NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION
ORGANISATION POUR LA CONSERVATION DU SAUMON DE L'ATLANTIQUE NORD

REPORT OF THE SIXTH ANNUAL MEETING OF THE COUNCIL

13-16 JUNE 1989

EDINBURGH, UK

PRESIDENT:	MR ALLEN E PETERSON (USA)
VICE PRESIDENT:	MR SVEIN AAGE MEHLI (NORWAY)
SECRETARY:	DR MALCOLM WINDSOR

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REPORT OF THE SIXTH ANNUAL MEETING OF THE COUNCIL OF THE NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION 13-16 JUNE 1989, SHERATON HOTEL, EDINBURGH, UK

1. OPENING SESSION

1.1 The President, Mr Allen E Peterson, opened the meeting and welcomed delegates to the Sixth Annual Meeting of the Council (Annex 1).

1.2 A list of participants is given in Annex 2.

1.3 The representative of Canada made an opening statement, (Annex 3).

1.4 The representative of Denmark (in respect of the Faroe Islands and Greenland) made an opening statement, (Annex 4).

1.5 The representative of the European Economic Community made an opening statement, (Annex 5).

1.6 The representative of Finland made an opening statement, (Annex 6).

1.7 The representative of Iceland made an opening statement, (Annex 7).

1.8 The representative of Norway made an opening statement, (Annex 8).

1.9 The representative of Sweden made an opening statement, (Annex 9).

1.10 The representative of the Union of Soviet Socialist Republics made an opening statement, (Annex 10).

1.11 The representative of the United States of America made an opening statement, (Annex 11).

1.12 The President expressed appreciation to the members for their statements and closed the Opening Session.

2. ADOPTION OF THE AGENDA

2.1 The Council adopted its agenda, CNL(89)34 (Annex 12).

3. SECRETARY'S REPORT

3.1 The Secretary reported to the Council on the status of ratifications of and accessions to the Convention and membership of the regional Commissions. The Council agreed that these items now be omitted from future agendas unless there were changes or a Party requested that the item be included.

3.2 The Secretary also reported to the Council on applications for non-government observer status to NASCO. Two new applications had been received, from the Atlantic Salmon Federation based in the USA and from the Institute of Fisheries Management based in the UK. Both Organizations had been granted observer status and had accepted the conditions laid down.

3.3 The Council agreed to retain the existing criteria for the admission of non-government observers and supported the actions taken by the Secretary, in consultation with the President, to limit this status to those organizations with a direct interest in the conservation and management of wild stocks.

3.4 However, the Council stressed the importance of NASCO maintaining close contact with a range of other bodies with salmon interests. The Council asked the Secretary to produce a discussion paper for its next meeting which would address this matter.

3.5 The Secretary reported on the Audited Accounts for 1988, the receipt of contributions for 1989, the Headquarters property at 11 Rutland Square and on the Headquarters Agreement and external relations.

4. REPORT OF THE FINANCE AND ADMINISTRATION COMMITTEE

4.1 The Vice-Chairman of the Finance and Administration Committee presented a report to the Council, CNL(89)8.

4.2 In addition to decisions taken relating to other agenda items the Council, upon the recommendation of the Committee, took the following decisions:

(a) to appoint Coopers and Lybrand of Edinburgh as auditors;

(b) to modify Financial Rule 6.3 by deleting each reference to 10,000 pounds sterling and inserting 20,000 pounds sterling, CNL(89)40) (Annex 13.

4.3 Upon the recommendation of the Finance and Administration Committee the Council:

(a) accepted the audited 1988 annual financial statement, CNL(89)6;

(b) adopted a budget for 1990 and a forecast budget for 1991, CNL(89)37, (Annex 14).

4.4 The Council thanked the Vice-Chairman of the Finance and Administration Committee, Mr Arni Isaksson, for his work and that of the Committee and expressed appreciation to the Secretary for the quality and early distribution of the papers.

5. SCIENTIFIC RESEARCH

Report to NASCO from the ACFM of ICES

5.1 The representative of ICES presented the report of the ICES Advisory Committee on Fisheries Management (ACFM) to the Council, CNL(89)10, (Annex 15).

Request to ICES for Scientific Advice for 1990

5.2 The Council adopted a decision to request scientific advice from ICES, CNL(89)35, (Annex 16).

5.3 The Council considered the general nature of the reports of the Working Group and the ACFM of ICES and how they were used in the deliberations of the Organization. The Council asked the Secretary to discuss this question with the General Secretary of ICES and to how the ICES Reports might be most effectively prepared by ICES for use by NASCO.

6. IMPLEMENTATION OF THE CONVENTION

Returns under Articles 14 and 15 of the Convention

6.1 The Secretary presented a report on the returns made under Articles 14 and 15 of the Convention, CNL(89)11, (Annex 17).

Return of Catch Statistics

6.2 The Secretary introduced a statistical paper presenting the official catch returns by the Parties for 1988 and historical data by Party, CNL(89)12, (Annex 18).

7. ANALYSIS OF CATCH STATISTICS

7.1 The Secretary presented an analysis of catch statistics which dealt with the methods of collection of catch statistics and the forms of publication of those data, CNL(89)14, (Annex 19).

7.2 The Council requested the Secretary to prepare a discussion paper reviewing the means to achieve improved comparability of the statistics. The Secretary was directed to review the range of problems which could lead to unreported or under-reported catches.

7.3 The Secretary indicated that he intended to consult the General Secretary of ICES during the preparation of these papers.

8. LAWS, REGULATIONS AND PROGRAMMES

8.1 The Secretary presented a progress report on the Laws, Regulations and Programmes database and outlined how it could be used. The database represented a unique record of salmon-related legislation over the whole of the North Atlantic and would be updated annually by the Article 14 and 15 returns. The Secretary advised that the data for each Party had been returned to that Party for checking and that when this step had been completed and all returns received a further review could be undertaken. The President requested those Parties that had not already done so to complete their returns as soon as possible.

8.2 The Council agreed that the information would be available to all Parties unless a Party instructed the Secretary otherwise.

9. SALMON TAGGING

Repository of tag release data

9.1 In accordance with the decision of the Council in 1988, the Secretary presented a summary of tag release data, CNL(89)16, (Annex 20), from the information submitted by ICES.

NASCO Tag Return Incentive Scheme

9.2 The Secretary reviewed the Tag Return Incentive Scheme that the Council had established for a trial period at its Fifth Annual Meeting and draft publicity for the scheme. The Council agreed the Rules of the Scheme, CNL(89)17, (Annex 21), and the wording for the publicity, CNL(89)41, (Annex 22). The Secretary will request official information from the Parties on their intent to participate in the scheme.

9.3 The representative of Canada expressed concern about implementing the scheme during the 1989 fishing season and explained that at the end of the trial period the Canadian authorities would have difficulty in funding the scheme in the light of the reservations expressed by the Working Group on North Atlantic Salmon.

9.4 The representative of the EEC also expressed concern about the scheme being initiated during the fishing season and asked that the publicity material be modified to make it clear that the scheme applies only to external tags.

SPECIAL SESSION: IMPACTS OF AQUACULTURE ON WILD STOCKS

In the Special Session a number of presentations were made by the Parties, by the North American Commission and by the Secretariat. A wide range of views and philosophies were expressed about an appropriate approach to dealing with the potential impact of increasing escapes of fish of farmed origin to the wild. These ranged from the view that impacts could not be prevented and that NASCO and the Parties should adjust their action to the situation, to the view that such impacts could be a serious threat to wild stocks and all possible steps should be taken to minimise them. In the absence of firm evidence regarding the extent and nature of impacts the Council agreed that it was desirable to take a cautious approach and came to a number of conclusions which are outlined below.

10. REPORT FROM THE JOINT NASCO/ICES MEETING

10.1 The Council considered a report from the joint NASCO/ICES meeting in Dublin on the genetic threats to wild salmon, CNL(89)19, (Annex 23). Council endorsed the need to identify genetic markers so that individual races of salmon could be distinguished and research on genetic and other impacts could proceed. As this work is of international significance the Council asked the Secretary to follow up the results of the Dublin meeting by preparing a report on this subject which includes a listing of the major research centres where the work was carried out.

10.2 The Council considered a number of other basic questions that might be answered by scientific research. These included assessment of natural straying rates, the migrations of escaped fish, the extent to which fish of farmed origin interbreed with wild fish and the nature of any ecological interactions between wild fish and fish of farmed origin. In addition the need to develop methods of identifying farmed fish in the wild was recognized. The Council asked the Parties to encourage the research on these questions.

11. ENVIRONMENTAL THREATS TO WILD STOCKS FROM AQUACULTURE

11.1 The Council considered a paper from ICES on the environmental threats to wild stocks posed by salmon aquaculture, CNL(89)20. The Council asked the Secretary to produce a review of the available information on the impact of salmon aquaculture on salmon habitats.

12. GENE BANKS FOR THREATENED STOCKS

12.1 The Secretary presented a paper, CNL(89)21, (Annex 24), on the mechanisms costs and benefits of gene banks for threatened stocks. Loss of Atlantic salmon production had occurred in a number of countries, in some cases leading to extinction of stocks.

12.2 In view of the serious nature of the potential threats the Council asked the Secretary to prepare, in consultation with the Parties, a list of all salmon rivers flowing into the NASCO Convention area where stocks had been lost or are threatened with loss.

12.3 The Council also asked the Secretary to consider possible draft guidelines for the establishment and operation of gene banks where Parties decide to establish them.

13. REVIEW OF LEGISLATION RELATING TO INTRODUCTIONS AND TRANSFERS

13.1 The Council reviewed the legislation relating to introductions and transfers, CNL(89)22, which was contained in the new database established by the Organization on Laws, Regulations and Programmes. This review showed that there is a considerable legislative framework for controlling the importation and movement of salmon and salmon eggs. But the marked increase in accidental introductions of fish farmed origin created a situation where this legislation would need to be kept under review by the Parties.

14. POSSIBLE CODES OF PRACTICE TO MINIMIZE THREATS TO WILD STOCKS

14.1 The Council considered the possibility of developing a series of recommendations or an advisory code of practice with the aim of reducing genetic, disease, and other damaging interactions between farmed and wild stocks. The broad areas considered included stocking practices and broodstock management, separation of wild and farmed fish, development of improved aquaculture techniques, avoidance of adverse effects from introductions and transfers and reduction of environmental impacts, CNL(89)23, (Annex 25).

14.2 The Council agreed that the Secretary should prepare draft guidelines in consultation with the Parties and taking account of the Codes of Practice, developed by ICES and EIFAC, to be submitted to the Council in 1990.

14.3 The Council further agreed on the desirability of improved liaison with the aquaculture industry and that current Codes of Practice, either voluntary or statutory, in salmon farming countries should be obtained and made available to the contracting Parties.

15. REPORTS FROM THE REGIONAL COMMISSIONS

15.1 The Chairmen of the three regional Commissions reported to the Council on their activities.

16. REPORTS ON THE ACTIVITIES OF THE ORGANIZATION

16.1 The Council adopted a report on the Activities of the Organization, CNL(89)24, for publication, subject to minor amendments to be made by the Secretary.

16.2 The Council adopted a report to the Parties, CNL(89)25, in accordance with Article 5, paragraph 6 of the Convention.

17. OTHER BUSINESS

18. DATE AND PLACE OF NEXT MEETING

18.1 The representative from Finland invited the Council and Commissions to hold the Seventh Annual Meeting in Helsinki from 12-15 June 1990. The Council expressed its appreciation to the Government of Finland and accepted this invitation.

18.2 The Council agreed that its Eighth Annual Meeting be held during the period from 11-14 June 1991 in Edinburgh.

19. DRAFT REPORT OF THE MEETING

19.1 The Council considered a draft report of the meeting, CNL(89)30.

20. PRESS RELEASE

20.1 The Council adopted a press release, CNL(89)39, (Annex 26).

JUNE 1989
EDINBURGH

ANNEX 1

OPENING STATEMENT MADE BY THE PRESIDENT

Distinguished Representatives and Commissioners, Delegates, Observers, Ladies and Gentlemen, it is both an honor and a pleasure to welcome you here to Edinburgh for the Sixth Annual Meeting of the Council and the Commissions of the North Atlantic Salmon Conservation Organisation.

This Council gave me the honor, last year in Reykjavik, of electing me to be its President. It is an honor that I very much appreciate and I will do everything in my power to further progress the important international collaborative work that we can achieve through NASCO.

First I would re-iterate that we have come a long way in our short life. Those who were here at the beginning will remember the great difficulties that we faced in reaching any agreement at all on regulatory measures and the bitter disappointment that we all felt when the gulf between us, and the unanimity rule, meant that we went home without agreement. But we are now in a situation where each Commission of NASCO has regulatory measures in place and where we can justly claim that we have produced longer term stability for salmon management in the North Atlantic.

Nevertheless, we should not ignore the fact that the regulatory measures that have been adopted have been based more on political compromise than scientific fishery management requirements. There also continues to be discontent over the allocation of catches between producing nations and host nations. But perhaps the most difficult issues we will have to deal with in the future involves the relationship between wild and domestic stocks of salmon. It is indeed a paradox that the total world-wide production of Atlantic salmon is at its highest level in history, yet some stocks of salmon are being threatened with extinction. The challenge for us at this Sixth Annual Meeting is to examine and explore those issues with diligence and open minds.

We must consider carefully the scientific advice in response to our questions to ICES. We must consider the accuracy and comparability of catch statistics so that all the nations represented here will have more confidence in these data. We must continue to make progress with our exchange of laws, regulations, and programs. We can all learn from each other on Salmon legislation. We must implement our agreement last year to develop an international reward system to encourage tag returns and we must give it the necessary publicity.

Finally I should like to say that the atmosphere of cooperation and collaboration which we have all developed in this Organisation is one of its great assets. We have all made good friends here. I shall do my best to continue to promote this remarkably good climate of international cooperation. This has been created by you, the Representatives, the Delegates, the Advisors, the Observers, and the Secretariat. I welcome you all here and may we continue to make progress.

JUNE 1989
EDINBURGH

ANNEX 2

SIXTH ANNUAL MEETING OF THE COUNCIL
13-16 JUNE 1989, SHERATON HOTEL, EDINBURGH, UK

CNL(89)29

LIST OF PARTICIPANTS

* Denotes Head of Delegation

CANADA

*MR WAYNE SHINNERS	Representative Department of Fisheries and Oceans, Ottawa, Ontario
DR GABY WARD	Representative Champlain College, Quebec
DR WILFRED CARTER	Representative Atlantic Salmon Federation, St Andrews, New Brunswick
MR DAVID MEERBURG	Department of Fisheries and Oceans, Ottawa, Ontario
MS EDITH DUSSAULT	Department of Fisheries and Oceans, Ottawa, Ontario
MS LOUISE COTE	Department of Fisheries and Oceans, Ottawa, Ontario
MR REX PORTER	Department of Fisheries and Oceans, St John's, Newfoundland
MR GLENN BLACKWOOD	Department of Fisheries, St John's, Newfoundland
MR DAVID MACLEAN	Department of Fisheries, Halifax, Nova Scotia
MR MALCOLM REDMOND	Department of Natural Resources & Energy, Fredericton, New Brunswick

DENMARK (IN RESPECT OF THE FAROE ISLANDS AND GREENLAND)

*MR KJARTAN HOYDAL	Representative Faroese Home Government, Torshavn, Faroe Islands
MR SVEN ADSERSEN	Representative Ministry of Foreign Affairs, Copenhagen
MRS KIRSTEN TROLLE	Representative Greenland Home Rule Office, Copenhagen

MR HJALTI I JAKUPSSTOVU	Fishing Laboratories, Faroe Islands
MR SOFUS POULSEN	Faroese Commercial Attache, Aberdeen
MR JENS MOELLER-JENSEN	Greenland Fisheries Research Institute, Copenhagen
MR ANFINN KALLSBERG	Ministry of Fisheries, Torshavn, Faroe Islands
MR MANNE NAESS	Ministry of Fisheries, Torshavn, Faroe Islands

EEC

*MR HENRIK SCHMIEGELOW	Representative Fisheries Directorate-General, EEC Commission, Brussels
MR JOHN SPENCER	Representative Fisheries Directorate-General, EEC Commission, Brussels
MR ANDREW THOMSON	Directorate-General for External Relations, EEC Commission, Brussels
MR JOAN CALVERA VEHI	Embassy of Spain, London
MR PAULINO PEREIRA	Council of the European Communities, Brussels
MR NICK BROWN	Ministry of Agriculture, Fisheries and Food, London
MR BOB WILLIAMSON	Department of Agriculture and Fisheries for Scotland, Edinburgh
MR TED POTTER	Ministry of Agriculture, Fisheries and Food, Lowestoft
MS EILEEN TWOMEY	Department of the Marine, Dublin, Ireland
MR RAPHAEL KELLY	Department of the Marine, Dublin, Ireland
DR DICK SHELTON	Department of Agriculture and Fisheries for Scotland, Pitlochry
DR ALAN YOUNGSON	Department of Agriculture and Fisheries for Scotland, Marine Laboratory, Aberdeen
MR CHARLES R MCCALL	Ministry of Agriculture, Fisheries and Food, London
MR THOMAS J KELLY	Department of Agriculture and Fisheries for Scotland, Edinburgh

MR DAVID DUNKLEY	Department of Agriculture and Fisheries for Scotland, Montrose
MR WILLIAM MALCOLM	Department of Agriculture and Fisheries for Scotland, Edinburgh
DR ANTHONY BURNE	Ministry of Agriculture, Fisheries and Food, London
FINLAND	
*MR PEKKA NISKANEN	Representative Ministry of Agriculture and Forestry, Helsinki
MR EERO NIEMELA	Representative Finnish Game and Fisheries Institute, Helsinki
ICELAND	
*MR ARNI ISAKSSON	Representative Institute of Freshwater Fisheries, Reykjavik
NORWAY	
*MR SVEIN MEHLI	Representative Directorate for Nature Management, Trondheim
MR OYVIND VASSHAUG	Representative Hordaland County Administration, Bergen
MRS ANNE CARINE TANUM	Representative Ministry of the Environment, Oslo
MR LARS HANSEN	Norwegian Institute for Nature Research, Trondheim
MR GEORG RIEBER-MOHN	Regional Board of Salmon Fishery, Oslo
MR STEINAR HERMANSEN	Ministry of the Environment, Oslo
SWEDEN	
*MR STEFAN DE MARE	Representative Ministry of Agriculture, Stockholm
DR INGEMAR OLSSON	Representative National Board of Fisheries, Goteborg
MR KARL ERIK BERNTSSON	National Board of Fisheries, Goteborg

USA

*MR ALLEN E PETERSON	Representative National Marine Fisheries Service, Woods Hole, Mass.
DR FRANK CARLTON	Representative National Coalition for Marine Conservation, Savannah, Georgia
MR RICHARD BUCK	Representative Restoration of Atlantic Salmon in America, Dublin, New Hampshire
DR VAUGHN ANTHONY	National Marine Fisheries Service, Woods Hole, Mass.
MR HOWARD LARSEN	US Fish and Wildlife Service, Gainesville, Florida
MR ARTHUR NEILL	National Marine Fisheries Service, Woods Hole, Mass.
MR RICHARD SEAMANS	National Marine Fisheries Service, Gloucester, Mass.
MR ROBERT JONES	Connecticut Bureau of Fisheries, Hartford, Connecticut
MR STETSON TINKHAM	Dept of State, Office of Fisheries Affairs, Washington DC
MR HENRY LYMAN	Atlantic Salmon Federation, Boston, MA
MR JAMES MCCALLUM	US House of Representatives, Washington DC
DR JAMES WEAVER	US Fish and Wildlife Service, Newton Corner, MA
MR GILBERT RADONSKI	Sport Fishing Institute, Washington, DC
MR JOHN PHILLIPS	Atlantic Salmon Federation, Ipswich, Mass.

USSR

*DR GUEORGUI LUKA	Representative PINRO, Murmansk
DR ALEXANDRE ZUBCHENKO	PINRO, Murmansk
MR SERGEI BOGDANOV	Ministry of Fisheries, Moscow
MR GUENNADY GOUSSEV	Ministry of Fisheries, Moscow

ICES

DR EMORY ANDERSON	International Council for the Exploration of the Sea, Copenhagen
DR RICHARD GRAINGER	International Council for the Exploration of the Sea, Copenhagen
MR BERNARD VASKE	Institut fur Hochseefisherei und Fischverarbeitung, German Democratic Republic

NON-GOVERNMENT OBSERVERS

A.I.D.S.A.	AMBASSADOR CLAUDE BATAULT CAPTAIN JEREMY READ
Alantic Salmon Trust	REAR ADMIRAL JOHN MACKENZIE LORD MORAN
Association of Scottish District Salmon Fishery Boards	GROUP CAPTAIN JOHN PROUDLOCK MR JONATHAN STANSFELD
Scottish Anglers National Association	MR WILLIAM BROWN DR DONALD MUIR
Salmon and Trout Association	LORD HUNTER COL JAMES FERGUSON
Water Authorities Association	MR TONY CHAMPION
Association of Icelandic Angling Clubs	DR DEREK MILLS
Institute of Fisheries Management	MR ALAN HOLDEN

SECRETARIAT

Secretary	DR MALCOLM WINDSOR
Assistant Secretary	DR PETER HUTCHINSON
PA to Secretary	MISS SANDRA LORIMER
PA	MRS THERESA GAWTHORNE

OPENING STATEMENT MADE BY THE REPRESENTATIVE OF CANADA

Mr President, representatives, delegates, observers:

It is a great pleasure for me to represent Canada at this Sixth Annual Meeting of the North Atlantic Salmon Conservation Organization and to have an opportunity to make a few remarks on behalf of my delegation.

First of all, I would like to join with my fellow Commissioners in thanking our President, Mr Peterson, for his warm words of welcome.

Although I may have already met some of you on other occasions, I think I should, in my capacity as the new Canadian Commissioner and Head of Delegation, start by introducing myself.

I have spent the last 30 years employed with the Department of Fisheries and Oceans in all walks of activities, from research laboratories to senior management, from Halifax, N.S. to Vancouver B.C. For the past four years I have been Head of Delegation to the Pacific Salmon Commission and alternating Chairman. I will be observing with some interest the working of NASCO as it compares with the Pacific Salmon Commission.

As you probably know, my predecessor, Bill Rowat was appointed last October to the Privy Council Office. He has asked that I convey his best regards to his NASCO friends and his thanks for the excellent cooperation he enjoyed during his three years as NASCO Commissioner.

You will recall that 1988 was the last year of Canada's five-year conservation strategy. You will also recall that this five-year management plan which we had implemented, contained drastic measures for Canadian fishermen and anglers. Canada has taken important steps towards rebuilding its Atlantic salmon stocks and we intend to continue doing so.

Earlier this year the Canadian Government approved a second five-year conservation strategy. Our new five-year strategy, while recognizing the continuing role for the commercial fishery in Newfoundland, still focuses on conservation and Canada's obligation regarding the interception of migrating salmon. For these reasons Canada has introduced this year the concept of an "allowance" in the Newfoundland and Labrador commercial fisheries. As well, since returns of large salmon in 1987 and 1988 were less than expected in most rivers, we have maintained a closure of the commercial fishery in the Maritime Provinces.

We hope that these efforts by Canada to restore the salmon stocks will continue to be supported by actions of other NASCO countries. Although I have not participated in past meetings, the record shows the great value that has been gathered from these meetings and I am sure that this will continue into the future.

The question of interception of Canadian fish as well as the problem of fish habitat destruction due to acid rain emissions continue to be of great concern to Canada. I therefore would like to emphasize the importance that Canada places on participation in this forum for the exchange of information and for the opportunity to discuss issues that are of concern to all of the contracting parties. NASCO has been an excellent vehicle for the international exchange and cooperation which are essential for effective conservation and management of the salmon resource.

I look forward to a productive meeting, with the goal of attaining mutually beneficial results.

JUNE 1989
EDINBURGH

ANNEX 4

OPENING STATEMENT MADE BY THE REPRESENTATIVE OF DENMARK (IN RESPECT OF THE FAROE ISLANDS AND GREENLAND)

Mr President,

On the occasion of the Sixth Annual Meeting of NASCO I want to take the opportunity to point out some matters of importance to my delegation.

Two years ago, at the Fourth Annual Meeting of NASCO, we succeeded for the first time to establish a regulatory measure for the fishing of salmon in the economic zone of the Faroe Islands for the calendar years 1987, 1988 and 1989.

Last year, at the Fifth Annual Meeting, we succeeded in establishing a regulatory measure for Greenland, also for three years.

These measures were very much a result of the willingness of the Contracting Parties to work towards compromises and to some extent sacrifice basic positions.

We are all well aware of the opposing interests of river state fishermen of all categories and host state fishermen.

This delegation has at great length over the years explained the basic stand of a host state, as other delegations with opposing interests have described their points of view.

The results achieved at the last two meetings set an example and found a framework of cooperation, which hopefully will persist in the years to come. This framework applies, in a very fine way, the principles laid down in the NASCO Convention and puts to use the advice offered by scientists under constraint to find solutions which do not awkwardly affect the well-being of the salmon stocks. Another very important feature has been the active role of the elected officers of this Organization working hard to bring together opposing points of view and finding durable and equitable solutions. At the same time the efforts of the Contracting Parties - both river and host states - to manage the fisheries and the factors influencing the salmon stocks in the different stages of their life cycle has to be appreciated.

Our delegation hopes that the spirit of the 1987 and 1988 meetings will help us to reach results on matters which have to be decided on this year and looks forward to the discussion in the Commissions.

JUNE 1989
EDINBURGH

ANNEX 5

OPENING STATEMENT MADE BY THE REPRESENTATIVE OF THE EUROPEAN ECONOMIC COMMUNITY

Mr President, Distinguished delegates, observers, ladies and gentlemen.

The Community looks forward to the Sixth Annual Meeting of NASCO in the expectation of a constructive meeting which will enable NASCO to fulfil its mandate of providing a forum for cooperation between Contracting Parties in the interests of the Conservation of North Atlantic Salmon.

As a major state of origin for the North Atlantic salmon stocks, the Community is conscious of its responsibilities and commitments under the NASCO and Law of the Sea Conventions. Whilst Community salmon stocks are in an apparently better state than some other Contracting Parties, there is no sense of complacency within the Community. Indeed the resources, financial and human, devoted to the management of our salmon stocks continue to expand, reflecting the considerable socio-economic importance the salmon stocks represent to the coastal communities as well as to the angling community.

The Community in particular welcomes the special session on the impact of aquaculture on wild salmon stocks. There has been considerable growth into the aquaculture sector within those Member States of the Community in which wild salmon stocks originate and research is being conducted within the Community into many facets of the potential interactions between the wild and reared salmon. This session will offer Parties a unique opportunity to exchange information on their experience to date on this important subject.

The issue of regulatory measures is also on the agenda of the Regional Commissions and the Community is confident, based on the experience to date, that balanced and meaningful measures will be adopted at the Sixth Annual Meeting.

OPENING STATEMENT MADE BY THE REPRESENTATIVE OF FINLAND

Mr President, Ladies and Gentlemen,

The work of our organisation has now reached the level where it is possible to deal effectively and practically with different problems. The results are encouraging.

However, there is a lot of work to do and as regards Finland we are facing some new threats affecting the reproducing areas of salmon.

In previous years Finland has paid attention in her opening statements to some possible risks concerning wild salmon stocks in rivers Teno and Naatamo. The risks we have pointed out are fish diseases and genetic disorders caused by escapees from fish farms. These risks still prevail. We have been informed that last winter some 70,000 salmon escaped from net cages in Teno fjord and it is more than probable that some of them migrate to river Teno. We are very concerned that salmon farming in this area is expected to increase further. I am satisfied to notice that NASCO is going to deal thoroughly with this problem in a special session.

A new threat to salmon reproduction which we unfortunately have to bring to your attention is related to environmental conditions. Remote areas far in the north have been considered to be in an undisturbed natural state and remain so. However, there is evidence that acid rains are already changing the pH-values of waters in the area of Teno and Naatamo. It is estimated that early next century the rivers in this area will be biologically dead if the course of events has not changed. Taking into account the importance of salmon fishery to local population the damages from air pollution will lead to difficult economic situations. The losses to the Convention area would be sizeable. The main source of air pollution in this area originates from industries in Kola peninsula in the Soviet Union. This has been recognised by the two countries and consequently an agreement concerning the decrease of air pollution was signed this Spring between Finland and the Soviet Union. In the agreement there is a specific reference to decrease sulphur releases in this region. We are confident that the agreement will lead to improvement in this regard and minimize the influence of acid rains.

Mr President, last year we mentioned that the revised agreement of fisheries in river Teno would come into effect early this year. However, we regret that this matter has been postponed somewhat. The Finnish Parliament will deal with the revised agreement early next autumn and it will enter into force later this year.

Lastly, Mr President, we would like to express our appreciation regarding the work this organization so far has done - Finland is confident that NASCO will carry out its duties also in the future for the benefit of member states as well as for wild salmon stocks.

Thank you Mr President.

JUNE 1989
EDINBURGH

ANNEX 7

OPENING STATEMENT MADE BY THE REPRESENTATIVE OF ICELAND

Mr President, Distinguished Representatives, Delegates, Observers, Ladies and Gentlemen.

Since the last Annual Meeting of NASCO in Reykjavik, there has been a rapid development in Icelandic salmon fisheries and ranching. The 1988 salmon season was the highest ever with over 135 thousand salmon caught in sports and commercial ventures, amounting to nearly 400 tons of salmon. Of this almost 50 percent were from salmon ranching, which is growing rapidly. It is estimated that by 1990 almost 80 percent of the Icelandic salmon catch will be from ranching. The total salmon catch may then be close to 800 tons, which is fourfold average for the last 10 years. This rapid expansion raises questions regarding the carrying capacity of the oceanic environment and possible competition of salmon with other valuable fish species.

The expansion of salmon rearing in cages has further aroused concern regarding the effects of interbreeding and possible disease transmission to wild stocks. Reared salmon were observed in rivers close to Reykjavik during the 1988 season and it was estimated that 16 percent of the salmon run in the Ellidaar River was of reared origin. Projects are being started which have the objective to compare Icelandic salmon stocks with protein electrophoresis and a gene bank will be established later this year.

This rapid development requires quick responses on the part of administrators and legislators. In July 1988 a regulatory measure was enacted, based on the Freshwater Fisheries Act, which imposed considerable restrictions on the aquaculture industry. The measure set the minimum distance of sea-cages and salmon ranches from the estuaries of major salmon streams to 15 kilometers, and to 5 kilometers in the case of minor streams. There were furthermore imposed restrictions on the movement of wild broodfish and their progeny between areas and watersheds. A second regulatory measure limited the use of imported Norwegian strains to land-based farms, in order to prevent the mixing of these strains with indigenous Icelandic salmon.

These regulatory measures, which must be considered fairly strict, are just set for a two year period and will be revised as additional scientific material becomes available.

