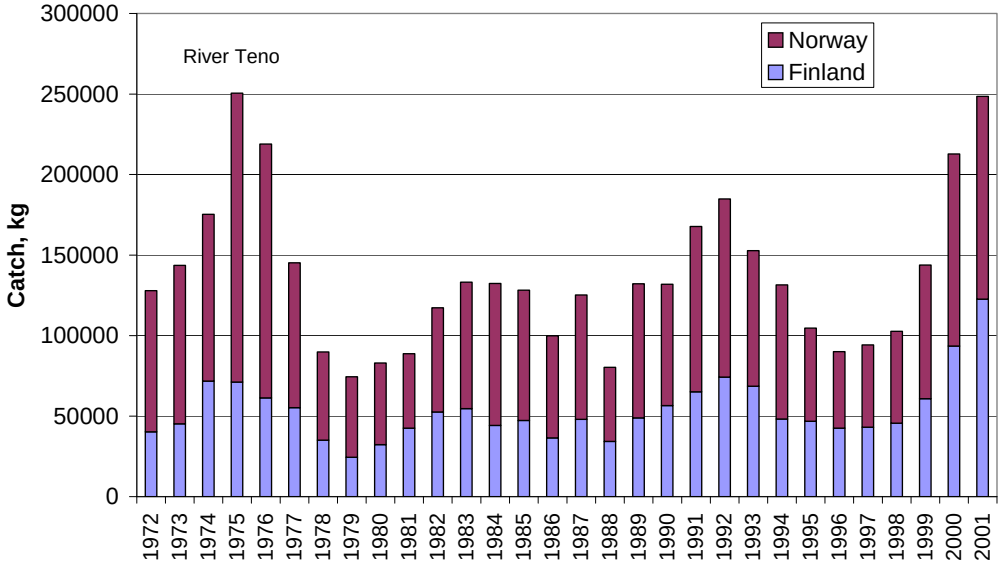
2. Habitat Degradation and Restoration/Enhancement Activities

Two main causes of current or potential habitat problems have been recognised in the River Teno valley: road construction with regard to tributary outlets, and river bank erosion.

2.1 Road construction causing migration obstacles to salmon

In addition to more than 20 tributaries with distinct spawning substocks of salmon in the River Teno system (Moen 1991, Elo *et al.* 1994), there are more than 100 small tributaries where adult salmon do not spawn but where juvenile salmon enter from the main stem of the river (Erkinaro 1995, Erkinaro *et al.* 1998). Most of these streams also support brown trout, either resident or migratory or both.

Many of these tributary brooks drain into the main stem of the Teno or into the major tributaries of the river, the River Utsjoki, Inarijoki, Karasjoki and Iesjoki (Figure 1), which all have roads following most of their courses (with the exception of the River Karasjoki). Most of the road crossings of the tributaries used to be equipped with culverts. In the 1980s many of the culverts of the largest tributary brooks were displaced by bridges, which substantially improved the access for salmon migration. However, in late 1980s several culverts were still identified as obstructions for juvenile salmon, and a recent inventory carried out by the Finnish and Norwegian environment authorities has further revealed at least half a dozen tributaries where road culverts were blocking the migratory route for juvenile salmon and brown trout, and where restoration activities could lead to a substantial increase in salmonid habitat (Lundvall et al. 2001). In some cases, the vertical drop in the culverts during the summer water level was as high as one metre, which obviously prevents upstream migration of any salmonid fish (Figure 3).



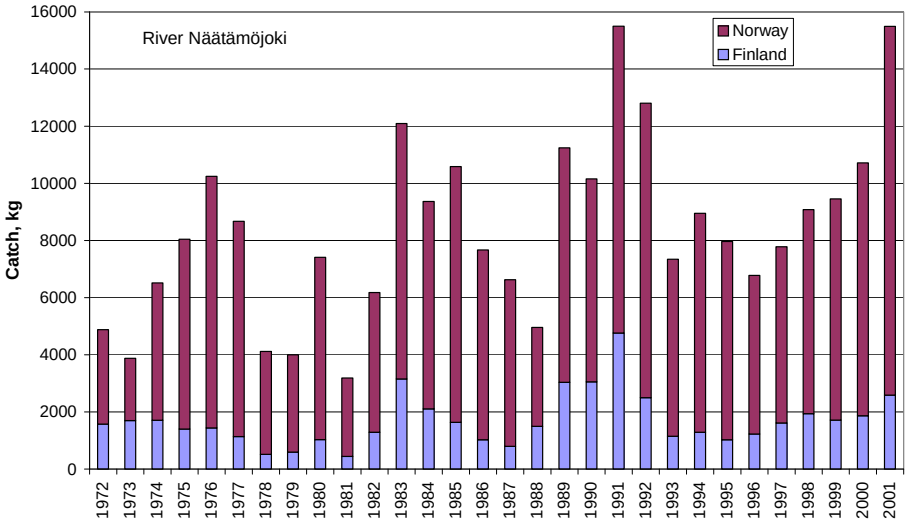


Figure 2: Atlantic salmon catches in the Rivers Teno and Näätämöjoki. Finnish and Norwegian catches are presented separately

Figure 3. A road culvert in the Bajit Boratbokcajohka, a small tributary brook of the River Teno, with a vertical fall, which prevents any fish migration up the stream. Photo: Eira Järviluoma, Finnish Road Administration, Lapland Region

During a pilot project in 2001, fish migration routes in five tributaries were improved by lowering the culverts deeper into the ground (Figure 4). In addition, transverse structures that reduce the water velocity were constructed in the culverts. Funding for a joint project between Finnish and Norwegian environment authorities and research bodies has recently been approved. This project will continue the culvert improvement activities and will include a biological controlled before-after study to monitor and demonstrate the improvement in fish migration in these tributaries.

In some cases, road and bridge construction have also caused erosion and a deterioration of the migration routes of adult salmon in the larger tributaries. A typical result of erosion is the filling of the tributary outlets and formation of a shallow delta-like, multi-channel outlet (Figure 5). This problem has been substantial in at least seven tributaries of the River Teno (Lundvall et al. 2001). During the 1990s, the road and environment authorities have tried to improve these river mouths by restoring the old, single-channel formation (Figure 6). The success and especially the permanence of such improvements has varied from river to river. In some cases, a sufficient solution has been the requirement for strong lining with large boulders to centralize the river flow into a single-channel outlet.

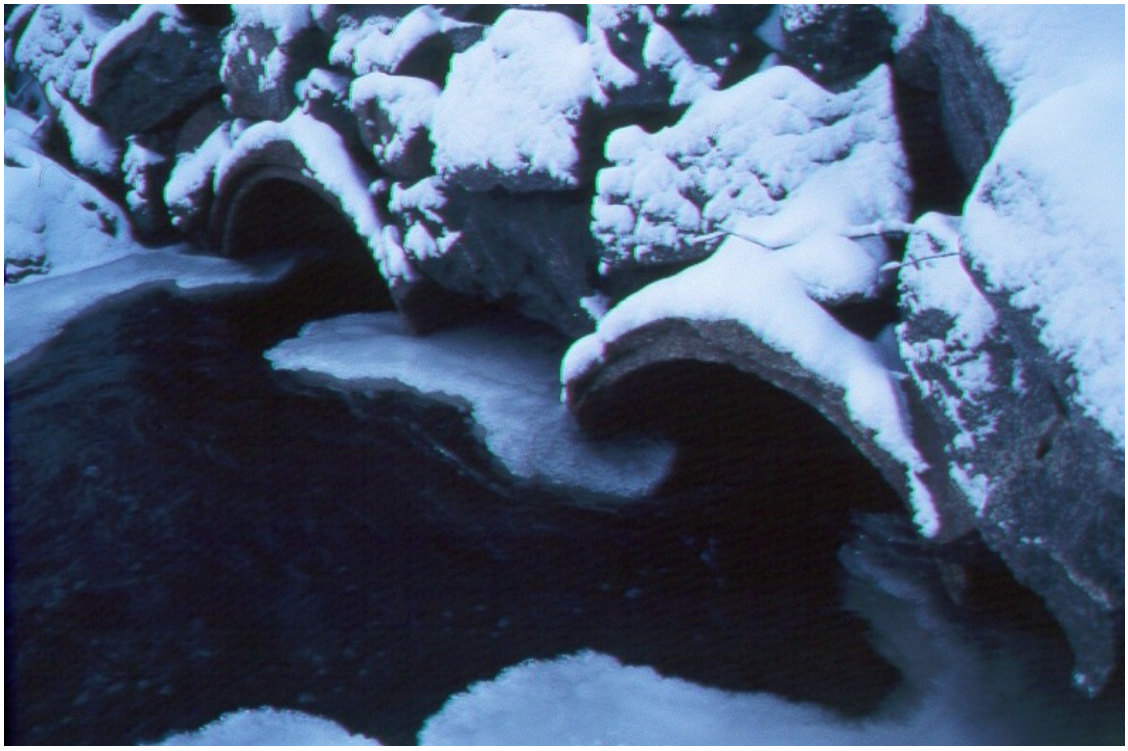


Figure 4: A rebuilt road culvert in the Bajit Boratbokcajohka, a small tributary brook of the River Teno, which allows fish migration upstream. Photo: Eira Järviluoma, Finnish Road Administration, Lapland Region

Figure 5: The outlet of the River Ahkojohka, a tributary of the River Teno in 1994, where the shallow, braided channel may prevent adult salmon ascent into this river. Photo: Timo Alaraudanjoki, Lapland Regional Environment Centre

Figure 6: The outlet of the River Ahkojohka, a tributary of the River Teno in 2001, where the reconstructed, single-channel outlet facilitates salmon entry. Photo: Timo Alaraudanjoki, Lapland Regional Environment Centre

2.2 River bank erosion

In a recent cooperative project between Finnish and Norwegian environment authorities an inventory of bank erosion detected more than 80 unstable river banks in the River Teno valley (Fergus & Rönkä 2001). In most cases (63%), the reason for erosion was natural, mainly the result of steep banks with fine post-glacial, stratified soils. In certain areas, however, removal of bank vegetation in connection with agriculture activities and road construction has caused erosion.

During the past two decades both the Norwegian and Finnish authorities have introduced river bank protection plans and carried out bank lining projects. In Finland, 12 sections (a total of 9 km in length) of banks have been strengthened and lined using large boulders. On the Norwegian side, nine such sections have been protected comprising seven kilometres of river banks (Fergus & Rönkä 2001). In their recent report, the bilateral project group (see above) gave recommendations on conducting and prioritizing the protection and restoration activities with regards to the river bank erosion (Fergus & Rönkä 2001).

Acknowledgements

I thank Eero Niemelä for useful information for this paper and commenting on an earlier draft. Eira Järviluoma (Finnish Road Administration, Lapland Region) and Timo Alaraudanjoki (Lapland Regional Environment Centre) kindly provided the photographs of the restoration sites.

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Protection and Restoration of Salmon Habitats in Ireland

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Introduction

NASCO's objective is to conserve, enhance, restore and rationally manage salmon stocks. This can only be achieved if habitat is also conserved and restored. Therefore the key objective is to maintain and, where possible, increase current productive capacity. In this regard, NASCO has requested a Habitat Restoration and Protection Plan from each Contracting Party which should describe:

- a consistent rational approach to protection and restoration;
- a reporting procedure to enable progress to be monitored.

Many initiatives have already been taken and within the EU there are individual legal and governance frameworks for dealing with habitat management including:

- national environmental law (this will be heavily influenced by the EU Water Framework Directive);
- EU Habitats Directive including the designation of most of the main salmon rivers as Special Areas of Conservation (SACs);
- Irish Wildlife Acts;
- forthcoming Irish Heritage and Biodiversity Acts.

NASCO also requires an inventory of rivers and, from this, the identification of priority/key habitats for protection and restoration. This should then lead to the development of specific plans for habitat restoration and protection and subsequent implementation of these plans. NASCO also requires that individual countries monitor and report progress to NASCO annually.

The Irish Approach to Protection and Restoration of Salmonid Habitats

The Irish plan can be summarized as follows:

- establish a river inventory;
- quantify the extent of existing habitat;
- estimate the productive capacity of this habitat;
- estimate the current level of production;
- identify shortfalls and the potential for recovery in damaged habitats;
- enhance damaged habitat;
- monitor the outcome and recovery rate.

Establishment of a River Inventory

There are approximately 190 rivers in Ireland with 130 capable of producing salmon (some of these support sea trout rather than salmon). Less than 30 rivers account for 90% of all salmon production. Small populations in smaller rivers are also important from a bio-diversity perspective and may also require protection and, in some cases, restoration. The approach adopted in Ireland is consistent with the proposed NASCO Plan of Action and the objectives of this plan. Under the proposed NASCO plan there is an initial requirement to develop an inventory of salmon rivers in order to initiate the process of identifying priority areas for habitat restoration and protection. Ireland has established an inventory of Irish Salmon Rivers and the following information is available for all of these rivers:

- river number (National Ordinance Survey index);
- region;
- river name;
- location (latitude and longitude);
- brief description of physical characteristics;
- NASCO category;
- catchment area;
- total length;
- axial length;
- maximum altitude;
- hydrographic characteristics;
- presence of trap or counter;
- salmon rod catch (2001 and 2002);
- conservation limit (provisional).

Acquisition of Information and Data

The management of the Irish freshwater resource requires the acquisition of data. Information on the freshwater resource is key to successfully identifying habitat problems. The first steps in developing the process of quantifying the habitat of salmon, have been to initiate an audit of Ireland's aquatic resource. This Aquatic Habitat Inventory will address several areas, including the deficit in habitat information for planning and Environmental Impact Assessment (EIA) and protection of EU Special Areas of Conservation (SACs). The importance of these data cannot be over-stated as they are the main elements in three of the major components of the Irish plan, i.e. describing present productivity, identifying shortfalls and problems and developing plans to rectify/remove problems.

The key data required in order to build up the habitat inventory have been identified in recent years and comprise:

- stream surface area (width x length);
- gradient;
- substrate;
- riparian conditions;
- chemical conditions;
- water quality;
- hydrological conditions (velocity, etc.);

- catchment/land use.

Of the above, the most significant parameters relating to salmon habitats and population dynamics are gradient, velocity and land use. Due to the enormous computing capacity (desktop level) which is now readily available, new technologies have been applied in the acquisition of salmon habitat data. In particular, the development of Geographical Information Systems (GIS) has significantly progressed the interpretation and analysis of multi-layered, spatially organised data such as the relationship between juvenile salmon productivity and the complex interactions between the physical, chemical and geological characteristics of the streams, rivers and lakes in which they live. Use of Global Positioning Systems (GPS) has facilitated sampling surveys, providing extremely accurate information on the location of important or sensitive salmonid communities relative to land-use facilities such as intensive agricultural and forestry developments. Significant advances in Digital Aerial Survey (DAS - see Figure 1) techniques have facilitated the collection of enormous volumes of information on the physical characteristics of whole rivers, catchments, districts, etc. in much shorter time-scales than was previously possible. As this information is in digital form and describes features such as stream bed type, length and width of channel and stream elevation, it is possible to auto-classify each stream reach and sub-reach and relate this back to biological information on salmonid productivity.

Figure 1: High-resolution digital image showing a forestry plantation (striated lines) draining into a small salmonid stream

Implementation of the Habitat Protection and Restoration Programme

The main catchment based problems in Ireland (Figure 2) have been identified as:

- arterial drainage;
- riparian zone damage;
- agricultural organic enrichment;
- overgrazing;
- dams.

Since 1995, significant EU support has been provided to identify problems in Irish rivers leading to reduced salmonid production and to design habitat rehabilitation and protection plans. Significantly, a large proportion of the funding was used to implement rehabilitation and advance these plans. The implementation of the Irish habitat protection and restoration programmes has involved the expenditure of €15 million on:

- surveying 2,000km of river channel;
- enhancing 400km of river channel;
- assessing programme effectiveness.

Under this programme Ireland has developed:

- greater integration of national agencies in tackling habitat problems;
- developed physical enhancement techniques (Figures 3, 4 and 5);
- developed more cost-effective procedures;
- shown the value of programmes to fish and general biodiversity;
- significantly increased salmon production in enhanced catchments (Figure 6).