With increased ranching and tagging there is additional evidence accumulating about the presence of Icelandic two-sea-winter salmon at the Faroes and off West Greenland. It seems clear that south and west coast stocks are going to Greenland, whereas north coast stocks go into the Norwegian Sea. Icelanders are quite concerned about the repeated incidences of foreign vessels fishing for salmon in the international quadrangle off eastern Iceland. There seems to be a great need for a cooperative international effort to patrol this area in order to honor the NASCO treaty.

This has a bearing on the well known Icelandic stand that salmon should only be harvested in a terminal fishery on their spawning migration and the 1983 resolution of the Icelandic Althing is well known. Iceland is, however, willing to cooperate with other countries of origin to improve salmon management and enhance Atlantic salmon resources.

Thank you Mr President.

JUNE 1989
EDINBURGH

ANNEX 8

OPENING STATEMENT MADE BY THE REPRESENTATIVE OF NORWAY

Mr President, Distinguished representatives and delegates, ladies and gentlemen,

Norway has from the fishing season of 1989 implemented substantial steps to protect, maintain and rebuild the strength of Norwegian salmon populations. For some years we have announced a ban on the drift net fishery. This question was for the second time discussed and agreed upon by the Norwegian government in 1989. We see this ban of the drift net fishery as a milestone in the future management of salmon in Norway.

In addition to the ban on drift netting, heavy measures of regulation are established for fishing with fixed engines in the sea and for fishing in rivers. From 1989 salmon fishing is banned in 74 rivers for a five year period. Together with a substantial increase in grants from the government on more specific areas concerning the salmon populations especially the salmon parasite Gyrodactylus salaris and liming, we have to conclude that Norway in 1989 has given a clear commitment to the maintenance and restoration of Atlantic salmon stocks. We will also mention that the Norwegian salmon act will be revised and is planned to pass the Norwegian Parliament in 1990. This will give the legal basis for salmon to be managed at the population level. We take all these measures as a clear sign of a more active interest and greater understanding from the politicians in Norway in protecting and securing natural resources. This is in the best spirit of the United Nations World Commission report on Environmental development, chaired by Mrs Brundtland, the Norwegian Prime Minister.

We expect that these regulations in salmon fishing in Norway will give consequences for the agreements and regulatory measures we are supposed to reach at this meeting.

Implementations of salmon regulations on the national level are based on biology but also include discussions with various and strong interest organizations. The international aspect, and NASCO more specifically with a more broadened responsibility for securing salmon as a species, gives important contributions in such national discussions. NASCO gives in this way valuable guidelines also on the national level.

Last year the activities of the NASCO organization were broadened. Norway has earlier welcomed this new strategy. Today, when we see possibilities for negative effects on natural salmon stocks from the fast growing fish farming industry and drastic effects on salmon populations from acid rain, I am happy to say that I find the NASCO work in this area very valuable. I hope the NASCO organization will be able to follow these lines and even strengthen them in the years to come.

Thank you Mr President.

JUNE 1989
EDINBURGH

ANNEX 9

OPENING STATEMENT MADE BY THE REPRESENTATIVE OF SWEDEN

Mr President, Distinguished Representatives, Delegates and Observers.

The Swedish Delegation is looking forward to this Sixth Annual Meeting of NASCO with special interest.

The NASCO Convention may be characterised as a long-term salmon management plan. Such a plan calls for shared sacrifices among all its users in the process of recovery and restoration. NASCO has reached considerable progress during its first five year period, that is, during roughly the span of a salmon life-cycle. Such a long and relatively complex lifecycle as that of the Atlantic salmon requires a relatively long-term, stable and integrated management plan. We are now at last in a phase where all the three Commissions of NASCO have established regulatory measures. The Swedish Delegation wants to strongly emphasize that no changes should be made in on-going regulations agreed upon. Changes would make the evaluation more difficult and act contrary to the stability aimed at in the management. A long-term management plan should neither suffer from institutional imperfections which hamper the safeguarding of the North Atlantic Salmon resource. This matter was strongly stressed by Sweden at the last meeting in Reykjavik. However, a proper management not only includes quota restrictions and effort regulations; there are quite a lot of other elements to consider. The Swedish Delegation has noticed with satisfaction the expanding roles of NASCO concerning several issues.

Mr President, wild Atlantic salmon stocks can neither recover nor be sustained in unacceptable habitats which are rejected by the salmon in its search for an unpolluted and unobstructed environment in which to live and reproduce. Issues of concern include acid precipitation, pollution in all its forms, habitat degradation, etc. During our last meeting in Reykjavik, the Norwegian Delegation raised the question of the threat of acidification in the north-eastern area. NASCO then decided to ask ICES for advice concerning estimates of the number of salmon lost due to acidification and the effectiveness of mitigation measures and the extent to which the measures were in current use. At the last ICES statutory meeting in Bergen a special Study Group was established to deal with those questions. The mandate of the Study Group was however widened to include also pure chemical conditions. The Study Group found great losses of salmon in Sweden and Norway. The Swedish losses had, however, to some extent been compensated for by intensive liming measures. The only satisfactory permanent solution to the problem of acidification is, however, to eliminate the multiple sources of acidity.

At the last meeting of NASCO the question of potential impacts of salmon farming on wild stocks was also raised. In the discussion that has recently taken place in the joint meetings between the relevant ICES working group and representatives of NASCO on "Genetic Threats to Wild Salmon posed by Salmon Aquaculture" a number of views on the impacts of farmed fish on the wild stocks was expressed which ranged from almost no impact at all to serious impacts. It was, however, recognised that there are considerable gaps in our knowledge. We therefore warmly welcome the discussions that will take place already this afternoon in the Council in a special session. The Swedish Delegation is also of the opinion that both the acidification problem and the genetic threats unfortunately seem to be long-term elements in our salmon management plan.

Thank you, Mr President.

JUNE 1989
EDINBURGH

ANNEX 10

OPENING STATEMENT MADE BY THE REPRESENTATIVE OF THE UNION OF SOVIET SOCIALIST REPUBLICS

Dear Colleagues, Ladies and Gentleman,

A year has passed since the last meeting. A year during which much has been done in uniting common efforts of member states of NASCO and in strengthening the authority of our Organization, in which I should like to mark the undoubted merits of the Secretariat.

A series of practical steps aimed at conservation and increase of Atlantic salmon stocks in the North European region has been undertaken in the Soviet Union during the past year. In particular, the portion of commercial removal of salmon in a number of rivers was downward revised.

The first batch of smolts was released at a new fish hatchery (fifth in the Murmansk Region) built in the Tuloma River area. Commercial withdrawal has ceased since 1989 in the largest salmon river of the USSR - Pechora.

Research carried out in salmon rivers was aimed at improving reproductive potential and developing an optimum regime of commercial exploitation of separate salmon populations.

As I have already said, many organizational matters concerning all countries, both separately and as a whole, have been settled and a number of concrete decisions have been taken, in particular on marine fishery limitation. But the Soviet Union is anxious, as previously, about ongoing, practically uncontrollable, scientifically unsubstantiated marine salmon fishery in the North-East Atlantic, the pressure of which, on separate populations, is far from being equivalent. The fishery is even more destructive at present when salmon year classes with low numbers entered the fishery.

For a long time there has been a practice in marine fishery to estimate allowable catch on the basis of total stock of the species, especially if this relates to the mixed stock.
In our opinion, solving the problem of marine salmon fishery in feeding areas of mixed stock on the basis of its annual estimate would be more reasonable. In this connection it seems essential for us to ask the ICES Working Group on North Atlantic salmon to consider the question at the next meeting.

In conclusion of my short speech, I want to express the hope that our meeting will be constructive and fruitful.

Thank you.

JUNE 1989
EDINBURGH

ANNEX 11

OPENING STATEMENT MADE BY THE REPRESENTATIVE OF THE UNITED STATES OF AMERICA

Mr President, Representatives, Delegates, Observers, and Guests,

The United States is pleased to participate in this Sixth meeting of the NASCO Council. In 1978 here in Edinburgh the United States introduced the first draft of an international fisheries treaty for the conservation of Atlantic Salmon. One of our Commissioners, Mr Richard Buck, was one of the prime movers of that concept and we are all indebted to him for his vision and persistence in working to make NASCO a reality and contributing materially to its subsequent accomplishments. During the last six years the Council has agreed upon several meaningful concepts and all of the Commissions have achieved significant conservation measures. During the last three years we have benefitted from a calm and stable period brought about by the cumulative TAC at West Greenland for the years 1988, 1989 and 1990. The stability of this period and the absence of the necessity to negotiate has contributed to our science and to our understanding of the abstract concepts that underlie the international fishery management process. The United States believes that the demonstrable advance achieved by ICES and various national scientists in our fund of basic information has been the greatest achievement of NASCO to date, but we also believe that our philosophical discussions of the interpretation of the UNCLOS, the NASCO treaty itself and the concept of "fair sharing" are also important and necessary if NASCO is to achieve lasting success.

The United States applauds these accomplishments and will continue to do everything in its power to encourage the continuation of this progress, but we are also mindful that enhancing science is only a part of the purpose of NASCO. Our principle purpose is, of course management; and in that area, although we are progressing, a universally acceptable system that is objective and fair on one hand, and insulated from political adulteration on the other hand, is still a year or two in the future. The United States would like to suggest that development of such a system is the highest and best use of NASCO and that recognising this ultimate goal will diminish the limitations and dangers of what might be termed traditional international fisheries negotiations, that is, meeting each year to divide the largest number of fish among the smallest number of fishermen with little thought for the past and even less for the future.

Although NASCO is evolving and although NASCO has had some success in reducing the interception of fish, the total level of interception of US fish at West Greenland and Canada remains at an unacceptable level. The United States continues to believe that states of origin have definite and explicit prerogatives that are not yet fully recognised by certain host nations. The United States continues to believe that if Article 66 of the UNCLOS means anything at all, it supports the contention that a state of origin has a legal right to a primary interest in the harvest of its anadromous stocks. And the hard fact is that, despite the validity of these beliefs, the catch of United States fish at West Greenland and Canada continues to be two times the total returns to our rivers - note, I am saying <u>returns</u> not <u>catches</u>.

The United States also recognises that with the recent explosion of aquaculture in Canadian and United States waters, we have much to learn from our Norwegian, Scottish and Irish friends about the perils and pitfalls associated with farmed and ranched fish. We are particularly fearful of the genetic impact these reared fish from both sides of the Atlantic could have upon the future of wild stocks.

The United States greets all of the other Parties here today warmly and with appreciation. We thank you for your commitment and cooperation thus far in a great and worthy conservation process, leading, we hope and believe, to the wise use of the Atlantic Salmon resource.

Thank you.

JUNE 1989
EDINBURGH

ANNEX 12

CNL(89)34

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION
SIXTH ANNUAL MEETING OF COUNCIL
13-16 JUNE 1989
SHERATON HOTEL, EDINBURGH, UK

AGENDA		PAPER NO
1.	Opening session	
2.	Adoption of the agenda	CNL(89)2 CNL(89)3 CNL(89)4 CNL(89)27
3.	Secretary's Report	CNL(89)5 CNL(89)6 CNL(89)33
4.	Report of the Finance and Administration Committee	CNL(89)7 CNL(89)8
5.	Scientific Research	
	- Report to NASCO from the ACFM of ICES	CNL(89)9 CNL(89)10
	- Request to ICES for Scientific Advice for 1990	CNL(89)35
6.	Implementation of the Convention	
	- Returns under Articles 14 and 15 of the Convention - Return of Catch Statistics	CNL(89)11 CNL(89)12 CNL(89)13
7.	Analysis of catch statistics	CNL(89)14
8.	Laws, Regulations and Programmes	CNL(89)15
9.	Salmon Tagging	
	- Repository of tag release data - NASCO Tag Return Incentive Scheme	CNL(89)16 CNL(89)17 CNL(89)18

Special Session: Impacts of aquaculture on wild stocks

10.	Report from the joint NASCO/ICES meeting	CNL(89)19
11.	Environmental threats to wild stocks from aquaculture	CNL(89)20
12.	Gene banks for threatened stocks	CNL(89)21
13.	Review of legislation relating to introductions and transfers	CNL(89)22
14.	Possible Codes of Practice to minimize threats to wild stocks	CNL(89)23

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15.	Reports from the regional Commissions	
16.	Reports on the activities of the Organization	CNL(89)24 CNL(89)25
17.	Other business	
18.	Date and place of next meeting	CNL(89)26
19.	Draft Report of the Meeting	CNL(89)30
20.	Press Release	CNL(89)39

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ANNEX 13

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

DECISION OF THE COUNCIL

ON WORKING CAPITAL

CNL(89)40

Having regard to the need to review the level of the Working Capital in the light of the Organizations responsibilities for its Headquarters property and other factors the Council decides

- to change the level of the Working Capital from £10,000 pounds sterling to £20,000 pounds sterling and therefore to amend Financial Rule 6.3 to read

- "The Working Capital Fund will be established in the initial budget at 3,000 pounds sterling and may be increased by budgetary provision, miscellaneous income and any cash surplus in the General Fund at the close of a financial year that is not required to meet outstanding commitments in terms of Rule 4.3 until the Fund reaches 20,000 pounds sterling. Any surplus above 20,000 pounds sterling shall be entered as income in the budget and used to offset members' contributions for the next financial year."

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ANNEX 14

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

COUNCIL

PAPER CNL(89)37

1990 BUDGET AND 1991 FORECAST BUDGET

CNL(89)37

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION
1990 BUDGET AND 1991 FORECAST BUDGETS (Pounds Sterling)

SECTION	DESCRIPTION	EXPENDITURE	
		BUDGET 1990	FORECAST 1991
1	STAFF RELATED COSTS	114820	121700
2	TRAVEL AND SUBSISTENCE	21520	14590
3	CONTRIBUTION TO ICES	20470	21690
4	CONTRIBUTION TO WORKING CAPITAL FUND	0	0
5	MEETINGS	3840	16790
6	OFFICE SUPPLIES, PRINTING AND TRANSLATIONS	27350	28980
7	COMMUNICATIONS	8750	9260
8	HEADQUARTERS PROPERTY	65950	61430
9	OFFICE FURNITURE AND EQUIPMENT	8270	8750
10	AUDIT AND OTHER EXPENSES	7690	8140
	TOTAL	278660	291330

		REVENUE	
11	CONTRIBUTIONS - CONTRACTING PARTIES	274302	288830
12	MISCELLANEOUS INCOME - INTEREST	2500	2500
13	SURPLUS OR DEFICIT(-)FROM 1988	1858	0
	TOTAL	278660	291330

NASCO BUDGET CONTRIBUTIONS FOR 1990 AND FORECAST BUDGET CONTRIBUTIONS FOR 1991 (Pounds sterling)

CATCH (tonnes)	PARTY		BUDGET 1990	FORECAST 1991
1280	CANADA		43769	46087
	DENMARK	(FAROE ISLANDS)		
		(GREENLAND)		
1111		(TOTAL)	39198	41274
2697	EEC		82101	86450
34	FINLAND		10063	10596
412	ICELAND		20289	21363
1104	NORWAY		39008	41074
40	SWEDEN		10225	10767
1	USA		9170	9656
419	USSR		20478	21563
7098	TOTAL		274302	288830

Contributions are based on 1988 catches as advised by the Parties.
Column totals can be in error by a few pounds due to rounding.

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ANNEX 15

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

COUNCIL

PAPER CNL(89)10

REPORT OF THE ICES ADVISORY COMMITTEE ON FISHERIES MANAGEMENT

(This paper makes reference to the report of the meeting of the ICES Working Group on North Atlantic Salmon (Copenhagen, 15-22 March 1989). That report is not annexed here but is available on request to the Secretariat).

CNL(89)10

REPORT TO THE NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

1. INTRODUCTION

Questions of particular interest to the West Greenland, North East Atlantic and North American Commissions are dealt with in Section 5, 6, and 7 respectively. Questions dealing with homewater fisheries appear in Section 8. Many of the questions posed related to more than one Commission area and these are answered separately. In this report, the tables, figures, references, and appendices referred to are from the Working Group report.

2. CATCHES OF NORTH ATLANTIC SALMON

2.1 Nominal Catches

Nominal catches of salmon by country for 1961-1988 are presented in Table 1. Catches of grilse (1SW) and salmon (MSW) in homewaters are shown in Table 2. Despite the fact that catches from England and Wales, Ireland, Northern Ireland, and Iceland increased from 1987 the provisional figure for 1988 (7,009t) when confirmed is likely to show an overall substantial decrease.

2.2 Catches in Numbers by Sea Age and Weight

Reported national catches for several countries by sea age and weight are given in Table 3. In Canada, a decrease in catch occurred in both 1SW and MSW components, in Norway only the MSW component decreased, while in Scotland a decrease was recorded only with 1SW fish. In Ireland and Iceland, the increase observed was mainly in the 1SW component.

2.3 Unreported Catches

For those countries that provided estimates of unreported catches (one country represented did not provide an estimate), the total was in the order of 2,500t.

It was agreed that the accuracy of unreported catch estimates will continue to be a problem as there were few ongoing studies on methods and for most countries unreported catches are "guess-estimates". Various methods of estimation that could be used in a variety of situations were listed.

3. MODELS OF THE FISHERIES

3.1 Background

NASCO asked ICES to continue the development of models to describe the fishery interactions and stock dynamics. By knowing the contribution that individual stocks make to each fishery and the exploitation rates on stocks in these fisheries, these models can be used to evaluate the effects of new or proposed management measures.

3.2 Models

Three models were presented to demonstrate possible approaches.

3.2.1 Salmon run reconstruction model

The model developed in 1988 was revised so that stock contribution and exploitation rates could be reconstructed. A description of the model and input parameters is provided in Appendix 4. The model was run with data from several indicator rivers; North Esk (Scotland), River Bush (Northern Ireland), River Imsa (Norway), and the Maine (USA) rivers. The input data needed are shown in Table 4 and the results of the model are shown in Table 5. These results are examples of the types of information which can be provided from this run reconstruction model.

With refinement of the input parameters the model can be used to evaluate effects of proposed management measures on the fisheries and spawning stock of specific populations. The extent to which these populations represent other populations within a region or country requires evaluation.

The importance for countries of engaging in tagging and tag-recovery programmes and obtaining reliable estimates of returning adults was pointed out. The work should be carried out on representative stocks.

3.2.2 Optimization model

Linear optimization is defined as the minimizing (or maximizing) of an objective function, subject to a set of constraints. Using multi-objective linear programming the trade-offs inherent in management decisions where competing objectives must be met simultaneously were considered.

The relationship between the objectives of maximizing the savings of USA salmon and minimizing the variability in Canadian catches is illustrated in Figure 1. The shape of the curve suggests that the variability of Canadian landings can be significantly reduced without forgoing much saving of USA salmon. For example, the saving of USA salmon need only drop 0.9% (= X) to affect a reduction in variability of Canadian catches from 99% to 58%.

Small reductions in either objective (either X or Y) (Figure 1) can lead to changes in the value of the other objective. The compromise solution, under a given set of constraints, might be to select a solution near the point circled in Figure 1. At this point each objective has sacrificed very little and yet the gains to the other objective are significant.

Further refinements are required before multi-objective linear programming can be used for scientific management.

3.2.3 Risk analysis model

The Canadian catch data were analysed to assess the risk of not achieving desired reductions in catch with specific closure strategies. The probability of not achieving a target fishery reduction was evaluated by quantifying for each year the percentage of the catch landed each week. Summaries of the data for the weeks by which 90% and 95% of the catch had been landed are given in Figures 4 and 5, respectively. For example, there would be a 57% chance that the fishery would be closed too early in Area A to catch 90% of the potential catch (a 10% reduction of the fishery), if the fishery were closed after week 28, and a 14% chance if it were closed after 29 weeks.

4. REVIEW OF THE STUDY GROUP ON TOXICOLOGICAL MECHANISMS INVOLVED IN THE IMPACT OF ACID RAIN AND ITS EFFECTS OF SALMON

4.1

The Working Group considered the report of the Study Group on the Toxicological Mechanisms Involved in the Impact of Acid Rain and its effects on Salmon (Anon., 1989b).

4.2 Basis of Toxicological Impact of Acid Rain on Water Quality of Salmonid Habitat

High concentrations of strong acid anions in wet and dry materials deposited from the atmosphere have resulted in changes in water quality of lakes and streams, yielding conditions that are toxic to fish. The most important toxic substances are H^+ and Al. Dissolved organic matter, H^+, and Al interact chemically, and Ca^{2+} modifies their effects on fish, so that mechanisms of toxic action are very complex.

4.3 Differences Between North American and Scandinavian Rivers

The conclusion was that loss of Atlantic salmon from acidic rivers in Nova Scotia has resulted primarily from H^+ toxicity whereas in Scandinavian rivers, it has resulted from both H^+ and exchangeable Al toxicity.

4.4 The Number of Salmon Lost Due to Acidification in the North East Commission Area

The total number of adult salmon lost to fisheries and spawning escapement was estimated to be between 106,000 and 332,000 annually, having an approximate weight of 400 to 1,242t.

Estimates of salmon lost in Norway, Sweden, and UK (England and Wales). No figures were available from other countries.

Country	No. salmon lost	Weight salmon lost (tonnes)
Norway	91,700 - 305,800	344 - 1,147
Sweden	13,870 - 23,125	52 - 87
UK (Engl. & Wales)	1,050 - 2,100	4 - 8
Total	106,620 - 331,025	400 - 1,242

The different assessment methods used were described and the Working Group noted the wide range of the estimates and agreed that more research is required to refine the methods so that estimates could be improved.

4.5 The Effectiveness and Current Use of Mitigation Measures

The Working Group recognized that the only satisfactory permanent solution to the problem of acidification is the elimination of the multiple sources of acidity. Feasible short-term mitigation measures are liming, stocking and the preservation of genetically diverse stocks. Liming of Atlantic salmon rivers has been used successfully in Europe and North America as a mitigation method to reduce juvenile salmon mortality and increase production.

Mitigation measures in current use in several countries were described.

4.6 Salmon Habitat Available, Areas Vulnerable to Acidification, Areas Lost to Productions and Salmon Lost Due to Acidification in the North Commission Area

No new information was available on the amount of salmon habitat available, its vulnerability to acidification nor the areas lost to salmon production.

An estimate of the numbers of salmon lost due to acidification in Nova Scotia in 1988 of 5,600 fish per year (Anon., 1988a) was revised in 1989. If it is assumed that rivers that currently have pH values below 4.7 were once as productive as rivers that are presently above 5.0 then the estimated loss of salmon in Nova Scotia is 8870, which is 58% greater than the previous estimate (Anon., 1989).

The Working Group concurred with the Study Group's recommendation (Anon., 1989a) that additional analyses for estimating productivity weighing factors be conducted.

5. QUESTIONS OF INTEREST TO THE WEST GREENLAND COMMISSION OF NASCO

5.1 The Fisheries in 1988

The fishery at West Greenland is described below and descriptions of fisheries in homewaters are given in Section 8.

5.1.1 Description of the fishery at West Greenland

In 1988, the fishery opened on 1 August in NAFO Division IF and on 25 August in NAFO Divisions 1A to 1E and ended on 4 December. The nominal catch was 893t (Table 7). This corresponds to a catch of 820t if the entire fishery had opened on 1 August.

To prolong the season and allow for better organisations within the fish plants the TAC was divided into individual "boat quotas" instead of the normal "free quota" and "small boat quota". This arrangement which allows each fisherman to fill his quota at his own pace may have resulted in a higher discard rate if they selected for high quality (higher priced) fish.

A comparison between the landings of second class salmon in different years in Divisions 1A-1C and Divisions 1E-1F shows that 2.91% of the landings in 1988 were second class whereas for the years 1975 to 1988 it was 5.19% (SD 1.35%).

The geographical distribution of the fishery in 1988 (Table 8) differs at little from 1987, the landings being lower in Divisions 1A and 1B, but higher in Division 1F. This could be a result of the early opening date in Divisions 1C to 1E. It should be noted that Division 1D, from which there are no samples, had a high catch.

Boats smaller than 30 feet took 723t or 81% of the catch compared to 77% in 1987. The number of fixed gillnets being used is decreasing each year. Most of the salmon were taken with driftnets with a target mesh size of 140mm stretched. On average, the small boats used 44 (SD 29) driftnets per fishing day while the bigger boats used 92 (SD 28) compared to 40 and 99 nets respectively in 1987.

The high catches taken by small boats indicates that the salmon fishery took place in the inshore area or very close to the coast.

Effort and catch information in 1988 was available from 47 logbooks out of a total of 350 distributed. These have not yet been fully analyzed but the CPUE appears to have been the same as in 1987.

5.1.2 Composition and origin of the catch for 1988

Using an improved discrimination function scale samples from commercial catches in 1988 indicated that the North American proportion was 48% (95% C.L = 38,59) and the European proportion was 52% (95% C.L = 41,62)(Table 9).

An alternative estimate of the proportion of North American and European origin samples for the years 1982-1988 was derived by weighting NAFO Division samples by catch in numbers. Pooled samples were applied to divisions with no samples. Results are presented below:

	Weighted by catch in numbers				Percentage of all samples combined	
	NA		EU		NA	EU
Year	%	Wt	%	Wt	%	%
1982	57		43		62	38
1983	40		60		40	60
1984	54		46		50	50
1985	47		53		50	50
1986	59	537	41	423	57	43
1987	59	556	41	411	59	41
1988	43	359	57	534	48	52

The Working Group recommends that the method of allocating continental proportions by weight and NAFO Divisions should be used in future.

The 43% and 57% proportions in 1988 correspond to catches of 359t or 12,456 North American salmon and 534t or 168,762 salmon of European salmon.

While the reporting of Carlin tags for 1988 is not yet complete, the USA reported 104 Maine origin tags recovered compared to 165 in 1987. Salmon landings were again scanned in 1988 for adipose fin clips and coded-wire tags (CWTs) using procedures similar to those in previous years and including the addition of a further sampling site at Godhaven (Division 1A).

A total of 22,327 salmon (7.5% of the catch) was examined for adipose fin clips and CWTs. The CWTs recovered in 1988 were apportioned as follows: 58 (53%) from USA, 23 (21%) from

Canada, 17 (15%) from Ireland, 8 (7%) from England and Wales, 1 (1%) from Scotland, and, new in 1988, from Iceland 3 (3%) (Table 11).

Proportionate contributions by various countries to the 1988 West Greenland harvest cannot be determined due to differential survivals of stocks tagged, as well as the different proportions of coded-wire tagged fish relative to total smolt production in each country.

The Working Group considered estimates of the number of USA fish at West Greenland based on the number of 1SW North American salmon of river age 1 in the fishery as apportioned by the relative proportion of 1-year-old smolts produced by USA (637,536) and Canadian (449,300) hatcheries in 1987 (the proportional harvest method). The estimate of USA salmon harvested at Greenland in 1988 was 4,811 (Figure 7).

An extension of this method based on the identification of North American 1SW salmon, which migrated as 1-year-old fish was used. Identification was by a discriminant function based on circuli spacing data of 1-year-old smolts produced by the various North American hatcheries in 1987. The results are considered preliminary but gave estimates of USA (Maine) and Canadian 1-year-old hatchery origin salmon as 5,087 and 4,516, respectively.

Three further stock identification techniques were considered:

- levels of mitochondrial DNA polymorphism within various salmon stocks and the use of mtDNA as a genetic marker for distinguishing North American from European stocks;

- the use of genetic protein variation of 8 loci to classify salmon to continent of origin;

- use of otolith shapes to identify continent of origin;

Further studies on all three methods are required and further development is encouraged by the Working Group.

5.1.3 Biological characteristics of the 1988 harvest

Biological characteristics (length, weight, and age) were recorded from samples of commercial catches from NAFO Divisions 1A, 1B and 1D-1F. A summary of the data divided into North American and European components based on the results of discriminant analysis is presented in Table 12.

As previously observed, the North American 1SW salmon were significantly shorter and lighter than their European counterparts, both overall and on a divisional basis. This was confirmed by samples from coded wire-tagged salmon. The sea and river age composition of samples is summarized in tables 13a, 13b and 14.

The mean smolt age of North American origin salmon at 3.04 was higher than in 1986 and 1987 (2.86 and 2.8 respectively). The mean for European salmon at 2.02 was about the same.

The sea age composition in 1988 (Tables 13a and 13b) of 97.4% 1SW, 1.7% 2SW, and 0.9% previous spawners was similar to that found in 1987.

Based on the estimate that 43% of salmon by number in 1988 West Greenland catches were of North American origin, the catch by age by continent of origin was as follows:

Sea age	NA	EU	Total
1	121,442	165,724	287,166
2	2,509	2,194	4,703
PS	1,505	844	2,349
Total	125,456	168,762	294,218

There was concern that sampling in 1988 was not as representative of the catch as in recent years and caution was advised in the extrapolation of sampling data on continent of origin, and biological characteristics of the catch outside the sampling period. It was recommended that the sampling programme be redesigned, if similar management measures (boat quota) are expected in 1989 and beyond.

5.1.4 Composition and origin of the catch for 1987 at West Greenland

Three methods were used to estimate contributions by USA to the West Greenland fishery:

- The harvest estimate for 1SW Maine-origin salmon using the Carlin tag method was 2,152 in 1987, a 2% increase from 1986 (Tables 15, 16 and 17). Tag returns suggest that the harvest occurred primarily in Divisions 1C and 1D, whereas in 1986 the largest tag returns (and harvest estimates) were from 1F, followed by 1D and 1C.

- The harvest estimate for Maine-origin stocks using the CWT method was 5,593, higher than the Carlin tag estimate of 2,152. The most likely explanation for the differences lie with the assumed reporting rate (80%) and non-detection of Carlin tags.

- The proportional method estimated the harvest of 1SW USA-origin salmon at West Greenland in 1987 to be 6,006. These estimates of harvest are compared in Figure 7 along with similar estimates for other years. For all years presented in Figure 7, the estimates of harvest of Maine-origin fish at West Greenland are much greater than those made from the Carlin tag data.

5.1.5 Stock abundance and exploitation at West Greenland

In 1987 and 1988, the Working Group considered a model to estimate exploitation in the West Greenland fishery based on virtual reconstruction of Maine stocks in both the Canadian and West Greenland fisheries. These calculations assumed constant proportions of the stock migrating to one fishery versus the other between years.

An analysis of the Carlin tag batch releases (12 per year) indicated that at least in some years batches behave similarly between the Canadian and Greenland fisheries.

Exploitation rates on 1SW Maine-origin salmon at both Canada and West Greenland were estimated from Carlin tag harvest data, assuming that populations are available to one or the other fishery, but not to both (Table 18). Estimated exploitation rates in West Greenland and Canada are inversely related within a given year by virtue of the uncertainty in the fraction of salmon returning from their respective fisheries (Figure 6). Until this parameter can be estimated, it is not possible to ascertain the absolute magnitude of exploitation in either fishery.

Two alternative hypotheses regarding the migration of Maine-origin salmon were considered.

The first hypothesis assumed that exploitation rates in Canada were constant over the period 1971-1986. This implies that the fraction of the stock migrating from West Greenland varies each year and, therefore, the exploitation rate derived for West Greenland is contingent upon the assumed level of exploitation in Canada and an annually varying migration pattern. Results from these analyses suggested that exploitation had increased in West Greenland since 1984. However, the model implied that the lowest possible exploitation rates in Canada would have to be 57% which was not consistent with experimental data.