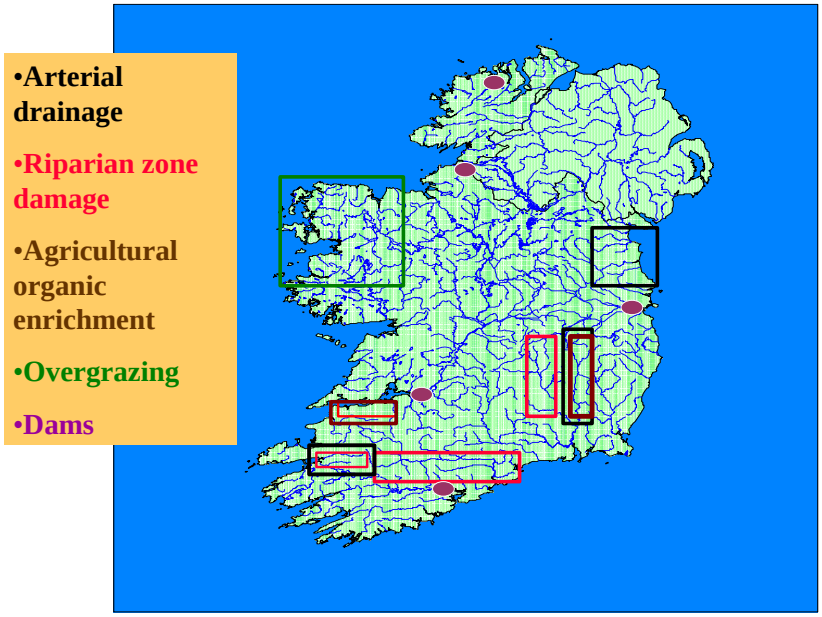

Figure 2: Main problems causing habitat deterioration and areas affected

Figure 3: Bank protection works in progress

Figure 4: Techniques to restore pool areas for salmonid nursery

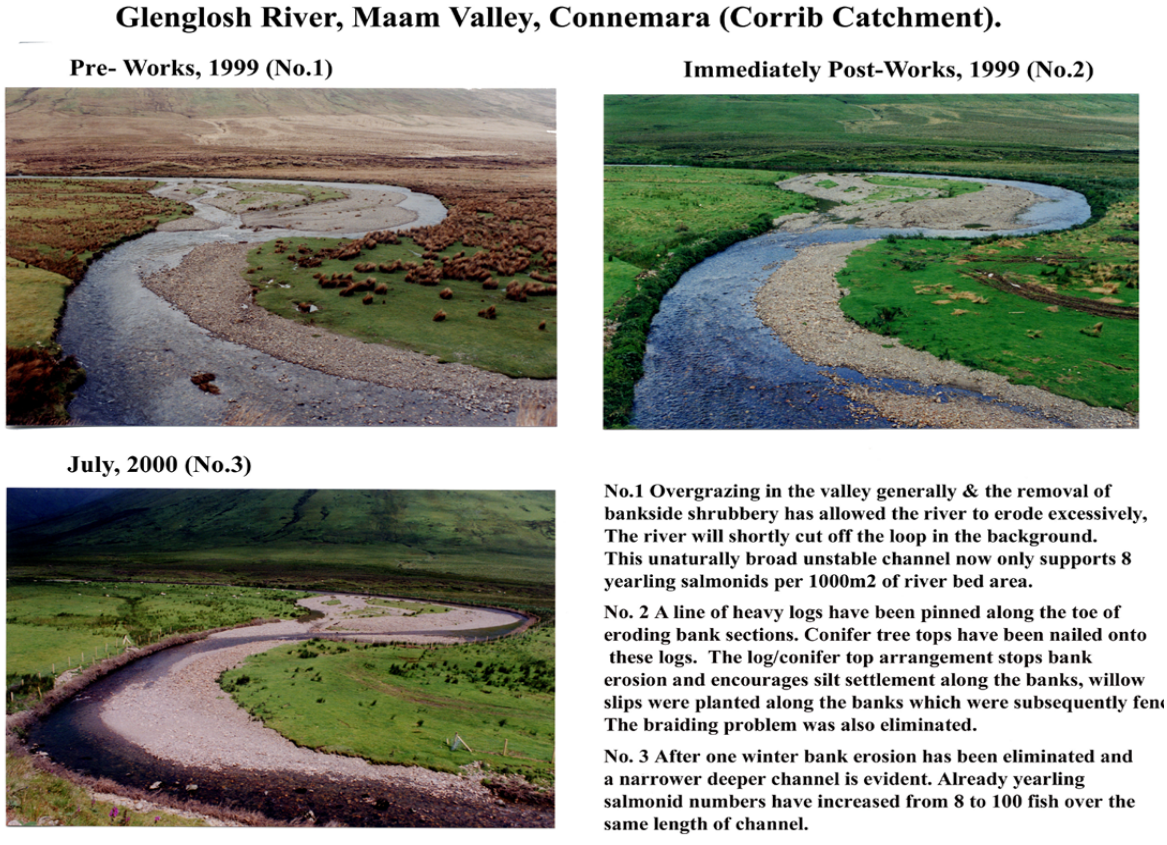

Figure 5: Tackling the problem of overgrazing in an Irish river

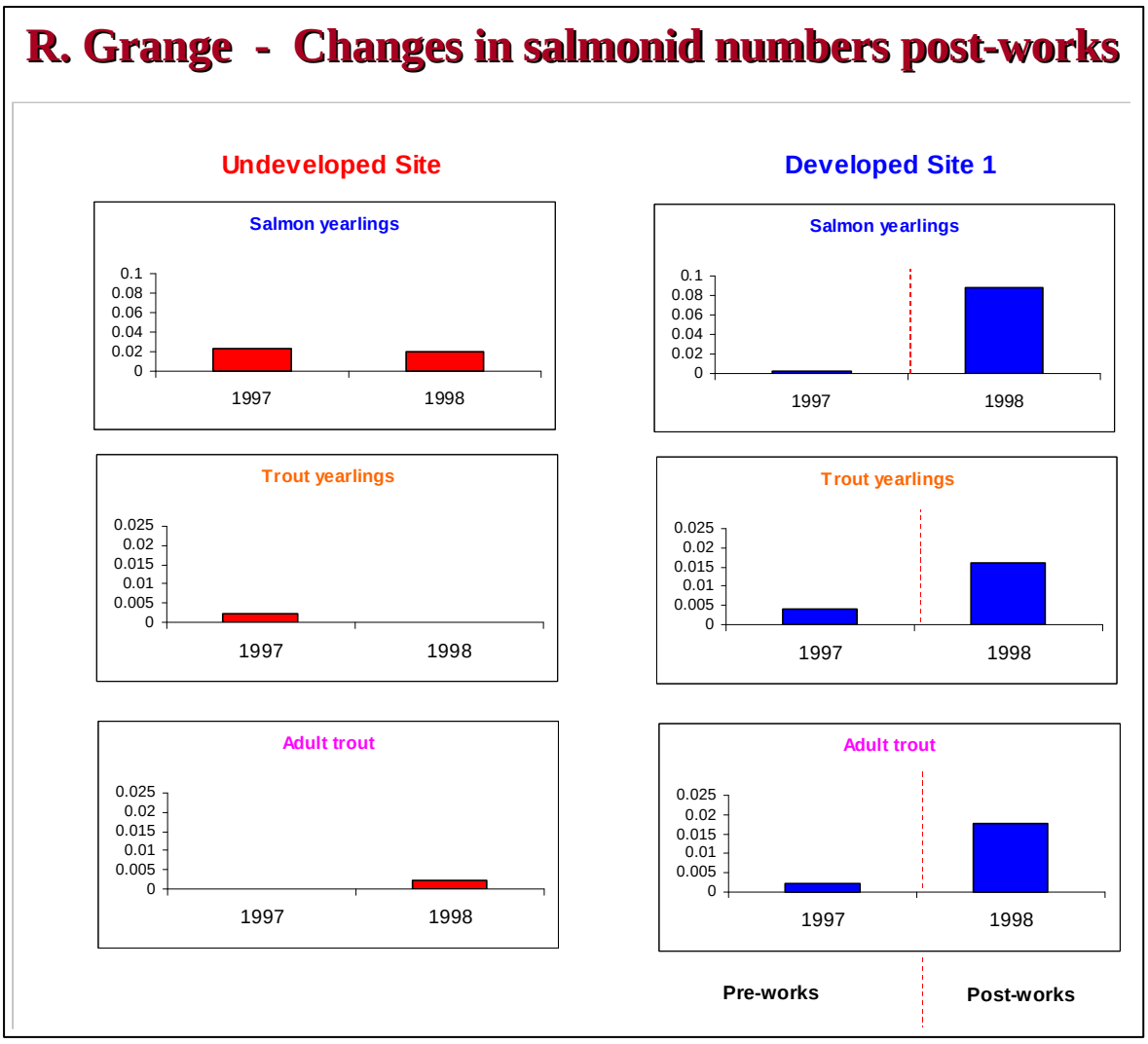

Figure 6: Results of development works in enhancement of juvenile salmonid populations

Conclusions

The salmon has always had a unique position in Irish economic, social and cultural affairs. Ireland's commitment to the protection and enhancement of salmonid habitats is underpinned, therefore, by the activities of two main Government Departments (i.e. Department of Environment and Department of Communications, Marine and Natural Resources) and several semi-state agencies such as the Marine Institute, the Central and Regional Fisheries Boards, the Environmental Protection Agency and Dúchas - the Heritage Agency. These agencies provide the legislative backup to existing national and EU legislation as well as providing invaluable monitoring and habitat restoration services. However, it is only with the support of the general public and the generation of environmental awareness that the long-term sustainability of the salmon's habitat will be protected. Irish freshwater rivers are linked to many different uses such as agriculture, forestry, water supply and abstraction, hydro-electric recreation, etc. Clearly, there are multiple stake-holders with an interest in the rivers and lakes in which salmon live. To this

end each of these organisations also has a mandate to inform and educate the public and assist in the development of rational catchment management plans which will ensure the proper use of this habitat by all of these vested stake-holders.

Development and Implementation of the NASCO Precautionary Approach to Habitat Protection and Development of Restoration Plans in the United Kingdom

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Guy Mawle, Environment Agency, England & Wales
Hazel Campbell, Department of Culture, Arts & Leisure, Northern Ireland
Walter Crozier, Department of Agriculture and Rural Development, Northern Ireland

1. Background - Salmon Habitat Problems in the UK

Most rivers in the UK have been impacted upon by man, to the detriment of the Atlantic salmon. Problems, elaborated in SCPA(01)15, can be summarised as:

- obstruction, caused by dams, hydro-electricity developments, river crossings;
- loss of habitat, caused by water and gravel abstraction, agriculture, forestry, in-river works, hydro-electricity; and
- pollution, caused by sewage, agriculture, forestry, industry (see Figure 1).

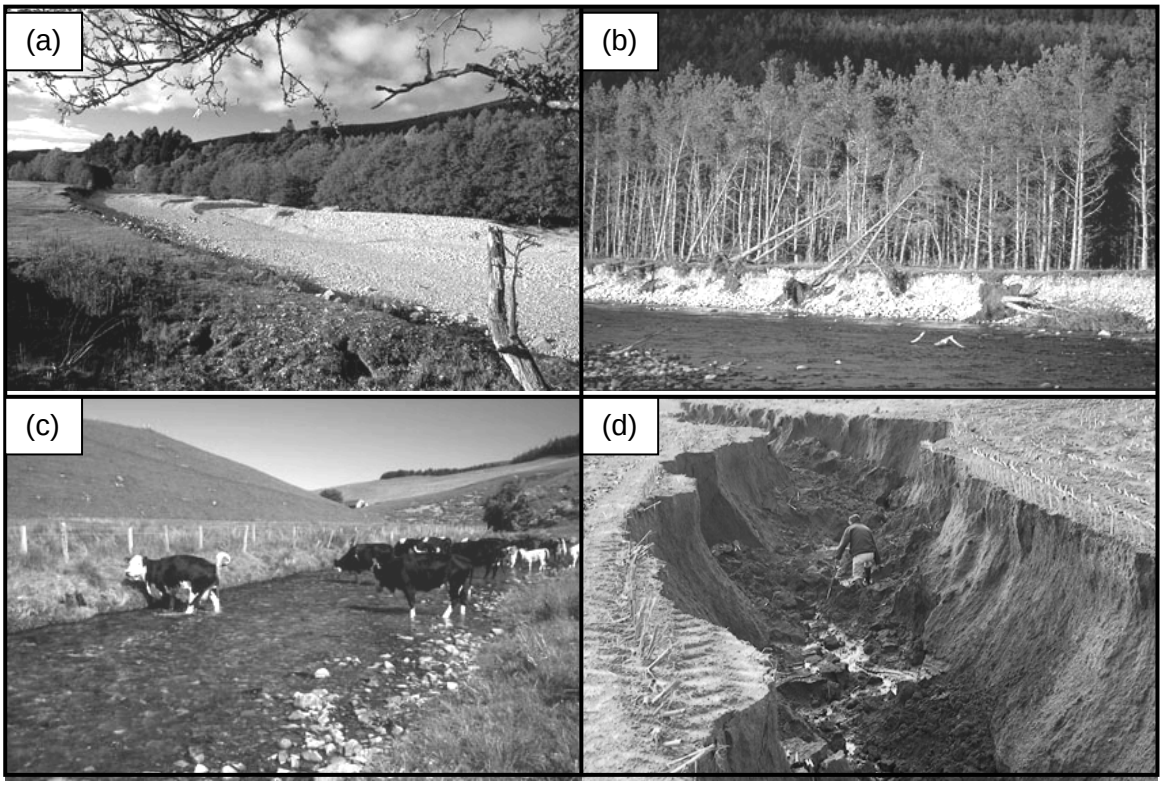


Figure 1: Examples of problems on UK salmon rivers. (a) Water abstraction, River Garry, (b) Bank erosion caused by afforestation, River Don, (c) Bank erosion caused by grazing cattle, River Garry, (d) Gullying in a maize field, Southwest England

While mortality at sea undoubtedly remains the over-riding cause of the observed continued decline in southern European stocks, habitat degradation has aggravated the situation.

2. Environmental Initiatives and Atlantic Salmon

Over the past 30 years, a number of major pieces of environmental legislation have been introduced, often as a result of various Directives issued by the European Commission. These include the EU Urban Wastewater Directive, the EU Drinking Water Directive, the EU Clean Air Act and the EU Freshwater Fisheries Directive. The level of investment resulting from implementation of this legislation has been massive. For example, some £130 million has been spent on construction of six sewage systems on the River Clyde, Scotland, alone during the past six years. In England and Wales, investment by the water industry currently runs to billions of pounds a year resulting in improvements in water quality (Figure 2).

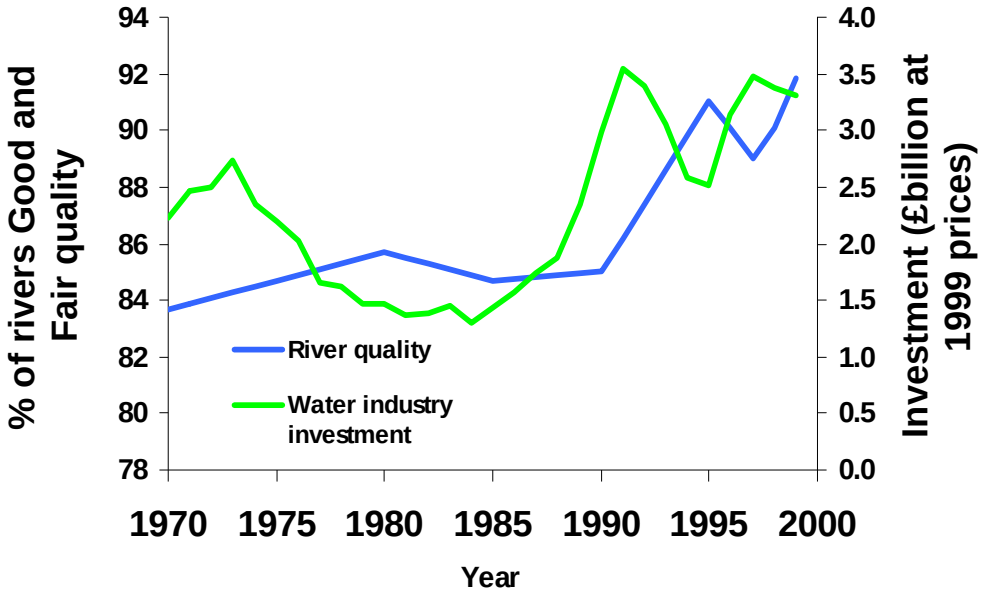
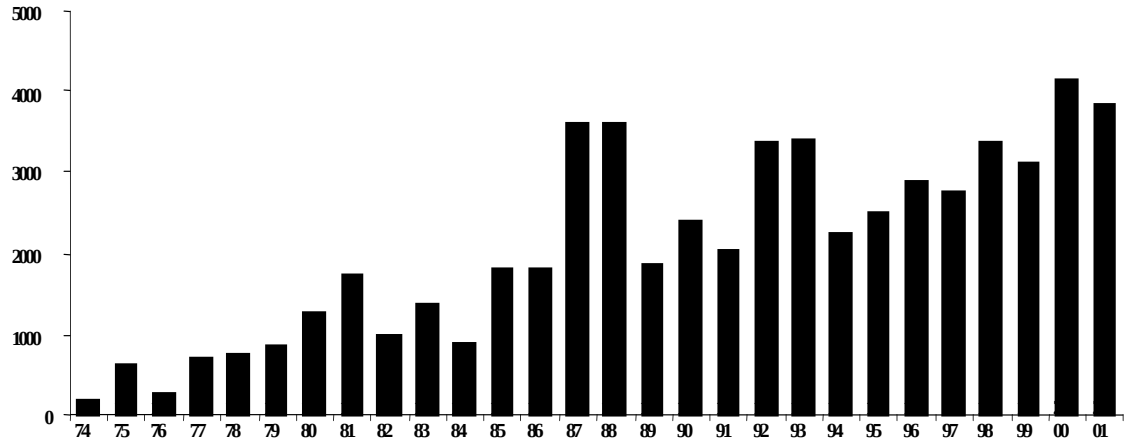


Figure 2: Water industry investment and river quality in England and Wales, 1970 to 1999

While these public spending initiatives have been almost entirely driven by issues other than Atlantic salmon, there have nevertheless been important benefits to the species. For example, Atlantic salmon are now present in 20 rivers in England and Wales where historically they have been absent (see Figure 3). Some 25% of total rod catches of Atlantic salmon in England and Wales now come from these rivers. Nevertheless, this should be seen against a picture of continuing decline.

Figure 3: Atlantic salmon rod catch (numbers) from eight of the 20 recovering rivers, England & Wales (Coquet, Tyne, Wear, Tees, Taff, Ogmore, Afan and Neath), 1974-2001



The Clean Air Act (1993) has led to significant reductions in air-borne pollutants, especially SOx, with concomitant improvements to acidified waters in highly impacted areas of Southwest and Central Scotland. One long-term dataset from Central Scotland illustrates this (Figure 4). Non-marine sulphate concentrations in rainwater declined from 90 to 24 μeq l^{-1} between December 1972 and December 1999 (bottom line). Concomitant decreases in non-marine sulphates were also found in two monitored streams in the catchment (top two lines). A similar picture is apparent in acidified water bodies in Southwest Scotland. However, while there is some evidence of recovery of invertebrate and fish fauna, it has been patchy[1].

The European Habitats Directive makes provision for the creation of Special Areas of Conservation (SACs) for endangered species. Within SACs declared for aquatic species there are obligations to prevent deterioration of habitats and to produce sustainable catchment management plans that contain codes of good practice for agriculture and forestry. In Scotland, planning permission will be required for gravel extraction, flood bank repair and river engineering, including fisheries improvement works.

[1] Harriman, R. et al. (2001) Interpretation of trends in acidic deposition and surface water chemistry during the past three decades. Hydrology and Earth System Sciences, 5, 407-420.

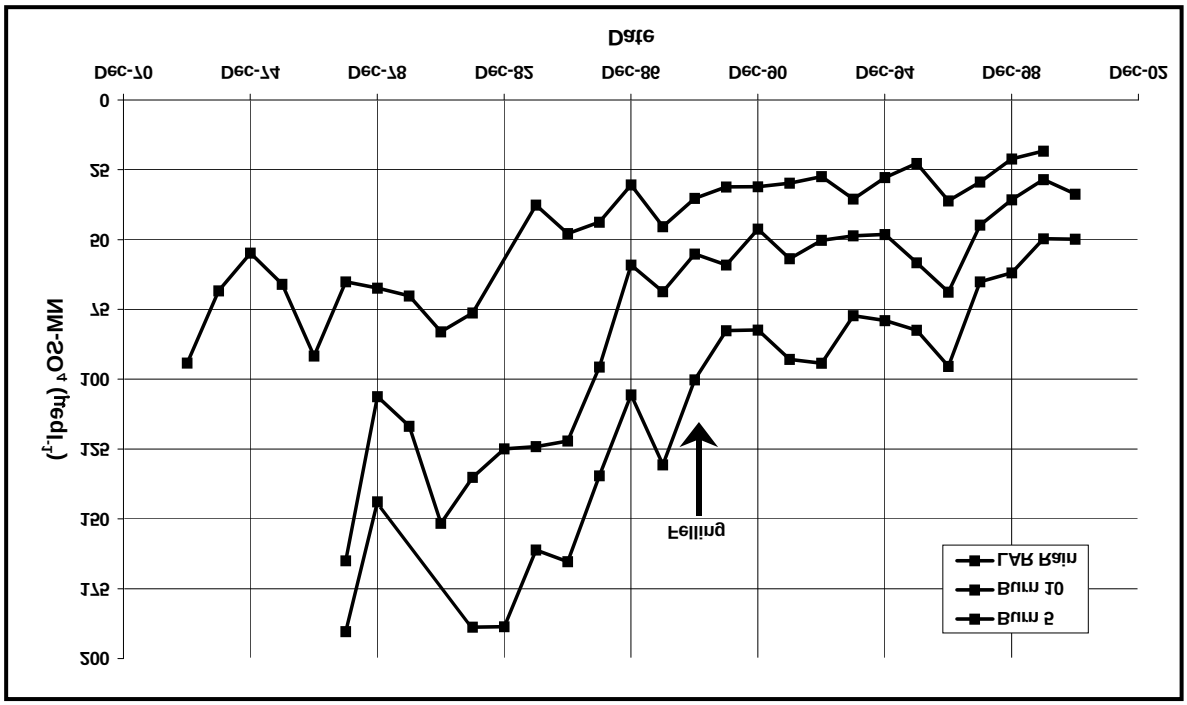
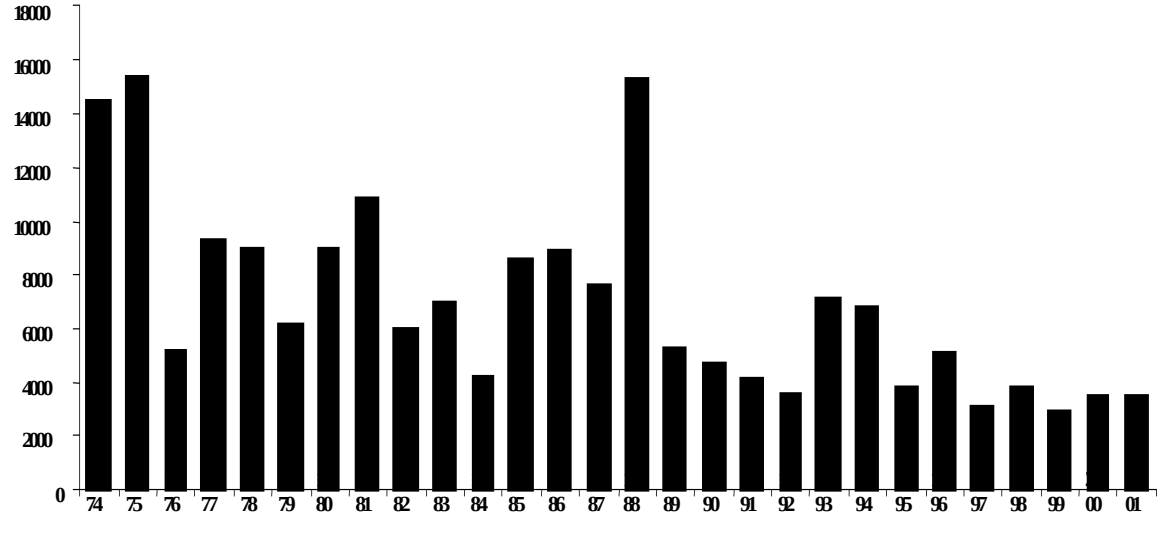


Figure 4: Non-marine sulphate concentrations (μeq l^{-1}) in rainwater (LAR) and two streams, Loch Ard catchment, Scotland, 1970-2000 (from Harriman et al., 2001)

During 2001-2002, some 16 rivers were proposed as SACs for Atlantic salmon in Scotland, covering a significant component of the biomass and biodiversity of stocks. A number of these sites have also been proposed as SACs for freshwater pearl mussels, otters and for seals, the latter two species posing challenges for conservation managers. In England and Wales 13 SACs for Atlantic salmon have been proposed (Figure 5).

Figure 5: Total Atlantic salmon rod catches (1974-2001) in eight of the rivers in England & Wales proposed as salmon SACs (Itchen, Hants Avon, Camel, Wye, Usk, Teifi, Tywi, Dee). Note that rivers in NW England are excluded



The private sector, including the water industry, fishery managers and proprietors, has also made substantial investments that have benefited Atlantic salmon. In Scotland, Fishery Trusts/riparian owners have rehabilitated many areas of poor in-river and bank-side works. The Tweed Foundation, for example, has spent close to £1 million over the past decade in habitat improvement and monitoring. A number of the guides to river habitat protection and rehabilitation that have been produced in the past decade have been by the private sector.

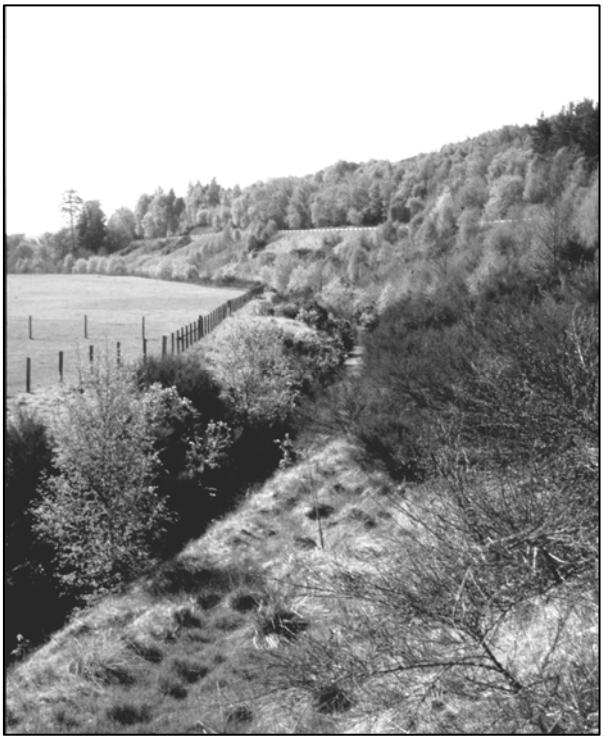


Figure 6: Fenced Atlantic salmon fry and parr habitat, showing bank-side improvements

3. Application of the Precautionary Approach to Atlantic Salmon Habitats in the UK

There are four key elements in the NASCO Plan of Action for Application of the Precautionary Approach to habitats:

- establish inventories of rivers;
- update inventories;
- identify and designate priority/key habitats for improvement;
- establish salmon habitat protection and restoration plans.

These elements have been addressed in different ways by England and Wales, Scotland and Northern Ireland, as these regions differ both quantitatively and qualitatively in terms of their aquatic and fish resources, and in terms of problems (e.g. degree of urbanisation, types and intensity of agriculture and extent of fish farming). In Scotland, management of salmon fisheries is largely in private hands, whereas elsewhere in the UK the public sector plays a greater role in management. The legal system in Scotland differs from that in England and Wales and in Northern Ireland.

In Northern Ireland, the NASCO Precautionary Approach is being incorporated into existing catchment-based management strategies in the Foyle and the Fisheries Conservancy Board (FCB) areas (Figure 7). GIS-referenced habitat inventories of catchments for development of management plans have been produced. Some 15% of rivers in the FCB area and 80% of habitats in the Foyle area have been surveyed and the results used to identify key problem areas and to refine conservation limits. To date, £3 million has been invested in habitat restoration through the EU-funded Salmonid Enhancement Programme. An extensive programme of research and development, including the elaboration of survey techniques,

investigations of sediment nutrient flux problems and rehabilitation methodology, is under way.

In Scotland, many of the problems have been identified and catalogued on a catchment basis. Although there is no single comprehensive database covering all 380 salmon rivers, the Scottish Fisheries Co-ordination Centre, based at the FRS Freshwater Laboratory, is cataloguing all habitat surveys being carried out by Fishery Trust Biologists. District Salmon Fisheries Board and Fishery Trust biologists have been developing fishery management plans that catalogue problems and prioritise remedial actions. Through the Tripartite Working Group[2], a national procedure is being introduced to identify and support restoration. It encourages managers to adopt processes to identify problems and use best advice to address problems and offers incentives of improved access to funds for restoration.

As part of the National Salmon Strategy for England and Wales, Salmon Action Plans are being prepared for 68 different catchments including assessment of stock status, identification of the factors limiting salmon production and, if unsatisfactory, what action should be taken to address them. All plans are due to be completed by 2003.

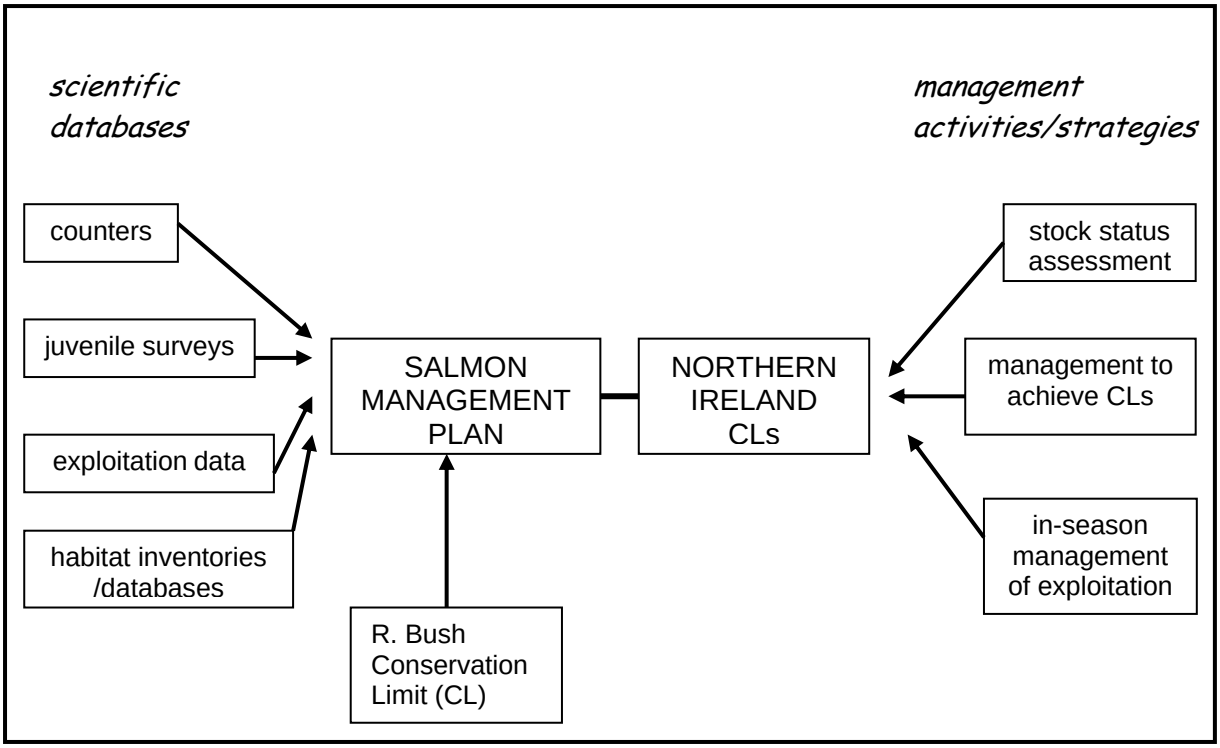


Figure 7: Atlantic salmon management plan, Northern Ireland, indicating the role of habitat inventories

4. Summary and Discussion

Over the past 30 years, there has been massive public investment, largely as a result of EC Directives such as the EC Drinking Water and Urban Wastewater Directives. Private sector investment has also been substantial. For example, around £1 million has been spent on the River Tweed alone since 1990, increasing the length of river accessible to Atlantic salmon by

[2] forum of angling, wild fish, aquaculture and Scottish Executive interests

some 1300 km, equivalent to some 40% of the entire river. Also notable is that salmon are now returning to more rivers in England and Wales than for the last 150 years, due largely to removal of barriers and the treatment of point-source pollution. These achievements have helped moderate impacts of increased mortality at sea.

The UK promotes the use of the Precautionary Approach among proprietors and fishery managers. More funds, both public and private, continue to be sought to support this work. A bid has recently been made to the Northern Ireland Assembly for resources to develop habitat action plans and to carry out a rolling programme of rehabilitation. Modest increases in funds for development of Salmon Action Plans have been announced this year in England and Wales. Three new Fishery Trust Biologists have been appointed in Scotland in the past year alone, and key among their tasks is habitat survey work and the production of rehabilitation plans.

Finally, a raft of new legislation and initiatives will ensure that the momentum on habitat protection and restoration will be maintained. The impending reform of the EU Common Agricultural Policy, which is likely to promote production of better food in a more environmentally sound manner, is anticipated to have beneficial effects on diffuse pollution and sediment loads. Notable too is the establishment of SACs under the European Habitats Directive. The EU Water Framework Directive that is currently being incorporated into legislation by Member States will assess rivers and lakes by a comprehensive set of biological indicators, including fish. It will further promote integrated catchment management and will require the introduction of measures to remove pressures that are causing systems to fail to attain 'good' ecological status. A summary of the main features of this Directive is contained in Annex 1.

While these initiatives are all to be welcomed, it will nevertheless be a challenge to integrate the various pieces of legislation for the conservation of Atlantic salmon habitats.

Acknowledgements

We thank colleagues in our respective organisations for assistance in assembling the data for this presentation, especially Mr David Hay for many of the photographs. We also thank Dr Liam Kelly and Mr David Dunkley (Scottish Executive), Mr Brian Wallace, Scottish Water, Dr James Butler, Spey District Salmon Fishery Board and Ms Judith Nicol, Tweed Foundation.

Annex 1

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 Establishing a Framework for Community Action in the Field of Water Policy

Official Journal L 327, 22/12/2000 P. 0001

Objectives:

The Directive lays down a new basis for coordinating the Member States' policies and measures to protect water resources. It will establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. The principal objectives are to:

- prevent further deterioration and protect and enhance the state of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;
- promote sustainable use of water based on the long-term protection of available water resources;
- aim at enhanced protection and improvement of the aquatic environment, *inter alia* through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;
- ensure the progressive reduction of pollution of groundwater and prevent further pollution thereof;
- help to mitigate the effects of floods and droughts;
- provide a sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use;
- significantly reduce pollution of groundwater;
- protect territorial and marine waters, and
- achieve the objectives of the relevant international agreements.

Description:

1. The framework Directive concerns surface fresh water, estuaries, coastal waters and groundwater within the Community.

2. It lays down environmental quality standards at Community level for a certain number of pollutants. Other environmental quality standards are laid down by the Member States for water abstracted for drinking purposes.

3. However, it does not lay down limit values for pollutant emissions, but coordinates the application of those required by other legal texts.

4. The Directive is thus intended to protect the available water resources in the long term by introducing:

    - river basin water management;

- an assessment of the characteristics of each river basin district;
- monitoring of the chemical, ecological and/or quantitative status of surface waters and groundwater in each river basin;
- monitoring of the protected areas within each river basin;
- pollution-measurement programmes, including mandatory and optional measurements;
- incorporation of all of the above factors in a river basin management plan;
- public consultation on this management plan.

5. More detailed programmes and management plans concerning specific aspects of water management may supplement the management plans.

6. The Directive provides for specific measures to be adopted by the Member States where the environmental quality standards are no longer met or where there is accidental pollution (floods, extinguishing products, by-products from fires, leakage of pollutants).

7. The Directive provides for a reporting procedure and for the exchange of information between the Member States and the Commission and the European Environment Agency. The following are to be provided:

   - the management plans;
   - the draft management plans;
   - the other programmes referred to in paragraph 5.

8. The Directive requires the Member States to take action in order that the price of water reflects the total cost of all of the services linked with water use (operation and maintenance costs, capital maintenance costs, capital costs, reserves for future extensions) together with environmental costs and resource depletion costs.