The second hypothesis considered that the population in the Newfoundland-Labrador early summer fishery (standard weeks 21-30) could migrate to the West Greenland summer fishery (standard weeks 31-40) from which the survivors were again vulnerable to the Newfoundland fall fishery (standard weeks 41-52). Analysis on this basis suggested that exploitation at West Greenland in the past two years was between 50 and 70% but that Canadian exploitation rates were less than 10%. This result also is not consistent with experimental data.

Regardless of the assumptions, results suggest that since 1983 exploitation rates have increased in West Greenland. Two of the assumptions imply that exploitation rates have decreased in Canada over the period. There are, however, other explanations for the trends, such as decreased reporting rates in Canada or increased reporting rates in West Greenland.

5.2 Effectiveness of Management Measures in the Fishery at West Greenland

Prior to 1984, the quota for the West Greenland salmon fishery was 1,190t (or its equivalent adjusted for season opening date). Since 1984, the quota has been lower.

In order to assess the impact of the change in quota, data collected from the fishery since 1978 were analyzed to estimate the catch of North American and European salmon. In investigating the periods prior to and subsequent to 1984 it was decided not to use the years 1983 and 1984 when the catch did not reach the quota (Table 7). Significant reductions have taken place in the total weight, lower by 22%, and in numbers, lower by 17% (Table 19). Total harvest in West Greenland averaged 304,000 fish during recent years, which is about 61,000 fish less than when the quota was 1,190t.

The introduction of an individual boat quota in the West Greenland fishery had the effect of extending the period of time over which the fishery took place. It was not possible to conclude, however, if this changed the proportion of the continent of origin or the exploitation rates in the fishery.

6. QUESTIONS OF INTEREST TO THE NORTH-EAST ATLANTIC COMMISSION OF NASCO

6.1 The Fisheries in the 1987/1988 Season and in 1988

The Faroese salmon fishery is described below and descriptions of fisheries in homewaters are given in Section 8.

6.1.1 Description of the fishery at Faroes

The fishery in the 1987/1988 season was poor yielding 204t (Table 20). Catch rates were fairly good at the beginning of the season but were poor from February onwards. The Landings were low because few boats fished in November and December, the weather was unfavourable in January, and most vessels stopped fishing from February onwards because the low catch rates (Table 21) made the fishery unprofitable.

The nominal landings by seasons broken down into numbers and weights by sea age group are given in Table 3. Catch in numbers by statistical rectangle for the season 1987/1988 is presented in Figure 8.

The normal programme of discard retention did not operate but an observer participated in two trips with commercial vessels. A total of 1,264 salmon were caught and the discard rate was 18.6%, which is high compared with previous years. The sample numbers, however, were low (23 hauls) and the figure was greatly influenced by one haul where discards were particularly high.

6.1.2 Fishing effort

A total of 464 sets was fished in the 1987/1988 season; this is 54% of the total for the 1986/1987 season. The catch in numbers per unit effort (1,000 hooks) by statistical rectangle is given in Figure 9. The CPUE by month and season is given in Table 21.

6.1.3 Origin of salmon in the Faroese fishery

The only new data presented on external tags were from the USSR. A recovery rate at the Faroes of 0-1.33 per 1,000 parr tagged is shown in Table 22.

The numbers of microtags estimated to have been taken in the Faroese fishery in the 1987/1988 season are presented in Table 23. The CWT return rates per 1,000 fish tagged for Ireland, England, and Wales remain low compared to estimates from external tags previously obtained for Norway (3.19) and Sweden (5.02). The figures suggest that the rates of contribution of fish to the Faroese fishery from England and Wales, Ireland, and Scotland are lower than the rates from Norway and Sweden.

6.1.4 Biological characteristics

All vessels but one now freeze their catches onboard. Accordingly, only two scale samples were obtained during market sampling in the 1987/1988 season. A further two samples were obtained by an observer during two commercial fishing trips.

The scale samples were used to establish age/length keys and the composition of the landings was 18% 1SW fish, 77% 2SW fish, and 5% 3SW fish. The proportion of 1SW fish was higher than in the two previous seasons when 1SW fish comprised about 1% of the catch. Data on smolt age composition from samples show that 3-year-old smolts formed the largest age group with either 2- or 4-year-olds the next most common smolt age.

An assessment of the use of fork length data to determine sea age, although based on only two seasons and not all months within a season, indicated that the length frequency distribution could be used to estimate the numbers in each sea-age class.

6.1.5 Abundance and exploitation

There are no measures of abundance of salmon in the Faroese EEZ other than CPUE figures (Table 21). These data suggest that stock abundance was not significantly lower than in previous seasons.

Data from the River Imsa tagging experiments (Tables 24, 25) indicate that the exploitation of this stock at Faroes during the 1987/1988 season decreased compared to previous years.

6.2 Stocked and Farmed Salmon in the Fisheries

The development in farming of Atlantic salmon has led to an increase of escaped fish in the wild. If not caught in the fisheries, adult escapees enter rivers to spawn (Hansen et al, 1987). Experimental releases in Norway of tagged farmed salmon during their first year at sea showed a much higher adult recapture rate of fish escaping at the smolt stage in spring than those escaping during summer and autumn (Hansen and Jonsson, 1989). When reared fish escape from a marine location at the smolt stage, the adults tend to return to the area from which they escaped and enter rivers in that area to spawn (Hansen et al, 1989).

6.2.1 Identification of reared fish

The reliability of morphometric methods and scale analysis to distinguish reared (farmed, ranched, or stocked for enhancement) and wild salmon has been evaluated by Lund et al, (in press). The best morphometric and scale characters to use in identification were listed. It was concluded that recently-escaped farmed fish could be identified with a high degree of accuracy both on morphological and scale characters. Regeneration of fins, however, reduced the accuracy of identification of fish that were released as smolts or escaped at an early sea age. The combined use of morphological characteristics and scale analysis improved the accuracy of identification.

It was recommended that further development of methods of analysis of salmon scales using circuli spacing and surface texture patterns to separate between wild, ranched, and farmed fish should take place.

6.2.2 Reared fish in the fisheries

It was noted that about 20% of the salmon caught in some commercial fisheries in Norwegian homewaters in 1988 were of reared origin (ranched and farmed escapees). In the Faroese fishery during the 1987/1988 season, 8.2% of a sample was classified as reared. Reared fish or cage escapees were reported in rivers in Iceland, Ireland, and Scotland.

6.3 Acoustic Survey at Faroes

Staff from the Marine Laboratory, Aberdeen, Scotland and the Fishery Laboratory at Faroes took part in an acoustic survey at Faroes from 18 January to 6 February 1989. The R/V "Magnus Heinason" was equipped with a towed 38 kHz sounder and a 330 kHz scanning sonar.

The horizontally scanning sonar was buoy mounted and operated at a depth of 20-40m on a 1,000m cable paid out from the boat. The system drifted at about 1-1.5 knot and the range (radius) of the sonar was 50-70m with a vertical beam angle of 30". The sonar was used 5 times for a total of 50 hours. Forty hours were at a position where the vessels had recently reported good catches. Single targets could be seen on the sonar, but in no case could these be confirmed as fish (salmon). It was not possible to track an echo from one scan to the next, and it was difficult to tell whether it was a target or noise. It was possible to identify a preset target (trawl float).

Some of the problems encountered apart from the very severe weather were listed; the range of the sonar was too short (maximum radius was 50-70m); the scanning rate was too slow (one revolution per 33 s at a range of 79m); handling of the sonar, shooting, and hauling, was difficult in bad weather.

It was agreed that if more suitable equipment were available, further tests should be conducted using a laterally scanning towed sonar operating between 35 and 120 kHz.

6.4 Effectiveness of Management Measures in the Faroese Fishery

In the 1987/1988 season, some fishing took place outside the Faroese fishing zone. The catch outside the zone comprised about 30% of the total for the season. After warnings, several vessels were apprehended by the Coast Guard in February, fines were imposed, and the catch and gear confiscated. No further landings were reported from outside the zone.

A total of 19 licenses was issued for the season. The fishery opened on 1 November 1988 as agreed. The closure during Christmas, however, was reduced from 1 month (15 December - 15 January) to 2 weeks (20 December - 4 January). The Faroese authorities decided to end the season 15 days early to compensate for this.

7. QUESTIONS OF INTEREST TO THE NORTH AMERICAN COMMISSION OF NASCO

7.1 Canada

7.1.1 The fisheries in 1988

Total salmon landings in Canada for 1988 were 1,280t (Tables 2 and 3) of which 80.3% came from commercial fisheries. Landings of 1SW salmon were about equal to the average for the previous 5 years; landings of MSW salmon were 19% below previous 5-year mean. To better account for the diversity of Atlantic salmon populations and fisheries in Canada, landings were subdivided into geographical regions and three fishery types: recreational, commercial, and native food (Tables 29, 30 and 31).

7.1.2 Composition and origin of the catch

Reported recoveries of Carlin tags in 1988 were 24% of the average number recovered annually between 1974 and 1987. There were 18 Penobscot River tags recovered in Areas A (6), C (1) O

(9), and Newfoundland (2).

The recovery programme for CWTs in Canada continued to expand with coverage of 5 Canadian ports. A total of 12,184 salmon were sampled. Of the 26 CWTs recovered, 21 were from USA hatchery releases in Maine and Connecticut and 5 were from Canadian releases.

It would be inappropriate to infer differential exploitation on the USA and Canadian tagged salmon because of differences in timing, location of sampling, and the number of fish scanned for tags.

7.1.3 Status of Canadian stocks

Biological assessment of 6 selected Canadian index rivers revealed that target egg depositions were achieved or exceeded in the Miramichi, Margaree, LaHave, and Conne rivers but not in the Restigouche and St John's rivers. In all of the above rivers, the numbers of 1SW salmon far exceeded target levels. Escapement of 1SW salmon in the Miramichi was nearly 5 times greater than the target value. Returns of MSW salmon were considerably lower than forecast from 1987 returns of 1SW salmon (Table 32).

7.2 France - St Pierre and Miquelon Islands

Mention was made of published reports of commercial landings of Atlantic salmon by residents of the St Pierre and Miquelon Islands. The quantity and significance of these landings remain to be determined.

7.3 USA

7.3.1 The Fisheries in 1988

Maine is the only state in the USA that allows a sport harvest of Atlantic salmon. The total catch in 1988 was 0.9t of which 19% were 1SW.

There was a low harvest of MSW salmon in the Penobscot River due to a season limit of 1 MSW fish per angler and lower returns to the river. Record high river temperatures during June and July also contributed to the low harvest.

The overall catch in Maine rivers (other than the Penobscot) continued to show a decline from 0.25 to 0.33 of the average annual catches recorded during the previous decade. This decline, which began in 1986, is due primarily to an apparent reduction in angling effort caused by low numbers of fish in the rivers.

7.3.2 Composition and origin of the catch

No salmon originating from any other country are taken in USA rivers.

7.3.3 Status of USA stocks

The status of Atlantic salmon stocks in Maine rivers was assessed using long-term angling catches, survival of hatchery-reared stocks, redd counts, juvenile salmon production, and 1SW:MSW salmon ratios in the Penobscot River.

Angling catches in 1987-1988 for Maine rivers with salmon runs that are predominantly of wild origin were 68% below the annual average for the previous 20 years.

Hatchery-reared salmon fry, parr, and smolt releases have more than tripled in the last 10 years (Anon, 1989a) yet adult returns have remained the same or declined in most rivers. Total return rates for Penobscot River smolt releases 1970-1986 are shown in Figure 13. The return rate for the 1985 and 1986 smolt classes were among the lowest observed in the past 18 years.

Juvenile salmon production, measured by electrofishing and expressed as numbers of 1+ and older parr/100 yd2 (unit) was reviewed for five Maine rivers. Unit values for all rivers sampled were lower than previously recorded except for a tributary of the Machias River where unit values have remained stable.

The 1SW:MSW ratio (by smolt class) for Penobscot salmon returns for the period 1970-1988 show that the 1985, 1986 smolt classes yielded the highest ratios since the restoration programme began.

It appears that more 1SW or fewer MSW salmon are returning to Maine rivers. It was concluded that there has probably been a decline in the sea survival of Maine MSW salmon or an increase in the proportion of fish maturing at 1SW.

7.3.4 Exploitation rate of tagged and untagged salmon

In the development of the Carlin tag harvest model for Maine stocks, it was necessary to estimate reporting rates for tagged and untagged salmon returning to Maine rivers. If the reporting rates are accurate, estimates of uncorrected angler exploitation from the return of tagged fish should be higher than those from returns of untagged fish. An examination of the historical time series of exploitation estimates for the two groups, however, showed that estimates were higher for untagged fish (dependent t-test, $p = 0.018$). Possible causes were discussed but it was considered premature to adjust the harvest model parameters.

7.4 Evaluation of the Effectiveness of New, Existing, or Proposed Management Measures for Homewater and Interception Fisheries on Stocks Occurring in the Commission Area

7.4.1 Effect of management measures in Canada on Canadian stocks

No new conservation measures were introduced in Canada in 1988. The impact on spawning escapement and harvests of management measures imposed in 1984 and 1985 were described in Anon 1986a.

Using preliminary figures for 1988 it was estimated that the measure of complete closure of some fisheries resulted in a decreased harvest and an increase in spawning escapement of 175t of MSW and 20t of 1SW salmon.

It was estimated that 55t MSW and 5t 1SW were forgone as a result of the delayed opening of the season in the Newfoundland and Labrador commercial fishing area. Some of these salmon would have been subject to fishing mortality when the season opened; however, this is not quantifiable.

As noted in Anon 1987, the average landing of salmon after 15 October (1981-1983 and 1985) was 7t. Some of these fish not taken because of the early closure may be available to the fisheries in the following years; however, the majority would probably return to rivers in the USA and Canada.

The mean ratio of total Canadian MSW salmon to 1SW salmon harvests of the same smolt class for the period 1983-1987 (1.14) was significantly lower ($P = 0.01$) than the mean ratio for the years 1975-1982 (1.97) (Table 33). This indicates that Canada is catching fewer MSW salmon relative to 1SW salmon of the same smolt class than before the 1984 Management Plan.

The impact that recent management measures have had on returns to five rivers of the Gulf of St Lawrence was investigated by an analysis of 1SW:MSW ratios (for the same smolt class) in the Bartholomew, Margaree, Miramichi, Mitis, and Nepisiquit rivers. Regression coefficients for pre-management plan years 1975-1983 and management plan years 1984-1987 indicated the numbers of MSW salmon relative to 1SW salmon returning to those rivers had increased by 60% and that the management plan appeared to have been effective.

The spawning escapements and ratios of MSW spawners to returns increased in the three New Brunswick rivers (Restigouche, Miramichi, St John) in 1984-1988 compared to previous observations due to measures to reduce fishing mortality within the rivers. However, in both 1987 and 1988, estimated returns of MSW salmon to the Miramichi and St John rivers were less than predicted. As most of the predictions are based on 1SW returns it appears that either MSW salmon sustained higher marine mortality, or that 1SW salmon experienced lower marine mortality than in previous years, or the proportion salmon maturing at 1SW increased.

7.4.2 Effectiveness of management measures taken in Canada in reducing the harvest of USA-origin salmon

7.4.2.1 Evaluation of management measures since 1984

In order to assess the combined effects of all measures taken by Canada 1984-1987, the harvest of 1SW salmon of Maine origin in the Newfoundland-Labrador commercial fishery was compared to the Maine run size of 2SW fish in the following year. For the years 1967-1983, the ratio of Newfoundland harvest to homewater run size averaged 0.53 ± 0.37 (Table 34). The 1987 ratio is less than for any year since 1981.

In order to test the effect of the 15 October closure, the mean ratio of the two most recent years 1986-1987 (0.25) was compared with the previous 18 years (0.518). The difference was not significant. Both harvest levels in 1987 and run size of the same smolt class decreased compared to 1984 and 1985; however, an increase was noted from 1986. The reduced harvest in Newfoundland in both 1986 and 1987 is consistent with the expected impact of the closure of the fall fishery by Canada in 1986.

7.4.2.2 Potential effects of USA proposed managements measures for the Newfoundland-Labrador commercial fishery on Atlantic salmon stocks in North American Commission area

The proposal to impose a quota of 416t in Statistical Areas A and B was examined to determine its effectiveness in reducing or stabilizing the harvest of USA-origin salmon and its impact on the harvest of Canadian-origin stocks.

It was considered that such a measure may result in saving less than 300 USA-origin salmon in years when the quota is attained. These fish would be subject to natural mortality and possibly fishing mortality in other fisheries before they could reach home rivers in approximately 10 months.

The implementation of a quota could have both positive and negative impacts on Canadian-origin salmon and these were listed.

7.4.3 Effect of management measures in USA

The primary new regulations enacted in the State of Maine in 1988 were: the prohibition of the sale of salmon taken by angling and the mandatory registration of all salmon caught in the sport fishery (1SW fish were previously exempt). Since these additional measures did not become effective until August, the impact of these management measures could not be evaluated in 1988.

The management measures taken in 1985 to reduce the fishing mortality in the Penobscot River have resulted in more than a 50% reduction in the exploitation rate of MSW salmon.

7.5 Numbers of USA-Origin Salmon Harvested in Canada

7.5.1 Historical catches in Newfoundland-Labrador commercial fisheries of 1SW salmon which originated in the USA

The time series of tag returns and harvest estimates of the Maine-origin 1SW salmon in Newfoundland and Labrador was updated and data for 1987 and 1988 fisheries added (Table 35). The parameters used in the harvest model remain unchanged from the previous assessment in Anon 1988b.

Summaries of tag returns and harvest estimates by year are in Tables 37 and 38. The 1987 harvest estimates are similar to those for the previous year. Harvest estimate summaries by week and area for years with changes in harvest are in Table 39.

7.5.2 Harvest estimates of USA-origin salmon from CWT and Carlin tag return data in Canada in 1987

Comparison of harvest estimates based on CWT and Carlin tag recoveries for the communities sampled and the neighbouring areas in the Newfoundland-Labrador fishery showed that the ratio between the two estimates varied among locations with usually higher estimates by the CWT method (Anon, 1989a). Concerns over these comparisons were discussed.

7.6 Potential Effects of NASCO's Lottery System on Tag-Return Rates and Provision of Scientific Advice

ICES was requested by NASCO to evaluate the potential effects of the trial 4-year, voluntary lottery on tag return rates and provision of scientific advice.

The intention of the lottery is to encourage and improve the return of tags and recapture information. Based on an analysis of tag releases and recoveries of Maine-origin salmon it was concluded that detection of a statistically significant increase in reporting rates could take many years. The concern by the Working Group on the potential adverse affects of the lottery were listed. The Working Group concluded that because of the potential problems of interpreting historical data, because of the low likelihood of detecting changes, and the confounding of ongoing programmes, they could not endorse the trial lottery proposal.

ACFM concurs with the Working Group's evaluation of potential problems of the lottery system with respect to detecting reporting rate changes, in estimating the reporting rate and interpreting historical data.

ACFM, however, notes that it was previously shown (Anon, 1985a) that the reporting rates of tags had the greatest influence on the calculation of estimated harvests. It was also mentioned earlier in this report (Section 5.1.4, p.18) that the most likely explanation of the big differences between the harvest of USA fish at West Greenland as calculated from Carlin tag and CWT data was due to the assumed reporting rate (80% being too high) and non-detection of tags. ACFM concludes, therefore, that any increase in tag reporting towards the 80% assumed level will tend to reduce the errors in the existing Carlin tag harvest model rather than continue or add to them.

8. HOMEWATER FISHERIES

Details of homewater fisheries are given in Section 8 of the Working Group report. The descriptions are under 4 main headings, the fishery in 1988, abundance and exploitation, status of stocks, and effectiveness of management measures. For Canada and the USA, these topics are mainly dealt with in Section 7.

9. GENERAL TASKS

9.1 Compilation of Tag Release Data for 1988

Data on tag releases were provided in a prescribed format and have been compiled as a separate report entitled "ICES Compilation of Microtag, Finclips, and External Tag Releases in 1988". An excess of 1.43 million microtags (CWTs) and 0.4 million external tags were applied to Atlantic salmon released in 1988 (Table 41). In addition, 1.46 million salmon were finclipped.

ACFM notes, however, an inconsistency in this information. In two places in the Working Group report comparisons are made between the number of fish with adipose fins clipped and the number of CWTs found. In Section 7.1.2 (p.28), 31% of the salmon with clipped adipose fins also contained CWTs. In Section 5.1.2 (Table 10, p.69), 27.5% of the salmon with clipped adipose fins also contained CWTs. In Anon 1988a, last year's report, 30% of fish with clipped fins also had CWTs. This suggests to ACFM that only 30% of the salmon on average in the ocean that have clipped adipose fins also contain CWTs. If 1.43 million salmon containing CWTs were released in 1988 and 1.3 million were released in 1987 (Anon, 1988a) then 4.8 million and 4.3 million fish with clipped adipose fins should also have been at large.

The North Atlantic Salmon Working Group reported only 2.89 million and 2.40 million fish with clipped adipose fins, or 60% and 55% respectively of the estimated releases. ACFM encourages Member Countries to make every attempt to report all of the Atlantic salmon that have clipped adipose fins.

9.2 ICES Data Base

The Working Group now feels that the need for this type of data compilation has been superseded by the progress on modelling.

10. DATA REQUIREMENTS AND RESEARCH NEEDS

ACFM endorses the 6 data requirements and research needs as listed in this report.

11. RECOMMENDATION

ACFM endorses the recommendations of the Working Group and of the three Study Groups.

JUNE 1989
EDINBURGH

ANNEX 16

COUNCIL

PAPER CNL(89)35

DECISION OF THE COUNCIL TO REQUEST SCIENTIFIC ADVICE FROM ICES

The Council decides to request the following scientific advice from ICES:

(1) With respect to Atlantic salmon in each Commission area:

(a) describe events of the 1989 fisheries with respect to gear, effort, composition and origin of the catch.

(b) estimate exploitation rates in home water and interception fisheries on stocks occurring in the Commission area.

(c) continue the development of models to describe the fishing interactions and stock dynamics in order to estimate the effects of management measures.

(d) evaluate the effectiveness of new or proposed management measures for home waters and interception fisheries on stocks occurring in the Commission areas;

(e) specify data deficiencies and research needs.

(2) With respect to Atlantic salmon in the North-East Atlantic Commission area:

(a) with respect to the impact of aquaculture on wild salmon stocks, provide quantitative estimates of the effect of escapees on the number of salmon in the open ocean and home waters.

JUNE 1989
EDINBURGH

ANNEX 17

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

COUNCIL

PAPER CNL(89)11

RETURNS UNDER ARTICLES 14 AND 15 OF THE CONVENTION

CNL(89)11

RETURNS UNDER ARTICLES 14 AND 15 OF THE CONVENTION

1. At its Fourth Annual Meeting the Council agreed a format for the annual return under Articles 14 and 15 of the Convention. The form for the 1988 return was circulated on 14 February 1989 for completion by the Parties. All Parties were requested to complete and return the form even if there had been no changes since the last notification. Where changes have been notified under Article 15, the Laws, Regulations and Programmes concerned have been lodged with the Secretariat and this information will be incorporated into the Laws, Regulations and Programmes database. Copies of the detailed submissions are available from the Secretariat. A summary of the new actions taken under Articles 14 and 15 of the Convention is attached.

2. At its Fifth Annual Meeting the Council asked the Secretary to consider how the summarised information submitted under Article 15 might be produced in a more standard form as regards content and length. It is difficult to do this where the returns themselves vary considerably but an attempt has been made to avoid extreme differences in length. With regard to content the differences in the submissions reflect the different systems of legislation and programmes in the different Parties and there is therefore little scope for producing a more standard form.

Secretary
Edinburgh
15 May 1989

ARTICLE 14

1. ACTIONS TAKEN TO MAKE EFFECTIVE THE PROVISIONS OF THE CONVENTION

1.1 The prohibition of fishing for salmon beyond 12* nautical miles from the baselines from which the breadth of the territorial sea is measured.

* 40 nautical miles at West Greenland
* Area of fisheries jurisdiction of the Faroe Islands

Denmark (in respect of the Faroe Islands and Greenland)

Five ships were charged for fishing in the area outside the fisheries jurisdiction of the Faroe Islands. The captain of each ship had to pay a fine of DKr 50,000 and further the catch and the fishing tackle were confiscated.

1.2 Inviting the attention of States not party to the Convention to any matter relating to the activities of the vessels of that State which appears to affect adversely the salmon stocks subject to the Convention.

NO NEW ACTIONS

1.3 Measures to minimise the by-catches of salmon originating in the rivers of the other member. [North American Commission members only]

Canada

The licensing policy in place since 1984 has resulted in a further reduction of 127 commercial salmon licences in Newfoundland-Labrador in 1988.

1.4 Alteration in fishing patterns in a manner which results in the initiation of fishing or increase in catches of salmon originating in the rivers of another Party, except with the consent of the latter. [North American Commission members only]

NO NEW ACTIONS

2. ACTIONS TAKEN TO IMPLEMENT REGULATORY MEASURES UNDER ARTICLE 13

NO NEW ACTIONS

ARTICLE 15

3. LAWS, REGULATIONS AND PROGRAMMES ADOPTED OR REPEALED SINCE THE LAST NOTIFICATION

Canada

Although no new measures have been adopted since the last notification, the Canadian authorities submitted details of amendments to the Prince Edward Island Regulations, the text of which had not been finalised in time for the 1988 Annual Return. The amendments reduce the number of Atlantic salmon that can be caught and released while angling from an unlimited number to twice the daily catch limit, ie. a maximum hook and release at present of two salmon per day. In addition the amendments reduce the number of salmon that can be retained by individual anglers on a seasonal basis from an unlimited number to a maximum of five.

EEC

The wealth of salmon legislation of a Community, national, regional or local nature within the Eruopean Community is subject to a process of continuous review and assessment to ensure its effectiveness for the conservation and rational management of the salmon stocks concerned. Therefore, whilst major framework legislation are not by their nature in the short-term subject to modification, laws are enacted, adopted or repealed relating to the day-to-day management of the stocks at the level of rivers or river systems in conformity with the objectives of Community management. The Community has submitted:

(a) New salmon conservation measures introduced in England, Scotland, Wales and Northern Ireland in 1988;

(b) A comprehensive list of Statutory Instruments made during 1988 in relation to the management of salmon in Ireland;

(c) Decrees introduced in France concerning the prohibition of salmonid fishing in certain estuaries.

Iceland

In 1988 a regulatory measure was enacted which limits the distance of sea-cages and salmon-ranching stations to 15km from the estuary of salmon streams with an average catch exceeding 500 salmon. For streams with a catch of 200-500 salmon this distance must be at least 5km, although this distance may be reduced if local stocks are being reared. A further enactment limits the use of Norwegian origin salmon stocks to land based rearing operations. Norwegian salmon eggs have been imported three times to Iceland under severe inspection and quarantine conditions. The progeny from these eggs are now becoming sexually mature and eggs are available to the aquaculture industry. Being of foreign origin these stocks are considered potentially harmful if released into the wild.

Norway

There is a total ban on drift net fishing in homewaters from the 1989 fishing season. Furthermore, it has been decided to reduce salmon fishing substantially inside the baseline including both marine and freshwater fisheries. Detailed regulations were agreed upon on 14 April 1989. The most important elements are a significant reduction in the effort of the bend net fisheries by shortening the season and increasing the weekly close time, and a ban on the use of monofilament materials in nets from the next season. In addition it is decided that nets with a mesh size of 35mm or more intended for fishing for marine fish, during a certain period, shall be set 3 meters below the surface. In freshwater there will be a 14 day shortening of the fishing season at the end of the season and a total ban on salmon fishing in 74 rivers for 5 years. However, in 51 of these, fishing for anadromous brown trout and arctic char will still be legal.

The government grants for the Gryrodactylus program and the gene bank for frozen sperm have been raised from 3.6 million kroner in 1988 to 5.4 million kroner in 1989. The liming programme also deals with acidified salmon rivers, and the total sum for the programme has been raised from 14 million kroner to 21 million kroner in 1989.

<u>Sweden</u>

A new ordinance about the prohibition to fish for salmon in the North Atlantic north of latitude 36 degrees N.

<u>USA</u>

Several new Atlantic salmon management measures, intended to clarify some perceived inconsistencies between statute law and Atlantic Salmon Commission regulations, became effective in the State of Maine during 1988. The impact of these measures will be to strengthen existing laws and regulations that prohibit the incidental and/or illegal take of Atlantic salmon. The measures may be summarised as follows:

(1) the minimum length in inland and coastal waters is defined as total length;
(2) the method of taking salmon in coastal waters from May 1 - October 15 is restricted to hook and line - salmon taken by any other means must be immediately released;
(3) the closed season in coastal waters is now from October 16 - April 30;
(4) the bag limit from all waters of the state (inland and coastal) is now expressly defined as one per day and five per season.

4. OTHER NEW COMMITMENTS RELATING TO THE CONSERVATION, RESTORATION, ENHANCEMENT AND RATIONAL MANAGEMENT OF SALMON STOCKS SUBJECT TO THE CONVENTION

<u>Canada</u>

Small scale projects at specific rivers throughout the Atlantic Provinces.

<u>EEC</u>

These new commitments are incorporated in the above-mentioned section. Further, the Community considers a commitment to maintain in force effective existing measures to be tantamount to a new commitment.

5. OTHER FACTORS WHICH MAY SIGNIFICANTLY AFFECT THE ABUNDANCE OF SALMON STOCKS SUBJECT TO THE CONVENTION

Finland

Low pH is likely to be a problem in the future and the number of escapees from the salmon farming industry in Northern Norway.

Iceland

Ranching is increasing rapidly in Iceland.

Norway

An increasing amount of farmed salmon has been observed in the Norwegian homewater fishery and among the spawning populations in many rivers. At least 600,000 - 700,000 salmon escaped after net pen breakage in 1988. That is the same amount of fish as the total estimated wild salmon run. An examination of the fish caught in connection with the brood stock fishery (for cultivation) in 54 rivers in 1988 showed that the frequency of farmed fish had doubled since the year before.

JUNE 1989
EDINBURGH

ANNEX 18

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

COUNCIL

PAPER CNL(89)12

CATCH STATISTIC RETURNS BY THE PARTIES

CNL(89)12

CATCH STATISTIC RETURNS BY THE PARTIES

1. At its Fourth Annual Meeting the Council decided that, in accordance with Article 15, paragraph 1, of the Convention, the Parties should be asked to provide available catch statistics for salmon stocks subject to the Convention, directly to the Council. A format for the return of the Official Catch Statistics was agreed by the Council at its Fifth Annual Meeting.

2. The Official Catch Statistics for 1988, as submitted by the Parties, are tabulated overleaf (Table 1). These catch statistics, rounded to the nearest tonne, will be used to calculate the contributions to NASCO for 1990 unless the Secretary is advised otherwise.

3. Under Article 12 of the Convention, the Secretary is to compile and disseminate statistics and reports concerning salmon stocks subject to the Convention. Table 2 presents catch statistics for the period 1960-88 by Party to the NASCO Convention.