9. The Directive authorises the Commission to rationalize and coordinate its plans for combating water pollution and, if necessary, to adopt new environmental quality standards or to initiate appropriate measures.

10. The following directives will be repealed in December 2007:

    - Directive 75/440/EEC;
    - Directive 77/795/EEC;
    - Directive 78/659/EEC;
    - Directive 79/869/EEC;
    - Directive 79/923/EEC;
    - Directive 89/68/EEC.

11. Adaptation of the annexes to scientific and technical progress.

12. The Commission will publish a report on the implementation of the Directive by, at the latest, 31 December 2006, and every six years after that.

Freshwater Habitat in Iceland - Status, Protection and Restoration

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Directorate of Freshwater Fisheries, Reykjavik, Iceland

Introduction

Since salmon spawn and spend a large part of their life in fresh water, protecting the quality of the freshwater habitat is one of the prerequisites for the existence of healthy salmon populations. It is the deterioration of this habitat in many salmon-producing countries which is one of the main reasons for the worldwide decline of Atlantic salmon through past centuries and decades.

Habitat is defined as the "type of environment in which an organism or group normally lives or occurs". Any biological, chemical or physical changes in the salmonid environment can, therefore, be considered changes in habitat, including factors ranging from pollutants to increased predation and fishing effort.

The Icelandic salmon resource is extremely valuable in economic terms. It has been estimated that the minimum direct and indirect annual revenue from salmon angling amounts to US$ 30 million, which corresponds to $1000 per salmon caught by angling. This is clearly a valuable resource, which must be conserved and protected.

In this paper I will describe the status of the freshwater habitat in Iceland, as well as the state of the salmon resource itself. The major factors which have affected, and can potentially affect, the salmon habitat will be described, as well as the actions which have been taken to prevent or reduce their impact.

Status of the Salmon Resource

Figure 1 shows the location and some vital statistics for the major salmon angling rivers in Iceland. The river systems concerned are indicated with blue lines. The areas in north-western and eastern Iceland are high in elevation and have relatively few salmon rivers. The primary species in those areas is arctic charr.

The major facts and conclusions to be drawn regarding the status of the salmon stocks are the following:

- the average angling catch in these 62 rivers for the last 25 years is 31,500 salmon, which is slightly above catches in recent years (approx. 30,000);
- the number of rods is highly restricted and the total number of salmon rods is about 350, distributed over the 62 major salmon rivers shown. This is equivalent to 5.5 rods per river;
- the average annual salmon catch per permitted rod for the whole country is close to 90 but varies considerably between rivers and localities, based on salmon abundance and the size and nature of the river;
- the catch per rod thus exceeds 100 salmon in the best salmon areas in western Iceland, which corresponds to one salmon per rod per day during the 100-day salmon season;

- the low catch per rod in southern Iceland is due to the great number of rods on the "Hvítá", a large glacial river system with low salmon catchability;
- approximately 75% of the salmon angling catch in southern Iceland is from the Rangá system, which is entirely based on smolt releases. Catches per rod on that system are thus comparable to those in western Iceland;
- as in many other countries, salmon abundance and return rates from the sea have been declining since the early 1990s, especially for the two-sea-winter component, which particularly affects northern Iceland;
- this is of great concern to management authorities as well as stakeholders in the light of the fact that no sea fishery for salmon is permitted within Icelandic territorial waters;
- despite the apparent decline in salmon abundance there is no indication of spawning deficiency in major salmon rivers;
- in general, it can thus be concluded that the Icelandic salmon resource is in an acceptable state and not threatened.

Factors Affecting the Quality of Salmon Habitat

The main factors which frequently affect the riverine habitat of salmonids and their relevance to the Icelandic situation are shown in Figure 2. The factors are listed clockwise in order of decreasing importance. The main relevant points are the following:

1. Soil erosion

Possible effects: Increases flash flooding and siltation.

- soil erosion has been a serious problem in Iceland for centuries. At the time of the settlement in the 9th century a large part of Iceland was presumably covered with vegetation;
- the settlers used any available wood for fire, and grazing of animals affected the lowland areas;
- increased sheep herding during the latter part of last century created erosion problems even in the interior of Iceland;
- human activity, wind, water and frost have thus acted in combination to increase soil erosion;
- this is being restored to some extent through fertilization and seeding of inland areas.

2. Land drainage

Possible effects: Increases flash flooding and extends low water periods.

- during the latter part of the 20th century many wetlands in Iceland were drained through canalization to create fields for farmers;
- this changed the habitat of various wetland birds and reduced the capacity of the lowland areas to act as a water reservoir for rivers.

3. Gravel mining

Possible effects: Changes river topography and increases siltation.

- rivers carry a great deal of gravel downstream, especially in high velocity mountain areas;

- gravel can be mined without environmental problems in certain rivers and areas;
- caution should be exercised in highly productive salmon rivers and gravel mining should be carried out under the supervision of experts.

4. New predators

Possible effects: Increased concentration of predators on rivers.
- mink were introduced to Iceland for culture in the 1930s and again in the 1970s;
- mink are now observed around most rivers in Iceland and are likely to cause considerable problems on small rivers, especially for smolt- and trout-size fish;
- sea gull populations have increased around populated areas and are a known menace for migrating smolts.

5. Agricultural pollution

Possible effects: Can cause enrichment in certain low-flow rivers. Is beneficial for the productivity of many rivers.
- agricultural pollution is due to agricultural waste from farms and the run-off from fertilized fields;
- not a problem on most rivers.

6. Sewage pollution

Possible effects: Can cause enrichment in certain low-flow rivers.
- poorly treated sewage only flows into a few major main-stem rivers;
- mostly applies to a few municipalities on Iceland's south coast.

7. Fish farms

Possible effects: Can cause pollution and create an escapee problem as well as disease risks.
- some smolt and charr farms in Iceland are located on rivers;
- very few fish farms are located on salmon rivers;
- pollution and escapee problems must be solved through appropriate filtering/screening techniques.

8. Sea-cage escapees and ranching

Possible effects: Ecological and genetic effects on natural salmonid populations.
- rearing in sea-cages is limited to non-salmon areas and commercial ranching is non-existent;
- escapees are currently not a problem in Iceland.

9. Hydroelectric projects

Possible effects: Can block migration of fish and limit spawning grounds.
- hydroelectric projects are mostly located in Iceland's interior areas;
- such developments are currently not a threat to salmonids;
- can create a better environment for salmon through removal of glacial debris.

10. Acid rain

Possible effects: Can disrupt the biological function of salmonids.

- acidic rain has not been observed in Iceland;
- the Icelandic basalt is an alkaline rock, which tends to neutralize acid;
- is currently not a problem for salmonid populations in Iceland.

Existing and Planned Management Measures

The major activities affecting the freshwater habitat in Iceland are shown in Table 1 together with the existing and planned management measures and the responsible authorizing agencies. The main points are the following:

- building of fish ladders and fishing holes as well as the reinforcement of river banks must be permitted and approved by the Directorate of Freshwater Fisheries. These activities are normally permitted upon the recommendation of the relevant fishing association and the project must be designed by an expert. Fish ladders have opened up large new spawning and nursing areas for salmon above impassable waterfalls;
- gravel mining in or close to rivers needs the approval of the Directorate of Freshwater Fisheries. There are efforts underway to reduce gravel mining, control site selection as well as the quantity taken and introduce river improvement technology;
- road culverts can be a problem with respect to salmonid migration and are under observation through environmental impact statements;
- construction of channels to drain wetlands, which is controlled by the Environmental and Planning Agencies, has been greatly reduced but limited measures have been introduced to restore the wetlands;
- fish farms need a licence both from the Environmental Agency and the Directorate of Freshwater Fisheries and through that process there are efforts underway to introduce rotating screen filters on all farms with outflows into rivers;
- relatively few small towns on Iceland's south coast spill sewage into large main-stem rivers. Some effort is underway to put in sewage treatment facilities;
- most hydroelectric projects are harnessing glacial rivers in Iceland's interior, which has proven benign for the salmon populations. There are no plans to put hydroelectric projects on major salmon rivers.

Conclusions

- this paper shows that the freshwater habitat as well as salmon stocks in Iceland are in a reasonable state but great care should be exercised in order to safeguard the rivers, especially close to populated areas. There are examples of rivers with a recent reduction in salmon catches, which can probably be linked to their location within or close to urban areas. With the current expansion of urban regions and limited precautionary measures in place, rivers in the vicinity of the greater Reykjavík area could be endangered within a few decades;
- although many adverse factors affecting salmon have been identified within the marine habitat, the safeguarding of freshwater habitat is of utmost importance as it is indispensable for the reproduction of salmon and is, in many cases, controllable by humans, in contrast to the marine environment, which is mostly beyond our control.

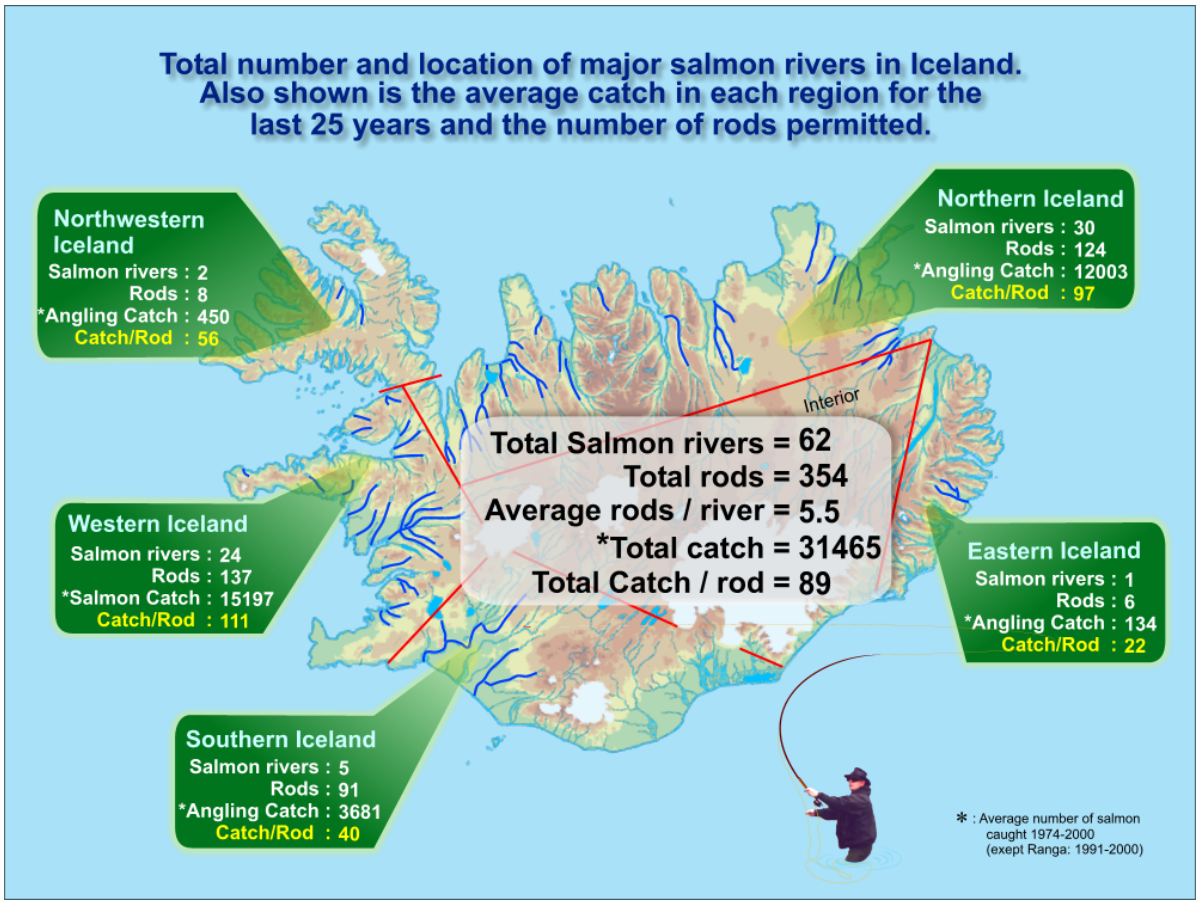

Figure 1

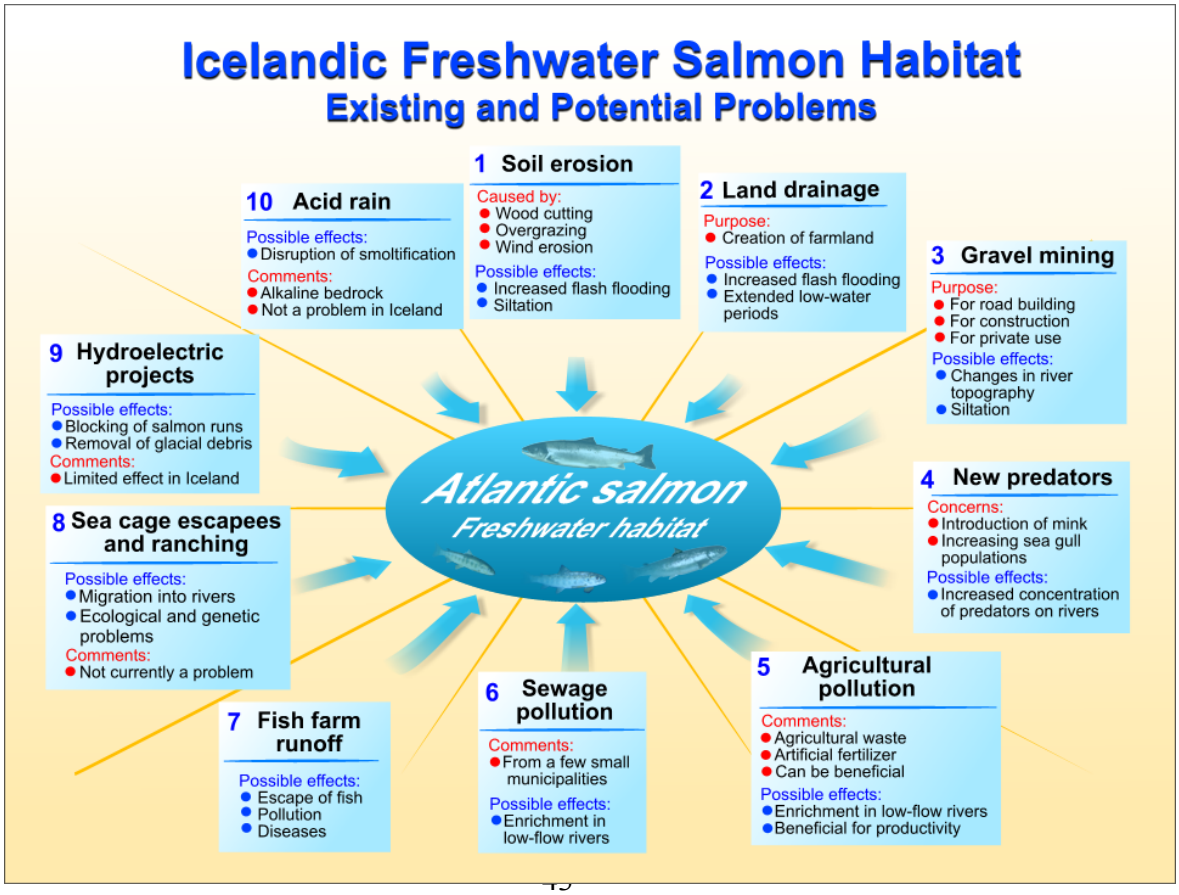

Figure 2

Table 1. Projects affecting Icelandic Salmon Habitat

Existing and planned Management Measures

Nature of Activity	Existing practice and planned management	Authorizing agency
Fish ladders	Have greatly increased the usable area of salmon habitat	Directorate of Freshwater Fisheries
Creation of fishing holes	Permitted but has to be approved by the river association and designed by an expert	Directorate of Freshwater Fisheries
Reinforcement of river banks	Permitted but has to be approved by the river association and designed by an expert	Directorate of Freshwater Fisheries
Gravel mining in or close to rivers	Permitted but has to be approved by the river association.There are existing efforts to reduce gravel mining, control site selection and magnitude and introduce river improvement technology	Directorate of Freshwater Fisheries
Construction of road culverts	Partly controlled through environmental impact statements	Directorate of Freshwater Fisheries, Planning Agency
Land drainage through canalization	Construction of channels to drain wetlands has mostly been stopped but limited efforts have been introduced to bring wetlands back	Environmental Agency, Planning Agency
Fish farms on rivers	Planned to introduce rotating screen filters in all fish farms with outflow into rivers	Environmental Agency, Directorate of Freshwater Fisheries
Rural towns on rivers	Relatively few small towns on Iceland´s south coast spill sewage into main-stem rivers. Some effort under way to put in sewage treatment plants	Planning Agency, Environmental Ministry
Hydroelectric projects	Keep hydroelectric development off major salmon or trout rivers	Planning Agency, Environmental Ministry

Development and Implementation of Habitat Protection and Restoration Plans in Norway

Øyvind Walsø, Directorate of Nature Management, Trondheim, Norway

Status of Atlantic salmon (*Salmo salar*) in Norway

The results from the 2002 survey of Norwegian salmon stocks are shown in Table 1. The category system is a classification of rivers based on the condition of the salmon stock in relation to harmful human impact factors. Category assignment is based on an overall assessment taking into consideration all factors of importance for the stock's existence and production. Only river systems which have or have had a self-reproducing stock are categorized.

49 stocks have been lost to salmon production. River systems where a salmon stock is being re-established, e.g. through stocking with fish from the gene bank or with fish of other origin, are categorized in the same way as other rivers with notes on their re-establishment. In Norway there are currently 18 re-established stocks and 25 stocks are affected by human impact factors which have both sufficiently damaging potential and scale to threaten the stocks with loss. This will often be the case when the stock is exposed to human impact factors which inflict high levels of mortality, e.g. *Gyrodactylus salaris* and river acidification.

A total of 454 rivers have been categorized using the system. In addition, there are 158 small rivers where salmon are known to occur but which do not have a self-reproducing stock, and 105 small rivers where the existence of a self-reproducing stock is uncertain.

The major impact factors affecting salmon stocks are acidification, the freshwater parasite *Gyrodactylus salaris*, hydropower development and other physical damage.

Table 1. Status categories of stocks of Atlantic salmon (*Salmo salar*) in Norway

	CATEGORY	NUMBER
1.	**Lost stocks** *Rivers where the stock has been lost as a result of human impact*	**49**
2.	**Threatened stocks** *Rivers where the stock is at high risk of becoming lost as a result of human impact*	**25**
3.	***Vulnerable stocks*** *Rivers where the stock can become threatened as a result of human impact*	
	a. Rivers where the stock is close to being considered threatened	**29**
	b. Rivers where the stock is maintained by mitigative actions	**20**
4.	**Reduced stocks** *Rivers with considerably reduced young fish production and/or adult fish stock resulting from human impact*	
	a. Rivers with considerably reduced young fish production	**60**
	b. Rivers with greatly reduced adult fish stock, but where young fish production is not considerably reduced	**5**
5.	**Moderate or slightly affected stocks** *Rivers where the stock is moderately or slightly affected by human impacts*	
	a. Rivers with stocks requiring special concern	**201**
	b. Rivers with stocks not requiring "special concern"	**48**
X	**Uncertain**	**17**
	Total	**454**

Threats to Norwegian Stocks of Atlantic Salmon

The impacts from acidification are most severe in the eastern, western and particularly the southern part of Norway (Figure 1). In these areas salmon stocks in 53 watercourses have become extinct or are threatened with extinction due to acidification.

Gyrodactylus salaris is a small (0.5mm), freshwater ectoparasite. It is, however, known that it can survive some time in brackish water. The parasite is host-specific and recent investigations indicate that salmonid species other than Atlantic salmon may be important in the successful reproduction and dispersal of *G. salaris*. In addition to salmon, the parasite can live and reproduce on Rainbow trout, Artic char and grayling.

The parasite was inadvertently introduced to Norway in 1975 with imports of smolts from Sweden. Following the initial introduction, the parasite was spread further within Norway mainly through fish stocking from infected hatcheries. Its spread has also occurred from infected rivers to neighbouring rivers through the brackish water layer in fjords.

The parasite has been recorded in 42 salmon rivers, distributed in seven regions (Figure 1). Most of the infected rivers are situated in the middle part of Norway. The salmon stocks in these 42 rivers have become extinct or are threatened with extinction due to *G. salaris*.

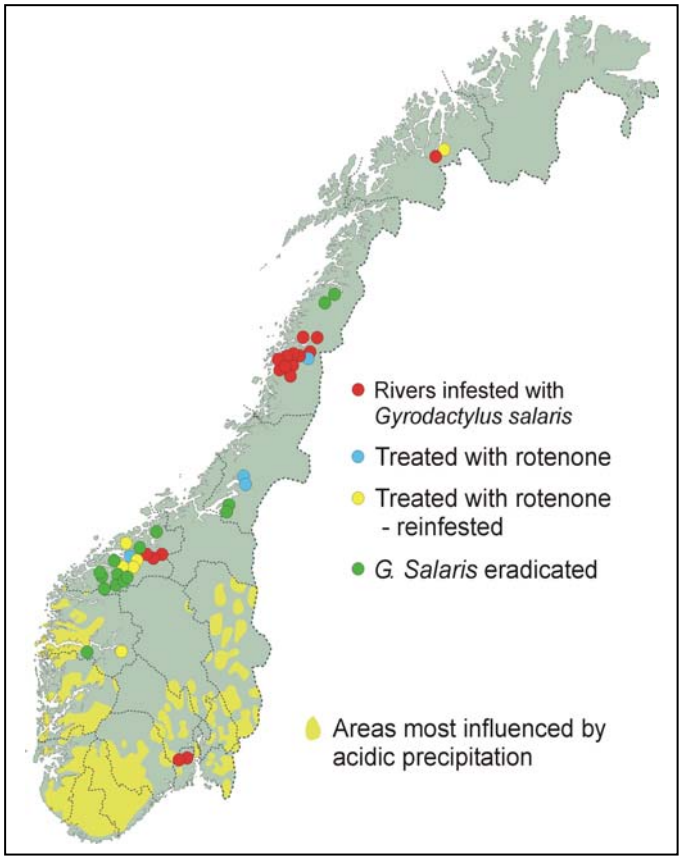

Figure 1: Map showing areas most influenced by acidification - indicated in yellow. Rivers which are, or have been, infected with Gyrodactylus salaris are marked with dots

Eradication of *Gyrodactylus salaris*

G. salaris has affected several of the country's most important salmon stocks. No specific chemicals have been developed that can eradicate the parasite without also affecting non-target species. Currently, the only method of eradicating *G. salaris* is to remove its hosts from the watercourse for a short period of time. The chemical used to remove fish from infected rivers is rotenone. In addition, fish barriers and rotenone treatments are being used in combination.

Rotenone treatment has been carried out in a total of 25 infected rivers in Norway (Figure 1). In 15 of the treated rivers the parasite has been eradicated. Three rivers are still being monitored. After treatment, five years of monitoring is necessary to confirm that the treatment has been successful. In six rivers the parasite has been recorded after rotenone treatment.

Liming

Acidification is one of the most serious environmental problems in the southern parts of Norway. In spite of the international agreement on reducing emissions (the "Sulphur Protocol" of 1994), the southern parts of Norway will have large acidified areas for decades to come. Acidification has resulted in the extinction of the salmon stocks in 25 rivers, and another 28 stocks are threatened.

The Norwegian environmental authorities undertake liming to reduce the damage to freshwater systems. Twenty rivers supporting salmon are currently being limed (Figure 2). The stocks in 9 of these rivers were lost before the liming commenced while the stocks in the other 11 rivers were either threatened, vulnerable or reduced.

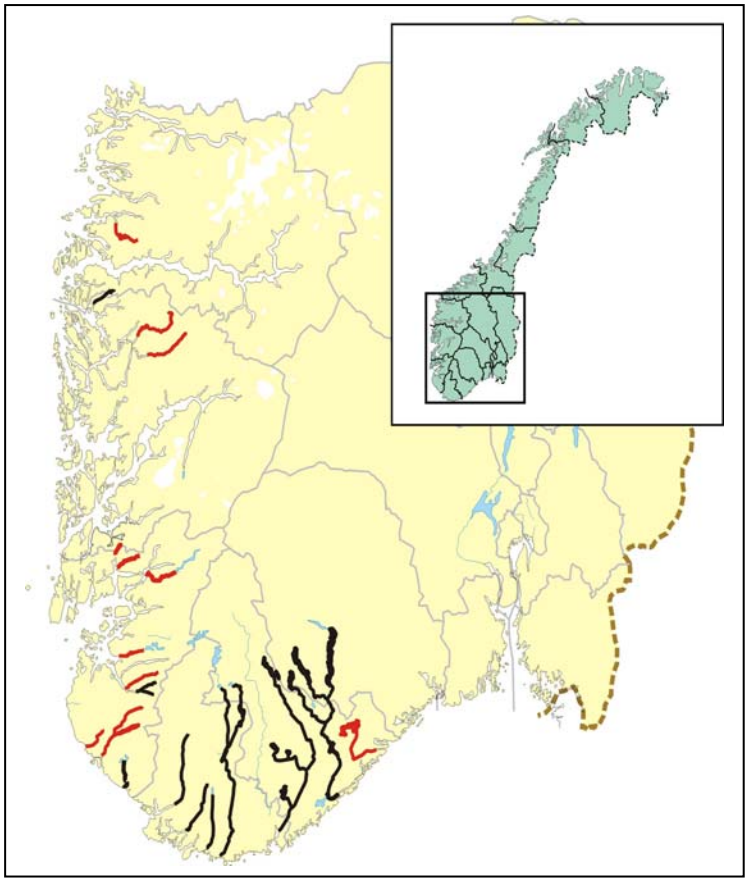

Figure 2: Map showing limed salmon rivers. Rivers shown in black are those in which the natural stock was lost before liming, while those drawn in red are those in which stocks were threatened, vulnerable or reduced

When the water quality is acceptable for salmon, which are one of the most sensitive organisms to acid water/toxic aluminium, stocking and reintroduction with material from gene banks or local hatcheries commence.

Currently, a total of 320 km of salmon rivers is being limed. It is estimated that salmon catches have increased from 12.7 tonnes to about 93 tonnes due to the liming of the 20 rivers. In the largest limed river, River Mandal, where the salmon stock became extinct because of acid rain, liming commenced in 1997. The water quality has improved considerably, and the salmon catches have increased since the liming programme started (Figure 3).

Wild Salmon Protection Areas

In February 2003 the Norwegian Parliament decided to establish a number of protected zones for Atlantic salmon. The aim is to provide enhanced protection to a number of Norway's most important salmon watercourses and appurtenant migratory areas in fjords and along the coast. In the protected areas the conservation of the salmon and its habitat will be given priority over any activity that may adversely affect it.

In the first phase, 37 so-called “National salmon rivers” and 21 “National salmon fjords” will be established. The Parliament also decided that in the second phase, to be completed in 2004/2005, a number of additional rivers should be designated. This means that, when complete, the system will include 50 of the most important salmon rivers in Norway. The National salmon rivers and fjords will protect about two-thirds of the total Norwegian wild salmon production.

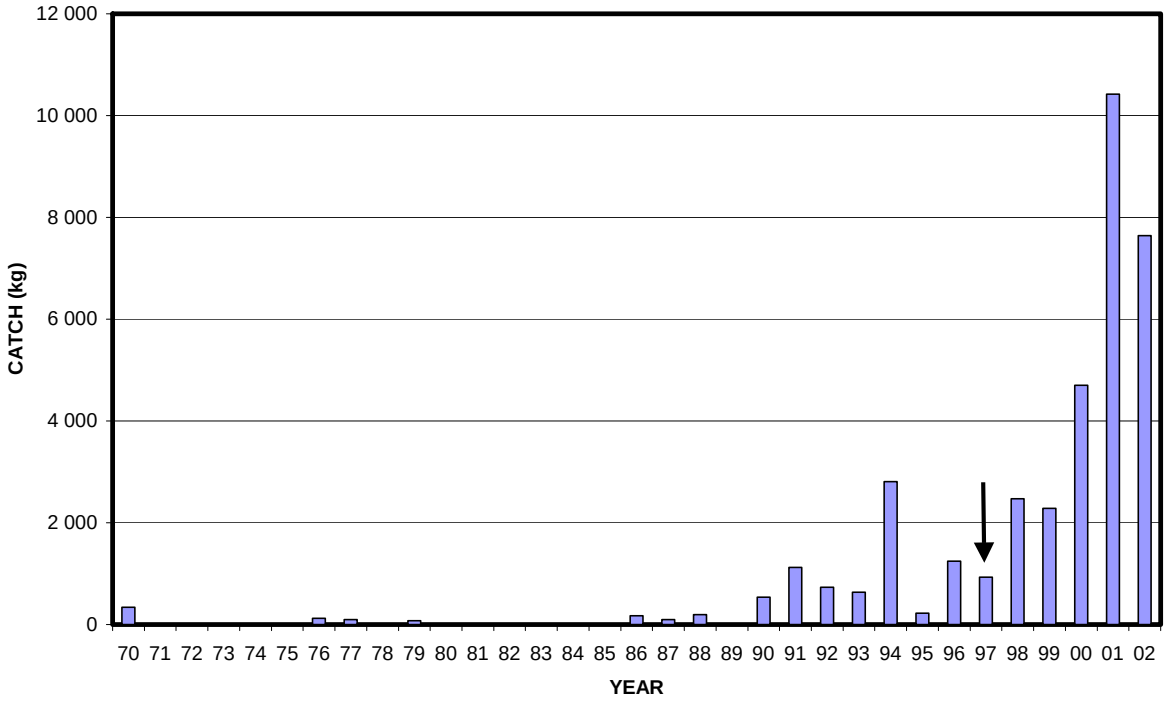

Figure 3. Catches of salmon in River Mandal. Arrow indicates time for the start of the liming

The Current Situation regarding Protection and Restoration of Atlantic Salmon Habitat in Russian Rivers

Dr Alexander Zubchenko, PINRO, Murmansk

Reliable records of Atlantic salmon exist for 120 rivers in the Northwest of Russia which are, in accordance with the legislation of the Russian Federation, federal property. The majority of these rivers flow over areas which are difficult for access, and therefore only insignificantly affected by man's activities. The nine largest rivers run through areas with economic activities, which certainly produce impacts on Atlantic salmon habitat. Ten rivers have hydro-electric schemes.

The main sources of adverse impact on Atlantic salmon habitat include:

- road building;
- hydro-electricity development;
- sand and gravel mining;
- production of oil and minerals;
- in-river engineering;
- deforestation;
- dredging;
- discharges from dams;
- industrial discharges;
- atmospheric deposition;
- aquaculture;
- navigation.

The State management authorities responsible for the regulation of the use of water resources, protection of waters and environment include:

- the Committee on Natural Resources;
- the Directorate on Protection and Enhancement of Fish Stocks;
- local management bodies.

All work on protection of salmon habitat is based on the following principal laws and regulations:

- Law on the Protection of the Environment;
- Law on the Animal World;
- Water Use Code;
- regulations on water protection zones beside watercourses and protected riverside buffer strips;
- regulations on protection of surface water;
- various ecological requirements established by the subjects of the Russian Federation.

In accordance with these laws and regulations:

- it is prohibited to site water abstraction facilities on, and to discharge effluents into, river stretches with salmon spawning and nursery habitat;
- all water abstraction facilities are provided with screens to prevent smolts from entering;
- discharge of effluents into stretches of rivers without salmon spawning and nursery habitat is regulated;
- specific measures have been developed to improve sewage processing;
- harvest management plans are applied for salmon rivers to regulate the abundance of predators and competitors of Atlantic salmon;
- a ban on loose log floating on rivers supporting salmon has been established;
- damage to salmon habitat is assessed and compensation arrangements as a mitigation measure are designed;
- allocation of funds is envisaged to implement habitat restoration programmes;
- penalty sanctions against those who caused pollution or other damage to habitat are imposed.

As an example of how salmon habitat protection and restoration are carried out in Russia, the situation on the Kola river will be described in more detail:

- total river length - 83km;
- catchment area – 3,846km^2;
- area of riverine habitat available to juvenile salmon – 1,355,000m^2;
- productive capacity of wild adult salmon by sea age;
- in 1974 1SW – 10,500, MSW – 6,900;
- in 1996-2000 1SW – 5,180, MSW – 1,860;
- productive capacity of wild salmon smolts – 114,500 smolts;
- proportion of adult production comprising reared fish in 1996-2000 - 6.3-20.6%;
- since 1959 a counting fence has been placed on the Kola river every year;
- in 1999-2001 there was no commercial fishery for salmon on the Kola river;
- only catch-and-release and catch-and-retain recreational fishing was conducted.

The Kola river has a water protection zone of 1km, where economic activities can be carried out provided that they comply with the requirements established by relevant regulations, and a protected riverside buffer strip of 100m where any economic activity is prohibited.

The population in the area of river watershed is about 60,000 people. The area is crossed by a major railroad and motorway, and has a brick production plant, two big agriculture farms, two fur farms, two chicken farms, a military installation, petroleum storage and machinery depots, 6 water abstraction facilities with a total capacity of 1.6 million cubic metres per year, and 10 sewage treatment plants discharging about 15 million cubic metres of effluent a year. A total of 20 various sources of pollution have been identified on the Kola river itself and its tributaries. At the same time the Kola river is a main source of potable water for half a million people in the Murmansk Region. All 6 facilities abstracting water for both human consumption and industrial purposes are provided with screens to prevent smolts from entering.

In order to protect salmon habitat in the river the following measures have been implemented to date:

- log floating was banned;
- requirements have been set for cleaning rubbish from the water protection zone of the river;
- all plants and other facilities discharging effluents into the river have been listed and are being controlled;
- actions are being taken to improve effluent treatment to ensure compliance with water quality standards established for salmon rivers.

Of all the factors adversely affecting the habitat in the river today, the run-off of manure slurry from chicken farms and fertilizers from adjacent agricultural fields and farms into the river during the spring flood should be highlighted. A 6km stretch of the river near its mouth is most severely affected. This leads to increased concentrations of nitrogen-bearing substances, easily oxidized organic matter, and pesticides. This negative impact resulted in increased siltation of spawning and nursery habitat, and extinction of some species of in-river vegetation and invertebrates in the river ecosystem. To counteract these negative effects, plans were developed and adopted in 2001 for upgrading of dams and manure depots at chicken farms. In addition, a non-commercial partnership of river users was established with the purpose of improving the ecological situation on the river through joint efforts.

Presently, in accordance with the Salmon Habitat Protection and Restoration Plan for the Kola river, the following actions are being taken:

- control of all activities in the 1km water protection zone of the river (a proposed construction work near the river can be permitted provided that no clear-cutting is undertaken and no damage is caused to vegetation);
- control of agricultural land use (cultivation, fertilization, insecticides, etc.);
- monitoring of status of spawning and nursery habitat (yearly surveys of the habitat, parr density estimates, advice on stocking of hatchery-reared juveniles, etc.);
- monitoring of the potential impact of farm escapees and pink salmon (at barrier fence on the river);
- monitoring of chemical impacts (particular focus on such sources of pollution as chicken farms, control of compliance with measures taken to avert pollution of the river, identification of all river uses discharging inadequately treated effluents, design of additional measures to reduce pollution and their enforcement);
- monitoring of the efficiency of fish screens at water abstraction facilities.