4. Tables 1 and 2 are set out in the format agreed by the Council at its Fifth Annual Meeting for the presentation of catch statistics. A further more detailed record of catch statistics during the period 1960-1988 is provided for information only in paper CNL(89)13.

Secretary
Edinburgh
16 May 1989

TABLE 1: OFFICIAL CATCH STATISTICS

	PROVISIONAL 1988 CATCH (TONNES)	PROVISIONAL 1988 CATCH ACCORDING TO SEA AGE						CONFIRMED 1987 CATCH (TONNES)
		1SW		MSW		TOTAL		
		NO.	WT	NO.	WT	NO.	WT	
CANADA	**1280**	361211	658	134217	622	495428	1280	1784
DENMARK (In respect of Faroe Islands and Greenland)	**1111**							1539
FAROE ISLANDS	**219**	--	--	--	--	--	219	576
GREENLAND	**892**	--	--	--	--	--	892	963
EUROPEAN ECONOMIC COMMUNITY	**2697.2**	--	--	--	--	--	2697.2	2592.8
FINLAND	**34**	--	8	--	26	--	34	49
ICELAND*	**412**	52709	176.4	16606	55.6	69315	232	249.5
NORWAY	**1104**	--	--	--	--	--	1104	1385
SWEDEN	**40.2**	--	--	--	--	--	--	46.7
UNION OF SOVIET SOCIALIST REPUBLICS	**419**	53158	138	43970	281	97128	419	559
UNITED STATES OF AMERICA	**0.9**	49	--	210	--	259	0.9	1.2

* The breakdown of the Icelandic catch according to sea-age does not include ranched fish.

TABLE 2: CATCHES OF ATLANTIC SALMON BY THE PARTIES TO THE NASCO CONVENTION

	CANADA	DENMARK*	EEC	FINLAND	ICELAND	NORWAY	SWEDEN	USA	USSR
1960	1636	60	2676		100	1576	40	2	1100
1961	1583	127	2342		127	1456	27	2	790
1962	1719	244	3948		125	1838	45	2	710
1963	1861	466	3862		145	1697	23	2	480
1964	2069	1539	4290		135	2040	36	2	590
1965	2116	861	3696		133	1900	40	2	590
1966	2369	1338	3611		106	1823	36	2	570
1967	2863	1600	4540		146	2058	25	2	883
1968	2111	1167	3645		162	1752	150	2	827
1969	2202	2350	4420		133	2083	76	2	360
1970	2323	2361	4036		195	1861	52	2	448
1971	1992	2511	3802		204	1847	35	2	417
1972	1759	2146	4187	32	250	1976	38	2	462
1973	2434	2402	4538	50	256	2126	73	3	772
1974	2539	1945	4339	76	225	1973	57	1	709
1975	2485	2086	4413	76	266	1754	56	2	811
1976	2506	1480	2901	66	225	1530	45	1	
1977	2545	1658	2977	59	230	1488	10	2	
1978	1545	1167	3070	37	291	1050	10	4	
1979	1287	1695	2542	26	225	1831	12	3	430
1980	2680	2053	2593	34	249	1830	17	6	631
1981	2437	2603	2532	44	163	1656	26	6	450
1982	1798	2610	2523	83	147	1348	25	6	311
1983	1424	1434	3509	78	198	1550	28	1	436
1984	1112	998	2290	73	159	1623	40	2	593
1985	1133	1437	2989	49	217	1561	45	2	652
1986	1559	1490	3524	38	330	1597	53	2	608
1987	1784	1539	2593	49	250	1385	47	1	559
1988	1280	1111	2697	34	412	1104	40	1	419

NOTES: * In respect of Faroe Islands & Greenland

1. The EEC catch consists of the sum of the catches of the present members of the Community for which data are available.

2. The catch for Denmark in respect of the Faroe Islands and Greenland includes the catch for Greenland when it was a member of the European Community and the catches up to 1983 by Denmark.

3. Figures from 1986 are the official catch returns to NASCO. Figures pre-1986 are based on data contained in the ICES Working Group Reports.

JUNE 1989
EDINBURGH

ANNEX 19

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

COUNCIL

PAPER CNL(89)14

REPORT ON THE ANALYSIS OF CATCH STATISTICS

In accordance with the decision of the Council at its Fifth Annual Meeting this paper was submitted to the Parties in draft form prior to production as a Council document. The information on which this review is based has previously been agreed in consultation with the Parties and is contained in Annex 1.

CNL(89)14
ANALYSIS OF CATCH STATISTICS

1. INTRODUCTION

1.1 At its First Annual Meeting the Council, taking into account Article 15, paragraph 1 of the Convention, asked the Secretary to undertake an analysis of catch statistics for salmon stocks subject to the Convention.

1.2 In order to undertake this analysis, a catch statistics questionnaire (CNL(86)11 Revise 1), designed to provide information about the Parties' salmon fisheries, the procedures for collecting the catch statistics and the data contained in the salmon statistical bulletins, was prepared. At its Third Annual Meeting the Council agreed that the Parties be asked to suggest detailed amendments to this questionnaire and that the amended version be sent to the ICES Working Group for comment. The result of these consultations was a questionnaire (CNL(87)11) which the Council agreed was appropriate for use in the analysis of catch statistics. This questionnaire was circulated for completion by the Parties on 11 November 1987 and responses were received during 1988.

1.3 The following analysis of catch statistics is based on the information contained in the catch statistics questionnaires. A summary of the information for each Party on which this review is based is contained in Appendix 1. These summaries and the analysis have previously been submitted in draft to the Parties and amended in accordance with comments received.

2. COLLECTION OF CATCH STATISTICS

2.1 This section of the analysis reviews the systems used by the Parties to enable the collection of catch statistics from the "recreational", "commercial" and "other" fisheries. Definitions of these terms are given in Appendix 2. Recreational fisheries for salmon occur in all countries with the exception of Greenland. Directed commercial salmon fisheries occur in all countries except the USA. In addition, native or subsistence fisheries occur in Canada and Finland. A variety of methods is used to enable the collection of salmon catch statistics by the Parties.

2.2 The most commonly adopted system of collection of salmon catch statistics involves licensing all salmon fishermen with a requirement that the fishermen, or fishing associations, submit catch returns. This system is used in the EEC (England and Wales, Ireland), Greenland, Iceland, Norway, USA and USSR. It is also the system adopted for the collection of catch statistics from the commercial salmon fisheries in the EEC (France, Northern Ireland), Faroe Islands and Sweden, although different methods are used for the collection of catch statistics from the recreational salmon fisheries.

2.3 In the Faroe Islands recreational salmon fishermen are not licensed and there is no requirement for the fishermen or fishing organizations to make catch returns.

2.4 In Sweden recreational salmon fishermen are not licensed by the State but a permit is required in freshwater and the catch statistics are submitted by the fishing associations.

2.5 In the EEC (England and Wales, Ireland) all salmon fishermen are licensed and are required to submit catch returns. This system is also used for the commercial fisheries in the EEC (France, Northern Ireland). In Northern Ireland all recreational salmon fishermen are licensed but are not required to make catch returns. Catch statistics are, however, requested for catches in the Foyle Fisheries Commission area. In both Ireland and Northern Ireland salmon dealer networks are operated, requirements of which are that the dealers maintain records of transactions. In France, recreational fishermen are not licensed and are not required to make catch returns. Scotland does not require licensing of salmon fishermen but all salmon fisheries are privately owned and the proprietors or occupiers of the fisheries are required to make catch returns.

2.6 In Finland all salmon fishermen are licensed but are not required by law to make catch returns. The Finnish Game and Fisheries Research Institute is responsible for collecting all catch statistics, which are requested from the fishermen.

2.7 In Canada, all recreational salmon fishermen are licensed by the provincial governments, but the method of collection of the statistics varies. In Nova Scotia, and in wildlife reserves in Quebec, the recreational fishermen are required to make catch returns. Elsewhere in Quebec the statistics are submitted by Private Clubs, outfitters etc. Similarly in Labrador the catch statistics are submitted by Sports Camp Operators. In New Brunswick recreational catch statistics are collected by survey method and in Prince Edward Island and Newfoundland estimates of recreational catches are made by Department of Fisheries and Oceans enforcement staff. The commercial fisheries in the Maritime Provinces are presently closed but in Quebec commercial salmon fishermen are required to make catch returns. In Newfoundland and Labrador there is no requirement to make returns but catches are reported by fish buyers through sales slips and by enforcement officers for local sales. Indian bands are also licensed to fish for salmon and the Band Councils submit the statistics.

2.8 With regard to the period of collection of catch statistics in all cases the Parties collect the salmon catch statistics according to calendar year. In some cases, however, information relating to shorter time periods is available. Thus, for example, in the EEC (England and Wales) the statistics from the commercial salmon fisheries are submitted monthly or annually depending on region and may provide data on daily or weekly catches. Similarly, in Canada estimates of the recreational catches may be made on a weekly basis. In the case of the Faroe Islands the quotas are allocated to the boats according to season but the catches are allocated according to calendar year.

2.9 In relation to catches of salmon in non-salmon gear, in Norway and Sweden, fishermen are required to make catch returns for salmon caught in non-salmon gear. In practice, however, the Norwegian catches from non-salmon gear are not usually reported. In Canada, Iceland, and in almost all cases in the EEC (Scotland) it is illegal to retain salmon caught in non-salmon gear. In the EEC (England and Wales, France, Ireland), Faroe Islands, Finland and USSR catch returns are not required for salmon taken in non-salmon gear.

3. PUBLISHED CATCH STATISTICS

3.1 The salmon catch statistics published by the Parties include catches from all gear types with the exception of the statistics for the Faroe Islands, the EEC (France, Northern Ireland (excluding the river Foyle)) which do not include catches from the recreational fisheries.

3.2 The statistics for Canada, EEC (England and Wales, Ireland, Scotland), Iceland, Norway, Sweden, and USA, include information on both numbers and weight. Those for the EEC (France, Northern Ireland), Greenland, Faroe Islands, and USSR include only weight data. In Finland both numbers and weights are published for the recreational fisheries, but only total weight for the commercial fisheries. In the main, published weights are derived from actual weighings of whole round fish. The exceptions to this are in Canada, Faroe Islands, Greenland and in some areas of Sweden. In Canada site specific average weights for large salmon and grilse are sometimes used. In the Faroe Islands the fish are landed with heads but gutted and glazed and are raised to round fresh weight equivalent using a raising factor of 1.11. In Greenland, the fish are landed with heads but gutted and are also raised to round fresh weight equivalent using a raising factor of 1.11. In Sweden the weights are mainly of whole round fish but in some cases the weight of commercially caught salmon is derived from fish with heads but gutted and raised to round fresh weight equivalent using a factor of 1.1.

3.3 In the published statistics for Canada, Iceland, Finland, Greenland and Norway the catches are allocated to weight classes. In the published statistics for Canada, Finland and the EEC (Scotland) the catches are differentiated into multi-sea-winter salmon and grilse. In Canada this differentiation is on the basis of length (grilse less than 63cm and salmon fish of 63cm and over) and some error is known to occur. In Scotland the differentiation is on the basis of weight. In Iceland although the published statistics do not distinguish between multi-sea winter salmon and grilse this would be possible on the basis of weight with grilse being fish under 7lbs. The published statistics for the other Parties neither allocate catches to weight classes nor differentiate between multi-sea-winter salmon and grilse.

3.4 In the published statistics for most Parties the catch statistics are allocated to gear type. In the case of the Faroe Islands the only permitted method of fishing in the commercial fishery is the floating long-line and in the USA only recreational (rod and line) fisheries exist. In Greenland the catches are all allocated to a type of gear known as "drivgern". In Iceland the catches are allocated to sport fishing, net fishing and sea-ranching. The published statistics for the EEC (France, Northern Ireland) and USSR are not allocated to gear type.

3.5 In Finland, Iceland, USA and USSR the fisheries are conducted exclusively in freshwater while in the Faroe Islands and Greenland the published statistics are for commercial fisheries conducted exclusively in the marine environment. In the EEC (England and Wales) and in Sweden the recreational fisheries are conducted almost entirely in freshwater while the commercial fisheries occur in the marine environment. Similarly, in Canada each of the three types of fishery occur only in either freshwater or the marine environment. In the EEC (Ireland) the recreational fishery is confined exclusively to freshwater and with the exception of a limited number of commercial fixed engines operating in freshwater the commercial fishery is conducted in marine and estuarine waters. In Scotland the recreational fisheries are almost exclusively in freshwater. The commercial catches are not allocated to marine and freshwater components but are allocated to net and coble which is used principally in inland waters, sea lochs and estuaries, and fixed engines which are only permitted outside these areas. The published statistics for the EEC (France and Northern Ireland) are not allocated to marine and freshwater components.

3.6 No allowance is made in the published statistics of any Party for non-catch fishing mortality associated with the fishing gear. In the commercial statistics for the EEC (Northern Ireland) allowance is made for the inclusion of sea-trout in the catch returns. No such allowance is made in the statistics of other Parties. Returns to ranching stations are included in the

Icelandic salmon statistics but elsewhere salmon ranching returns are not included in the published statistics.

3.7 In addition to the return of official catch statistics to NASCO, all Parties submit their statistics to ICES. In addition some Parties submit statistics to FAO (Canada, Greenland) and NAFO (Canada, Greenland, USA). The inland component of the catch statistics are submitted to EIFAC (FAO) by the EEC (England and Wales, Ireland, Northern Ireland and Scotland).

4. SUMMARY

4.1 The most commonly adopted method of collecting salmon catch statistics in the North Atlantic is to licence all fishermen and to require licensed fishermen to make catch returns. However various other methods of collecting catch statistics are also used. An assessment of the relative merits of these systems is not possible. In most cases, salmon catch statistics are collected from all components (i.e. recreational, commercial and other) of the fisheries although in the EEC (France, Northern Ireland (with the exception of the river Foyle)), and the Faroe Islands statistics from the recreational fisheries are not collected. The magnitude of these omissions is unknown.

4.2 There are also differences in the way in which salmon caught in non-salmon gear are treated. Some Parties require catch returns to be made for salmon caught in non-salmon gear, some do not require a return to be made and others make it an offence to retain salmon caught in this type of gear.

4.3 At its Fifth Annual Meeting the Council discussed the question of unreported catches and agreed that the question could be reviewed in the light of the analysis of catch statistics. No assessment of unreported catches is possible on the basis of the information contained in the questionnaire. The Working Group on North Atlantic Salmon considers unreported catches to be an important component in stock assessment but reported that the accuracy of unreported catch estimates will continue to be a problem since there are few definitive studies being undertaken on which to base such estimates.

4.4 In most cases the published salmon statistics include catches from all gear types. Both numbers and weights of salmon are published except in the EEC (France, Northern Ireland), Greenland, Faroe Islands, USSR, and Finland (commercial catches), where weight data only are provided. Weight data are in the main derived from actual weighings of whole round fish. However, in Greenland, Faroe Islands and in some areas of Sweden the weights are based on gutted or glazed gutted fish weights raised to round fresh weight equivalent, though different raising factors are used. In Canada, site specific average weights are sometimes used. In most cases the published statistics do not differentiate between multi-sea-winter salmon and grilse, although weight classes are often used. In most Parties' published statistics, the catches are allocated to gear type and in many cases to freshwater and marine components. In some cases the occurrence of fisheries in estuarine waters makes such allocation difficult. In most countries returns to ranching units are not included in the statistics although the statistics for Iceland do include such returns. In the EEC (Northern Ireland), allowance is made in the statistics for the inclusion of sea-trout in the returns.

5. CONCLUSIONS

5.1 The analysis of catch statistics, both the method of collection and the processing and publication of the data, is a complex matter as can be seen from the above report. There are clearly differences which may affect the comparability of the catch data. If the Council so wishes, the Secretariat could prepare a paper reviewing means to achieve a more comparable approach. This would take the form of a discussion paper for the 1990 meeting.

5.2 With regard to unreported catches this review can offer no new information. A broad study by the Secretariat of the range of problems which lead to unreported or under-reported catches could be produced as a discussion paper for the 1990 meeting.

Secretary
Edinburgh
16 May 1989

Appendix 1

SUMMARIES OF CATCH STATISTICS QUESTIONNAIRES ACCORDING TO PARTY

CANADA:

Collection of Catch Statistics

1. In Canada all recreational salmon fishermen are licensed by the provincial governments. In New Brunswick, salmon anglers under 16 years of age may, obtain their own licence or fish under their parents licence and utilize the parents tags and a portion or all of the parents daily limit. Licensed, recreational fishermen in New Brunswick are not required to submit catch statistics, which are collected by a survey method. In one small area the recreational catch statistics are submitted and these are used as a check on the province wide catch statistics. In Nova Scotia individual licensed salmon fishermen are required to make catch returns according to calendar year. In Quebec all recreational salmon fishermen are licensed and are required to make catch returns for salmon taken in wild life reserves. Outside wildlife reserves the catch returns are made by Private Clubs, Zones d'exploitation controlee, outfitters and the Park Service. These statistics are collected according to calendar year. In Prince Edward Island all recreational salmon fishermen are licensed but are not required to make catch returns. These are obtained by Department of Fisheries and Oceans enforcement staff. At present the recreational salmon fishery in Prince Edward Island is restricted to the Morell River. In Newfoundland and Labrador all recreational salmon fishermen are licensed. They are not required to make catch returns but are requested to submit catch records although this is not a requirement of the licence. In addition estimates of weekly catches are made by Department of Fisheries and Oceans enforcement staff. In Labrador, sports camp operators provide their customers catch statistics to the Department of Fisheries and Oceans.

2. All commercial salmon fishermen in Canada are licensed. Commercial catch statistics are collected according to calendar year. When the commercial salmon fisheries in the Maritimes were open, log books were mandatory. These fisheries are presently closed. The Prince Edward Island commercial salmon fisheries are closed at present and all but one licence have been bought back from the fishermen. In Quebec all commercial salmon fishermen are required to make catch returns according to calendar year. In Newfoundland and Labrador, all commercial salmon fishermen are licensed but are not required to make catch returns. These are reported by fish buyers through sales slips and by enforcement officers for local sales.

3. In addition to the recreational and commercial fisheries described above, some Indian Bands are licensed to fish for Atlantic salmon and the Band Councils submit the catch statistics, according to calendar year, to the Department of Fisheries and Oceans. The retention of salmon caught in non-salmon gear is now prohibited by law in Canada.

Published Catch Statistics

4. The published salmon catch statistics for Canada include catches from all gear types used in the recreational, commercial and subsistence fisheries. Both numbers and weights of salmon

are presented but the weights are not derived from actual weighings of whole round fish. Average weights are sometimes used for large salmon (63cm and over) and grilse (less than 63cm) and prorated on local sales estimates. Average weights are usually site specific rather than an average weight being used for the total Canadian catch. The catch statistics differentiate between grilse (fish less than 63cm) and multi-sea-winter salmon (fish 63cm and greater in length) although some mis-classification is known to occur. Catches are allocated according to gear when different gear types are used e.g. drifting gill nets, set gill nets, trap nets. Catches are not, however, allocated to freshwater or marine components since each of the three fisheries are restricted to either freshwater or marine environments. No allowance is made in the published statistics for non-catch fishing mortality, or the inclusion of sea-trout or ranched fish. In addition to the return of official catch statistics to NASCO the Canadian statistics are reported to ICES, FAO and NAFO.

DENMARK (IN RESPECT OF THE FAROE ISLANDS AND GREENLAND):

Collection of Catch Statistics

1. In the Faroe Islands recreational salmon fishermen are not licensed although fishing cards are issued on two lake systems. There is no requirement for recreational salmon fishermen or recreational fishing organizations to make catch returns.

2. All Faroese commercial salmon fishermen are licensed and are required to make catch returns on landing sheets. These landing sheets for individual vessels must be returned by buyers and have to be countersigned by official inspectors. Although quotas on the commercial salmon fishery are based on seasons, the catch statistics are presented according to calendar year. Fishermen are not required to make returns for salmon caught in non-salmon gear.

3. All salmon fisheries in Greenland are commercial fisheries taking place in the marine environment. All commercial fishermen are licensed and are required to make catch returns. These statistics are collected according to calendar year.

Published Catch Statistics

4. The published statistics for the Faroe Islands comprise the catches from the commercial fishery, in which only one gear type (floating long line) is permitted. Only weight data are included in the statistics. The weights are derived from the gutted weight at landing (glazed) raised to whole round fish equivalent by a factor of 1.11. The catches are not allocated to weight classes, are not differentiated between multi-sea-winter salmon and grilse and are not allocated to gear type since only one type of gear is permitted. The commercial catch is taken exclusively in the marine environment. No allowance is made in the statistics for non-catch fishing mortality or the inclusion of sea-trout or ranched fish. Returns of salmon to ranching units are not included in the statistics. In addition to the official catch statistics submitted to NASCO the Faroese commercial catch statistics are submitted to ICES.

5. In Greenland only one gear type is used and all the catch is taken in the marine environment. The published statistics include weight data but no details of numbers. The weight data are derived from weighings of salmon with heads but gutted and raised to a round fresh weight equivalent by multiplying by a factor of 1.11. The catch statistics are allocated to 6 weight groups but are not differentiated between multi-sea-winter salmon and grilse. These weight

groups are as follows:

(a) from 1kg to under 3kg first class or second rate
(b) from 3kg to under 5kg first class or second rate
(c) over 5kg first class or second rate.

No allowance is made in the published statistics for non-catch fishing mortality or the inclusion of sea-trout or ranched fish. In addition to the official catch return to NASCO the catch statistics for Greenland are also submitted to NAFO, ICES and FAO.

EUROPEAN ECONOMIC COMMUNITY:

Collection of Catch Statistics

1. Within those Member States of the European Community in whose rivers salmon originate and where salmon fisheries are authorised, salmon fishermen are required to make catch returns and are usually subject to a licensing system.

2. In Ireland and in England and Wales, all recreational salmon fishermen are licensed and are required to make catch returns. These statistics are collected according to calendar year. In Ireland the recreational salmon fishermen submit their catch statistics to the Department of the Marine. Statistics relating to sales of salmon by recreational fishermen are collected by the Regional Fisheries Boards. In England and Wales, in addition to the licensing of individual fishermen who are required to make catch returns, a number of general licences are issued to catch salmon where returns are made by the proprietors or clubs concerned. In Northern Ireland all recreational salmon fishermen are licensed but are not required to make catch returns. However catch statistics are requested for catches in the Foyle Fisheries Commission Area. In France recreational salmon fishermen are not licensed and are not required to make catch returns. In Scotland, recreational salmon fishermen are not licensed. The salmon fisheries are, however, privately owned and it is the responsibility of the proprietor or occupier of a fishery to provide catch return information, according to calendar year, in respect of their fishery.

3. All commercial salmon fishermen in Ireland, France, Northern Ireland and England and Wales are licensed. In England and Wales the individual commercial fishermen are required to make regular catch returns which, depending upon the region, may be monthly or annual and may provide data on daily or weekly catches. Similarly, in France all commercial fishermen are required to make catch returns. In Ireland, it is mandatory for salmon dealers to enter in a register all salmon purchased/sold. The catch statistics are then collected according to calendar year by the Regional Fisheries Board from the salmon dealers. An individual who wishes to export salmon outside the country must obtain an export licence. Similarly, in Northern Ireland, fishermen are required to make annual returns to the Department of Agriculture for Northern Ireland and, where applicable, also to the Foyle Fisheries Commission. A salmon dealer network is in operation and a requirement of this is that a return of all transactions is made to the Department of Agriculture for Northern Ireland. In Scotland, commercial fishermen are not licensed. These fisheries are privately owned and catch returns are required from the proprietor or occupier of the fishery.

Published Catch Statistics

4. The published salmon catch statistics for England and Wales, Ireland and Scotland include catches from all gear for both the recreational and commercial fisheries, with the number and weight data of whole round fish being published.

5. Catch statistics in Ireland, for instance those submitted to ICES, differentiate between one-sea-winter and multi-sea-winter salmon. In England and Wales, statistics are differentiated into multi-sea-winter salmon and grilse using the total weight of the catch and average weight for each sea-age class. In Scotland the statistics are not allocated to weight classes but are differentiated into multi-sea-winter salmon and grilse on the basis of weight. The catch statistics are allocated according to gear type in England and Wales, and Ireland.

6. In Ireland, the recreational fishery is confined exclusively to freshwater with the commercial fishery being conducted in marine and estuarine waters with the exception of a limited number of commercial fixed engines which operate in freshwater. In England and Wales the catch is also allocated into commercial instrument and rod and line components. In Scotland the recreational fisheries are almost exclusively freshwater. Catches are allocated between fixed engine, net and coble and rod and line. The commercial catch is not allocated to marine and freshwater components but of the two categories used, net and coble is principally used in inland waters, sea lochs and estuaries and "fixed engines" are only permitted outside these areas.

7. In the published statistics for England, Wales, Ireland and Scotland there is no allowance made for non-catch fishing mortality, the inclusion of ranched fish or the mis-classification of sea trout as salmon. Sea trout are however reported separately in Ireland's annual report.

8. Catch statistics for the recreational fisheries are not maintained in France or in Northern Ireland (other than those described above for the Foyle Fisheries Commission). Information on numbers of salmon is not published for the commercial fisheries in France and Northern Ireland but the weight data are derived from actual weighings of whole round fish. The published catch statistics for France and Northern Ireland are not allocated to weight classes, differentiated between multi-sea winter salmon and grilse, or allocated according to gear type or to freshwater and marine components. No allowance is made in the published catch statistics for France and Northern Ireland for non-catch fishing mortality or the inclusion of ranched fish but allowance is made in the published statistics for Northern Ireland for the inclusion of sea-trout in the commercial salmon catch returns.

9. In addition to the return of official catch statistics to NASCO, the inland waters and estuary and coastal component of the statistics for England and Wales, Ireland, Northern Ireland and Scotland are reported to ICES and the inland component to the European Inland Fisheries Advisory Commission of the F.A.O.

FINLAND:

Collection of Catch Statistics

1. In Finland, all recreational and commercial salmon fishermen are licensed but are not required

by law to make catch returns. The Finnish Game and Fisheries Research Institute is responsible for collecting all catch statistics. These are collected by requesting the information from the individual licensed fishermen. The statistics are collected according to calendar year. In addition to these fisheries there is a small rod and line subsistence fishery carried out principally by Lappish residents of the Teno valley. Participants in this subsistence fishery are licensed but are also not required to submit catch statistics. These are requested, according to calendar year, by the Finnish Game and Fisheries Research Institute.

Published Catch Statistics

2. The published salmon catch statistics for Finland include catches for the recreational, commercial and subsistence fisheries. Both numbers and weights are provided for the recreational fishery but commercial and subsistence fishermen report only the total weight of salmon. The weight data are derived from actual weighings of whole round fish. The reported statistics are allocated to weight classes and are differentiated between multi-sea-winter salmon and grilse (since 1986). The catches are also allocated to gear type. Rod and reel fishing is the only permitted method in the recreational and subsistence salmon fisheries but five different types of fishing gear are used in the commercial fisheries. Catches from all fisheries are made in freshwater. No allowance is made in the published statistics for non-catch fishing mortality or the inclusion of sea-trout or ranched fish in the statistics. In addition to submission of official salmon catch statistics to NASCO, the catches for Finland are also reported to ICES.

ICELAND:

Collection of Catch Statistics

1. In Iceland all recreational salmon fishermen are licensed and are required to make catch returns. The statistics are collected according to calendar year from the fishermen by the Fisheries Associations for individual streams or by sports clubs that have rented the streams from the Fisheries Associations. The Fisheries Associations submit the catch returns to the Institute of Freshwater Fisheries. Similarly, all commercial salmon fishermen are licensed and are required to make catch returns. Commercial fishermen make these returns according to calendar year. In Iceland it is illegal to retain incidental catches of salmon taken in the sea.

Published Catch Statistics

2. The published Icelandic salmon catch statistics include both recreationally and commercially caught salmon. Both numbers and weights of salmon are provided with the weighings being of whole round fish. The data are allocated to weight classes and although multi-sea-winter salmon and grilse are not distinguished in the published figures an estimate could be made by assuming that grilse weigh less than 7lbs. The catches are allocated into sport fishery, net fishery and ranching. Ranched fish are separately specified in the published statistics if the fish return to ranching stations. No allowance is made in the statistics for non-catch fishing mortality or the inclusion of sea-trout. In addition to submission of official catch statistics to NASCO the Icelandic catches are also reported to ICES.

NORWAY:

Collection of Catch Statistics

1. In Norway all recreational salmon fishermen are licensed and are required to make catch returns. In accordance with the Salmon and Freshwater Fisheries Law of 1964, a State fishing license is required by any person above the age of 16 who intends to fish for salmon, sea-trout, sea-run arctic char or freshwater fish. In addition, the permission of the land owner must be obtained i.e. a local area fishing license. Recreational fishing in the sea by rod and line and trolling is free for all persons who have purchased the state fishing license. Norway is divided into 34 salmon districts each with its own salmon board. The salmon board compile the catch statistics submitted by the fishermen and the fishery proprietors. Recreational catch statistics are collected according to calendar year.
2. Similarly, all commercial salmon fishermen are licensed and are required to make catch returns. The State fishing licence is paid by all commercial salmon fishermen but in addition the drift net fishery is regulated by a special state licence. In 1987, there were 578 commercial fishermen with such a drift netting licence. No special licence is required for fishing with anchored gear and the right to fish with such gear belongs to the land owner. In Finnmark county, the State is the principal landowner and permission to fish is granted to a limited number of fishermen, upon payment of an additional fee to the State. The catch statistics for commercial salmon fisheries using anchored gear are compiled by the Salmon Boards in each district. The catch statistics for drift nets are based upon catch journals submitted by the fishermen to the Central Bureau of Statistics. Catch statistics for commercial salmon fisheries are collected according to calendar year. Fishermen are required by law to report catch statistics for salmon caught in non-salmon gear. In practice these catches are not usually reported.

Published Catch Statistics

3. The published Norwegian salmon catch statistics include data from both the recreational and the commercial fisheries. Both numbers and weights are provided with the weighings being of whole round fish. The data are presented for two weight classes (<3kg and 3kg and over) but are not differentiated into grilse and multi-sea-winter salmon. The catches are allocated to gear type. Recreational fisheries are divided into rod, net and unspecified gears, and the commercial fisheries are divided into pound net (both single and double), bend net, stationed lift net, drift net and unspecified gears. The catch for each of these gears is divided into sea and river catch. Catches of sea-trout and sea char are pooled in the published report but are separated from the salmon catches. No allowance is made in the statistics for non-catch fishing mortality or the inclusion of ranched fish. In addition to submission of official salmon catch statistics to NASCO the Norwegian salmon catches are also reported to ICES.

SWEDEN:

Collection of Catch Statistics

1. In Sweden there is no State salmon fishing licence for recreational fishermen. However, a fishing permit is generally required for salmon fishing in freshwater and the catch statistics

are collected, according to calendar year, by the fishing associations or by regional fishery officers. No permit is required for recreational salmon fishing in the sea.