Development and Implementation of Habitat Protection and Restoration Plans According to the NASCO Plan of Action in the USA

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Ms Mary Colligan, National Marine Fisheries Service, Gloucester, Massachusetts
Mr Joseph McKeon, US Fish and Wildlife Service, Nashua, New Hampshire

Introduction

Atlantic salmon populations in the US exist in the southern part of the range of the species, posing significant challenges to the restoration of self-sustaining runs in some rivers. While Atlantic salmon returns to North America have decreased by about one half to two thirds since the early 1980s, the decline in US salmon stocks has been more severe, resulting in the listing of eight salmon populations in Maine as endangered under the federal Endangered Species Act on November 13, 2000.

The complex life-history requirements of Atlantic salmon populations have created a wide range of biological, environmental, and socio-political problems that pose unique challenges to restoration and management of the species wherever it is found. Many of these problems were documented and have existed for a long time in North America and elsewhere (Netboy 1968, and 1980; WWF 2001), illustrating the degree of difficulty in ultimately resolving them.

The severe decline of US salmon stocks in recent years has caused concern among fishery managers, anglers, conservationists, and others and has raised concern about the future of Atlantic salmon in the US. As a consequence of this concern, Atlantic salmon habitat issues (quantity, quality, and accessibility) are currently a high priority in US restoration programs throughout New England. Strategies and actions currently being undertaken in the US in recent years to protect, restore, and enhance existing Atlantic salmon habitat are presented in the following report. As will be described in this report, these efforts are a combination of mandatory regulatory programs and voluntary incentive-based initiatives.

Inventory of Current US Atlantic Salmon Rivers

Atlantic salmon restoration and management programs are being undertaken in 22 rivers throughout the New England region of the US (Figure 1). In southern New England waters (south of Cape Cod, Massachusetts) salmon restoration and management programs are in progress in the Connecticut River Drainage, which drains portions of the states of Connecticut, Massachusetts, Vermont and New Hampshire, and the Pawcatuck River, which is located within the state of Rhode Island. In northern New England (north of Cape Cod, Massachusetts) salmon restoration and management programs are being implemented in three rivers in New Hampshire (the Merrimack and two small coastal rivers), and 17 rivers in Maine. The Penobscot River represents the largest Atlantic salmon restoration program in the State of Maine. Fourteen of the 22 US Atlantic salmon rivers currently contain facilities for counting adult salmon returns.

Figure 1. US Atlantic salmon rivers.

*Rivers in **bold** are listed as Endangered under the US Endangered Species Act.*

1 Aroostook
2 Meduxnekeag
3 Prestile Stream
4 Saint Croix
5 Dennys
6 East Machias
7 Machias
8 Pleasant
9 Narraguagus
10 Tunk Stream
11 Union
12 Penobscot; ***12a Cove Brook***
13 Ducktrap
14 Sheepscot
15 Kennebec
16 Androscoggin
17 Saco
18 Cocheco
19 Lamprey
20 Merrimack
21 Pawcatuck
22 Connecticut

Since 1950, US State and Federal fishery resource agencies have employed a variety of stream habitat survey methods to measure and evaluate the quantity and quality of Atlantic salmon riverine habitat. These surveys have permitted scientists to: characterize the various types of salmon habitat; apply statistical analysis to these data; establish rational partitions of habitat data into various categories; and standardize survey methods used to define and measure salmon spawning and rearing habitat. In addition to providing biologists, managers, and others with reliable estimates of available units of salmon habitat, these surveys provide insight into the potential and limitations for the production of Atlantic salmon in US rivers. The proportion of salmon habitat surveyed to date varies from 70% for Maine rivers to 95-99% for New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island rivers.

An estimated 813,000 units (one unit = 100 m^2) of Atlantic salmon spawning and nursery habitat have been quantified in US rivers (Table 1). Of the total US Atlantic salmon habitat inventoried to date, 30% occurs in the Connecticut River Drainage, <1% occurs in the Pawcatuck River Drainage, 9% occurs in the Merrimack River and two small coastal NH river drainages, and 60% occurs in 17 rivers in Maine. The US is committed to protecting the current productive capacity of existing Atlantic salmon habitat in these rivers, and, where possible, to restoring the productive capacity of salmon habitat which has been adversely impacted due to human activities.

Table 1. Inventory of current US Atlantic salmon rivers.

River No.	River	Location (States)	Length (Km.)	Drainage Area (Sq. km.)	Atlantic Salmon Habitat Units (1 unit = 100 sq. m.)			Salmon Population Status [4]
					Surveyed Since 1990	Surveyed Prior To 1990 [3]	Total Habitat (Minimum)	
1	Aroostook	Maine	115	5,931	30,000	30,775	60,775	L
2	Prestile Stream	Maine	39	562	-	835	835	L*
3	Meduxnekeag	Maine	65	1,287	-	10,000	10,000	L*
4	Saint Croix	Maine	50	6,475	29,260	+	29,260	L
5	Dennys [1]	Maine	32	342	2,414	+	2,414	T
6	East Machias [1]	Maine	59	650	3,006	+	3,006	T
7	Machias [1]	Maine	98	1,191	6,156	+	6,156	T
8	Pleasant [1]	Maine	45	220	1,220	+	1,220	T
9	Narraguagus [1]	Maine	78	601	6,014	+	6,014	T
10	Tunk Stream	Maine	27	104	-	627	627	L
11	Union	Maine	100	1,295	-	8,370	8,370	L
12	Penobscot [2]	Maine	267	22,196	-	125,000	125,000	L,T [5]
13	Ducktrap [1]	Maine	17	93	845	+	845	T
14	Sheepscot [1]	Maine	55	591	2,797	+	2,797	T
15	Kennebec	Maine	242	15,540	43,483	114,300	157,783	L,T [5]
16	Androscoggin	Maine	207	6,475	-	47,900	47,900	L
17	Saco [6]	Maine & NH	201	4,395	12,540	15,000	27,540	L
18	Cocheco	NH	70	479	3,070	+	3,070	L
19	Lamprey	NH	100	549	2,968	+	2,968	L
20	Merrimack	NH & Massachusetts	302	12,976	68,842	+	68,842	L
21	Pawcatuck	Rhode Island	52	798	4,490	+	4,490	L
22	Connecticut	Connecticut, MA, VT & RI	667	29,138	243,000	+	243,000	L
		Total	2,888	111,888	460,105	352,807	812,912	

[1] Atlantic salmon populations in these rivers listed as Endangered on November 13, 2000 under the US Endangered Species Act.

[2] Cove Brook, a tributary to the lower Penobscot River, is included with the 7 rivers identified in footnote 1.

[3] Data based upon older surveys conducted primarily in 1950s-1960s; a + indicates that some minor tributaries have not been surveyed.

[4] NASCO categories: L = lost, M = maintained, R = restored, T = threatened with loss, N = not threatened with loss. L* designation indicates current population status unknown but assumed to be lost.

[5] T designation applies to selected tributaries below the first hydrodam; populations above first dam considered lost.

[6] Surveyed habitat located in Maine; additional ~15,000 habitat units located in NH.

Potential Risks To US Atlantic Salmon Habitat

Much of the historical freshwater Atlantic salmon habitat in New England rivers has been destroyed, degraded, or rendered inaccessible during the past 200 years as a result of the construction of numerous dams and of other human activities impacting the quantity, quality and accessibility of US rivers and streams. For example, a minimum of 1,000 dams currently exist on the Connecticut River Drainage alone, with a similar number in existence in the other northeastern US salmon rivers as a whole. Physical, chemical, and biological risks to Atlantic salmon habitat include: water extractions for municipal, industrial, and agricultural uses; sedimentation; addition of nutrients; exposure to herbicides, fungicides, pesticides, and endocrine-disrupting chemicals; timber harvesting activities; elevated water temperatures; exposure to acidified water and aluminum found in soils; habitat modification; removal of stream bank vegetation; and obstructions to upstream and downstream passage. In some localized situations efforts to protect salmon habitat are hampered by a lack of public awareness of the importance of habitat to salmon restoration programs.

While the known threats to Atlantic salmon habitat are currently being addressed at the federal, state, and local levels, some continue to imperil the sustained existence of Atlantic salmon in selected rivers. Although in most cases there are regulatory mechanisms to address these threats, the regulatory process can be slow and controversial and often the focus of legal challenge. It is for these reasons that many of the recently implemented Atlantic salmon habitat protection and restoration strategies in the US are currently of a voluntary nature. Most stakeholders prefer to implement desired outcomes in a voluntary manner because results are often achieved more quickly and efficiently when all parties agree to work together cooperatively. There are a great number of programs that provide incentives to landowners to work cooperatively with agencies and conservation organizations to address habitat problems.

US Atlantic Salmon Habitat Protection and Restoration Programs

Overview of Existing Laws and Regulations to Protect Salmon Habitat

US federal laws and regulations currently provide a comprehensive regulatory framework to protect Atlantic salmon habitat and water quality in salmon rivers and coastal zones. Federal laws include the following: the Sustainable Fisheries Act of 1996, P.L. 104-297; Marine Protection, Research, and Sanctuaries Act (regulates ocean dumping); the Clean Water Act; the Coastal Zone Management Act of 1972; the Endangered Species Act of 1973; the Federal Power Act; the Fish and Wildlife Coordination Act; and the National Environmental Policy Act. Some of the key provisions of a selection of these laws are summarized below.

- Fish and Wildlife Coordination Act (FWCA): The FWCA requires that wildlife conservation receives equal consideration with other features of water resource development. The FWCA requires that federal permitting and licensing agencies consult with the National Marine Fisheries Service and US Fish and Wildlife Service before issuing a permit for activities that modify any body of water;
- Endangered Species Act (ESA): The ESA provides for the conservation of ecosystems upon which threatened and endangered species depend. It is important to note that while it is individual species that are listed under the Endangered Species

Act, the goal of the ESA is focused upon ecosystem conservation. Federal agencies are required to ensure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of listed species or to modify their critical habitat;

- National Environmental Policy Act (NEPA): The NEPA requires federal agencies to document the effects of their recommendations, proposals, or other major actions that affect the quality of the human environment significantly. This documentation includes consideration of a range of alternatives;
- The Federal Power Act (FPA): The FPA requires the Federal Energy Regulatory Commission (FERC) to consider the fish and wildlife recommendations from federal and state resource agencies and Indian Tribes to ensure selected projects are best adapted to the comprehensive development of the waterway. A critical provision of the FPA states that FERC shall require the licensee to construct, maintain, and operate fishways prescribed by the Secretaries of Interior or Commerce;
- The Magnuson-Stevens Act: In 1996 the Magnuson Fishery Conservation and Management Act was amended to give heightened consideration of fish habitat in resource management decisions. These amendments directed the National Marine Fisheries Service (NMFS) to identify essential fish habitat (EFH) for all federally managed species, including Atlantic salmon. Essential fish habitat has been described for US Atlantic salmon as: all waters currently or historically accessible to Atlantic salmon within the streams, rivers, lakes, ponds, wetlands, and other water bodies of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. Specific habitat conditions are described for eggs, juveniles, and adults. The NMFS is directed to minimize to the extent practicable the adverse effects of fishing on EFH and to identify other actions to encourage the conservation and enhancement of EFH.

Numerous federal government agencies [e.g. National Marine Fisheries Service (NMFS); US Fish and Wildlife Service (USFWS); US Army Corps of Engineers (USACE); Federal Energy Regulatory Commission (FERC); Environmental Protection Agency, Office of Water (EPAOW); Natural Resources Conservation Service (NRCS); US Forest Service (USFS)], as well as all states have various types of land use regulations that govern forestry practices, fish passage requirements for hydropower and other dams, water quality requirements for fresh and coastal waters, shoreland zoning ordinances, laws and regulations pertaining to the use and disposal of pesticides, herbicides, and hazardous substances, site location and development laws, etc.

Additionally, federal laws in combination with existing international, interstate, and local regulatory mechanisms provide a wide range of protection against practically any activity which could contribute to the destruction or alteration of US Atlantic salmon habitat and populations. All six New England states also have a broad array of statutory and regulatory requirements administered by numerous agencies designed to protect, enhance, and restore aquatic habitat and other natural resources such as fish and wildlife.

Overview of US Atlantic Salmon Habitat Protection and Restoration Programs

Most US Atlantic salmon habitat protection and restoration activities are designed with the intention of restoring the natural processes that maintain habitat in natural harmony with the environment. Examples of the extent and diversity of recent habitat protection, improvement, and restoration programs throughout the Northeastern US follow.

On-going Atlantic Salmon Habitat Surveys

In order to protect and restore salmon habitat, it first must be identified and surveyed for quantity, quality, and accessibility to Atlantic salmon. Although all US Atlantic salmon rivers listed in the inventory above have been surveyed within the last 50 years (some numerous times), new survey methodologies and technologies are continually being developed and implemented (Figure 2). The highest priority US rivers and streams have been re-surveyed in the last decade, and all information has been incorporated into various types of land use overlay surveys which are recorded and documented in an extensive Geographic Information System (GIS) habitat database. Additionally, the quality, quantity, and accessibility of Atlantic salmon habitat in US rivers is continually being revised and updated as new, more reliable information is acquired. These surveys are also used to identify habitat deficiencies and limitations that can be addressed through future habitat enhancement or restoration projects.

Maine: Most of the potential salmon habitat in the US that remains to be resurveyed is located in the State of Maine. Substantial progress was made in 2001 in the following drainages:

- Habitat surveys were conducted on over 37 kilometers of the mainstem of the Aroostook River in northern Maine. A team of four biologists surveyed over 30,000 units of salmon habitat;
- On the East Machias River, salmon habitat was re-surveyed in the lower mainstem and in Chase Mill Stream. Several overlay surveys were also conducted, completing all major components of the East Machias habitat survey. These data will be added to the existing GIS habitat database for the river;
- Atlantic salmon habitat surveys were conducted on the mainstem and portions of four tributaries to the Kennebec River. These surveys included approximately forty-seven kilometers of riverine habitat which documented more than 43,000 units of salmon habitat. Habitat maps will be produced and included in existing databases;
- Two overlay habitat surveys were conducted in 2001 within the Machias River drainage and these determined the type (narrative, overlay, or full survey) of survey required for six additional tributaries. These data will be compiled and entered into the existing Atlantic salmon habitat database, which was originally completed on the Machias drainage in 1998;
- The West Branch of the Union River was resurveyed for potential salmon habitat in 2001. These data will be analyzed and utilized to refine stocking recommendations and other management activities.

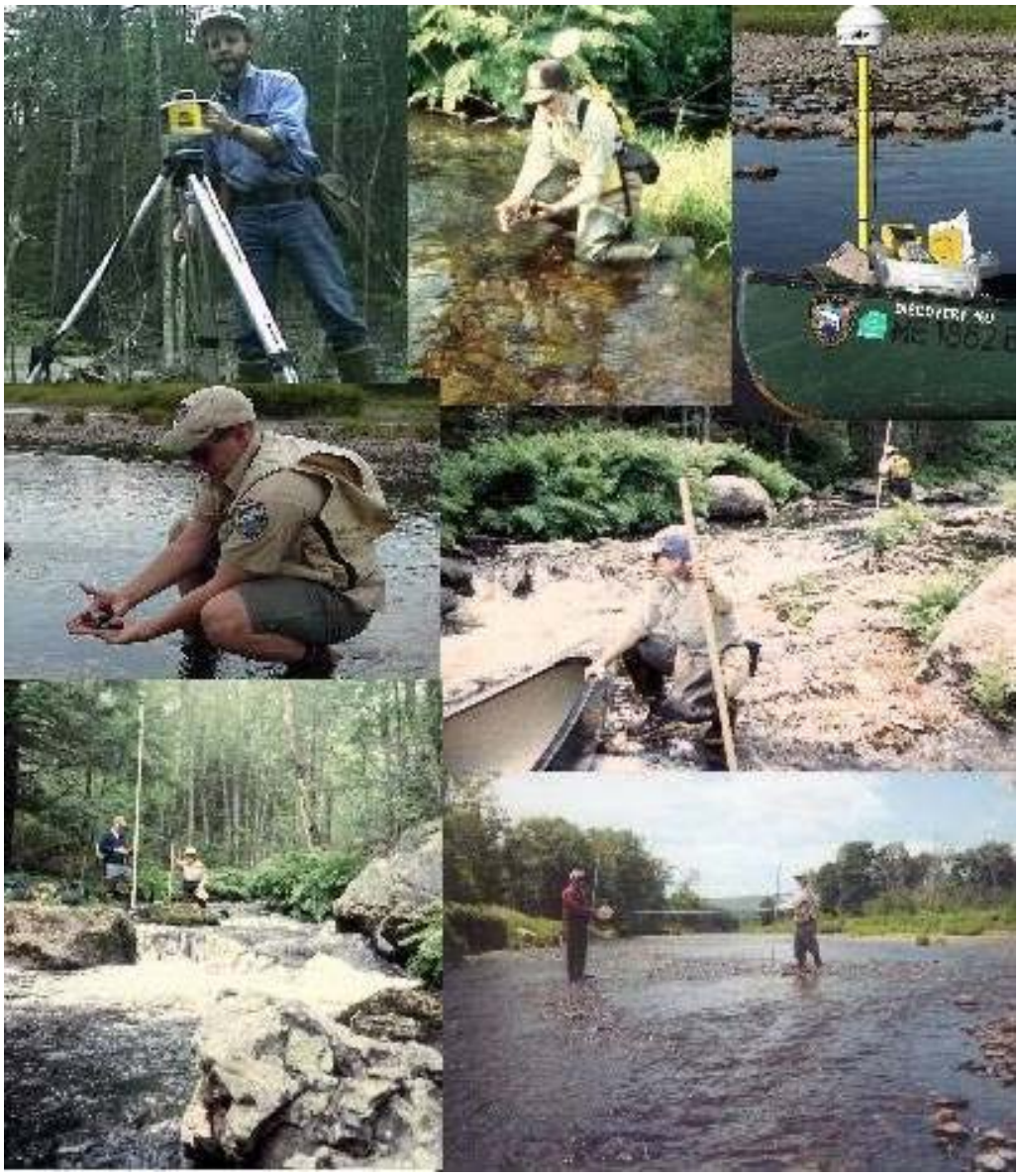

Figure 2: The quantity, quality, and accessibility of Atlantic salmon habitat in US rivers is continually being re-evaluated. These surveys are also used to identify and prioritize future habitat restoration projects. (Photos: US Fish & Wildlife Service and Maine Atlantic Salmon Commission)

Land Purchases and Conservation Easements[1]

Maine: In the Ducktrap River watershed, the Coastal Mountains Land Trust has protected 81% of the mainstem of the river through land purchases and/or easements, and 46% of the land along the river's three principal tributaries has been put into permanent conservation (Figure 3). The goal of the Ducktrap Coalition is to place 100% of the land along the river and 3 principal tributaries into permanent conservation, unless the land is already developed for residential use (a very small fraction of the drainage).