2. All commercial salmon fishing in Sweden generally requires a license and licensed salmon fishermen are required to maintain log books to make catch returns. These returns are made according to calendar year. In addition fishermen operating fixed gear require permission to fish from the regional County Office. Fishermen are required to make returns for salmon caught in non-salmon gear e.g commercial trawl fishermen.

Published Catch Statistics

3. The published Swedish catch statistics include both recreationally and commercially caught salmon. Both numbers and weights are provided with the weighings being, in the main, of whole round fish. In some cases the weight of commercially caught salmon is derived from fish with heads on but degutted and raised to round fresh weight equivalent by multiplying by a factor of 1.1. The published salmon catch data are not allocated to weight classes or differentiated into multi-sea-winter salmon and grilse. They are, however, allocated to gear type and freshwater and marine components. No allowance is made in the statistics for non-catch fishing mortality or the inclusion of sea-trout or ranched fish. In addition to submission of official catch statistics to NASCO (both recreational and commercial catch data) the Swedish catches are also reported to ICES (commercial catch data only). The commercial catch data are published by the National Swedish Bureau of Statistics. The Swedish authorities hope to gradually improve their catch statistics.

USA:

Collection of Catch Statistics

1. In the United States of America all salmon fishing is recreational in nature. There are no directed commercial salmon fisheries. All recreational salmon fishermen are licensed and are required to make catch returns. These statistics are reported according to calendar year.

Published Catch Statistics

2. The published catch statistics for the recreational salmon fishery in the United States refer to both numbers and weights of fish and the weighings are of whole round fish. The published salmon catch statistics are not allocated to weight classes or differentiated into multi-sea-winter salmon and grilse. No allowance is made in the published statistics for non-catch fishing mortality, or the inclusion of sea-trout or ranched fish. In addition to submission of official salmon catch statistics to NASCO the catches for the United States are also reported to ICES and NAFO.

USSR:

Collection of Catch Statistics

1. In the USSR all recreational and commercial salmon fishermen are licensed and are required

to make catch returns. The catch statistics are collected according to calendar year. In addition, licences may be issued for salmon fishing for scientific purposes and for capture of broodstock. Fishermen operating under such licences are required to make catch returns according to calendar year. Fishermen catching salmon in non-salmon gear are not required to make catch returns.

Published Catch Statistics

2. The published salmon catch statistics for the USSR include catches from all gear types. Only weight data are presented with the weighings being of whole round fish. The data are not allocated to weight classes or gear type and are not differentiated into multi-sea-winter salmon and grilse. All catches of salmon are taken in freshwater. No allowance is made in the published statistics for non-catch fishing mortality or the inclusion of sea-trout or ranched fish. In addition to submission of the official commercial catch statistics to NASCO, the commercial catch statistics are reported to ICES.

Appendix 2

DEFINITIONS

Recreational	-	means salmon fishing carried out principally for leisure or sporting purposes (eg. rod and line)
Commercial	-	means salmon fishing carried out principally for the provision of income to the fishermen (eg. drift net, long line, net and coble, fixed engines etc)
Other	-	means any fishery taking salmon but not covered by recreational or commercial above (eg. subsistence, by-catch, etc).

JUNE 1989
EDINBURGH

ANNEX 20

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

COUNCIL

PAPER CNL(89)16

SUMMARY OF MICROTAG, FINCLIP AND EXTERNAL TAG RELEASES IN 1988

CNL(89)16

SUMMARY OF MICROTAG, FINCLIP AND EXTERNAL TAG RELEASES IN 1988

1. At its Fifth Annual Meeting the Council asked that the new compilation of tag release information requested by NASCO and provided by ICES should continue on an annual basis so that the information be deposited with NASCO. The General Secretary of ICES and the Secretary of NASCO have arranged that this procedure continue. The Secretary was also asked to consider how the information might be presented to the Council in a summary form.

2. A summary of the information on tagging programmes conducted by the Parties in 1988 is attached as Table 1. A total of almost 3.3 million fish were either tagged or marked during 1988, prior to release of which 43% were microtagged, 44% were finclipped, 12% were tagged with external tags and 1% were branded or dyemarked. In addition approximately 1.5 million auxilliary marks were used, principally adipose clips used in conjunction with microtagging. Out of the total of 3.3 million marked fish released, approximately 95% were of hatchery origin.

3. Table 2 presents a comparison of the tagging programmes in 1987 and 1988. The 1988 figure of 3.3 million released marked fish is 17.5% higher than the number released the previous year. This increase was due to a 19% increase in the release of microtagged fish and a 23% increase in the number of finclipped fish. There was a reduction in the number of external tags applied in 1988 although there was a 53% increase in the number of external tags applied to wild fish. The number of wild fish tagged increased in 1988.

Secretary
Edinburgh
7 June 1989

TABLE 1

SUMMARY OF 1988 TAG RELEASES BY PARTY

PARTY	ORIGIN	MARKING METHOD: MICROTAGS	EXTERNAL	BRANDS, DYEMARKS ETC.	FINCLIPS	AUXILIARY, FINCLIPS, MARKS ETC.
Canada	Hatchery	9160	59189	-----	330494	46356
	Wild	4162	23399	-----	66028	-----
	Mixed*	-----	1130	-----	------	-----
	TOTAL	13322	83718	-----	396522	46356
Denmark (Faroe Islands)	Hatchery	46446	----	-----	------	46446
	Wild	-----	54	-----	------	-----
	TOTAL	46446	54	-----	------	46446
EEC	Hatchery	373920	1869	18730	108135	394365
	Wild	34072	7954	1105	61	40079
	Mixed	-----	-----	-----	300	-----
	TOTAL	407992	9823	19835	108496	434444
Iceland	Hatchery	231394	3099	-----	------	231394
	Wild	7021	-----	-----	------	7021
	TOTAL	238415	3099	-----	------	238415
Norway	Hatchery	-----	102606	-----	------	-----
	Wild	-----	8880	-----	------	-----
	TOTAL	-----	111486	-----	------	-----
Sweden	Hatchery	-----	7835	-----	------	-----
	Wild	-----	941	-----	------	-----
	TOTAL	-----	8776	-----	------	-----
USA	Hatchery	723400	165218	-----	158152	723400
	Wild	-----	-----	-----	------	-----
	TOTAL	723400	165218	-----	158152	723400
USSR	Hatchery	-----	9600	-----	792274	8100
	Wild	-----	-----	-----	444	-----
	TOTAL	-----	9600	-----	792718	8100
TOTAL	Hatchery	1384320	349416	18730	1389055	1450061
	Wild	45255	41228	1105	66533	47100
	Mixed	-----	1130	-----	300	-----
	TOTAL	1429575	391774	19835	1455888	1497161

* Not differentiated into hatchery or wild fish.

TABLE 2

COMPARISON OF 1987 AND 1988 TAGGING PROGRAMMES

	1987	1988	% CHANGE
MICROTAGS			
Hatchery	1169402	1384320	+18.4
Wild	32773	45255	+38.1
TOTAL	1202175	1429575	+18.9
EXTERNAL TAGS			
Hatchery	358216	349416	-2.5
Wild	26954	41228	+53.0
Mixed	3621	1130	-68.8
TOTAL	388791	391774	+0.8
BRANDS, DYEMARKS			
Hatchery	30575	18730	-38.7
Wild	--------	1105	-------
TOTAL	30575	19835	-35.1
FINCLIPS			
Hatchery	1172501	1389055	+18.5
Wild	2797	66533	+2279.0
Mixed	8867	300	-966.2
TOTAL	1184165	1455888	+22.9
TOTAL			
HATCHERY	2730694	3141521	+15.0
WILD	62524	154121	+146.5
MIXED	12488	1430	-88.5
TOTAL	2805706	3297072	+17.5

JUNE 1989
EDINBURGH

ANNEX 21

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

COUNCIL

PAPER CNL(89)17

NASCO TAG RETURN INCENTIVE SCHEME

CNL(89)17

NASCO TAG RETURN INCENTIVE SCHEME

1. At its 1988 Meeting the Council agreed that, to encourage and improve tag returns, a NASCO Tag Return Incentive Scheme would be established on a trial basis for four years: 1989, 1990, 1991 and 1992. The United States agreed to fund the scheme for the trial period and participation by the Parties is on a voluntary basis.

2. The Council asked the Secretary to ensure that the scheme was in conformity with the Headquarters Agreement. Consultation with the Foreign and Commonwealth Office and the Home Office confirmed that the NASCO scheme is not a lottery in the legal sense since no payment is required by any participant. It is therefore not subject to any UK legislation. Therefore, in view of the confusion that the word "lottery" might cause, the scheme is now called the NASCO Tag Return Incentive Scheme.

3. The Secretary was asked to establish the scheme and I therefore drew up, in consultation with the President, some Draft Rules and submitted them to the Parties for comment on 4 October 1988. After further consultation with the Parties there are minor changes to the Rules and a copy of the revised Rules is attached at Appendix 1. A number of Parties have already indicated that they will participate.

4. Under the scheme the Secretary will contact the Parties at the end of December 1989 to request the details of eligible tags. Those that are received by 1 May 1990 will be entered into the award selection procedure.

Secretary
Edinburgh
22 March 1989

Appendix 1

RULES OF THE NASCO TAG RETURN INCENTIVE SCHEME

1. The objectives of the scheme are to encourage and improve the return of tags and recapture information.

2. Participation by the Parties in the NASCO Tag Return Incentive Scheme is on a voluntary basis.

3. The scheme will operate for a trial period covering tags returned in each of the calendar years, 1989, 1990, 1991 and 1992.

4. The Scheme will initially apply only to individually identifiable external tags. Only tags returned to the appropriate official agency of a NASCO member Party and deemed to be legitimate by the official agency will be eligible. The authorities where the tag originates reports the tag to NASCO.

5. The Secretary will, in December prior to the year when the prizes will be awarded, request each Party wishing to participate to send a list of the names and addresses of eligible tag numbers received during the calendar year ending on 31 December. A Party may choose to submit only a list of eligible tag numbers for each Commission Area as long as that Party knows the identity of the tag holder and can supply this information in the event of the tag winning an award.

6. The Secretary will request that this list of returns for the previous year be received by NASCO by 1 May. Only tag returns received by that date will be eligible.

7. All tag return numbers will be subject to a random selection procedure in which they will be mixed in one closed container and one tag number will be selected blind. The procedure will be scrutinised by a representative of the auditor to NASCO. The person who returned the selected tag will receive a Grand Award of $2500 which the President will announce at the Annual Meeting of the Council. This tag will not be eligible for a further award.

8. The returns will be sorted into the three Commission areas of NASCO according to the place of recapture of the tagged fish. For the purposes of this scheme, the Commission areas shall be considered to include the river systems flowing into the appropriate Commission Area.

9. All tags returned from the North American Commission Area will be subjected to the same procedure as described in paragraph 7 above except that 10 tag numbers will be randomly selected. The persons who returned the selected tags will receive awards as follows:

   The First selected will win an award of $1500
   The Second selected will win an award of $1000
   The Third selected will win an award of $500
   The next seven selected will win awards of $100

   The awards will be announced by the Chairman of the Commission at its Annual Meeting.

10. All tags returned from the North-East Atlantic Commission Area will be subjected to the same procedure as described in paragraph 7 above except that 10 tag numbers will be randomly selected. The persons who returned the selected tags will receive awards as follows:

The First selected will win an award of $1500
The Second selected will win an award of $1000
The Third selected will win an award of $500
The next seven selected will win awards of $100

The awards will be announced by the Chairman of the Commission at its Annual Meeting.

11. All tags returned from the West Greenland Commission Area will be subjected to the same procedure as described in paragraph 7 above except that 10 tag numbers will be randomly selected. The persons who returned the selected tags will receive awards as follows:

The First selected will win an award of $1500
The Second selected will win an award of $1000
The Third selected will win an award of $500
The next seven selected will win awards of $100

The awards will be announced by the Chairman of the Commission at its Annual Meeting.

12. The Secretary will send cheques to the winners within 60 days of the announcement of the award. The Secretary will circulate a list of winners to the Parties.

13. In the event of any dispute by a participant in this scheme the decision of the Secretary shall be final.

14. The Council shall decide after the trial period whether this or a further scheme shall continue.

JUNE 1989
EDINBURGH

ANNEX 22

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

COUNCIL

PAPER CNL(89)41

PUBLICITY FOR INCENTIVE SCHEME (REVISED)

CNL(89)41

PUBLICITY FOR INCENTIVE SCHEME (REVISED)

1. In order to achieve its objective of encouraging the return of tags the new scheme will need publicity. This will vary from Party to Party but a simple poster will probably be required for all Parties and a proposed format is shown in Appendix 1.

2. The proposed procedure would be for each Party to arrange a translation or translations (modifying the format or wording as it sees fit), for example, the name of the authority to which tags are returned would be included. NASCO would then have the posters printed centrally and distributed to the appropriate authorities as agreed by the Party concerned.

3. In addition to the posters a press release would be agreed to be used at the discretion of the authorities concerned. A draft of the Press Release is attached at Appendix 2.

Secretary
Edinburgh
July 1989

NASCO

Appendix 1

REWARDS FOR SALMON TAGS

A TAGGED SALMON COULD BE WORTH UP TO $2500

TO ENCOURAGE TAG RETURNS NASCO WILL BE OFFERING 31 CASH PRIZES EACH YEAR RANGING FROM $2500 TO $100. YOUR TAG WILL BE AUTOMATICALLY ENTERED IN A DRAW FOR THESE PRIZES IF YOU RETURN IT IN THE USUAL WAY TO

....

THIS PRIZE IS IN ADDITION TO THE USUAL TAG RETURN REWARD.

ONLY EXTERNAL TAGS ARE ELIGIBLE.

SEE YOUR LOCAL FISHERIES OFFICIAL FOR DETAILS.

RETURN YOUR TAG

WIN UP TO $2500

11 Rutland Square Edinburgh EH1 2AS Scotland UK
Tel: 031-228 2551 Telex: 94011321 NASC G Fax: 031-228 4384

PRESS RELEASE

LARGE REWARDS FOR SALMON TAGS

The Council of the North Atlantic Salmon Conservation Organization (NASCO) has recently announced the establishment of a tag return incentive scheme with cash prizes of up to $2,500.

NASCO was established by an international Convention in 1984 with the objective of contributing to the conservation, restoration, enhancement and rational management of salmon stocks. The Parties to the Convention are Canada, Denmark (in respect of the Faroe Islands and Greenland), the European Economic Community, Finland, Iceland, Norway, Sweden, the Union of Soviet Socialist Republics and the United States of America. The Organization consists of a Council and three regional Commissions - the North American Commission, the North-East Atlantic Commission and the West Greenland Commission.

The NASCO tag return incentive scheme will apply to tag returns for the calendar years 1989-92. Only external tags are eligible. The objective of the scheme is to encourage the return of external tags and in each year of the scheme 31 cash prizes ranging from $100 to $2,500 will be awarded. In each of NASCO's three Commissions there will be a first prize of $1,500, a second prize of $1,000, a third prize of $500 and seven awards of $100. Tags returned from within each Commission area will be eligible for these prizes. In addition, a grand prize of $2,500 and for which all tags will be eligible will be offered. Any fishermen catching a tagged salmon during the 1989 fishing season, should return the tag in the usual way to the authorities and the tag will be entered in the draw. Prize winners will be announced at the annual meeting of the Organization in June each year. The NASCO prizes will be in addition to the usual tag rewards. Posters giving details of the scheme will be displayed prior to and during the fishing season and local fisheries officials will have details of the scheme.

JUNE 1989
EDINBURGH

ANNEX 23

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

COUNCIL

PAPER CNL(89)19

REPORT OF DUBLIN MEETING ON GENETIC THREATS TO WILD STOCKS FROM SALMON AQUACULTURE

CNL(89)19
REPORT OF THE DUBLIN MEETING ON GENETIC THREATS TO WILD STOCKS FROM SALMON AQUACULTURE

1. At its Fifth Annual Meeting the Council requested the Secretary, in consultation with the General Secretary of ICES, to convene a one-day meeting during the first half of 1989 to assemble what information was available on genetic threats to wild stocks.

2. In accordance with this decision a joint NASCO/ICES meeting was held at the Department of the Marine, Dublin on 23 May. The meeting was well attended by salmon geneticists, biologists and managers from throughout the North Atlantic countries and the report of this meeting is appended to this paper as Appendix 1.

3. The meeting consisted of five formal papers which were presented in the morning session and which served as a basis for an afternoon discussion session. The papers addressed the following questions:

    - To what extent are farmed and wild salmon genetically distinct?
    - Are difference in performance related traits likely to exist between farmed and wild fish and their crosses?
    - Is the stage of life at which fish are released or escape a determinant of their subsequent performance?
    - Can the factors likely to limit the crossing of wild fish and fish of farmed origin be identified?
    - Is aquaculture likely to affect the genetic integrity of wild populations?

4. A number of views on the impacts of farmed fish on the wild stocks was expressed. These ranged from no impact (or even benefits) to serious impacts. The only evidence presented, however, suggested that adverse effects were possible. There was general agreement that there were considerable gaps in our knowledge, and on the need for the necessary experimentation to assess the genetic impact. Such experimentation would be facilitated by the development of techniques to identify individual fish through genetic markers. The urgent need to support such research was recognised.

5. The meeting agreed a number of basic questions including:

    - what are natural straying rates?
    - where do escapees go?
    - to what extent are fish of farmed origin represented among spawners?
    - do wild and farmed fish interbreed?
    - do wild fish and fish of farmed origin interact ecologically?

    In addition the need to develop improved methods of identifying farmed fish in the wild was recognised.

6. In these circumstances where large numbers of farmed fish are occurring in the habitat of wild salmon and their impact is unknown, the meeting recognised the need for

caution. The development of gene banks and of internationally agreed Codes of Practice or recommendations was agreed. Such codes or recommendations could include the following elements:

- cage security
- the use of sterile fish
- tagging of farmed fish and adequate reporting of escapes
- zones free of aquaculture
- emergency netting of severe escapes of farmed fish where legislation permits
- encouragement for the use of local stocks for farming purposes
- measures to maintain the vigour of existing natural stocks
- adoption of Codes of Practice for reducing genetic threats and the impacts of introductions and transfers in general.
- introduction and permanent scientific control of gene banks including sperm preservation as well as wild stock preservation.

7. The Council might like to consider if and how the development of genetic markers and research on impacts might be stimulated. The Council might wish to take note of the recommendation on the practical steps which might be taken in the meantime (such as the development of Codes of Practice or series of recommendations, and gene banks) as covered in other papers on these subjects CNL(89)21 and CNL(89)23.

Secretary
Edinburgh
26 May 1989

Appendix 1

JOINT NASCO/ICES MEETING ON "THE GENETIC THREATS TO WILD SALMON POSED BY SALMON AQUACULTURE" THE DEPARTMENT OF THE MARINE, LEESON LANE, DUBLIN 2 TUESDAY 23 MAY 1989

1. OPENING REMARKS

1.1 The Chairman Dr Alan Youngson opened the meeting, thanked the Irish Government for the arrangements which had been made for the meeting and welcomed all delegates.

2. INTRODUCTION

2.1 The Secretary of NASCO, Dr Malcolm Windsor, introduced the meeting by outlining the involvement of NASCO in the debate concerning the interactions of salmon aquaculture and the wild stocks (Attachment 1).

3. PRESENTATION OF PAPERS

3.1 Dr Tom Cross of the University of Cork, Ireland, presented a paper entitled "To what extent are farmed and wild salmon genetically distinct?" (Attachment 2).

3.2 Dr John Bailey of the Atlantic Salmon Federation, Canada, presented a paper entitled "Are differences in performance related traits likely to exist between farmed and wild fish and their crosses?" (Attachment 3).

3.3 Mr Lars Hansen, of the Norwegian Institute for Nature Research, Norway, presented a paper entitled "Is the stage of life at which fish are released or escape a determinant of their subsequent performance?" (Attachment 4).

3.4 Dr Alan Youngson of the Department of Agriculture and Fisheries for Scotland, presented a paper entitled "Can the factors likely to limit the crossing of wild fish and fish of farmed origin be identified?" (Attachment 5).

3.5 Dr Eric Verspoor of the Department of Agriculture and Fisheries for Scotland, presented a paper entitled "Is aquaculture likely to affect the genetic integrity of wild populations?" (Attachment 6).

4. GENERAL DISCUSSION ON THE GENETIC THREATS TO WILD STOCKS.

4.1 A list of objectives for possible future research was presented by the Chairman and discussed by the meeting. These objectives were:

1. To define genetic units in wild fish assessing gene flow between units.
2. To monitor strains in culture identifying genetic changes entrained by culture itself.
3. To find the means by which introgression of genetic material from farmed fish to wild fish may be studied in the field.

4. To determine the nature of any behavioural or physiological constraints to introgression.

5. To describe the dynamics of introgressed genetic material in wild populations.

6. To monitor the genetic condition of wild and domestic stocks and their performance and productivity.

7. To understand the genetic basis of performance.

4.2 The need to establish priorities for these issues was recognised. Some of these studies might be pursued with existing expertise and facilities. Others would be facilitated by accelerated development of emerging techniques.

4.3 The development of techniques for the analysis of variation in nuclear DNA was described by Dr Ferguson of Queens University, Belfast. Such markers would be very useful in establishing natural gene flow and in structuring experimental studies using neutral genetic tags. The technique is expensive to develop but once suitable probes have been developed it is quicker and screening costs are therefore lower than for mitochondrial DNA analysis. The development of these techniques might enable a biological impact experiment to be set up.

4.4 Present electrophoretic studies being conducted in Scotland, Ireland, England and Wales and Norway were described. In Norway 25% of fish ascending rivers were escapees from fish farms but there is not enough knowledge to predict what the genetic impact of these fish will be. A review of the literature was presented which suggested that some adverse effects were possible. However, in order to make better predictions experiments needed to be devised involving the use of genetic markers. One proposal was that a controlled experiment could be carried out in a monitored salmon stream by manipulation with a farmed stock.

4.5 The attention of delegates was drawn to a number of forthcoming meetings concerning the interactions between aquaculture and wild stocks. These include a meeting in Ireland in September 1989, a meeting in Norway in April or May 1990, a one day meeting of the World Aquaculture Society in Halifax, Nova Scotia in July 1990 and a meeting in Nanaimo, British Columbia in September 1990. It was agreed that there might also be a need for a further joint NASCO/ICES meeting on this subject in 1991.

5. CONSIDERATION OF RECOMMENDATIONS.

5.1 A range of views was expressed by the delegates concerning the genetic threats to the wild stocks posed by salmon aquaculture. These ranged from those who felt that there was unlikely to be any impact (or might even be benefits) to those who felt that there were potentially serious impacts.

5.2 The only evidence presented, however, suggested that some adverse effects were possible. There was general agreement that there were considerable gaps in our knowledge regarding the genetic impact of reared fish on wild stocks. There was also general agreement on the need for, and difficulty associated with, the necessary experimentation required to assess the genetic impact. The development of techniques for the analysis of variation in nuclear DNA would help to solve many of these and other open questions, including introgression, as a basic part of genetic impact and the meeting therefore urgently recommended that development work in this field should be supported.

5.3 The meeting agreed a number of basic questions which need to be answered in order to assess the genetic impact of farmed salmon on wild stocks. These were

- what are natural straying rates?
- where do escapees go?
- to what extent are fish of farmed origin represented among spawners?
- do wild fish and farmed fish interbreed?
- do wild fish and fish of farmed origin interact ecologically?

A number of these questions may be answered by applying or improving current methods. Some of these questions have been addressed by research presently being undertaken in Norway. Similar studies should be conducted in other countries. In addition the need to develop improved methods of identifying farmed fish in the wild was recognised.

5.4 The meeting approved the list of objectives presented by the Chairman as guidelines for future work (Paragraph 4.1). Much of this research was likely to be of a long term nature. The meeting recognised that in the absence of knowledge on impacts there is a need for caution in the meantime and endorsed a number of practical measures such as the development of gene banks and the development of Codes of Practice or Recommendations to minimise possible impacts. Such Codes or Recommendations might include the following elements:

- cage security
- the use of sterile fish
- tagging of farmed fish and adequate reporting of escapes
- zones free of aquaculture
- emergency netting of severe escapes of farmed fish where legislation permits
- encouragement for the use of local stocks for farming purposes
- measures to maintain the vigour of existing natural stocks
- adoption of Codes of Practice for reducing genetic threats and the impacts of introductions and transfers in general.
- introduction and permanent scientific control of gene banks including sperm preservation as well as wild stock preservation.

Dublin
24 May 1989

Attachment 1

INTRODUCTION

by
Malcolm Windsor
Secretary
North Atlantic Salmon Conservation Organization
11 Rutland Square, Edinburgh EH1 2AS

Over the last 15 or 20 years we have seen the rise of a completely new industry - salmon farming. It did not exist in its present form before 1965. The growth of this industry has been so spectacular that we may have already reached the stage where there are more salmon in the sea in cages than there are in the wild. While there is much to admire in this new industry, and it may exert some protective influence on the wild stocks, at least economically, concerns have been expressed about the possible threats this industry poses to the wild stocks. There are a number of potential interactions between aquaculture and the wild stocks including interactions with the aquatic environment, interactions relating to diseases and parasites and, what we are here to discuss today, genetic interactions. We know that farmed salmon now occur in considerable numbers in the wild and these numbers are likely to increase if industry growth projections are accurate. However, little attention has been given to the question of the effects these fish have on the wild stocks. NASCO Council took the view that, as the international body charged with the conservation, restoration, enhancement and rational management of the salmon, we should try to assess the situation. To this end, at its Fifth Annual Meeting the Council recognised the serious nature of some of the threats posed by the aquaculture industry and agreed on a number of steps. These included the possibility of developing an internationally agreed Code of Practice to minimise the impacts on wild stocks, a review of the benefits of gene banks, a request to ICES for information available on the environmental threats, a review of legislation relating to introductions and transfers and, of course, convening this meeting to assess the genetic threats.

I think the basic question we need to address is "Are we now placing at risk 10,000 years of genetic selection and diversity, and if so is this a cause for concern?". I suspect that we shall find various points of view expressed in this room today.

Attachment 2

TO WHAT EXTENT ARE FARMED AND WILD SALMON GENETICALLY DISTINCT?

by
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Most studies comparing the genetic composition of reared strains and wild populations of Atlantic salmon (*Salmo salar*) have utilised enzyme electrophoresis. The method is briefly described and ways of calculating genetic composition (as gene frequencies at polymorphic loci) and extent of genetic variability (as mean heterozygosity) are demonstrated. Results of electrophoretic surveys, from Sweden, Norway, Finland, Ireland and Canada are summarised and other studies, as yet unpublished or in the planning stage, are mentioned. Published results fall into two categories: (i) where reared strains (and sometimes different year-classes of the same strain) are compared directly with the wild populations from which they were derived; and (ii) where a number of reared strains are compared with wild populations from the same general area, but not with their ancestral populations. The first category demonstrates that statistically significant differences in gene frequencies usually occur between reared strains and their wild progenitors. Furthermore, significant differences in allele frequency may occur between various year classes of a particular strain. Both categories show that some reared strains have lower genetic variability (measured as mean heterozygosity) than wild populations. One aspect of this loss of variability is that rare alleles present in the wild ancestral population may be lost in a reared strain.

Mitochondrial (mt) DNA analysis has also been applied to the comparison of reared strains and wild populations of Atlantic salmon. The methodology is described and it is noted that mt DNA, because it is haploid and inherited maternally, is more sensitive to factors which reduce genetic variability, than the nuclear DNA which is assayed indirectly by enzyme electrophoresis. One published investigation of Atlantic salmon from Sweden showed a profound reduction in variability in reared strains compared with wild populations.

It is argued that genetic differences between reared strains and neighbouring wild populations can be due to the origin and/or breeding regime of the reared salmon. If a reared strain originates from another geographic race than local wild populations, then genetic differences are likely to be very large. Three major races, detected electrophoretically, occur in Atlantic salmon. These occupy rivers: (1) in countries surrounding the Baltic; (2) in western Europe and Iceland; and (3) in eastern North America. Inter-racial transfers are not recommended, since for example, differences in disease occurrence or susceptibility have been demonstrated between races. Within races, significant allele frequency differences occur between nearly all wild populations assayed. Thus reared strains are likely to differ genetically from all wild populations except their ancestral population. There have been suggestions by managers and conservationists that reared strains should not be moved between countries. The present evidence from population genetics to support such a ban is ambiguous, with a positive relationship between genetic difference and geographic distance being reported in a few cases and not in most. In this context, it is noted, that the Scottish and Irish salmon farming industries rely heavily on strains of Norwegian origin. In the short term, it would be difficult to replace these with native strains since the imported strains have been selected for fast growth and late maturity over several generations.
The other factor discussed which acts on genetic composition is breeding regime. Two aspects are of importance here: the number of adults used as broodstock and artificial selection. The use of inadequate numbers of parents (less than 50 of each sex equally represented) leads to a type

of inbreeding which results in a loss of genetic variability and changes in gene frequencies at polymorphic loci. This form of inbreeding is progressive in each generation where small numbers of parents have been used. It can be halted by increasing parental number but not reversed except by outcrossing with suitable stock. Many authors have reported such inbreeding in Atlantic salmon and in other salmonid species.

The importance of changes in gene frequencies is not known. If a particular suite of gene frequencies is adaptive or marks adaptation to a certain river, then any change in genetic composition will reduce fitness. (In this context, it is noted that polymorphic gene frequencies of wild populations seem relatively constant over time.) It has been reported that various year classes of the same strain can have significantly different gene frequencies. If such frequency differences are indicative of fitness variations, then cohorts could vary in performance.

Such inbreeding can also result in reductions in variability. Some authors have shown in other salmonid species that such reductions can lead to a decline in overall performance. A reduction in variability can also lead to the loss of rare alleles at polymorphic loci. A loss of this type is permanent (unless outbreeding occurs) and reduces the adaptive potential of a strain. All of the sources of change listed above are potentially alterable. Directional selection as discussed below is less so.

Directional selection for fast growth and late maturity is widely applied in producing smolts for the farming industry. A typical selection programme, while improving the targeted traits, can lead to reduction in heterozygosity and to changes in gene frequencies at other polymorphic loci. It is noted that such a reduction in variability has been prevented in some reported cases by strain crossing, which artificially boosts variability before commencing selection. Such a practice, while suitable for producing smolts for captive rearing, may actually reduce the fitness of these fish in the wild.

In conclusion, it is noted that many more reared strains need to be assayed electrophoretically. It is also noted that reared fish may not only enter the wild through escapes from sea farms. Freshwater rearing facilities and enhancement and ranching programmes are also potential problem areas.

ARE DIFFERENCES IN PERFORMANCE RELATED TRAITS LIKELY TO EXIST BETWEEN FARMED AND WILD FISH AND THEIR CROSSES?

by
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To my knowledge, there have been no studies where marked, domestic salmon have been wilfully released from aquaculture sites. However, there have been several studies, with brook trout (*Salvelinus fontinalis*) and wild rainbow trout (*Salmo gairdneri*) in natural and semi-natural environments that bear directly on this question. Although their results were not consistent, the above trials indicated that performance differences exist between domestic and wild trout and their hybrids. Similar differences should be anticipated between domestic and wild Atlantic salmon.

In Atlantic salmon, differences in performance have been found among wild stocks grown in a common environment, released from the same sea ranching facility, grown in cages, and stocked into the same stream for enhancement purposes. Similar results have been found among domestic strains reared in the same environment and within the same strain reared in different environments. In total, the above examples lead to one general conclusion. Quantitative genetic differences exist among salmon populations, whether they are wild or domestic, and genotype-environment interactions can be expected when stocks or strains are transferred from one environment to another. The question of real concern to salmon managers is whether escaped aquaculture fish are likely to have detrimental genetic effects on indigenous, wild salmon populations.

The homing habitat of Atlantic salmon has led to the differentiation of a large number of relatively discrete stocks that are generally assumed to be locally adaptive. However, it is inappropriate to think that all stock characteristics are necessarily adaptive. Examples exist that suggest some traits may result from a relaxation of selection pressure. Similarly, with respect to fitness, it is naive to suspect that there could only be one successful life history strategy for a given set of environmental conditions. In addition to the pressures of natural selection, gene pools can also be altered by mutation, migration and genetic drift. The latter three forces occur at random and are not predictable. Chance is also a genetic isolating mechanism.

In order to realise a genetic effect in a wild stock, its gene pool, and therefore, gene frequencies, must be permanently altered. However, because selection, mutation, migration and drift act in concert, at all times, the gene frequencies of wild stocks must be considered as dynamic and not static. Similarly, environments are also dynamic. A detrimental effect is more likely to be the result of too rapid change.

Where stable stocks exist in pristine habitats, the relative importance of these forces much achieve some form of equilibrium and remain balanced over protracted time intervals. Throughout their natural range, many salmon stocks are not stable. This may be symptomatic of an environment that is changing faster than new checks and balances can be re-established and natural selection cannot keep pace with the rate of environmental change.

Aquaculture has the potential to further upset this balance by making it possible for a significant increase in the immigration of domestic stocks into the wild. To have a genetic impact, the escapees' alleles and allele frequencies must differ from wild stocks and they must either add their genes to the gene pool or cause the loss of indigenous genes. A genetic impact can result from either introgression or displacement.

The introgression of new alleles from aquaculture escapees may provide additional raw material for natural selection. Escapees can be expected to increase the genetic variability within stocks at the expense of genetic variation between stocks. This may prove to be a benefit in rapidly changing habitats. With respect to fitness, there can be three possible effects. Fitness can remain unchanged, it may decrease or it may increase.

Few will argue that a decrease in natural fitness is not detrimental. However, if the alleles of the "initial gene packet" are not destroyed, this is unlikely. If the alleles contributed by escapees confer a selection disadvantage, the directional nature of natural selection will attempt to redefine the "historically established" gene frequencies. If they are neutral, allele frequencies may change, but fitness and stock characteristics should remain similar to that of the wild stocks. Should the novel alleles confer a selection advantage, fitness may actually increase. The nature and direction of such changes are only speculative.

The "historically established" gene and allele frequencies of proven fitness, cannot be re-established, if alleles from the "initial gene packet" are lost. Natural selection must then begin a new experiment to determine alternative successful combinations. Thus, displacement has the potential to be much more disruptive than introgression.

Among other animals, there are few examples where domestic strains both escape and successfully breed with wild stocks. The majority of domestic animals are unable to survive in the wild or compete successfully for wild mates. In the examples that do exist, there has been a broad range of responses. These include examples of minimal impact in the case of domestic dog (*Canis familiaris*) and coyote (*Canis latrans*) hybrids, successful introgression of domestic genes into a wild pig (*Sus scrofa*) stock, and the virtually complete displacement of European by African honeybees (different sub-species of *Apis mellifera*).

The second example, that of domestic and wild pigs may be of particular relevance in a discussion of the possible genetic effects of escaped salmon. Salmon, like pigs, are noted for their plasticity. They have adapted to inhabit a wide range of environmental conditions, both among stocks and within the same stock in different years. Perhaps the greatest effect of domestication is the simple relaxation of a variety of natural selection pressures which also may vary with environmental conditions.

In domestic environments, alleles that were adaptive in the wild may be unnecessary and therefore have a neutral effect, in terms of fitness. If broodstocks are large enough to minimize inbreeding and drift, null alleles can be maintained in the gene pool for many domestic generations. Should these fish escape they may be capable of a rapid return to the feral state.

While it is uncertain whether all of the conditions necessary to make a genetic impact even exist, it is prudent to assume that some changes will occur. The magnitude of any potential genetic impact will be influenced by the genetic differences between the populations involved. The long term consequences of changing the gene frequencies in wild stocks are unknown.

Nevertheless, in the absence of definitive evidence, the conservation of genetic diversity among stocks is a desirable objective. Preventing the escape of farmed fish is the only sure method of avoiding a genetic impact in wild stocks and husbandry techniques can be expected to improve in this respect. Practices designed to reduce the risk of detrimental genetic impacts should be encouraged.

Some will undoubtedly contend that any change is detrimental and should be prevented, at all costs. Such an inflexible stance is somewhat utopian and perhaps unrealistic. Evidence from other species suggests that, in the rare instances of hybridization between domestic strains and wild stocks, the long term genetic effects are usually of little consequence with respect to either fitness or behaviour. Both the gene pools and environments of wild stocks are dynamic and natural selection will continue to operate on any new gene pool.

IS THE STAGE AT WHICH FISH ARE RELEASED OR ESCAPE A DETERMINANT OF THEIR SUBSEQUENT PERFORMANCE?

by
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The development in farming and ocean ranching of Atlantic salmon has led to an increased proportion of reared fish in nature. Salmon may escape from fish farms at all life stages, while ranched fish are mainly released at smolt stage. The life stage at which fish are released or escape determines the future migration pattern and survival of the salmon. This paper reviews this, with particular reference to Norwegian conditions.

Fish that are released or escape at smolt stage from a river, return with high precision to that system when mature, independent of stock origin (eg Carlin 1969). If smolts are released in the estuary, the straying rate will increase (Carlin 1955, Eriksson et al, 1981). If salmon escape at smolt stage from a marine locality, the adults will tend to return to the area from which they escaped (Sutterlin et al, 1982, Hansen et al, 1989a). These fish are not imprinted to (or have learned) the "home stream" and would therefore have no motivation to enter freshwater before they of physiological reasons have to (Jonsson et al, 1989, Lund & Hansen in prep.), but they will enter rivers and streams in the area to spawn. This lack of motivation might also result in a lower proportion of escaped fish among the spawners far upstream than in the lower part of the stream. When salmon are released or escape at postsmolt or adult stage, they seem to stray to rivers farther away from the site of release when mature (Hansen et al 1987, Hansen & Jonsson in prep). The reason for this could be that salmon are not able to imprint to cues used in homing throughout the whole year and/or at all life stages.

There are many factors determining the survival of salmon in nature. In particular, released salmon and escapees from fish farms have to pass through a number of "bottlenecks" before they are ready to spread their genes. To survive in the sea, the salmon must be physiologically and behaviourally fit for a life in sea water. Size, age and state of maturity of the salmon, and the time and site of release or escape are important factors determining the future fate of these fish.

Experimental releases of reared Atlantic salmon show that there is a seasonal variation in survival (Hansen & Jonsson 1989). Survival is much higher for those fish escaping at smolt stage in the spring than those escaping the following summer and autumn. However, survival will also improve with increased body size which will reduce the predation. Previous male maturity will reduce the number of migrating smolts (Hansen et al, 1989b), and therefore contribute in reducing the overall survival of a smolt group (Lundqvist et al, 1988).

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CAN THE FACTORS LIKELY TO LIMIT THE CROSSING OF WILD FISH AND FISH OF FARMED ORIGIN BE IDENTIFIED?

by
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When both native Atlantic salmon (*Salmo salar*) and fish which have escaped or been released from culture are present in a single drainage system they may not cross freely at spawning. Two categories of restraint can be envisaged. One category will limit contact through differences in the distribution of the two types of fish in the spatial framework of the catchment. The other category will restrain the interaction of fish of both types through behavioral or physiological incompatibility, even when they are present together in the same reaches of stream.

While native fish will disperse throughout a drainage system, escapes or releases may be confined to particular parts of the system. Lack of homing stimulus in opportunist entrants may impair migratory drive. Low motor capacity in recent escapes from culture may reduce migratory vigour. Both effects may be expected to confine farmed fish to the lower parts of catchments. When indigenous and non-native fish are present together, crossing may be limited by behavioral differences between the groups. The density dependent mortalities to which groups of wild fish are exposed are greatly reduced in culture. This may also result in lowered overall levels of aggression. The performance of cultured fish generally may be impaired because of this. In particular, many cultured males may not compete effectively with wild males in pairing with wild females.

In addition, both large and small adult males of the salmonid *Oncorhynchus kisutch* are more effective in competitive spawning than those of intermediate size. Gross (1985) considered this to result from disruptive selection for size at maturity. Cultured *S. salar* males may be disadvantaged in this way since they are often smaller than wild males at adulthood. Crossing will be reduced if farmed males spawn less with wild females than either large, dominant wild adults or sneaking wild parr (Hutchings and Myers, 1988).

Under other circumstances, normally dominant wild males may be prevented from crossing with smaller cultured females by their large size. Female choice of spawning site is in part determined by body size. The lesser flows and water depths likely to be particularly favoured for spawning by small cultured females may preclude the attendance of larger wild males. Cultured males may be reciprocally favoured because of their size-match with cultured females.

Any restraints to the crossing of wild and farmed fish which depend on alterations in the behaviour or physiology of cultured fish caused by the culture environment itself will only act in the first generation of escape or release. Even in this group, the strength with which the restraints may act will be dependent on the stage of life at which release has occurred. Early releases will revert most fully to the condition of wild fish.

However, physiological incompatibility based on genetic differences may limit crossing to an extent which is independent of stage of release. Heggberget (1989) described wide variation in the date of peak spawning in different rivers in Norway. Heggberget hypothesised that the differences were adaptive and a response to differences in over-winter temperature. Spawning early in streams where winter temperatures are low and later where temperatures are higher may result in the matching of the duration of egg incubation to optimum hatching date.

Spawning date may be determined by environmental cues which differ between streams before or as spawning takes place. However, to be of adaptive value in the context of Heggberget's hypothesis, any such cues must be predictive of over-winter temperatures. It seems unlikely that cues of consistent predictive value exist, at least in temperate regions of Scotland, where the same wide range of peak spawning dates exists. In Scotland, as in Norway, peak spawning date also appears correlated with over-winter temperatures but in many rivers peak spawning takes place in the transitional period when winter temperatures are becoming established. Peak spawning date is relatively fixed at single sites but the time at which water temperatures fall to winter levels is often weather dependent rather than seasonal. As a consequence, in single Scottish rivers, fish may spawn in different years at about the same date but over a relatively wide part of the normal temperature range.

The differences in spawning date identified by Heggberget probably therefore result from stock specific selection for spawning date itself. If the differences are genetic they may limit the crossing of escapes or releases from culture with native fish, through asynchronous sexual maturation.

Most of the factors listed above as possible limits on the crossing of wild and farmed fish of the single species *S. salar* might also be considered to be among those limiting the intergeneric crossing of brown trout (*S. trutta*) and Atlantic salmon. Yet such crossing can be demonstrated to occur. Salmon-trout hybrids can be identified electrophoretically particularly where trout have been introduced into the salmon's range (Verspoor, 1988) or where distribution of one or other species is patchy (Garcia de Leaniz and Verspoor, 1989). Since hybridisation between these species is occasionally quite common, it seems unlikely that any of the factors which may limit the intraspecific crossing of native and introduced salmon will prove to be of major or consistent significance.

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IS AQUACULTURE LIKELY TO AFFECT THE GENETIC INTEGRITY OF WILD POPULATIONS?

by
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Farmed Atlantic salmon ascending into a river with an existing wild population of salmon may potentially cause a genetic impact through ecological or reproductive interactions. Ecological interactions could cause a reduction in the numbers of wild fish in subsequent generations increasing genetic drift and reducing genetic variability. Ecological interaction could also cause selective pressures on wild populations to change and so change their genetic make-up. Whether a change occurs will be dependent on the specific nature of the interaction and the circumstances in which it occurs. In contrast, interbreeding will always have a genetic impact. However, its significance will be highly dependent on the degree of adaptively relevant genetic differentiation existing between the farmed and wild stocks involved.

A number of ecological interactions can be envisaged which might give rise to genetic change in the wild stock. The first is the introduction of a disease vector to which the farm but not the wild stock is resistant. Here the wild population would be reduced in size, at least short term and possibly for a large number of generations, until the vector disappears or the population evolves resistance. The second is interference with reproduction. For example, farmed fish may breed later and superimpose their redds on those of wild fish, or they may compete with wild fish for a limited amount of suitable spawning sites. This might both reduce numbers of wild fish the next generation as well as select for changes in spawning timing. Such specific changes may be immediately adaptive but also disruptive of the overall coadaptive nature of the existing gene complex. This could lead to a lower productivity in the longer term until selective pressures restore an optimal genetic make-up. Ecological interactions will also occur between the offspring of farm fish and those of wild fish. For example, with respect to territories and food. Unfortunately, few studies are available to shed light on the actual and potential extent to which ecological interactions might be adverse.

The impact of interbreeding between wild and farm salmon will be to introduce into the wild population genetic types which would normally be infrequent or absent. As the genetic make-up of wild populations will have been moulded by natural selection to provide the mix of genetic types which is optimal for long-term survival and maximum productivity, the new genetic types will on average be expected to be less well adapted. If so, then the productivity of the population will decrease until selection can restore an optimal genetic constitution for the population. This may take many generations. The degree of decrease in productivity and the time taken to restore it will depend on the extent to which the farm stock differs genetically. The genetic change caused by interbreeding may also result in short-term, or even permanent changes to the character of the wild population affected. Studies which have been carried out on interbreeding between salmonid stocks suggest that hybrids between native and hatchery fish will often do less well than native fish in the wild, for example, with regard to juvenile survival and probability of returning as an adult to the natal river to spawn.

Concern for adverse impacts of escaped farm salmon on wild salmon populations is justified based on our understanding of population genetics and on the evidence currently available. How concerned we should be is unclear but undoubtably the extent of any impact will be highly dependent on the numbers of farm salmon relative to wild salmon involved in the interactions which occur.

JUNE 1989
EDINBURGH

ANNEX 24

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

COUNCIL

PAPER CNL(89)21

SALMON GENE BANKS

SALMON GENE BANKS

1. At its Fifth Annual Meeting the Council requested the Secretary to prepare a review of the mechanisms, costs and benefits of establishing gene banks for threatened stocks. This review is appended as Appendix 1.

2. Reduction in the genetic resources of natural fish populations through human activities has become an important fisheries management problem and part of a larger global concern that the genetic resources of the biosphere be preserved. Habitat alteration has caused substantial losses of Atlantic salmon stocks and attempts to restore these stocks suggest that important genetic adaptations may have been lost with the stocks. In the United States many salmon stocks have been lost and are now being rehabilitated. In Norway and Canada it has been estimated that a total of 41 rivers may have lost their salmon populations through acidification. Loss of Atlantic salmon production has also occurred in Sweden and England and Wales. The parasite *Gyrodactylus salaris* has caused large losses in a further 32 river systems in Norway.

3. A new threat, the escape of farmed salmon, may have a potentially even greater impact on natural salmon genetic resources. These escapees now occur in the natural habitat of Atlantic salmon in many countries. A scientific assessment of the likely impact of reared fish on native stocks can only be made when there is a better understanding of salmon genetics and the dynamics of Atlantic salmon populations. However, a number of international conferences have called for a "conservative approach" to the conservation of genetic resources.

4. A number of techniques for preserving genetic resources are available including cryopreservation (freezing of milt), living gene banks (hatchery maintained populations) and wildlife reserves. The cheapest method offering absolute protection of genetic resources for at least 200 years is cryopreservation, a technique which has been widely used in medical and veterinary science and which may benefit the salmon aquaculture industry. Attachment 1 provides details of the present "state of the art" of cryopreservation.

5. Under the NASCO Convention the Parties agree to promote the conservation and restoration of salmon stocks in the North Atlantic Ocean. In view of the serious nature of the threats outlined above, which could lead to further losses in genetic diversity, the Council may wish to consider what information should be gathered and what action might be taken. Among the possible approaches are:

   (a) The production for the Council, in consultation with the Parties, of an international list of all salmon rivers indicating those where stocks have been lost or are threatened with loss.

   (b) The development of agreed guidelines for the establishment and operation of gene banks where Parties decide to establish them. This would help to ensure that such gene banks are technically compatible. Draft guidelines could be submitted to the Council at its next meeting.

Action along these lines would be in line with advice to international organizations made by the FAO of the United Nations which recommended the collection of baseline information on vulnerable populations and the prevention of the extinction and genetic deterioration of valuable stocks.

Secretary
Edinburgh
24 April 1989

Appendix 1

CNL(89)21

SALMON GENE BANKS

1. Introduction:

1.1 At its Fifth Annual Meeting the Council considered the potential threats to wild salmon stocks from the rapidly expanding salmon farming industry. The Council recognised the serious nature of some of these threats and requested the Secretary to prepare a review of the mechanisms, costs and benefits of establishing gene banks for threatened stocks.

2. Background:

2.1 Preservation of genetic material in a gene bank requires a method of long-term storage which will prevent any genetic alteration to the stored material. In the case of plant material storage of seeds at low humidity enables conservation of all but the "recalcitrant" species which have been stored either as fully imbibed seeds at normal temperatures or by cryopreservation in liquid nitrogen (Frankell and Hawkes, 1975). Although there are reports of the successful freeze drying of spermatozoa in rabbits, poultry and bulls (in Zell, 1978), the principal technique of long-term storage of animal material has involved freezing or cryopreservation. This technique has been widely used in agriculture and medicine for storage of erythrocytes (red blood cells), bone marrow, skin, corneas, bone and gametes (in Grout and Morris, 1987). Spermatozoa from a large number of mammalian and avian species has been successfully cryopreserved thereby revolutionising artificial insemination for agricultural and clinical purposes. More recently the embryos of a variety of mammals including cattle, sheep, goats, mice and rabbits have been successfully cryopreserved (in Grout and Morris, 1987).

2.2 The short-term storage (over several days) of fish spermatozoa has been possible for over a hundred years (Truscott et al, 1968), but in the last 20-30 years research has focused on developing cryopreservation techniques. Most attention has been focused on the cryopreservation of spermatozoa of the Salmonidae because of their high value in commercial and recreational fisheries, their importance in aquaculture and the strong public concern for their protection and enhancement (Horton and Ott, 1976). Techniques for cryopreservation of salmonid spermatozoa have now been developed and these have been reviewed by Horton and Ott (1976) and Scott and Baynes (1980). Progress in the four years between these reviews was dramatic with many authors reporting up to 90% fertilization success with cryopreserved spermatozoa (Scott and Baynes, 1980). As in agriculture, cryopreservation offers considerable advantages to the aquaculture industry and gene banks for use in salmon aquaculture have been established at the Institute of Aquaculture, Stirling, UK (Rana, 1988), and Cell Systems Ltd, Cambridge, UK. A gene bank for the preservation of the genetic diversity of threatened wild stocks of salmon has recently been established at the Directorate for Nature Management, Trondheim, Norway (Gausen, 1987). Details of these gene banks are given in Attachment 1. Furthermore, an "egg bank" has been established at the Research Station for Salmonids, Sunndalsora, Norway, with funding from the Farmers Union. The bank produces eggs from selected lines for fish farming, produces eggs for rearing in hatcheries and release, and preserves salmon strains threatened by environmental factors.

2.3 In contrast to the successful long-term storage of the embryos of mammalian species, the ova and embryos of fish have not so far been successfully cryopreserved although there are recent reports of some success with embryos of grass carp from China (Morris, personal communication). Embryos of Atlantic salmon have survived freezing at -55 degrees C and would probably have survived colder temperatures (Zell, 1978). However, the large size of the salmonid egg, the existence of two membranes (the perivitelline membrane and the zona radiata) and low water permeability present considerable technical problems (Stoss and Donaldson, 1983). Ideally a gene bank for the preservation of the genetic diversity of wild salmon stocks would contain spermatozoa and eggs, or embryos but, for the time being at least, cryopreservation of salmon ova and embryos is not feasible. Gene banks for Atlantic salmon based on cryopreservation are therefore restricted to sperm banks. Any genetic material inherited along maternal lines would not, therefore, be included in the gene bank. Sex reversal, where female fish are masculinised would enable the production of sperm from genetic females. The technique is widely used in the aquaculture industry in the production of all female stock. However, it is doubtful if it would be advantageous in gene banking since the mitochondrial DNA genome, which is inherited along maternal lines, would not be present in sex reversed spermatozoa. However, this is a small genome and it is likely that a sperm bank, based on a sound sampling strategy, will incorporate most of the genetic diversity of the wild stocks.

2.4 Living gene banks for Atlantic salmon could also be established as a method of preserving the genetic diversity of wild stocks. For example, the Dexter National Fish Hatchery, New Mexico, has been used since 1974 to rear a variety of threatened and endangered fish species, some of which are extinct in the wild and exist only in captivity (Meffe, 1986). In Hungary, a government sponsored programme maintains 18 "landraces" of common carp, *Cyprinos carpio,* providing fingerlings for aquaculture, for stocking impoundments for recreational fishing and for restoration and enhancement of depleted populations (Lannan et al, in press). Similarly, reference collections of tilapias are being maintained at the Institute of Aquaculture, Stirling (Rana, 1988) and the gene bank programme in Norway aims to develop the technical capacity to maintain salmon stocks over several generations in a living gene bank, although the initial emphasis is on cryopreservation of spermatozoa (Gausen, 1987). However, live fish gene banks are expensive to establish and maintain and do not offer absolute protection for the maintenance of pure and viable strains (Rana, 1988) because of the possible effects of changes in selection pressure in the hatchery environment (Youngson, personal communication). Wildlife reserves are another type of live gene bank intended to preserve both species and genetic diversity. In the river Danube, some areas have been designated as reserves in an attempt to protect the rare Danube salmon or huchen, *Hucho hucho.* Again, however, absolute protection is not guaranteed. Cryopreservation of spermatozoa allows for the maintenance of genetic material in a stable form, over long time periods at relatively low cost (Rana, 1988). The remaining sections of this review examine the mechanisms, costs and benefits of gene banks based on cryopreservation of salmon spermatozoa.

3. Mechanisms:

3.1 In any gene bank system it is essential that the sampling, cryopreservation and thawing procedures are precise to prevent the introduction of unacceptable levels of genetic selection into the recovered population (Morris, personal communication). A reliable system of documentation of samples is vital.

3.2 The design of the optimal sampling strategy for the preservation of genetic diversity requires knowledge of the amount and distribution of genetic diversity in the target species (Allendorf and Phelps, 1981). Lannan et al (in press) considered that although technologically feasible, it will be a major undertaking to ensure adequate representation of population gene pools in gene banks. Representative sampling will require the maintenance of very large collections with consequent implications for funding. Marshall and Brown (1975) considered optimum sampling strategies in the conservation of plant populations. They considered the objective of a sampling programme to be to obtain as representative a sample of the common alleles in the population as possible (i.e. at least 95% of all alleles with a frequency of at least 0.05). However, excessive sampling of any population reduces the total number of populations that may be sampled with given resources, and in the absence of any specific information on the distribution of variation in nature they concluded that a random sample of 50-100 individuals would be more than adequate under most circumstances. However, in the collection of plant material, individual gametes are not being sampled but single heads, panicles etc which represent a number of different gametes in most species. In sampling male salmon an individual's gametes would be collected. Allendorf and Phelps (1981) considered that a standard sample should comprise 40-50 individuals but the possibility of sympatric genetically isolated populations occurring may require additional sampling. Furthermore, the nature of reconstituting the genetic character of a lost stock through back crossing with sperm from the gene bank may require considerable reserves.

3.3 Cross and Healy (1983) concluded that the rivers in their study and possibly all Atlantic salmon rivers should be regarded as genetically separate populations and Stahl (1983) demonstrated differences within river systems. Allendorf and Phelps (1981) considered that the best approach is first to complete a preliminary investigation to estimate the proportion of polymorphic loci and the amount of microgeographic differentiation. The optimal sampling strategy should then be determined on the basis of this information. In the absence of detailed genetic mapping and given the considerable concern about the possible effect of fish farm escapees the strategy adopted by the Norwegian gene bank is to sample spermatozoa from at least 50 individuals from each river system (Gausen, 1987). However, in rivers with threatened populations it may not be possible to obtain samples from this number of individuals and repeat sampling over a number of years may be necessary. The Norwegian gene bank aims to sample approximately 110 rivers during 1989.

3.4 Precautions must be taken to ensure that reared fish are not included amongst males selected for stripping (Attachment 2 provides details of methods for identifying reared fish). Once donor males have been selected they should be anaesthetised and excess water should be removed before stripping (Horton and Ott, 1976). Kazakov (1981) showed that the quality and quantity of sperm produced by Atlantic salmon varied considerably. Thus, the volume of ejaculate ranged from 1.0 to 40.0cm^3, the activity of spermatozoa varied from 13 to 62 seconds and their concentration ranged from 0.19 to 55 million per mm^3. Furthermore, at the end of the spawning season these parameters had fallen by 11-14%, 22% and 21% on average respectively. There will therefore be variation in the fertilizing capacity of cryopreserved sperm (Mounib et al, 1968). Horton and Ott (1976) recommend that males yielding watery or bloody semen should be discarded and only semen that is creamy white should be collected. The same volume of milt should be taken from each fish. Urine contamination does not appear to adversely affect the spermatozoa's fertilization capacity (Horton and Ott, 1976), although the Institute of Aquaculture scientists advise taking steps to avoid such contamination. All equipment coming into contact with the sperm should be sterilized and dry.

3.5 The easiest and most practical cryogen for long-term storage of salmon milt is liquid nitrogen (-196 degrees C) (Scott and Baynes, 1980). At this temperature normal aqueous-based chemical reactions are inhibited thereby preventing alteration in the stored material. However, because damage caused by back-ground radiation is cumulative, in the absence of repair reactions at -196 degrees C, there is the possibility of injury to stored material (Morris, personal communication). Theoretical estimates indicate that samples maintained under liquid nitrogen can be held for between 200 and 32,000 years (Rana, 1988) and experiments with mammalian cells have indicated that the effects of back-ground radiation will be insignificant over periods of up to 1000 years (Ashwood-Smith and Grant, 1977). Bull semen which was cryopreserved in the UK in 1952 has recently been used to successfully fertilise cattle and has resulted in healthy calves (Rana, personal communication).

3.6 Although certain cells can survive freezing at optimal rates, it is generally necessary to add a cryoprotectant. It is thought that the major role of the cryoprotectant is to bind electrolytes preventing them from concentrating in the residual unfrozen solution in and around the cell during freezing. Additionally, they bind to water molecules and reduce pure ice crystal formations and they lower the freezing point of the intracellular fluids to -45 degrees C (Scott and Baynes, 1980). Lovelock and Bishop (1959) considered that cryoprotective properties were limited to substances which are not toxic, have a low molecular weight, a high solubility in aqueous electrolyte solutions and an ability to permeate living cells. Certain macromolecules which cannot permeate living cells have been shown to act as cryoprotectants but their action has not yet been explained (Scott and Baynes, 1980). Glycerol has been widely used as a cryoprotectant for a wide variety of living cells but in some cells, either because of their size or impermeability, dimethyl sulphoxide (DMSO) is a more appropriate protectant (Lovelock and Bishop, 1959). DMSO has proved very successful for freezing salmonid milt (Scott and Baynes, 1980) and has been used extensively for freezing Atlantic salmon milt (Stoss and Refstie, 1983; Mounib, 1978; Truscott and Idler, 1969; Truscott et al, 1968; Gausen (1987); Rana, 1988).

3.7 Undiluted milt with or without cryoprotectant is not suitable for freezing and must therefore be diluted with a suitable extender i.e. a solution which maintains the viability of the cells without activating them (Scott and Baynes, 1980). Truscott and Idler (1969) used an extender based on the chemical composition of seminal plasma and containing sodium chloride, potassium chloride, calcium chloride, sodium bicarbonate, sodium dihydrogen phosphate, magnesium sulphate, fructose and glycine. More recently, however, less complicated formulations have been used and the simplest formulations have generally been most successful (Scott and Baynes, 1980). Stoss and Refstie (1983) believed that the importance of the extender composition appeared to be limited since distilled water with 10% DMSO resulted in 44% fertility in Atlantic salmon. However, they found that the most successful extender was a very simple solution consisting of 0.3m glucose. Insemination with cryopreserved spermatozoa using a freezing medium consisting of 0.3% glucose and 10% DMSO resulted in between 64.7-91.3% eyed eggs. This freezing medium is used in the Norwegian Directorate for Nature Management's gene bank and has resulted in average fertilization rates of 60% for Atlantic salmon. (Gausen, personal communication). The dilution rate used has varied considerably but Truscott and Idler (1969) found that Atlantic salmon milt could be diluted to 20 volumes and be maintained in an inactive but potentially motile condition for several days. High fertilization rates have been achieved for Atlantic salmon using dilution rates of 1:3 by Mounib (1978), Stoss and Refstie (1983), and the Directorate for Nature Management, Norway, Gausen (1987) and 1:8 by Rana (1988).

3.8 A number of techniques of storing the extended milt are available and all have been successfully used with Atlantic salmon. Mounib (1978) used 2ml ampoules (vials) placed over crushed ice and into which 0.5ml of extended milt was pipetted. Stoss and Refstie (1983) used a pelleting method in which extended milt is pipetted into indentations in a block of dry ice (-79 degrees C) with the pellets then being stored in vials in liquid nitrogen. This technique is used in the Norwegian gene bank (see Attachment 1) where 6ml of extended milt is used to form 120-130 pellets, enough to fertilise 1000 eggs. "French" straws, as developed for cryopreservation of bull semen, are preferred by the Institute of Aquaculture, UK and Cell Systems, UK. In the former the straws are cooled to -70 degrees C in a cooling chamber prior to transfer to liquid nitrogen, while in the latter they are suspended at a given height above liquid nitrogen until frozen and then immersed. Clearly, the different techniques result in different freezing rates. Scott and Baynes (1980) consider that the experimental data suggests an optimum freezing rate of between 30-160 degrees C min -1, with slower freezing rates generally being unsuccessful. Fine control of freezing is most easily achieved using the straw technique while the "pellet" technique is restricted to a freezing rate, which will be variable and dependent on the diameter of the pellets formed, of approximately 30 degrees C min -1. However, there is little to choose between the techniques since all have been successfully used (Scott and Baynes, 1980) and have given high fertilization rates.

4. <u>Costs of establishing gene banks:</u>

4.1 The cost of establishing a gene bank will vary according to the sampling costs, the storage system required and the techniques adopted. Costs will also vary from country to country. It is possible to give some indication of costs based on discussions with the Directorate for Nature Management, Norway; Cell Systems Ltd, UK and the Institute of Aquaculture, UK. Where funds permit there may be benefits in having a duplicate gene bank located separately in case of catastrophic loss at any one site.