In late 2001, International Paper transferred ownership of most of the company-owned riparian habitat along the Dennys River and its main tributary, Cathance Stream, to the State of Maine. This acquisition will ensure the integrity of the riparian habitat along the Dennys River and will provide significant benefits to Atlantic salmon.

The US Fish and Wildlife Service, along with the Nature Conservancy, the Maine Department of Conservation, and International Paper have provided funding to the Maine Atlantic Salmon Commission to develop a permanent conservation easement along most of the mainstem of the Machias River and several of its important tributaries. Nearly $10 million in State, Federal, and private funding has been committed to this important undertaking.

In the Pleasant River Drainage, the Downeast Rivers Land Trust (formed in 2001) acquired its initial parcel of land. This tract encompasses 70 acres with about 3,000 meters of shore frontage on the Pleasant River and a major tributary. A conservation easement on another property already permanently protects an additional 1,000 meters of shore frontage in the same vicinity.

Dam Removal Projects

The removal of dams from US rivers can be controversial because often there is no existing remembrance of certain rivers without dams. Also, local residents characteristically oppose dam removal because of the resistance to change, emotional attachment to dams, aesthetics, developed infrastructure around impoundments, historical recreational opportunities, and apprehension that property values may be negatively impacted. Despite these obstacles, many dams have been removed from US Atlantic salmon rivers in recent years. Examples of these dam removal projects throughout New England follow.

Connecticut: During the last 10 years seven dams have been removed in Connecticut, with individual dam removal costs ranging from $50,000 to $200,000.

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[1] A conservation easement is a nonpossessory interest in land, granted by a land owner and held by a charitable corporation or a government entity, which grants a right to the holder or a third party to enforce the specific conservation purposes for which the easement was created. The right to cut trees, the right to subdivide, and the right to farm are examples of nonpossessory interests. These interests can be restricted by a conservation easement. By contrast, a possessory right is traditionally considered to be some physical relationship or occupancy of land with the right to exclude others; this possessory right is not usually restricted through an easement and remains with the holder of the deed. In the US, conservation easements are usually held by land trusts or government entities.

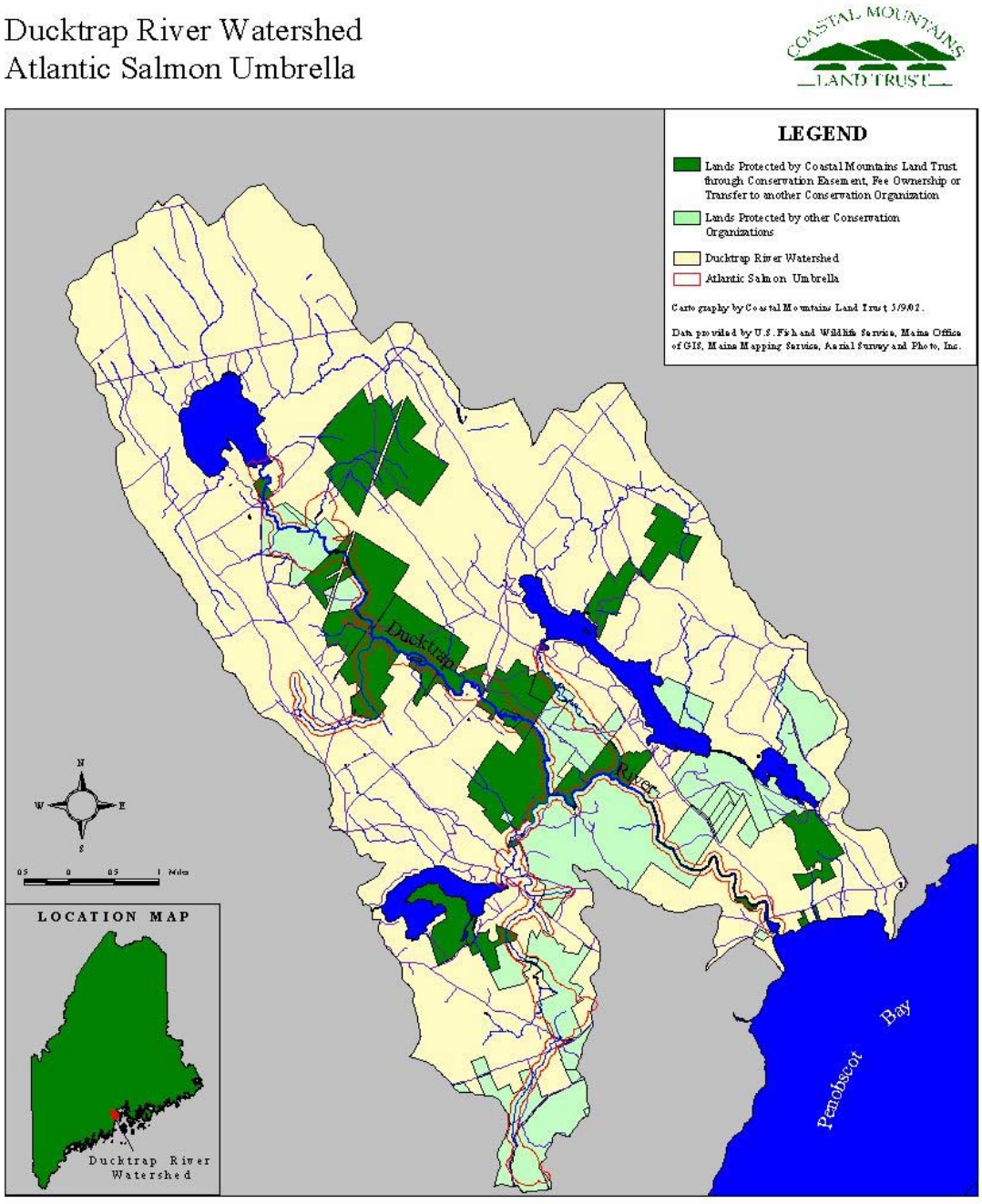

Figure 3: The Coastal Mountains Land Trust and other conservation organizations have protected 81% of the Atlantic salmon habitat in the Ducktrap River, Maine. (Map prepared by Tarn Dickerson, CMLT)

New Hampshire: In 1998, the New Hampshire Fish and Game Department initiated an effort to remove three unutilized dams in the Ashuelot River watershed, a tributary to the Connecticut River. The first obstruction, McGoldrick Dam, was removed in July of 2001 (Figure 4), and the second dam (Winchester) is scheduled to be removed in the summer of

2002. Removal of the third dam (Swanzey) is currently being investigated. Removal of the McGoldrick Dam in 2001 opened up about 2.6 km of river to Atlantic salmon and other migratory fish species.

Figure 4: McGoldrick Dam on the Ashuelot River watershed in New Hampshire, a tributary to the Connecticut River, was removed in July of 2001. (Photos: US Fish & Wildlife Service)

In 2001 a multi-agency River Restoration Task Force (RRTF) continued to work on identifying dams for removal in New Hampshire and is pursuing the removal of six dams already targeted. A Dam Removal Coordinator Position was created within the New Hampshire Department of Environmental Services, which has been identified as the lead agency within the state for dam removal. Several proposed projects in various states of progress will benefit historic and currently targeted Atlantic salmon habitat in the Merrimack River watershed.

Maine: Seven dams have been removed in the State of Maine in recent years, including the Columbia Falls Dam on the Pleasant River in eastern Maine (1988), the Bangor Dam on the mainstem of the Penobscot River (1995), the Grist Mill Dam and Paper Mill Dam (1998) and the Brownville Dam (1999) on tributaries to the Penobscot River, the Edwards Dam (Figure 5) on the mainstem of the Kennebec River (2000), and the East Machias Dam on the East Machias River (2001). Seven additional dams in Maine are currently proposed for removal in future years pending environmental, social, legal, and economic issues that have to be addressed.

Fish Passage Improvements

Connecticut: In recent years the Inland Fisheries Division of the Connecticut Department of Environmental Protection has constructed about 25 fishways, ranging from $100 to $200,000 in cost.

Maine: A new anadromous fish passage facility on the Saco River (at Skelton Dam) was completed in late summer 2001. It is one of the highest fish lifts on the east coast of the US, with a maximum lift to the headpond of about 24 m and up to 35 m to the elevated fish sorting and holding tanks (Figure 6). The $6.0 million facility features an inclined rather than vertical hopper travel, and includes a fish counting station with a viewing window in the exit channel. All fish can be lifted to the headpond or to a sorting, holding, trapping and trucking facility. The fish lift is designed to pass 2,000 Atlantic salmon, 80,000 American shad and 340,000 river herring.

In recent years increased attention has focused on investigating the extent to which existing road culverts may impede fish passage in US Atlantic salmon rivers. A large number of improperly designed culverts have been identified and efforts are underway to repair these culverts to ensure that they are not barriers to fish passage. Resource agencies have worked with the various state Departments of Transportation and paper industry representatives to ensure that adequate consideration is given to fish passage when designing and installing temporary or permanent culverts.

Figure 5: Edwards Dam, Kennebec River, Maine, before and after dam removal in 2000. The structure was 280 m long, 6 m high and impounded 30 km of riverine habitat. Total cost for removal: $3.77 million. (Photos: Steve Brooke, Kennebec Coalition)

Figure 6: Anadromous fish passage facility completed in 2001 on the Saco River, Maine. It is one of the highest fish lifts on the US east coast, with a maximum lift to the headpond of 24 m and up to 35 m to the elevated fish sorting and holding tanks. The $6.0 million facility features an inclined hopper travel, and includes a fish-counting station with a viewing window in the exit channel. (Photo: Matt Leblanc, Florida Power and Light Co.)

River Channel Restoration, Erosion and Sedimentation Controls, Stream Bank Stabilization, Riparian Vegetation Planting, Nutrient Management Plans, Livestock and ATV Crossings, etc.

In the US, natural channel design techniques are increasingly utilized to restore channel stability and the fluvial geomorphic processes that form and maintain aquatic habitat features. The role of channel and floodplain geometry and sediment transport/distribution in maintaining riffle and pool quality is extremely important. The form, function, and equilibrium of fluvial aquatic systems can be disrupted by a variety of common changes to hydrologic parameters, sedimentation, watershed land uses, and channel management; applied fluvial geomorphology techniques are used to assess these events with dynamic treatment of temporal and spatial scale issues (see *Salmon Habitat Research* later in this section). Examples of recent Atlantic salmon habitat enhancement projects in this area follow.

Connecticut: The Connecticut River Atlantic Salmon Commission, member agencies, and non-government organization cooperators are working to restore habitat for Atlantic salmon, American shad and river herring. Restoration of habitat is considered to be essential to restoration of diverse species in the Connecticut River aquatic ecosystem. Biomass, micro-nutrients, and predator-prey interactions will be impacted positively by projects that restore balance to habitat.

Vermont: Over the past 12 years, the Green Mountain and White Mountain National Forests and their partners have completed 75 stream habitat projects on about 42 km of stream. Project objectives have included:

- placing substantial quantities of large woody debris to upland (first and third order) streams) to create pools, increase, trap, and store spawning gravel, stabilize stream banks and bed load transport, and provide instream cover for salmon (Figure 7);
- increasing habitat diversity and complexity (i.e. improve pool/riffle ratios, lateral habitats such as backwater and stream margin habitat, etc.);
- stabilizing eroding stream banks;
- establishing riparian buffers if they currently do not exist or widening them where needed;
- working toward a stable stream condition where the channel's plan, form, dimension, and profile meet geomorphic and hydrologic conditions. This will also provide more stable habitat conditions for salmon and other species.

Figure 7: The Green Mountain and White Mountain National Forests and their partners in Vermont have completed 75 habitat enhancement projects on about 42 km of stream. Many projects involve the placement of substantial quantities of large woody debris (LWD) in

upland streams to create pools, trap and store spawning gravel, stabilize stream banks, and provide in-stream cover for salmon. (Photo: Steve Roy, Green Mountain NF)

Four riparian and stream habitat restoration projects were implemented in the White River Watershed, a tributary to the Connecticut River, in Vermont in 2001. A variety of habitat enhancement and channel structure techniques were utilized to address river instability, and restore channel pattern, dimension and profile of selected river reaches. These stream conservation projects were completed by a coalition of Federal and State agencies, and several nongovernmental organizations. Two additional stream habitat restoration projects were implemented in 2001 by the US Forest Service in upper Connecticut River tributaries to the West River in Vermont. The projects utilized large trees, some with attached roots, to create deeper, lower velocity habitats in conjunction with protective cover for salmonids.

New Hampshire: The recent development of a dedicated Fish Habitat Program by the New Hampshire Fish and Game Department is expected to generate several hundred thousand dollars annually which, when matched by grant dollars, is anticipated to fund a variety of projects in the coming years that will include benefits to Atlantic salmon.

Maine: A channel restoration project on a tributary to the Penobscot River (Kenduskeag Stream) was initiated in 2001. Habitat degradation had been caused by livestock access to an upper section of the stream, resulting in sedimentation and severe channel instability. A long-term agreement has been reached with the farmer to keep cattle out of the stream. The project installed fencing in 2001, and plans in 2002 include reshaping and seeding the eroding gully and restoring riparian habitat. The channel restoration will use natural design techniques, including reference reach information collected in stable reaches.

In cooperation with state and local government agencies, many nongovernmental organizations implemented riparian plantings and nonpoint source remediation projects on Maine Atlantic salmon rivers during 2001 (Figure 8). Examples include:

- the Sheepscot Valley Conservation Association completed a remediation project on the West Branch of the Sheepscot River by planting 500 trees in the riparian zone;
- the Sheepscot River Watershed Council completed the following eight remediation projects in the Sheepscot River watershed: four nonpoint pollution sites, removal of an overboard discharge, drainage repair in Alna, tree planting in Weeks Mills, and road repair in China;
- in eastern Maine, watershed councils participated in six riparian planting projects, covering four salmon watersheds. Thousands of trees were planted in projects designed to provide windbreaks, act as riparian spray buffer in agricultural areas, and to vegetate the riparian zone. In addition, a large paper company restored more than 70 nonpoint pollution sites (primarily related to roads or use of recreational vehicles) that had been contributing sediment to the Machias and Narraguagus Rivers;
- Maine Watershed Councils, with assistance from State agencies and Project SHARE, also helped to eliminate vehicle fords throughout Atlantic salmon rearing habitat and several small tributary streams, constructed a 34-meter bridge for use by all-terrain vehicles (ATVs), installed culverts, bridges, water diversion measures, and stabilized general erosion in the first kilometer of an ATV trail along the West Branch Narraguagus River;
- some of the projects listed above were financed with a one-time, State of Maine appropriation (in 1999) of $750,000 for additional habitat protection on the rivers

listed under the Federal ESA. Additional funding that has contributed to these types of projects has also been provided by the National Fish and Wildlife Foundation.

Figure 8: Many US salmon habitat restoration programs involve river channel restoration projects, erosion/sedimentation prevention, riparian vegetation planting, and provisions for livestock and all-terrain vehicles to cross rivers and streams. (Photos: Project SHARE and Dan Kircheis, NMFS)

In central Maine, the Ducktrap Coalition is also active in improving salmon habitat by rehabilitating damaged land that is affecting the habitat in the Ducktrap River Drainage. For example, the Coalition has regraded and renegotiated three gravel pits that were releasing suspended silt, clay, sand, and gravel into the river and its salmon spawning and nursery areas. In addition, in the summer of 2002, habitat rehabilitation will proceed with the restoration of about 1,457 m of a small stream that is directly releasing suspended silt, etc. into the most productive salmon spawning habitat in the river.

Water Quality Monitoring

Water temperatures in US salmon rivers are routinely monitored with automated temperature loggers; these data often also include over-winter temperatures at many sites. In Maine alone, more than 50 sites on 13 river systems were monitored in 2001.

Water Quality in Maine ESA Listed Rivers: In 1999 three groups (the Maine Department of Environmental Protection, watershed councils located on Atlantic salmon rivers, and the University of Maine's George Mitchell Center for Environmental and Watershed Research)

began a water quality monitoring program to examine environmental trends and to evaluate environmental stresses that may be affecting salmon populations. Two types of water samples are collected for analysis: 1) baseflow conditions are monitored when river conditions are dominated by groundwater (i.e. no major rain event within the previous seven days); and 2) stormwater is monitored in the salmon rivers during and after a rain event. In order to investigate the water chemistry variability during a storm, stormwater samples are sometimes taken before the flood peak, near the peak, and again as the flood waters recede. Water quality parameters that are monitored include pH, alkalinity, temperature, conductivity, major nutrients, turbidity, and total suspended solids. Because of its association with acid rain, total dissolved aluminum is also measured in baseflow samples. In the 2001 field season, total dissolved aluminum was measured in both baseflow and stormwater samples. In addition, if the pH was less than 6.0, total dissolved aluminum was separated into organic and "exchangeable" forms.

Project SHARE

Formed in mid-1994, Project SHARE (**S**almon **H**abitat **A**nd **R**iver **E**nhancement) is a voluntary association of landowners, businesses, government officials, researchers, educators, and conservation organizations committed to conserving and enhancing Atlantic salmon habitat and populations in the Downeast region[2] of Maine (Figure 9). This organization is not involved in land acquisition or advocacy. Project SHARE participates in a variety of projects aimed at understanding and improving Atlantic salmon habitat and restoration. Examples include: water temperature monitoring; salmon habitat mapping; and establishing training sessions for foresters, landowners, and others on Atlantic salmon biology and habitat requirements. Other projects include assistance with installing weirs to exclude aquaculture escapees, locating and removing river blockages caused by log and debris buildup, assisting with construction and operation of the Pleasant River Hatchery and Education Center, repairing fish ladders and water control structures (e.g. gate at the Meddybemps Dam on the Dennys River), carrying out riparian planting and erosion control projects, and instream channel restoration projects, etc.

Education Programs

The primary purpose of many educational programs in the US is to ensure that targeted groups and the general public are informed and, ideally, supportive of programs to protect and restore Atlantic salmon habitat. Additionally, these programs often provide meaningful opportunities for these same groups to become actively involved in and to contribute to salmon habitat conservation efforts on US salmon rivers. Recent examples of education and outreach programs in the Northeastern US are presented below.

Maine: A workshop entitled "Protecting and Restoring Salmon Habitat: Lessons Learned Around the World" was held in October 2001, at the University of Maine, Orono, Maine. Participants from Ireland, Scotland, Canada, Washington, Oregon, California, and Maine described the use of watershed assessments to establish criteria and prioritization schemes for determining which salmon habitats should be protected and restored and why. Workshop presenters described how citizens, communities, landowners, government, and scientists have collaborated to protect and restore habitat and to bring back the salmon.

[2] The Downeast region of Maine is a loosely-defined region in the Eastern portion of the state. The area includes five of the eight salmon rivers listed as Endangered under the US Endangered Species Act.

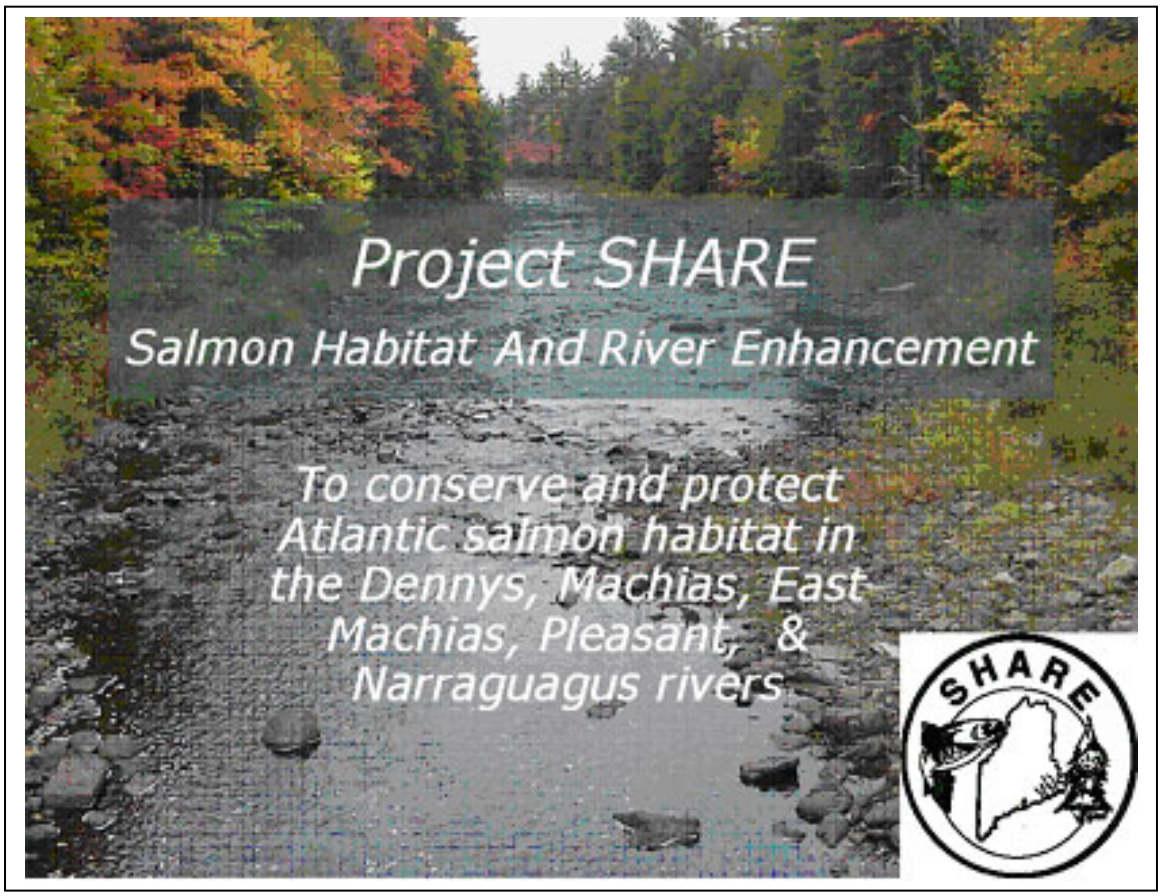

*Figure 9: Formed in mid-1994, Project SHARE (**S**almon **H**abitat **A**nd **R**iver **E**nhancement) is a voluntary association of landowners, businesses, government officials, researchers, educators, and conservation organizations committed to conserving and enhancing Atlantic salmon habitat and populations in eastern Maine. (Photo: Project SHARE)*

Project SHARE sponsored the following workshops in eastern Maine: 1) Nonpoint Source (NPS) Pollution Prioritization Workshop, December 10, 2001; 2) NPS Lands Protection Options Forum, June 21, 2001; 3) Lands Protection Options Roundtable, May 31, 2001.

New Hampshire Dam Removal Outreach Project: An educational outreach program is being used in New Hampshire to: promote dam removal as a selective process and not as an environmental movement to remove all dams; instill public appreciation for rivers and the restoration of ecological values and functions; link dam removal and river restoration to community and riverfront revitalization; and emphasize the creation of new public recreational opportunities.

Also in New Hampshire, a partnership of State, Federal, and private entities creates and implements broad-based educational outreach programs. These programs are based at the Amoskeag Fishways Learning and Visitor Center in Manchester, NH. With the Merrimack River as a general focus, the partnership offers educational outreach programming to school groups, teachers, the general public, and other targeted audiences. The partnership was formed to create, manage, and oversee educational activities at the Amoskeag Fishways. The four-way collaboration among partners was formed in 1995 to increase visitation to the

Amoskeag Fishways by creating new and improved educational programs, by expanding year-round hours of operation, and by creating an innovative, hands-on exhibit hall. Additional goals included strengthening relationships among organizations involved in migratory fish restoration and conservation activities in New Hampshire and broadening the educational focus of the visitor center to encompass more than just the fish passage facility.

Data Management

Highly accurate computerized habitat databases are now available for most US salmon rivers. The databases are maintained in order to document the quantity and quality of Atlantic salmon habitat as well as areas of habitat degradation. For example, 170 sites have been identified on the Sheepscot River in Maine. These databases allow stakeholders to prioritize needs based upon habitat location and quality as well as upon the severity of the identified problem. As an example, surveys to locate the location of beaver dams and debris jams are conducted on many salmon rivers on an annual basis. With the help of volunteers, these obstructions can be breached in order to provide an adequate migration window for salmon.

Salmon Habitat Research

US Forest Service, Vermont: Research on salmon habitat requirements and habitat restoration is generally constrained by the limited temporal and spatial scales at which most studies are conducted. The US Forest Service Northeastern Research Station, in collaboration with academic and management partners, is conducting and supporting research designed to provide a larger perspective on salmon habitat issues. One major focus of interest is the long-term effect of current and historic land use change on habitat in salmon restoration streams. This issue is being addressed by several research initiatives including:

- modeling the dynamics of loading and retention of large woody debris (LWD), a major determinant of physical habitat structure, to New England streams;
- testing the effects of LWD additions on Atlantic salmon habitat and performance, along with effects on potential prey, predators, and competitors;
- documenting and comparing channel unit structure across salmonid streams in the Green and White Mountain National Forests;
- assessing the potential role of anadromous fish populations on nutrient budgets and stream chemistry.

The second major focus is on the development and application of methodologies designed to assess the spatial scale of habitat use in juvenile Atlantic salmon. It has been possible to determine the characteristic scale of dispersal in age 0+ salmon, using stable isotope signatures and genetic marks. In addition, using micro-milling techniques to isolate isotopic signatures in the otoliths of returning adults, evidence has been found of significant differences in large-scale habitat use patterns among individuals. Overall, this work indicates that expanding the temporal and spatial framework of Atlantic salmon habitat research is likely to yield new and useful insights into management and conservation.

Maine: The development of regional hydraulic geometry curves was initiated in 2001 in order to develop stream restoration assessment tools and to implement natural channel restoration projects in Maine. Regional curves will be developed in order to relate the dimensions (width, depth, cross-sectional area, velocity) of streams at bankfull discharge to drainage area. While the general physical characteristics of productive juvenile Atlantic

salmon habitat are understood, less information is available on the processes that maintain stable channels in Maine salmon rivers. These geomorphologic processes, including sediment transport and deposition, are critical to maintaining stable and productive fish habitat. Without regional curves, degraded stream channels are less likely to be restored to mimic natural salmon habitat. At present this information is not available for any Maine rivers.

Aquaculture

In recent years significant progress has been made in protecting US Atlantic salmon habitat from potential impacts from aquaculture operations. The US reported upon these activities in detail at the Eighteenth Annual Meeting of NASCO during the "Special Liaison Meeting to Review Measures to Minimize Impacts of Aquaculture on Wild Stocks;" consequently, only one aspect of the program will be reviewed here.

The permitting process for salmon farming operations in Maine[3] is complex, since Federal, State, and local government authorities regulate the US Atlantic salmon farming industry extensively (Figure 10). A Federal permit is required by the US Army Corps of Engineers (ACOE) for structures in navigable waters (Section 10 of the Rivers and Harbors Act of 1899), by the US Environmental Protection Agency (EPA) for discharges into coastal waters (Section 404 of the Clean Water Act under the National Pollutant Discharge Elimination System), and by the US Coast Guard for navigational markings. A Federal importation permit is also required if live fish or eggs are imported from outside of the US.

In Maine, State permits are required for aquatic lands leases and water quality certification. An initial environmental assessment prior to issuance of a lease for cage sites and extensive annual monitoring at hatcheries and cage sites are required. The State of Maine has a very stringent finfish aquaculture monitoring program (FAMP) that requires annual spring and fall diver survey reports and videos, water quality monitoring data at, and in the vicinity around, cage sites, and biennial benthic survey reports.

Technical and Funding Assistance

Many habitat protection and restoration projects in the US include providing technical assistance to local conservation groups and funding for land acquisition and protection. Habitat maps and GIS coverages are shared with land protection organizations in order to help focus their activities on high value Atlantic salmon habitat. Potential sources of funding for salmon habitat restoration (and fish passage) projects in the US include:

1. US Fish & Wildlife Service, National Fish and Wildlife Foundation (NFWF)
2. Natural Resources Conservation Service (NRCS), Wildlife Habitat Improvement Program (WHIP)
3. US Federal Government Clean Water Act, "Section 319" grants
4. NOAA, National Marine Fisheries Service, "Community Partnership Grants"
5. US Fish & Wildlife Service, Ecosystem Team Challenge Grants, etc.
6. Grants From Various New England State Agencies
7. Private Foundations
8. Contributions from Partner Organizations (Business & Industry)

[3] US Atlantic salmon farming occurs only in the states of Maine (east coast) and Washington (west coast).

9. Supplemental Environmental Projects (US Environmental Protection Agency, etc.)

Figure 10: The US Atlantic salmon farming industry is extensively regulated by Federal, State, and local government authorities. (Photo: Atlantic Salmon Unlimited).

Progress Toward Preparation of US Comprehensive Salmon Habitat Protection and Restoration Plan

As this summary illustrates, there is a great variety and diversity of programs within the US for the preservation, enhancement, and restoration of Atlantic salmon habitat in New England. These programs, both voluntary and mandatory, are resulting in significant improvements to Atlantic salmon habitat throughout the New England region. While efforts are made to coordinate habitat conservation initiatives, they are not currently integrated into a comprehensive national plan. With so many entities involved (numerous Federal agencies, six states encompassing dozens of individual agencies, local conservation entities such as watershed councils, NGOs, business and industry, et al.) and, in light of the complexity of the various management mechanisms, it will take time and effort to assimilate all US efforts into a single plan. The US will continue and intensify its efforts to protect and restore Atlantic salmon habitat in light of our commitment to the NASCO Plan of Action for the Application of the Precautionary Approach to the Protection and Restoration of Atlantic Salmon Habitat.

Acknowledgements

The authors gratefully acknowledge the assistance of the following people for contributing information, photographs, and editorial comments used in the written and oral presentations of this report:

- M. Baum, Atlantic Salmon Unlimited, Hermon, Maine
- Steve Brooke, Project Coordinator, Kennebec River Coalition, Augusta, Maine
- Scott Dickerson, Executive Director, Coastal Mountains Land Trust, Camden, Maine

- Tarn Dickerson, Conservation Lands Manager, Coastal Mountains Land Trust, Camden, Maine
- Norm Dube, Fishery Biologist, Atlantic Salmon Commission, Bangor, Maine
- Steve Gephard, Supervising Fisheries Biologist, Department of Environmental Protection, Inland Fisheries Division, Old Lyme, Connecticut
- Gabe Gries, Fisheries Biologist, New Hampshire Fish and Game Department, Inland Fisheries Division, Keene, New Hampshire
- Doug Grout, Biologist, NH Fish and Game Department, Marine Fisheries Division, Durham, New Hampshire
- Dan Kircheis, Biologist, NOAA/National Marine Fisheries Service, Orono, Maine
- John Kocik, Fisheries Biologist, National Marine Fisheries Service, Orono, Maine
- Steve Koenig, Executive Director, Project SHARE, Cherryfield, Maine
- Matt Leblanc, Biologist, Florida Power and Light Company, Saco, Maine
- Christine Lipsky, Senior Biologist, Division of Fish and Wildlife, West Kingston, Rhode Island
- James McMenemy, District Fisheries Biologist, Department of Fish and Wildlife, Springfield, Vermont
- Steve Roy, Biologist, US Forest service, Green Mountain & Finger Lakes NF, Rutland, Vermont
- Torrey Sheafe, Technical Resources Coordinator, Project SHARE, Cherryfield, Maine
- Ken Sprankle, Fishery Biologist, US Fish & Wildlife Service, Nashua, New Hampshire
- Ben Rizzo, Hydraulic Engineer, US Fish & Wildlife Service, Newton Corner, Massachusetts
- Joan Trial, Senior Biologist, Atlantic Salmon Commission, Bangor, Maine
- Bob Wengrzynek, Biologist, US Department of Agriculture, Natural Resources Conservation Service, Bangor, Maine
- Jed Wright, Biologist, US Fish & Wildlife Service, Falmouth, Maine

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Summary of the Discussion Period

David Meerburg, DFO, Ottawa, Canada

During the discussion period, the question was posed as to where we are in terms of relative amounts of Atlantic salmon habitat lost in the various countries. Canada replied that about 15% of salmon habitat has been lost in the last 100 years although it is difficult to precisely estimate the loss. The USA indicated that habitat is now being gained as the policy of "no net loss" has become standard procedure. Russia indicated that much habitat had been lost historically due to hydroelectric development but this has ceased and no further habitat is being lost. The European Union responded that the situation varied in each member state. For example, in the UK, habitat was being recovered in Scotland and Northern Ireland and some new habitat gains were being achieved in England and Wales but problems still continued to exist in "rural" rivers; overall in England and Wales it was felt that a net gain was being achieved. In Ireland, habitat loss has stabilized and some gains are now being made. In Norway, in recent years, there has been a net habitat gain as a result of both liming of acidified areas and decreases in the amount of acid rain; regulations concerning hydroelectric developments have become much more stringent, especially for license renewals of older sites. In Iceland, considerable gains in accessibility to salmon habitat have resulted from the extensive use of fish ladders around natural and man-made obstructions. In the Galicia region of northern Spain, improvements in the amount of habitat available have been achieved, mostly due to fish pass improvement; however, the number of salmon rivers has declined from 18 to 7. In Finland, there has been little loss of Atlantic salmon habitat and net gains are now being achieved.

The question was raised as to what proportion of effort should be focussed on the marine versus freshwater environments. There was a response that there has been a generalized clean-up of coastal marine habitats in most countries. The view was expressed that NASCO should only focus on the riverine habitat, although it was recognised that increased marine mortality is an important factor that is poorly understood. NASCO's new International Cooperative Salmon Research Board would be coordinating a programme of marine research designed to improve understanding of this phase of the salmon's life-cycle. Concerns were expressed about the current variability in climate, with more frequent droughts and then massive floods. It was noted that, in Scotland, as a result of high flood events, salmon redds have been washed out. The general conclusion was that extreme events are likely to become more frequent as a result of climate change, and that these extremes are not generally of benefit to salmon. Reference was made to Norway's intention to introduce special protection for some of their rivers. The question was raised as to whether the other rivers were being "written off". Norway responded that on the rivers under "special protection", many new regulations were being introduced; on the remaining rivers, rules concerning development will continue as before and with no relaxation of protection for salmon.

In closing the Special Session, the President thanked the speakers for their contributions and all participants for their attendance. He noted that the Precautionary Approach to habitat management is more than just a paper exercise since NASCO will now have regular reports from the Parties, which will enable progress in protecting and restoring salmon habitat to be assessed. He noted that progress is being made in the development of habitat inventories, in implementing "no net loss" policies and in making gains in habitat.