4.2 Much of the cost of establishing gene banks is associated with sample collection. Portable field equipment, eg. dry ice, liquid nitrogen, Dewar flasks, disinfectants, etc, is unlikely to cost more than about £1000 ($1700). However, collection is a time consuming activity and costs will depend on the geographical distribution of the sampling sites, their accessibility and the availability of fish capture facilities. In Norway, the Directorate for Nature Management has a total gene bank budget of NOK 2,700,000 (£233,000 or $398,500) in 1989. It is estimated that the total cost of each sample (of 120-130 pellets capable of fertilising 1000 eggs) is approximately NOK 800 (£69 or $118). The cost for 50 fish (1 race) would therefore be NOK 40,000 (£3,500 or $5,900). Cell Systems Ltd, UK have estimated that the cost of collection from 50 fish of 1 race including viability testing and documentation together with one year storage would be £5,500 ($9400). However, this figure excludes the cost of travel and subsistence for Cell Systems staff and transport of equipment. Disease indexing would add a further £1250 ($2140) per race to this cost.

4.3 The cheapest method of storing the samples, legislation permitting, is to use an agricultural University or other institution which routinely stores material in liquid nitrogen. The Directorate for Nature Management makes use of the storage facilities at the Breeding Station for Norwegian Red Cattle in Trondheim who charge the Directorate approximately NOK 20,000 (£1720 or $2950) per annum. These costs have been built into the sample costs given above. Cell Systems Ltd have estimated annual storage costs per race (50 fish) to be £420 ($718).

4.4 If, however, cryostorage facilities have to be purchased then higher capital costs will be incurred. The Breeding Station for Norwegian Cattle in Trondheim stores samples (pellets contained in vials) in 530l tanks capable of holding samples from 3000 fish (for example, 60 rivers with 50 fish sampled from each river). Such a tank together with a 200l liquid nitrogen store might cost £10,000 ($17,100) with running costs in terms of liquid nitrogen of approximately £500 ($855). The Institute of Aquaculture uses a system based on storage of 1/2 ml straws in narrow neck Dewar flasks. Each flask can hold 5000 straws. The cost of each flask is approximately £700 ($1200) and a liquid nitrogen store (160l) is approximately £1,500 ($2560). Running costs in terms of liquid nitrogen would be approximately £20 ($34) per annum per flask. Each flask could hold samples from 1250 fish (capable of fertilizing 1000 eggs). Labour costs would be additional in both systems but these costs will depend on whether or not regular viability testing is carried out. In addition some form of alarm system to warn when liquid nitrogen levels are low might be desirable (approximate cost £400 or $684). In large systems where running costs in terms of liquid nitrogen are high a liquid nitrogen generator might be considered, although the cost is high (approximately £25,000 or $42,750).

4.5 Gausen (personal communication) has recently calculated the cost of production of each alevin from cryopreserved sperm to be NOK 3 (£0.26 or $0.44).

5. Benefits of gene banks

5.1 Gene banks have many applications and offer considerable benefits in crop, medical and veterinary science. More recently they have been established for fish species, particularly salmonids, and offer considerable benefits both to the managers of wild salmon populations involved in protection and enhancement of these stocks and to the aquaculture industry. The development of cryopreservation based on liquid nitrogen offers a low cost method for the maintenance of salmonid spermatozoa in a stable genetic form (Rana, 1988).

5.2 The development of salmon gene banks provides a means of protecting threatened genotypes and enables re-introduction of those genotypes in the event of destruction or degradation of the population. It is for this reason that the Directorate for Nature Management in Norway has established a gene bank in Trondheim. There is growing concern in Norway about the extinction of local, indigenous stocks and the erosion of genetic resources. Approximately 25 stocks of Atlantic salmon have been lost or are close to extinction and 15 more have been severely reduced as a result of acidification. The parasite *Gyrodactylus salaris* now occurs in more than 30 river systems and has caused large scale mortalities. Furthermore, the Norwegian authorities consider that the occurrence of fish farm escapees poses a potentially greater threat to the wild salmon stocks than either surface water acidification or Gyrodactylus. These escapees now occur in the habitat of wild Atlantic salmon in a number of countries. Because of these threats to the wild salmon stocks the Norwegian Department of the Environment has funded the Gene Bank Programme in order to preserve the genetic diversity of the wild stocks. Maintenance of the genetic diversity of the wild stocks is also likely to be of benefit to the salmon farming industry.

5.3 Gene banks have made a huge impact in cattle breeding and their potential in fish farming is just as great (Scott and Baynes, 1980). Although salmon farmers are now developing their own "in house" strains, the origins of which become less certain with each generation, the genetic variation in the wild stocks enabled initial selection of strains from rivers such as the Namsen and Alta (Norway) and Shin (Scotland) with rapid growth rates and other attributes favourable to the farmer (Laird and Needham, 1985). Because of economic constraints on broodstock size the cumulative effects of genetic drift, selection and inbreeding in hatcheries may require the introduction of additional genetic information into the stock. For cultured species, the wild stocks must serve as the principal reserve at least until adequate gene banks have been established (Lannan et al, in press). For example, the "egg bank" at Sunndalsora, Norway, uses 20-30 brood stocks of each sex but milt from wild stocks is periodically imported to offset genetic drift. Because of concern about the introduction of disease from wild stocks, the establishment of gene banks with disease free cryopreserved sperm may be of particular interest to the industry in the event of problems with their own lines. In the event of inbreeding, the gene base on farms could be rapidly increased by the introduction of different strains from a gene bank to check inbreeding growth depression (Rana, 1988). Cell Systems Ltd have developed a sperm bank of disease-free sex reversed rainbow trout milt which can be used in the production of all female progeny, without the farmers having to masculinise a proportion of their stock.

5.4 Perhaps the greatest benefit to hatchery managers is that the maintenance of male broodstock would become unnecessary (Scott and Baynes, 1980; Erdahl and Graham, 1978; Rana, 1988) thereby reducing costs without increasing the risks of inbreeding depression (Rana, 1988). Horton and Ott (1976) considered that in hatcheries where Spring Chinook *(Oncorhynchus tshawytscha)* salmon are held for up to 3 months the mortality associated with crowded conditions could be reduced by gene banking resulting in larger broodstocks being available for enhancement programmes.

5.5 The preservation of genes of "wild" stocks before domestication will enable comparisons to be made with "improved" strains at a later date and to determine if any improvements are the result of genetic or husbandry changes (Rana, 1988). In addition, gene banks would enable the geographical - and time - independent distribution of genetic material (Stoss and Donaldson, 1983; Erdahl and Graham, 1978; Horton and Ott, 1976 and Rana, 1988). Thus, for example, crossing of odd and even year pink salmon *(Oncorhynchus gorbuscha)* populations would be possible (Horton and Ott, 1976). Furthermore, transport of frozen material would be cheaper than transport of fish and would minimize the risk of disease transfer (Rana, 1988).

6. Rationale for gene banks:

6.1 Reduction in the genetic resources of natural fish populations has become an important fisheries management problem, part of a larger global concern for the genetic resources of the biosphere (Thorpe and Koonce, 1981). Human activities, such as habitat alteration and destruction, have had a marked effect on the genetic diversity of fish populations. Saunders (1981) reported that habitat alteration had caused substantial loss of Atlantic salmon stocks and attempts to restore these stocks indicate that important genetic adaptations were lost with the stocks. Maitland et al (1981) drew attention to the urgent need to monitor wild salmonid populations.

6.2 The Working Group on North Atlantic Salmon (Anon, 1989) has estimated that losses of Atlantic salmon to the fisheries and spawning escapement within the North-East Atlantic Commission due to habitat acidification are between 106000 and 332000 fish annually with an approximate weight of 400-1242t. These losses were in Norway (344-1147 tonnes), Sweden (52-87 tonnes) and in England and Wales (4-8 tonnes). In addition, the Working Group has previously estimated that losses of salmon due to acidification in Nova Scotia amounted to 5600 fish per year. In Norway, the Directorate for Nature Management has estimated that approximately 25 stocks are extinct or close to extinction, with stocks in another 15 rivers extremely reduced, as a result of acidification (Gausen, 1987). In the Southern Uplands of Nova Scotia 16 rivers have lost their salmon populations, while in another 19 only remnant populations survive in high pH tributaries (Anon, 1987).

6.3 Large mortalities of salmon have also been caused by the parasite *Gyrodactylus salaris* in Norway. This parasite has now been recorded in 32 river systems where it has caused estimated annual losses of 250-500 tonnes (Johnson and Jensen, 1986). There is also growing concern in some North Atlantic countries about the possible genetic impact of reared fish, particularly fish farm escapees, on wild salmon populations. The Norwegian authorities believe that the escape of farmed salmon represents a new and potentially greater threat to natural genetic resources than either acidification or the parasite *Gyrodactylus salaris* (Gausen, 1987). These escapees are now occurring in a number of North Atlantic countries. Davidson et al (1989) considered that a scientific assessment of the likely impact of reared fish on native stocks can only be made when there is a better understanding of salmon genetics and the dynamics of Atlantic salmon populations. However, Meffe (1987) discussed the philosophical problems concerning conservation of genetic resources and recommended the adoption of a "conservative approach". By adopting such an approach, and thus assuming that as much genetic diversity as possible should be retained, Meffe (1987) argued that the probability of inflicting irreparable harm upon systems which are not fully understood would be minimised. Similarly, Soule (1985) described conservation biology as a "crisis discipline" in which action must be taken before knowing all the facts.

6.4 A number of international conferences have recently adopted this "conservative approach" in their recommendations. For example, the Nordic Symposium on Gene Banks held in Helsinki in 1978 recommended the establishment of gene banks in each of the Nordic countries and research into techniques of storing eggs and milt. A symposium on "Fish Gene Pools - Preservation of Genetic Resources in Relation to Wild Fish Stocks" arranged by the Swedish Commission for Research on Natural Resources and held in Stockholm in 1980, recommended that "Management Programmes should be initiated for the conservation of as much genetic variability within and between populations as possible..." and advised that "Techniques need to be developed for the long-term storage of sperm, eggs and embryos" (Ryman, 1981). Similarly the Food and Agriculture Organization of the United Nations (FAO) held an Expert Consultation in Rome in 1981 on the Genetic Resources of Fish. This group formulated a number of recommendations including:

- UNESCO and perhaps other international organizations should consider establishment of a programme of education and training on genetic resource conservation/preservation in fish. The programme should assemble baseline information (a) on the diversity and vulnerability of aquatic genetic resources (b) on procedures for identifying vulnerable species and populations and (c) on appropriate methods of assuring that information regarding vulnerability and direct threats comes to the attention of agencies competent to act.

- the many international organisations for the regulation of fish stock exploitation are encouraged in their efforts to prevent the extinction and genetic deterioration of valuable stocks (FAO, 1981).

6.5 The Norwegian gene bank demonstrates that the techniques for the successful cryopreservation of salmon spermatozoa now exist and that fertilization rates of 60% can be achieved with material stored in this way.

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EXAMPLES OF SALMONID GENE BANKS

1. Directorate for Nature Management, Trondheim, Norway

Background

1.1 In 1986, on the recommendation of the Advisory Committee of the Sea Ranching Programme, the Directorate for Nature Management began a gene (sperm) bank programme. The Programme is planned to run for a 10 year period and involves the establishment of a sperm bank together with population genetic mapping and registration of the genetic and biological effects of introductions. It is estimated in Norway that an average of 12% of fish in sea cages escape. There is growing concern in Norway about the extinction of local, indigenous salmon stocks and the erosion of genetic resources. Approximately 25 stocks of Atlantic salmon have been lost as a result of acidification and 15 more are severely reduced. In addition, enormous mortalities have been caused by the parasite *Gyrodactylus salaris* which now occurs in over 30 watercourses and has caused loss of production of between 250-350 tonnes. The Directorate for Nature Management believes that the escape of farmed salmon poses a potentially greater threat to natural genetic resources than either Gyrodactylus or acidification. Norwegian scientists are monitoring the occurrence of reared fish, principally fish farm escapees, in 62 river systems. Approximately 20% of returning adult fish have been found to be of reared origin and in some rivers it is as high as 80%. On one river system 73% of fish sampled on the spawning grounds were of farmed origin. There is circumstantial evidence that such fish can breed and there is therefore the likelihood of inter-breeding between wild and farmed stocks.

1.2 It was against this background that the Norwegian government embarked on the gene bank programme. In 1989 funds for the Gene Bank were increased by 55% (to 2.7 million NOK) over 1988 levels, reflecting the Norwegian authorities concern that introgression between farmed and wild fish will have occurred to a significant extent by 1990, and that sampling and preservation of the genetic diversity of the wild stocks is now urgently required. Approximately 110 rivers will be sampled during 1989, representing all rivers with Sport Fishing Association hatcheries and therefore capture facilities on site.

Norwegian Procedures for collecting and operating salmon sperm banks

1.3 The following collection strategy has been adopted for the Norwegian gene bank:

(a) Sperm from at least 50 individuals from each stock is frozen.
(b) Emphasis is placed on sampling stocks from a wide geographical and ecological range.
(c) Stocks threatened by extinction are given priority over other stocks.
(d) Stocks which are of particular scientific or sport fishing value are given priority.

1.4 Precautions are taken to avoid including fish farm escapees in the gene bank. Field staff are trained to differentiate between farmed and wild fish visually using characteristics such as fin and nose erosion, marking and colouration. In addition farmed fish can be differentiated from wild fish on the basis of scale growth patterns and scales are taken from all fish sampled. Finally, a sample of sperm is analysed genetically.

1.5 All sampling for the Norwegian gene bank takes place at Sport Fishing Association hatcheries. Precautions are taken to prevent transfer of disease between hatcheries including the use of sodium hypochlorite disinfectant to sterilise equipment, and paper suits and boots are worn by gene staff personnel (a new set for each hatchery). The following equipment is required at the site:

(i) a box about 75cm x 75cm x 75cm, very well insulated, and containing a 20kg block of carbon ice, solid CO_2 (which has a temperature of about -78 degrees C). An ordinary electric drill is then used on the top surface of the block to produce lines of shallow holes about 0.5cm deep and 1.0cm wide.

(ii) a flask, of about 10 litres capacity, containing liquid nitrogen (which has a temperature of -196 degrees C).

(iii) A solution of 10% DMSO and 3% glucose.

1.6 The fish are stripped and the milt is collected in a beaker. It is essential that both the fish and the collecting vessel are dry because salmonid sperm becomes motile upon contact with water. Immediately on collection of the milt from a fish about 1.5ml is taken and mixed with 4.5 ml of the DMSO/glucose freezing medium. Drops of the extended semen (about 130 from each fish) are then frozen in the shallow holes in the CO_2 ice block. The drops freeze at a rate dependent on their diameter. But because a range of sizes results some of the drops will freeze at the optimum rate.

1.7 The pellets are frozen after about 3 minutes and are then placed in labelled polypropylene vials and sealed prior to transfer to liquid nitrogen. On return from the field site the samples are transferred to permanent storage facilities.

1.8 The samples may be tested every year and compared to fresh semen. Norwegian tests show that, on average, cryopreserved salmon spermatozoa has a fertilization rate of 60% of fresh spermatozoa. In contrast, the same techniques have resulted in 80-90% fertilization with rainbow trout. If the stocks from a threatened river were ever lost or were genetically altered by inter-breeding the gene bank could be used, with females, preferably from a neighbouring watercourse, to produce a first generation of fish with 50% of the genetic material from the original stock. This percentage could be increased by back-crossing with more spermatozoa from the bank.

2. Cell Systems Ltd., Cambridge, UK

2.1 Cell Systems Ltd is a small company, established in 1986, specialising in research and development in cryopreservation of rainbow trout spermatozoa and the production of dried algal cells for use in hatchery first feeding either directly in for example mollusc culture, or for culturing rotifer populations for first feeding turbot.

2.2 The cryopreservation work presently involves supplying the rainbow trout farming industry with sex reversed, disease free milt. This enables the farmers to produce all female offspring which have desirable attributes with regard to delayed maturation and appearance. The company is now experimenting with cryopreservation of rainbow trout ova and embryos. Reports from China indicate that some success has been achieved freezing grass carp embryos - with up to 25% survival after freezing. Other reports of success with freezing salmonid ova seem to be spurious. Results from Cell Systems seem to indicate that late embryos appear to be more resistant to freezing which is somewhat surprising since it might be assumed that the greater the embryos structural complexity the more susceptible it would be to freezing damage. Cell System scientists anticipate that cryopreservation of salmonid embryos and/or ova may be possible in 3 to 5 years time. Freezing of fish spermatozoa is relatively new and therefore long-term viability testing has not so far been possible. However, testing of 40 year old cryopreserved cattle semen has indicated that viability can be maintained over long time periods. Background radiation levels are only believed to be significant after 10,000 years. Simulations of the effects of background radiation have indicated insignificant effects on viability after 200 years. It is clearly important that the process doesn't affect the genetic quality, of the stored material. Early indications are that genetic quality is maintained.

2.3 The techniques developed by Cell Systems enable fish gametes to be frozen at optimal rates in flasks developed for use in the field. Following stripping of fish, the milt plus freezing medium is contained in specially coated straws and transferred directly to a flask containing liquid nitrogen. Using this system freezing is controlled at the optimum rates determined by Cell Systems through laboratory trials.

2.4 Cell Systems have considerable expertise in cryopreservation for the aquaculture industry. At present it is only possible to cryopreserve salmonid spermatozoa but Cell Systems scientists are developing techniques for the cryopreservation of salmonid ova or embryos and anticipate that this will be feasible in the next 5-10 years.

3. Institute of Aquaculture, Stirling, UK

3.1 In 1985, the Institute of Aquaculture was awarded a grant by the Overseas Development Administration to develop techniques for the cryopreservation of the gametes of tilapia and other species. Within a year, a sperm bank for tilapia had been successfully established. Fertilisation rates have consistently been in excess of 80% of controls and 0.4ml thawed tilapia milt can successfully fertilise between 400-500 eggs. Other species, including salmon, are now being included in the gene bank.

3.2 The Institute has investigated the effects of different diluents and cryoprotectants and freezing and thawing rates on salmon spermatozoa viability. Results have shown that the cooling rate and dilution of milt are more critical for salmon than for tilapia. Indications are that an extender consisting of DMSO and glucose followed by a medium to fast freezing rate and fast thawing are most successful for salmon. The Institute is also experimenting with the bulk storage (100ml quantities) of salmon sperm in teflon coated bags.

3.3 Samples of salmon milt have been collected from a commercial salmon farm and preliminary results of the cryopreservation process look promising. In order to avoid the contamination of milt by urine the Institute of Aquaculture staff remove the gonad surgically. The extracted milt is then stored chilled (salmon milt has been maintained this way for up to 1 month) and transported back to the laboratory. The samples are examined microscopically and those with less than 90% motile spermatozoa are rejected.

3.4 The milt is then diluted 1 part semen: 8 parts extender and stored in 1/2 ml straws. These straws are sufficient to fertilise 250-350 eggs. Trials have shown that 1/2 ml of extended milt can fertilise up to 500 eggs. Transfer of straws directly to liquid nitrogen was unsuccessful since precise control of the cooling rate was not possible. The Institute of Aquaculture has therefore adopted a technique of cooling to -70 or -80 degrees C in a cooling chamber capable of cooling at rates from -0.01 degrees C min to -200 degrees C min before transfer to liquid nitrogen (-196 degrees C). Up to 60-70% of the sperm in cryopreserved milt can be activated on thawing using these techniques. The Institute of Aquaculture stores the material in narrow neck flasks capable of holding 5000 straws. They recommend that 50 straws are held for each fish to enable viability testing from time to time.

IDENTIFICATION OF REARED FISH IN THE WILD

1. In any programme aimed at preserving the genetic diversity of wild stocks it is of paramount importance that the wild fish can be distinguished from reared fish on an individual level. In Norway the authorities recommend the use of local stocks only in enhancement programmes and in order to avoid undesirable hybridization between wild and reared salmon, it is necessary to identify the reared component. A number of techniques have been used for distinguishing reared and wild salmon.

2. **Scale Growth Pattern (see Figures 1 and 2)**

The Study Group on the Norwegian Sea and Faroese salmon fishery (Anon, 1987) recognized a number of criteria for distinguishing between wild and reared salmon on the basis of scale characters:

a) The width of the freshwater zone in relation to total scale radius is larger in reared smolts than in wild.

b) Summer checks occur more frequently in the first sea year on scales of farmed fish.

c) The transition between freshwater and sea-growth appears to be less marked on the scales of farmed fish.

d) High smolt age is associated with wild fish.

e) The proportion of regenerated scales might be higher in reared than wild fish.

3. **Fin Erosion and Deformities (See Figure 3)**

Reared salmon have eroded fins compared to wild fish. Craik et al (1987) used direct observation of pectoral and dorsal fin abrasion and deformity to identify reared salmon in the Faroese fishery. Potter (1987) measured the dorsal, pectoral and caudal fins of wild and stocked salmon caught in the English north-east coast fishery and of farmed salmon from Scotland. Discriminant function analysis provided good discrimination between wild and farmed groups and between stocked and farmed fish, but there were only small differences between the wild and stocked groups. However, observations in the Faroese fishery suggest that a significant proportion of Norwegian fish released for enhancement or mitigation purposes may show the types of fin damage more commonly associated with farm rearing. Potter (1987) cautioned that the discrimination power of this technique should be tested with large salmon. Similarly, Hansen et al (1987) measured pectoral, dorsal and caudal fin lengths for farmed, wild and ranched fish from fish farms and commercial fisheries and for ranched and wild salmon from the river Ims Research Station. They concluded that morphometrical analysis could partly solve the problem of distinguishing wild and reared fish although it was not possible to separate salmon released as smolts for enhancement from ranched salmon and salmon escaping from fish farms at the smolt stage. Hansen et al (1987) used fish in the size range 1-10kg for fish farm stock and 1-15kg for salmon from the fisheries.

4. **Pigment Analysis**

Craik et al (1987) used muscle pigment analysis, based on the detection of the carotenoid canthaxanthin, to identify reared fish in the Faroese fishery. Canthaxanthin is not normally fed to farmed salmon in freshwater and analysis for this pigment can therefore be used to identify salmon escapees from marine farms i.e. fish escaping after the smolt stage. Craik et al (1987) considered that the technique probably under estimated the proportion of farmed fish:

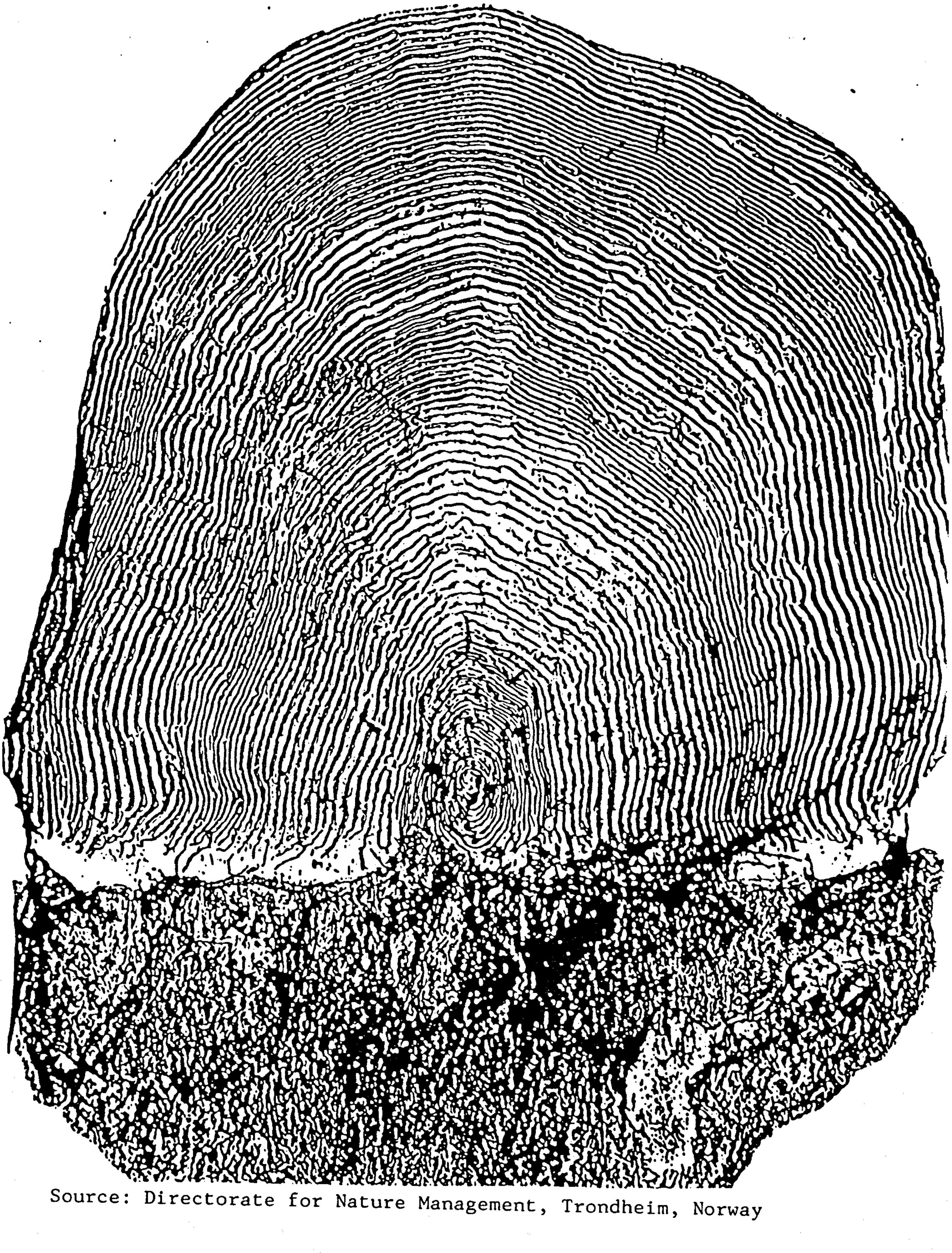
a) because of uncertainty about how long canthaxanthin remains detectable after escape to the wild: Experiments in captivity have shown that it is readily detectable six months after it ceases to be fed.

b) synthetic astaxanthin is used in some countries instead of canthaxanthin and its use may increase in the future.

5. In comparisons of direct observation of pectoral and dorsal fin abrasion, scale reading and muscle pigment analysis, Craik et al (1987) found that of a sample of 219 salmon from the Faroese fishery, direct observation identified 11% as reared, scale reading identified 7% as reared and pigment analysis revealed 3% as reared. They attributed the differences to the fact that pigment analysis identifies only those fish which have been held on marine farms after smolting and fed canthaxanthin while fin and scale characters may identify all salmon which have been reared for some period of their life.

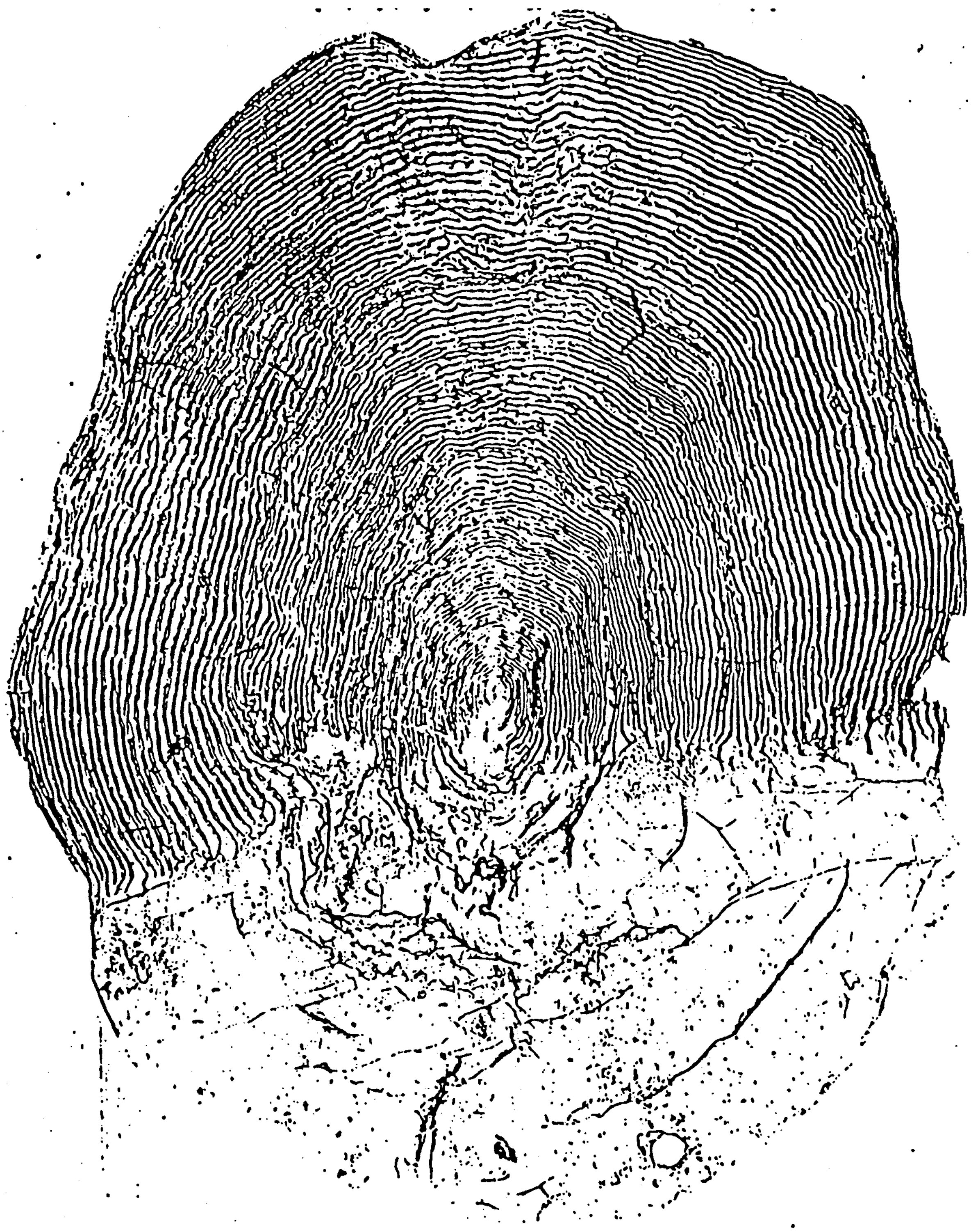
6. Scientists involved in collections for the Norwegian gene bank programme use direct observation in the selection of source material. Scale samples are also taken in order to eliminate reared fish. Finally, surplus sperm samples are retained for genetic analysis. However, Hansen et al (1987) considered that at present escapees from fish farms can only be identified by biochemical genetic analysis in special cases e.g. in northern Norway where a large proportion of smolts in the fish farms are of Baltic origin. Clearly, the progeny of wild fish and fish farm escapees which are unlikely to be detectable by fin or scale characters pose a particular problem for those involved in selection of material for gene banks. It is for this reason that the Norwegian authorities have increased expenditure on the gene bank programme in order that as many sites as possible can be sampled before introgression occurs (Gausen, personal communication).

FIGURE 1: SCALE OF WILD SALMON



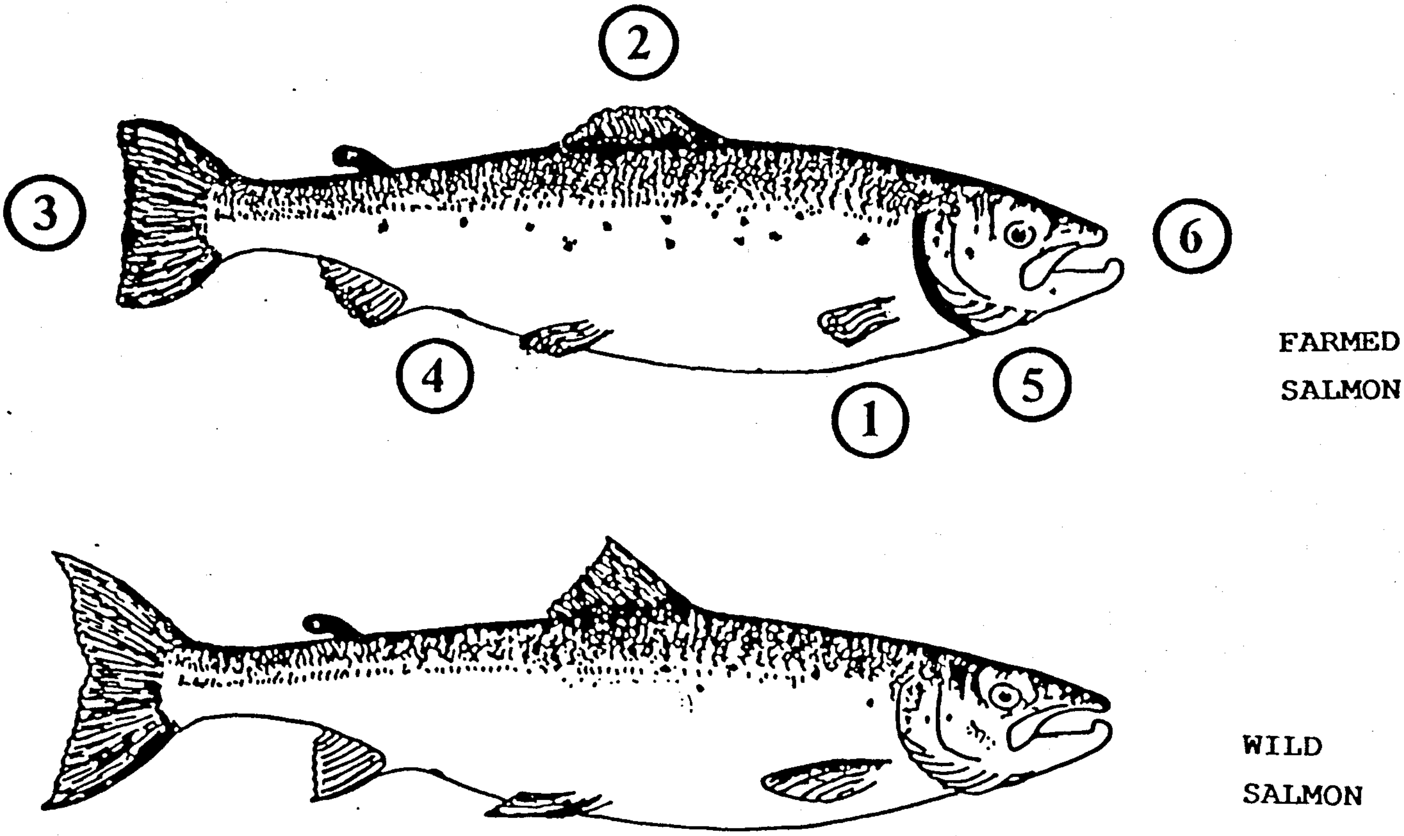
Source: Directorate for Nature Management, Trondheim, Norway

FIGURE 2: SCALE OF A FISH FARM ESCAPEE

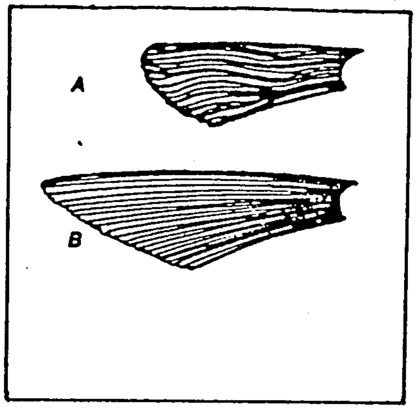


Source: Directorate for Nature Management, Trondheim, Norway

FIGURE 3: ILLUSTRATION OF THE MORPHOMETRIC DIFFERENCES BETWEEN FARMED AND WILD SALMON



1 - 4 Eroded or deformed fins
5 Damaged operculum
6 Eroded snout



A and B - Close up views of the pectoral fin of a farmed (A) and a wild(B) salmon.

Source: Directorate for Nature Management, Trondheim, Norway

JUNE 1989
EDINBURGH

ANNEX 25

COUNCIL

PAPER CNL(89)23

POSSIBLE DEVELOPMENT OF CODES OF PRACTICE TO MINIMISE THREATS TO WILD STOCKS

CNL(89)23

POSSIBLE DEVELOPMENT OF CODES OF PRACTICE TO MINIMISE THREATS TO WILD STOCKS

1. The main potential threats posed to wild salmon by salmonid aquaculture are:

   - genetic interactions

   - disease and parasite interactions

   - introduction of non-indigenous salmonids

   - impacts on the aquatic environment.

   The Council of NASCO recognised the serious nature of some of these threats and decided to consider the possibility of developing an internationally agreed code of practice or series of recommendations, so as to minimise the impacts, as part of its responsibility under the Convention to conserve salmon stocks.

2. The attached paper (Appendix 1) outlines present evidence on these impacts and introduces some of the possible measures for minimising these impacts. This summary outlines these measures and the options for further development of such codes of practice or recommendations.

MAIN ELEMENTS OF DRAFT RECOMMENDATIONS

3. The draft recommendations might be developed so as to cover the following main areas:

   Development of guidelines for stocking and broodstock management

   A. The desirability when stocking of using only fish from the river concerned. Where a stock is extinct or at low numbers the need to use fish from the nearest ecologically similar river.

   B. The desirability of using broodstock which represent the gene pool of the total stock by sampling through the entire spawning migration period. The avoidance of selection in terms of size, or place of capture.

   C. The use of as large a number of broodstock fish as practicable in hatcheries.

   D. The desirability of using broodstock for enhancement which have been regularly obtained from the wild and not held in captivity for more than one generation.

   Separation of wild and farmed fish

   E. Establishment of zones free-of-aquaculture could be considered in watercourses which are particularly valuable for their wild salmon.

   F. Establishment of recommended minimum separation distances between aquaculture sites so as to minimise potential for disease transmission.

Development of improved aquaculture techniques

G. The encouragement of research and development on methods of reducing the escape of farmed fish, eg the installation of anti-predator nets and improvement of security systems.

H. Specific recommendations could be considered regarding the release to the wild of excess or diseased stock from the aquaculture industry.

I. Assessments of the implications of the use of all-female triploid salmon (which are sterile) in the fish farming industry could be made.

Avoidance of adverse effects from introductions and transfers

J. The detailed recommendations being developed now by the NAC Bilateral Working Group might be included so as to reduce the risks of adverse effects arising from introductions and transfers of salmonids of non-indigenous and of species in the Convention area.

Reduction of environmental impacts

K. Establishment of minimum separation distances between aquaculture operations could be considered so as to reduce adverse impacts on water quality.

L. The development of outline criteria for the choice of sites and for cage construction.

M. The encouragement of further research and development on low pollution feeds and improved feeding techniques could be considered.

N. The development of procedures to ensure that harmful chemicals used in aquaculture are not released to the environment.

CONCLUSIONS

4. The Council might consider that the draft series of recommendations or code of practice serves as a starting point for further consultation with the Parties by the Secretariat. A revised paper could then be submitted to the Council in 1990. The aim would be to produce an internationally agreed list of guidelines that might be appropriate for Parties to take to minimise damage to wild stocks. There would be no intention that these be mandatory and not all measures would be necessary in all situations.

5. Steps might be taken to improve liaison with the salmon farming industry. In the first instance the Codes of Practice presently used, either voluntarily or by legislation, by the producers in salmon farming countries could be obtained for NASCO.

Secretary
Edinburgh
16 May 1989

CNL(89)23

POSSIBLE DEVELOPMENT OF CODES OF PRACTICE TO MINIMISE THREATS TO WILD STOCKS

1. INTRODUCTION:

1.1 At its Fifth Annual Meeting the Council considered a review of the potential impacts of salmon aquaculture on the wild salmon stocks (paper CNL(88)21). This review included consideration of the following potential threats to wild stocks:

- genetic interactions
- disease and parasite interactions
- introductions of non-indigenous salmonids
- impacts on the aquatic environment.

1.2 The Council recognised the serious nature of some of these threats and decided to consider the possibility of developing an internationally agreed code of practice or series of recommendations to minimise the impacts, as part of its responsibility to conserve salmon stocks under the Convention. The Council asked the Secretary to produce a review of those actions which might be addressed. This review considers possible mechanisms for reducing the potential impact of salmon aquaculture on wild salmon stocks under the broad headings described above.

1.3 Cornerstones of the successful marketing of farmed salmon by organisations such as the Norwegian Fish Farmers Sales Organisation and the Scottish Salmon Growers Association have been the health value of salmon in the diet and the image of the wild fish occurring in unpolluted waters. The industry has tended to respond rapidly to environmental issues which could adversely affect the marketability of their product, and the industry, in a number of countries, has already formulated or is in the process of formulating Codes of Practice or Recommendations. For example the National Farmers Union of Scotland has already prepared Codes of Recommendation for the Husbandry and Welfare of Farmed Fish which include some provisions of relevance to the wild stocks, and the Irish Salmon Growers Association is presently preparing Codes of Practice for its farmers. It is likely that the industry would be responsive to recommendations or guidelines as to how to minimise the threats to wild stocks.

2. THE POTENTIAL THREATS TO WILD STOCKS

2.1 There is now growing evidence that substantial numbers of farmed Atlantic salmon have gained access to the wild, either through escape (as a result of handling errors, weather and predator damage, vandalism or collisions) or through deliberate release of surplus or unwanted stock (principally potential S2 smolts but possibly also diseased stock). As the industry has developed, the number of smolts produced has increased rapidly. For example, Norway now has the capacity to produce 216 million smolts a year and it is estimated that 28 million smolts will be produced in Scotland in 1989. In Norway, it has been shown that approximately 26% of fish in the fisheries are of reared origin and in one river system 73% of fish sampled on the spawning grounds were of farmed origin (Gausen, personal communication). It has been estimated that at least 600-700,000 salmon escaped from net pens during 1988, approximately the same number of fish as the total wild salmon run (see paper CNL(89)11). There is circumstantial evidence that such fish can breed leading to concern for the genetic integrity of the wild stocks (see paper CNL(89)19) and concern about other possible ecological interactions between farmed and wild fish.

2.2 The rapidly expanding aquaculture industry has led to an associated increase in the number and severity of diseases of farmed fish (Smith, 1985) and to concern about the possibility of transfer of diseases and parasites from fish farms to wild stocks. The potential negative interactions are not, however, one sided. Both farmed and wild stocks are potentially at risk (Anderson, 1987). There is little documented evidence of significant adverse effects on the wild stocks as a result of diseases introduced to the wild from fish farms and hatcheries (Mills, 1987; Anon, 1987) although transmission from farmed to wild stocks is hard to establish (Anderson, 1987). The exception is the problem caused to wild salmon stocks in Norway by the trematode parasite *Gyrodactylus salaris* which was introduced to Norway with hatchery stocks. This parasite has subsequently spread to 32 watercourses and has caused annual losses of between 250-500 tonnes (Johnson and Jensen, 1986). Cage rearing can cause eutrophication and this has been linked to increased parasite loads in some fish populations, pathogenic fungal infections are more common in eutrophic waters and bacterial numbers are related to trophic status (Phillips et al, 1985). Rosenthal et al (1988) considered that although there are cases of mariculture introducing a disease organism into an area where it had not previously occurred there are no documented cases of mariculture leading to increased incidence of disease in wild fish by a pathogen already present in the environment. However, Needham (1988) warned that because Norwegian salmon reared in Scotland can suffer badly from Proliferative Kidney Disease while Scottish salmon remain largely unaffected, it could be that if released Norwegian salmon interbreed with native fish, susceptibility to this particular disease could be passed on to the detriment of wild stocks.

2.3 Non-indigenous species, with attributes favourable for aquaculture, have been introduced into the North Atlantic, often accompanied by accidental introductions of disease organisms (Anon, 1989). The importation of exotic species or disease organisms poses the greatest environmental risk of mariculture since the consequences may be widespread and irreversible (Rosenthal et al, 1988). The legislation relating to introductions and transfers is summarised in paper CNL(89)22. Under this legislation a number of introductions of Pacific salmon (*Oncorhynchus spp*) have occurred within the Convention area and concern has recently been expressed about the growing interest in the use of rainbow trout (*Salmo gairdneri*) in sea-cages along the eastern seaboard of North America (NAC, 1987). In addition transfers of Atlantic salmon have occurred from Norway to Iceland, from Scotland to Norway, from Scotland to Canada, from Scotland to USA, from Canada to USA, from Iceland to USA etc. The Canadian Atlantic Fisheries Scientific Advisory Committee concluded that the risk from introductions of young Atlantic salmon and salmon eggs to Canada outweighed the apparent benefits. The potential risks are highlighted by the *Gyrodactylus* problem in Norway.

2.4 Salmon culture is an intensive industry involving the net addition of nutrients and causing the following changes to the water column:

i) addition of waste products, principally nutrients and suspended solids.
ii) reduction of ambient dissolved oxygen levels
iii) addition of chemicals, including chemicals used in disease treatment, materials incorporated in feeds and treatments applied to equipment (Anon, 1989).

Concern about the rapid expansion of the industry and its effects on the aquatic environment has recently been expressed by a number of conservation organisations. This concern is shared by both the conservationists and the fish farmers who fear that the harmful feedback could affect the economic viability of the farm (Gowen and Bradbury, 1987). Gowen and McClusky (1988) concluded that with the exception of the most well flushed marine sites fish farms cause enrichment of the benthos, (usually restricted in extent to the area around the cages), and release of inorganic nitrogen can result in hypernutrification and this can cause eutrophication, depending on the hydrography of the site. Such problems are likely to be more severe where wet diets are used. There are examples of localised phytoplankton blooms occurring in enclosed sea lochs causing mortality of farmed stock and in one case a salmon farm was implicated. There is therefore a need for caution since such phenomena could have serious consequences for farmed and wild fish (Anon, 1989).In some countries the rapid expansion of the industry has also resulted in cage rearing of smolts in freshwater lakes. These cage units reduce the capital costs associated with smolt rearing but may cause hypernutrification of inland waters through addition of phosphorus. In addition to hypernutrification growth of specific algae may be stimulated by certain vitamins in fish feed (eg Vitamin B12 is a growth requirement of the toxic microflagellate *Prymnesium parvum*) and anoxic sediments could prevent excystment of dinoflagellate cysts leading to blooms under certain conditions (Rosenthal et al, 1988).

2.5 A wide variety of chemicals are used in mariculture which if misused represent a health threat to both the farmed stock and the indigenous biota (Rosenthal et al, 1988). Although there is no evidence that the chemicals in general use in mariculture pose a threat to the environment, with the possible exception of Tributyltin (TBT) (Rosenthal et al, 1988), Maitland (1985) considered that more information is needed on the effect after discharge of therapeutic and prophylactic chemicals.

2.6 There is also evidence that the behaviour of wild fish may be influenced by aquaculture operations eg juvenile saithe stocks have been found to feed in the area around cages. The relationship between these stocks and species such as sand eels which are an important component of the diet of salmon smolts requires further study. Clearly it is also important to ascertain whether the migratory behaviour of salmon is adversely affected by farming in and around rivers supporting wild populations of salmon (Phillips et al, 1985) by for example pheromones (see paper CNL(89)20). Furthermore, if wild smolts are attracted to and enter the cages they may be preyed upon by farmed stock.

3. POSSIBLE METHODS OF REDUCING THE IMPACT OF SALMON AQUACULTURE ON WILD STOCKS

3.1 A number of recommendations have recently been made regarding hatchery procedures to ensure that hatchery managers concerned with enhancement minimise the genetic differences between stocked fish and wild stocks. These include:

(i) use of native or local stock (NAC, 1987; Maitland, 1987; Nyman and Norman, 1987; Thorpe, 1988), if necessary using kelt regeneration procedures (NAC, 1987). Verspoor (1989) considered that stocking should be carried out by using fish from the river being stocked or where available, from the nearest river with similar ecological circumstances to those at the stocking location.

(ii) collection of broodstock representing the gene pool of the total stock (Helle, 1981) by sampling through the entire spawning migration period (Nyman and Norman, 1987;

Maitland, 1987) and avoiding unconscious selection in connection with size or place of capture (Maitland, 1987).

(iii) use of large broodstocks in order to maintain a diverse stock of fish in the hatchery and avoid genetic drift (Maitland, 1987). For example, 25 pairs of parental fish (Nyman and Norman, 1987); 30 of each sex for each stock component (Thorpe, 1988); 40-50 individuals (Allendorf and Phelps, 1981); a minimum of 50 to ensure a rate of inbreeding of less than one percent per generation (Anon, 1981).

(iv) broodstock for enhancement purposes should be obtained regularly from the wild and not held in captivity for more than one generation (Maitland, 1987).

The Bilateral Scientific Working Group of the North American Commission on Salmonid Introductions and Transfers has recommended that the aquaculture industry should use salmon stocks originating as close to the project area as possible. However, farm broodstocks need to be certified free of certain disease agents that can be readily picked up in the wild and more importantly, quantitative strain differences are being recognised that need to be either retained or bred out in the farmed fish (Laird and Needham, 1985). For these reasons, introduction of wild stocks is likely to be unpopular with the salmon farming industry and in Scotland, for example, over 80% of farmed fish are presently bred from ova derived from farm broodstocks rather than wild fish. Given the loss of genetic diversity in hatchery salmon stocks compared to the wild stocks from which they were derived (Ryman and Stahl, 1980; Cross and King, 1983) and the benefits to the farmers of strains developed for aquaculture, it may be that measures which reduce the escape or release of farm stocks, for example, rather than measures concerned with farm broodstocks, would be more acceptable to the industry.

3.2 Zones in which no aquaculture development is permitted have been established in Norway and Iceland. In Norway, a three year research programme with a budget of NOK 40 million, the National Analysis for the suitability of the Norwegian Coast for Aquaculture (LENKA), has identified the most suitable locations for new fish farms which avoid conflict with the environment and other society interests. The area has designated areas where fish farms will not be permitted. These are:

(i) Watercourses where the annual catch of anadromous salmonids is greater than 500kg per annum.

(ii) Watercourses where the fish populations are attacked by serious diseases or parasites.

(iii) Watercourses containing genetically valuable stocks of salmonids.

(iv) Watercourses or parts of watercourses which flow through areas protected by law.

In areas where fish farms already exist further development will be prevented. 125 Norwegian rivers now have "security zones".
In Iceland a new regulatory measure was enacted in 1988 preventing the siting of sea cages and ranching stations within 15km of major salmon streams (catches in excess off 500 salmon), and within 5km of minor streams (catches of 200-500 salmon per annum). Reduced distances may be permitted if local stocks are being reared. In Great Britain, the Nature Conservancy Council considers that a locational strategy should be established to govern development policy for fishfarming in terms of areas where there would be a presumption against development, a presumption against further development or a presumption in favour of development subject to regulation (Anon, 1989).

3.3 Escapes from cages could be reduced by installation of anti-predator nets to prevent net damage by for example seals, and efficient security systems to prevent vandalism. Careful attention should be paid to handling procedures and cage structure should be considered carefully in relation to site conditions. In Iceland a regulation introduced in 1988 limits the use of Norwegian origin salmon stocks to land based rearing operations. Norwegian salmon eggs have been imported 3 times to Iceland under severe inspection and quarantine conditions. The progeny from these eggs are now becoming sexually mature and eggs are available to the aquaculture industry. Being of foreign origin these stocks are considered harmful if released into the wild and the risks of escape are considerably less for land based units.

3.4 Several authors have advised that surplus or diseased stock from the aquaculture industry should not be released to the wild. If surplus stock cannot be sold to other farms, marketed for consumption (Maitland, 1987), or used in stocking programmes of rivers that have lost their salmon stocks (eg the river Thames, England; river Carron, Scotland) they should be killed. Thorpe (1988) considered that in stocking a river that has lost its stock there may be advantage in using a broader genetic range initially thereby providing more scope for rapid natural selection of combinations in subsequent generations. A Code of Recommendations prepared by the Natural Farmers Union of Scotland advises that fish should not be released into open waters, except where it is part of a planned restocking programme, and not without the prior consent of the riparian owner. This Code also advised that dead fish should be disposed of by burning or burying in quick lime.

3.5 All female triploid salmon are sterile and escapes of such fish would be unable to interact genetically with wild salmon stocks. It is not clear how such sterile fish would behave on escape but if they did ascend into freshwater the possibility of other intraspecific interactions could not be ruled out. All-female triploid rainbow trout have been successfully used to solve problems of maturation associated, particularly, with rearing large fish for smoking. Experimental trials with all female triploid Atlantic salmon have indicated that these fish grow slightly less rapidly than diploid fish but their growth is more predictable and there is no problem of grilsing thereby avoiding labour intensive grading. Furthermore, triploids are reported to be less aggressive than diploid fish and for both of these reasons may be attractive to the farmer. Full scale commercial testing has been undertaken (Anon, 1986a) and a number of salmon farms have adopted the technology. The NAC Bilateral Scientific Working Group on Salmonid Introductions and Transfers considered that the genetic integrity of North American salmon stocks could be protected by the aquaculture industry and public and private enhancement agencies using sterile or triploid salmon for aquaculture projects. However, there is some concern in the industry about the use of hormones required to produce masculinised females, albeit one generation away from the harvested fish, since it is a perceived threat to the marketability of the product. There is also some concern that the flesh quality of triploid fish may be slightly inferior. Recent results of feeding reduced rations in February and March indicate that the industry could reduce grilsing by as much as one-third in this way and this may be a more attractive option to farmers whose stocks have grilsing problems (Anon, 1988).

3.6 In 1973 the International Council for the Exploration of the Sea adopted a Code or Practice to Reduce the Risks of Adverse Effects arising from Introductions of Non-Indigenous Marine Species in response to concerns about the ecological impacts of introductions. A similar code was adopted for inland aquatic organisms by EIFAC. In 1979 a revised ICES Code was issued. This Code recommended the following action if the decision to proceed with an introduction is taken:

(a) A brood stock should be established in an approved quarantine situation. The first generation progeny of the introduced species can be transplanted to the natural environment

if no diseases or parasites become evident, but not the original import. The quarantine period will be used to provide opportunity for observation for disease and parasites. In the case of fish, broodstock should be developed from stocks imported as eggs or juveniles, to allow sufficient time for observation in quarantine.
(b) All effluents from hatcheries or establishments used for quarantine purposes should be sterilized in an approved manner (which should include the killing of all living organisms present in the effluents)
(c) A continuing study should be made of the introduced species in its new environment, and progress reports submitted to ICES.

However, some countries have not endorsed either Code of Practice (NAC, 1987) while in some other countries the code is only applied to the import of non-indigenous species (ICES, 1987). In 1987, the NAC Bilateral Scientific Working Group on Salmonid Introductions and Transfers made the following recommendations to the North American Commission of NASCO:

i) reduce potential adverse genetic effects by prohibiting transfers of eastern hemisphere and Icelandic Atlantic salmon to states and provinces bordering the Atlantic coast and the Great Lakes.
ii) reduce potential transfer or introduction of diseases by prohibiting transfers of all salmonids from west of the continental divide (including Asia),
iii) reduce the risk of diminishing the productivity of wild Atlantic salmon populations through ecological interactions by prohibiting expansion of intentional introductions of Pacific salmon, and steelhead trout, to new areas in the eastern portion of North America (except for research purposes),
iv) reduce the risk of detrimental effects on wild salmon populations by providing alternate sources of stocks for both enhancement and aquaculture efforts from within the local area.

The North American Commission endorsed approval of these recommendations as interim measures. The Working Group is presently preparing protocols to govern the introduction and/or transfer of salmonids along the eastern seaboard of North America.

3.7 In some countries no new licences for salmonid mariculture are being granted eg Norway (Anon, 1989). The Irish Government has recently prohibited the use of freshwater lakes for cage culture of smolts because of environmental concerns.

3.8 In several countries minimum separation distances between aquaculture operations have been established in order to reduce water quality impacts and to minimise the potential for disease transmission between culture facilities or between cultured and wild animals (Rosenthal et al, 1988). The required separation of salmon culture facilities is 500-1000m in Norway, 1000m in several Canadian provinces and 2km in Iceland. Other restrictions on productions may also be used to limit the waste loading to the environment. For example, in the Maritime Provinces of Canada salmon cage culture is limited to no more than 24 cages and a maximum of 2ha per site and in Norway, principally for social reasons, salmon farmers are limited to a maximum cage volume of 8000m^3 (Anon, 1989). Careful attention should also be paid to siting with poorly flushed, enclosed sites being avoided. Farmers could also be encouraged to reduce treatments required through sound husbandry, adopt correct procedures for treatments and ensure that harmful chemicals are not released as recently recommended by the Nature Conservancy Council in Great Britain (Anon, 1989).

3.9 Rosenthal et al (1988) considered that since the nitrogen not retained in fish is mainly in soluble form, sludge collecting devices in cage culture are not practical. They concluded that the only reasonable way to reduce loadings, other than restricting production or relocating the farm unit, is by attention to feeding techniques and the development of low pollution feeds. A number of possible management measures have been recommended which might reduce the impact of wastes from aquaculture on water quality including the use of dry diets (with dust removed) rather than wet or moist diets and careful attention to feed requirements (Anon, 1989) based on accurate assessments of fish growth rates, environmental conditions and biomass (Rosenthal et al, 1988). For example, computerised feeding systems based on automatic monitoring of the environment and giving low conversion ratios (Anon, 1989) and computerised systems capable of detecting surplus food passing through cages (Anon, 1987) have been developed. Floating pellets released near the bottom of the cage may also be of benefit in reducing feed losses and experimental testing of such pellets is presently being undertaken. The development of low pollution feeds with reduced non-utilizable nitrogen content in relation to metabolizable energy (Rosenthal et al, 1988) and high digestibility (Anon, 1986b) may also be of significance although the marketability of these feeds will depend on their expense.

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ANNEX 26

CNL(89)39

PRESS RELEASE

The Sixth Annual Meeting of the North Atlantic Salmon Conservation Organization (NASCO) was opened by its President, Mr Allen E Peterson of USA. Representatives of Canada, Denmark (in respect of the Faroe Islands and Greenland), EEC, Finland, Iceland, Norway, Sweden, Union of Soviet Socialist Republics and the United States of America attended the meeting. The Organization, which is the only inter-government organization based in Scotland, was established by a Convention in 1984 with the objective of contributing to the conservation, restoration, enhancement and rational management of salmon stocks.

The potential impact of salmon aquaculture on wild stocks was the subject of a special theme session at the Sixth Annual Meeting of the North Atlantic Salmon Conservation Organization (NASCO), held this week in Edinburgh.

A number of interactions between reared and wild salmon were discussed including the genetic impact on wild stocks of escapees from salmon farms, the environmental threats and possible effects on wild stocks. A number of possible means of minimising these threats were discussed. These included the possible use of gene banks to protect threatened stocks and the development of a series of recommendations to minimise the threats to wild stocks.

The Council of NASCO discussed a number of other issues including the operation of a tag return incentive reward programme to encourage returns of scientific tags applied to salmon, a repository of tag release information and the comparability of catch statistics.

The North-East Atlantic Commission agreed a new regulatory measure for the Faroese salmon fishery for the years 1990 and 1991. This measure reduces the Faroese catch quota to a maximum of 1100 tonnes over the two year period with flexibility to allow the yearly catch to exceed the annual average by 15%.

The West Greenland and the North American Commission monitored the status of their fisheries and agreed on further research needs.

The Seventh Annual Meeting of the Organization will be held in Helsinki from 12-15 June 1990.

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ANNEX 27

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION

LIST OF COUNCIL PAPERS

Paper No	Title
CNL(89)1	Provisional Agenda
CNL(89)2	Draft Agenda
CNL(89)3	Explanatory Memorandum on Draft Agenda CNL(89)2
CNL(89)4	Proposed schedule of meetings
CNL(89)5	Secretary's Report
CNL(89)6	Audited Accounts for 1988
CNL(89)7	Outline of 1990 Draft Budget and 1991 Forecast Budget
CNL(89)8	Report of the Finance and Administration Committee
CNL(89)9	Report of the ICES North Atlantic Salmon Working Group
CNL(89)10	Report of the ICES Advisory Committee on Fisheries Management
CNL(89)11	Returns under Articles 14 and 15 of the Convention
CNL(89)12	Catch Statistic Returns by the Parties
CNL(89)13	Historical Catch Record 1960-1988
CNL(89)14	Report on the analysis of catch statistics
CNL(89)15	Report on Laws, Regulations and Programmes
CNL(89)16	Summary of microtag, finclip and external tag releases in 1988
CNL(89)17	NASCO Tag Return Incentive Scheme
CNL(89)18	Publicity for Incentive Scheme
CNL(89)19	Report of Dublin meeting on genetic threats to wild stocks from salmon aquaculture

CNL(89)20	Environmental threats to wild stocks posed by salmon aquaculture
CNL(89)21	Salmon gene banks
CNL(89)22	Review of legislation relating to introductions and transfers
CNL(89)23	Possible development of Codes of practice to minimise threats to wild stocks
CNL(89)24	Report on the Activities of the Organization in 1987/88 (for publication)
CNL(89)25	Report on the Activities of the Organization in 1988 (not for publication)
CNL(89)26	Dates and places of 1990 and 1991 meetings
CNL(89)27	Revised Proposed Schedule of Meetings
CNL(89)28	Addendum to paper CNL(89)22
CNL(89)29	List of Participants
CNL(89)30	Draft Report of the Sixth Annual Meeting of the Council of NASCO
CNL(89)31	Draft Press Release
CNL(89)32	Draft Decision of the Council on Working Capital
CNL(89)33	Contributions by the Parties
CNL(89)34	Agenda
CNL(89)35	Decision of the Council to request scientific advice from ICES
CNL(89)36	Report of the Sixth Annual meeting of the Council of NASCO
CNL(89)37	1990 Budget and 1991 Forecast Budget
CNL(89)38	Draft Decision of the Council to request scientific advice from ICES
CNL(89)39	Press Release
CNL(89)40	Decision of the Council on Working Capital
CNL(89)41	Publicity for Incentive Scheme (Revised)

<u>NOTE</u>: This list contains all papers submitted to the Council prior to and at the meeting. Some but not all of these papers are included in this report as annexes.